Ph.D. Dissertation of International Studies

Nexus between Inter-state Communication Networks and International Conflicts:

The Impact of Weaponization of ICTs and Asymmetric Information Networks on International Security Competitions in the Telegraph Era, 1849-1914

국가 간 통신 네트워크와 국제분쟁의 상관성 연구:

전신의 시대(1849-1914), 국제안보경쟁에 미치는
정보통신기술과 비대칭 정보 네트워크 무기화의 영향 분석

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Abstract

Nexus between Inter-state Communication Networks and International Conflicts:

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This dissertation is designed to explore the impact of asymmetric information and communication networks on international conflicts in the telegraph era. The dissertation proves the following proposition. The international diffusion of telegraph technology creates asymmetric information and communication networks by distinguishing the hub and spoke states based on network externalities. Most of states share the identity of potential adversary to each other in the telegraph era, 1849-1914. The relationship between hub states and spoke states is defined as an asymmetric interdependence in the information flow and inter-state communication. In the asymmetric relation, hub states can leverage the asymmetric network to maximize the panopticon effect and chokepoint effect in inter-state militarized conflicts. Hub states' strategical weaponization of telegraph technology and the technology-driven

network creates asymmetric uncertainty to information flow against spoke states This leads to the shift of offense-defense balance and hub states with increased military effectiveness easily decides to declare war against spoke states and advantageously lead the war. Therefore, hub states with offensive advantage are more likely to initiate and win wars against spoke states.

The initial impact of ICT on international relations is that the dynamics of international security competition change due to an increase in inter-state communication and information flow. This dissertation aims to be the first to explore the impact of asymmetrical interdependent networks on sovereignty and international security competitions after the international ICT diffusion in the telegraph era, 1849-1914. The dissertation focuses on telegraph technology with the network externalities and the technology has shown to overcome the following challenges: speed, volume and spatial range of information flow and inter-state communication. Also, the dissertation examines the hub and spoke relations in the asymmetric interdependent network created by the diffusion of the telegraph technology and explores the international security competitions and conflicts dynamics among hub and spoke states. The second purpose of this dissertation is to provide a theoretical contribution by overcoming the limitations of existing literature, technology-driven power transition theory, interdependence theory, and international conflicts theories of bargaining and spiral models of war. This can be empirically tested with the telegraph technology and network data.

To answer the research question, this dissertation leverages a mixed-methods design, incorporating both a matching method and a process tracing case study. Also, the dissertation constructs a novel dataset collected from 19th century documents and telegraph network data, providing a comprehensive understanding of the hub and spoke relations during the era. The case analysis focuses on international strategic and security competitions in the telegraph era to delve into the telegraph networks, how these networks yield asymmetric information networks among states, and how hub states leveraged these networks for military purpose. Particularly, hub states were selected based on literature review and network in addition to the novel dataset that was constructed for analyzing the ICT network.

The results of the dissertation indicate that telegraph technology showed an increase in information flows and complexities among potential adversaries, leading to an increase in inter-state armed conflicts. Additionally, the network externality of the ICT industry encouraged states to monopolize or weaponize telegraph technology, which was perceived as a threat to other states. The dissertation distinguishes hub and spoke states based on their ability to control information flows, with hub states able to control information flows and exploit critical information on potential adversaries, which eventually led to an increase in military effectiveness. This weaponization of network interdependences equipped states with two effects: the ‘panopticon effect’ on information flows and the ‘chokepoint effect’ on

information and communication networks. The results show that hub states were more likely to initiate and win wars by weaponizing ICTs and exploiting the panopticon and chokepoint effects. The case study demonstrates that out of 127 wars, hub states won 102 cases during the target periods, demonstrating the enhancement of their military effectiveness and intention to initiate wars against spoke states through the weaponization of the asymmetrical interdependent network. Therefore, the dissertation demonstrates how the asymmetrical interdependence relationship that emerged in the information network of the telegraph era changed the offense-defense balance dynamics and affected the initiation and outcome of international conflicts, proving its causality.

Keyword : Technology and International Relations, Information and Communication Technology, Asymmetric Network, Weaponized Interdependence, Military Application of Asymmetric Network, International Security, Network Industry, Network Externality, Telegraph Technology, Sovereignty

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Table of Contents

List of Tables

List of Figures

Chapter I. Introduction

1. The Purpose of the Dissertation

This dissertation is designed to explore the impact of asymmetric information and communication networks on international conflicts in the telegraph era. Information and communication technologies, hereafter ICTs, have played an important role in international security competition by creating asymmetric interdependent networks among states. From the era of telegraphs to the digital revolution, the history of ICTs in inter-state relations is marked by attempts of states to manage conflicts by improving communication methods to interact with one another (Finn & Yang, 2009; Headrick, 1991; Hunt, 2021; Müller, 2016; Nickles, 2003; Wenzlhuemer, 2013; Winkler, 2008). The initial impact of ICT on international politics is that the dynamics of international security competition change due to an increase in inter-state communication and information flow. This dissertation is designed to have its first objective to explore the impact of asymmetrical interdependent networks on international security competitions after the international ICT diffusion.

The second purpose of this dissertation is theoretical contribution to overcome the limitations of existing literature. Scholars of international security have tried to explain the causes and effects of international conflicts by exploring the relations among information, communication, and international conflicts. There exist two schools with conflicting perspectives

on the relationship between information and communication, and inter-state conflicts in the international security scholarship: optimistic view and pessimistic view.[1] This dissertation finds the missing component of identity and technology contexts as the answer behind two conflicting arguments.

By considering the identity context, credibility of information and communication flows varies depending on whether a state finds another state's identity as an adversary or ally. As for the technology context, ICTs increase the volume of information and communication among states and the diffusion of ICTs create asymmetric information and communication network. Thus, how ICTs and ICT-driven networks are strategically adopted by states also affects the propensity of going into a conflict by changing an offense-defense balance. Yet there lacks a discussion on the contexts of identity and technology in the existing literature. Considering these contexts, I believe the pessimistic view is more reliable for the representative cases in this dissertation of the imperial and telegraph eras when most states recognized each other as potential adversaries and utilized telegraph networks to

[1] On the one hand, scholars holding the optimistic view argue that increases in inter-state communication mitigate inter-state conflicts (Fearon 1994; Sartori, 2002; Trager, 2010; Levntoglu and Tarar, 2008; Smith, 2021). On the other hand, scholars with a pessimistic view assert that increases in inter-state communication exacerbate inter-state conflicts (Jervis, 1978; Sechser, Narang, and Talmadge, 2019; Lindsay, 2020). This means there exist two competing causal mechanisms and predictions in the existing literature. Scholars provide various concepts and theories to analyze international conflicts, such as bargaining, spiral model of war, deterrence, the impact of technological changes or innovation on wars. Such researches of information flow, inter-state communication, and international conflicts were actively discussed. This dissertation does not only delve into the technological change that affects the bargaining and the war itself but also into the ICT, which enforces the creation of asymmetric information and communication network through network externalities. It deals with the international security competition and asymmetric information and communication network that emerges when such ICT develops and spreads.

communicate and exchange information.[2]

Departing from the discussion from international security theories, technology and international relations (hereafter: IR) literature takes a broader approach. IR studies on a nexus between technology and international security have been accumulated with two different views: the realism and the liberalism. The realist approach offers an explanation based on power transition theory while the liberal approach on interdependence theory. They both emphasize competition and interdependences caused by technologies. However, the existing studies only limited interdependences caused by technologies merely to the context of economics and overlooked the characteristics of technology. Moreover, they callously disregarded the military aspect of interdependences which can increase conflicts between states. Although it is a time when asymmetric interdependence emphasized by existing literature appeared strongly, the period has not been properly explored in terms of interdependence theory.

To overcome these limitations of existing studies, this dissertation pays detailed attention to the asymmetric information and communication networks created by the diffusion of ICTs during the telegraph era and its

[2] The telegraph era refers to a period of time in the late 19th and early 20th centuries when the telegraph became widely used as a means of long-distance communication. The telegraph allowed people to send messages using Morse code over long distances using wire cables, revolutionizing the way information was transmitted and received. This had a profound impact on international relations, including facilitating bargaining and more efficient military communication, as well as diffusion of the telegraph created asymmetric interdependence on information flow among states. Thus, it created hub and spoke relations among states.

impact on international conflicts. In particular, I argue that the diffusion of ICTs generated the asymmetric information and communication networks by establishing a hierarchical network status of hub states and spoke states. A hub state, theoretically, is determined by the degree of centrality in networks, and empirically, by whether a state has established proper ICT infrastructures, full access to information flow, and institutions for properly usage of ICT and ICT-driven networks.[3] This state leverages the asymmetric network to enhance their military power. Thus, the dissertation hypothesize that hub states are more likely to initiate militarized disputes and more likely to win a war against spoke states.

To fill in the gap of the prior literature, this dissertation explores the IR literature on ICTs and asymmetric interdependence networks to investigate the missing link between the two. Then, this dissertation discusses the characteristics of ICTs to explain the process of forming an asymmetric network and its impact on international conflicts during the Victorian period.[4]

[3] The concept of "hub and spoke" states in the context of asymmetric information and communication networks during the telegraph era refers to the idea that some states played central or "hub" roles in the global information network, while others were more peripheral or "spoke" states. In this sense, states that were well-connected by telegraph infrastructure and had strong telegraph capabilities were considered 'hubs' and had greater access to and control over information flows. They were able to receive, process, and transmit information more quickly and efficiently than 'spoke' countries, which had weaker telegraph networks and capabilities. The distinction between hub and spoke countries was significant because it could influence their bargaining power and security competition in the international arena. For example, hub states were better positioned to gather intelligence, coordinate actions, and shape global events, whereas spoke states were more reliant on information from the hubs and may have had limited ability to affect the international security landscape. In short, the concept of hub and spoke states highlights the impact of asymmetric information and communication networks on the distribution of power and influence in the international system. During the telegraph era, the ability to access and control information was a key factor in shaping the balance of power between nations.

[4] This dissertation focuses on the Victorian era. This means the eras of Imperialism and Telegraph era from the 19th century to the early 20th century is the main focus of this study.

The IR scholarship has already accumulated discussions about the influence of asymmetric networks on international relations. However, the existing discussion on interdependences has focused on economic interdependences such as trade disputes, economic coercions, and statecrafts after the mid-20th. Nonetheless, although 19th century is the era remarked by asymmetric interdependences developed from the diffusion of telegraph technology and its military applications, the discussion on asymmetric interdependences has rarely developed in the military and security sectors. To connect this missing link, the dissertation delves into the relationship between the ICT network and its military applications in the era of telegraphs. In particular, this dissertation analyzes the process of states weaponizing their asymmetric independence in the ICT network for military purposes.[5] The military applications of asymmetric interdependent networks fall into two categories: the application of the 'panopticon effect' on information flows and the 'chokepoint effect' on information and communication networks.[6]

[5] Numerous experts have acknowledged that asymmetries in interdependence can serve as a means of coercion. Primarily, Albert O. Hirschman was the first to propose that the inherent asymmetry in commercial interactions could lead to power subordination (Hirschman, 1945). The foundation for liberal international political theory was built by Robert O. Keohane and Joseph Nye, who integrated Hershman's theory of interdependent resources of power with Cooper's international economics of interdependence to create complex interdependence theory (Keohane & Nye, 1989). Numerous following research has been influenced by the political account of interdependence offered by Hershman, Keohane, and Nye. Barbieri (1996), Gartzke, Li, and Boehmer (2001), Lee (2014), and Park (2018) are only a few illustrative examples. This study focuses on telegraph technology and interdependencies in information and communication networks, which contain network externalities as well as their military applications during the age of the first information revolution which is just before digitalization. Put another way, this study highlights the structural explanation of the Hershman-Keohane-Nye interdependence theory and contributes to the existing literature by suggesting the possibility of weaponization as structural power and its actual military usage. It underlines the necessity of differentiating weaponization. Therefore, I have investigated on how actors make practical use of the network for military purposes in the structurally constructed asymmetric network.

[6] Existing weaponized interdependence theory mostly focuses on economic sanction and structural power in the digital era. This research focuses on its practice for international conflicts in the telegraph era. Potential adversaries exist during the telegraph era when the first information network was formed. Military weaponization of telegraph technology includes the monopolization of information flow and preventing military communication and forming alliances by access denial to the information network.

Unlike spoke states, hub states with ICT infrastructures and institution can well manage the information flows and monopolize important information, which is called the panopticon effect. Through the panopticon effect, hub states decrease the uncertainty on wars and increase the uncertainty of spoke states with the identity of potential enemy. In other words, when spoke states start a war with hub states, this leaks an information and thus, decreases its defense readiness. Then, hub states can decide when to inflict provocation and attack. This allows hub states to take an advantageous position to attack. [7] Therefore, the military application of panopticon directly affects the balance between attack and defend, afterwards called as the offense-defense balance. The panopticon effect means hub states have advantages in attacks over spoke states.

As for the chokepoint effect, this effect can be divided into two types: the ‘hard choke point effect’ and the ‘soft chokepoint effect’. A hard choke

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Also, it contains the control of information flow. Monopolization of information flow and access denial to the information flow.

[7] In the existing offense-defense balance theory, the distribution of power, the characteristics of the weapon system, and the intention of the state are discussed as main variables for the outbreak of a war. In particular, Jack Levy and Van Ever emphasized cutting-edge science and technology as a variable, and among them, Jack Levy saw that the balance of attack and defense is determined based on the ‘possibility of acquiring territory’, ‘characteristics of weapons’, and ‘advantage of preemptive strikes’. In other words, the hub state of the telegraph network exploits the enemy's vulnerabilities, secures incentives for pre-emptive strikes, and increases military effectiveness. In this dissertation, I emphasize that the state that dominates the information network maximizes the advantage of a preemptive strike and creates an attack advantage, and asserts that it monopolizes the opponent's important information even in war, removing uncertainty while increasing the enemy's uncertainty at the same time. That is, they have access to the information flow, allowing them to exploit and manipulate critical information about potential adversaries. This strategic superiority can detect the enemy's maneuver, strike position, and defensive posture in advance, which affects defense preparedness and increases military effectiveness. And this discussion can be extended and applied to the telegraph era where information flows telegraph dominantly and potential enemies exist. See Chapter 2 and 5 of this dissertation. It is to create the setting in which an offensive strategy is advantageous based on abundant information about the enemy (Segal, 2016).

point effect is generated by infrastructures while a soft one is generated by information flow and its networks within infrastructures. In detail, a hard chokepoint effect is adopted to physically block information flows by cutting the cable of information infrastructures. A soft chokepoint effect is used to prevent spoke states from absorbing external information sources from their information networks to balance their imbalanced positions. Hub states utilize chokepoint effects to isolate spoke states and strengthen the existing power imbalance from the asymmetric network structure.

Thus, hub states are more likely to start and win a war because hub states can take military advantages by strategically utilizing the panopticon and chokepoint effects in the asymmetric interdependent network during the telegraph era when most of the inter-state relations were defined as potential enemies. Therefore, the dissertation aims to make a theoretical contribution by filling a gap in the literature by exploring the missing links and verifying the arguments with the mixed-methods design.

2. Literature Review and Motivating Puzzles

2.1 Existing Literature of information, communication, and International Conflicts

Scholarships in international conflict pointed out various factors to explain the causes of international conflicts. Among those factors, scholars emphasize information and communication as a central role in analytical models of

conflicts (Fearon, 1994;1995; Jervis, 1976; Kurizaki, 2007; Leventoğlu, 2022; Levenloglu & Tarar, 2008; Lindsay, 2020; Powell, 2006; Sartori, 2002; Schelling, 1966; Trager, 2010; Quek, 2021).[8] In particular, Fearon (1994;1995) and Jervis (1976) emphasized information and communication as the main driver to analyze inter-state conflicts. They hold different perspectives on information and communication and how they affect conflicts and its consequences.

Information and communication are related to the bargaining process in terms of timing and sequencing (Fearon, 1994; 1995; Leventoglu & Tarar, 2008; Quek, 2021). International relations theory conceptualizes a war as an outcome of a bargaining process between states (Schelling, 1960; Fearon, 1995). Wars recur because of frictions in the process of bargaining by information asymmetries or time consistency problems which prevent governments from finding a peaceful resolution. Therefore, diagnosing causes of a war necessitates identifying bargaining frictions that prevented belligerents from peaceful settlement of disputes (Lake, 2010). Systematic variations in the intensity of these bargaining frictions can explain the variations in states' propensity to initiate war (Lemke & Werner, 1996;

[8] In light of this, it is surprising that systematic empirical studies of the effects of communications media on international political outcomes at the global level are relatively few, despite a vast literature on the impacts of technological innovation on war (Lindsay, 2020; Rosen, 1991; Posen, 1984; Horowitz, 2010; Grissom, 2006). For recent exceptions, see Adler-Nissen and Drieschova, (2019) and Lindsay (2020). In addition, findings also speak to the role technology plays in particular times and places in the changing patterns of political control and identity (e.g. Anderson, 1983; Gellner, 1983; Hobsbawm, 1990). Headrick (1991), Headrick and Griset (2001), Wenzlhuemer (2013), Müller (2016), and others address many of these issues in the context of telegraphs.

Schultz, 1999; Reed, 2003; Reed et al., 2008).

Fearon (1994) stressed that the timing of information reveals about opponent's capabilities and costs of war during the bargaining process and influences the onset and escalation of military crises. Speedy bargaining enables actors to be patient. Thus, a timely bargaining process prevents actors from choosing a cost-inefficient war (Leventolu & Tarar, 2008). In terms of the rationalist's view, the cost of war is more expensive than negotiated settlements. This is why rational actors choose to initiate a war which is more expensive than a negotiation because actors lack trust on each other due to the uncertainty on the opponent's intent and its military capabilities (Fearon 1995). When these information and commitment problems get squared away, the rational actors would not have chosen an expensive war.

Building on the aforementioned discussion, optimistic bargaining scholars argued that unfragmented information sharing will prevent a war and credible information sharing serves a pivotal role in making a successful bargaining (Fearon, 1995; Powell, 2006). To this end, consistent information sharing and trust building among actors are indispensable for a successful bargaining. Nye (1992) regarded a hot line as a place for actors to learn from each other. Although it could not prevent the war from happening, Nye further emphasized that the hot line was critical for the reconciliation in arms control

negotiations during the Cold War (Nye, 1992).[9] Hence, Leventoglu and Tarar (2008) argue speedier bargaining would reduce a war though its prediction power is imperfect (Leventoglu & Tarar, 2008). Rapid increase of information flows between actors provides an opportunity to embark on a journey to alleviate military conflicts.

The liberal perspective on the increase of information and communication between states facilitates commerce and investments and thereby alleviates conflicts. By strengthening states' mutual interests, information and communication converge to mutual expectations for cooperation (Copeland, 2014). Modern communication systems will promote international trade and investments and thus, increase economic interdependence. The spread of ICTs alleviates uncertainties in information about the cost and ability of states in participating in conflicts (Ejrnass & Persson 2010; Lew & Cater 2006). In sum, the liberal perspective on the processes of ICTs and conflicts suggests that the connection of communication not only strengthens economic interdependence but also serves as a learning ground to update the information about one's adversary. Therefore, the optimistic view argues that ICTs will mitigate the escalation of conflicts.

[9] For similar approaches, see Morgan, P. M. (1989). "On Strategic Arms Control and International Security." *Security and Arms Control, 2*, p.301. Lawrence Freedman (1991) "Arms Control: Thirty Years on" *Daedalus*. pp. 69-82. Joseph Nye (1991) "Arms Control and International Politics" *Daedalus*. pp. 145-165.

On the other side of the coin, the pessimistic view suggests that credibility can never be fully verified. At the end of the day, increases in information will increase misinterpretation of each other's intention, which will lead to a security dilemma. Merely providing simple information without the context will rather exacerbate conflicts. Through the concept on information complexity, Lindsay (2020) emphasized the negative effect where conflicts can be escalated as more information is provided to actors.

Increased information volumes may make communication more complex. By challenging states' ability to separate reliable signals from noises in information-rich environments, ICTs could instead exacerbate informative signaling in bargaining situations (Lindsay, 2020). Information complexity directly links to the discussion of the security dilemma. The security dilemma emphasized by Waltz (1979) and Jervis (1976) structurally influences the behavior of states. A structure that exacerbates the information complexity increases the information asymmetry and eventually causes misperceptions among states. Such structural uncertainty increases conflicts among states.

As such, these two conflicting views provide contradictory predictions about a nexus between information and communication, and conflicts. To better understand which view provides a valid understanding of reality, we need to consider the identity of information and communication, and technologies which influence this relationship. Whether information and communication pass to a foe or friend determines the credibility of bargaining

processes, and ICTs are the factor which examines the explanatory power of two conflicting perspectives. Telegraph case enable empirical analysis, because telegraph technology innovated rapid and vast distance communication and drastic increase information flow and communication between states. Therefore, this dissertation delves into the international security competition and asymmetric information communication network arising from the spread and development of ICT in the telegraph era when potential enemy identity was vastly shared among states.

2.2 Existing Literature of Technology and International Relations

Realist Approach: Technology and Power Transition Theory

There are two broad categories of explanations on a nexus between technology and international relations. One is the realist approach where a technology is considered as a main factor for power transition or as a source of economic and military power to strive for national prosperity and survival in an international anarchy (Drezner, 2019; Eriksson & Giacomello 2007; Eriksson & Newlove-Eriksson, 2021; Fritsch, 2011; 2014; Gilpin, 1981; 2001; Herrera, 2006; Krishna-Hensel, 2010; Lewis, 2022; McCarthy, 2015; Mearsheimer, 2001; Organski, 1958).

In particular, Drezner (2001) emphasized that historically, great powers have acquired hegemony because they monopolized the leading sector

innovation (Drezner, 2001). In addition, Taylor (2016) highlighted that external threats arising from international security competition are more severe than domestic political threats (Taylor, 2016). Therefore, international security rivals who want to survive and become great powers seek to achieve their military and diplomatic goals in the international political environment through technology investments. Thus, states try to dominate others relatively as well as absolutely in terms of technological power in international relationships (Gilpin, 1981; 2001; Kennedy, 1987; Mearsheimer, 2001).

In other words, countries try to maintain absolute and relatively superior technology compared to that of their competitors. The international security competition resulting from external pressures from the international structure makes states engage in a competition policy to enhance their technological prowess (Kennedy, 1989; Taylor, 2016; Tilly, 1990; Waltz, 1979). Put differently, security pressures of anarchy force states to take actions. Scholars who viewed technology as a tool for military development and economic growth sought to understand the behavior of states in the context of security derived from the international structure. They mainly focused on the political consequences of new technologies. In particular, they discovered a new international political dynamic with the spread of technology, emphasizing the military aspect.

In terms of increasing military power, scholars have focused on the consequences of new military technologies in international relations,

especially their impact on changes in perceptions of offensive or defensive advantage (Jervis, 1978; Levy, 1984; Christensen & Snyder, 1990; Tang, 2009; Acharya & Ramsay, 2013). Strategic military concerns are the result of choices to survive and compete in an international state of anarchy, allowing dual-use considerations for technological advancements. In other words, the technology policy to develop national military power is one of the main national security strategies. Also, from the economic point of view, historian Paul Kennedy outlines the process of rise and fall among great powers as "differential growth rates and technological change lead to shifts in the global economic balances, which in turn gradually impinge upon the political and military power balances" (Kennedy, 1990. p. xxii). Historical analyses, spanning from the 10th to 21st century in some cases, have established a connection between major technological innovations and the first outcome in Kennedy's causal chain: shifts in economic leadership (Akaev & Pantin, 2014; Modelski & Thompson, 1996; Thompson, 1990).

Thus, states select and develop technology as a means to enhance national economic productivity and military power. To elaborate, different actions of states result in heterogeneous technological advancement, and this brings differences in military and economic power. The differential rate of economic growth and, implicitly adoption of new technologies brings global changes and inter-state conflicts. Also, the differential rate of military power accelerates international security competition. Existing studies established

that a nation's success in adapting to revolutionary technologies is determined by the match between its institutions and demands on these technologies to survive and maintain its power in the international security competition (Gilpin, 1981; 2001; Modelski & Thompson, 1996; Thompson, 1990).[10]

As for discussions on a power transition theory, scholars stress that the interaction between technology and hegemony have developed their logic of technology driven power transition theory mainly focusing on the leading sector and general-purpose technologies. The scholarship explained the transition of hegemony from the perspective of 'co-evolution' of the world economy in the leading sector and world hegemony, unlike Wallerstein's view that changes in the world economy determine world politics (Modelski, 2001; Modelski & Thompson, 1988, 1996). In their world systems theory, a hegemon is a country with strong naval power, innovative capability in commerce and industry, social openness, and responsibility for the world order. In other words, dominance in the core field of the leading sector becomes the main condition for hegemony, and big powers compete for it.[11]

[10] Gilpin (1981), for example, argues that the international economic system is characterized by uneven technological change and therefore uneven distribution of economic growth. The economics of growth literature in economics has long argued that technology is a major, if not the major, component of economic growth – of increased productivity (Herrera, 2003). This argument dates back to Solow's article which relaxed some of the assumptions of the Harrod-Domar model for long-run economic growth and added what he called 'neutral technological change'. Solow, 1956. "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, 70 (1), pp. 65-94.

[11] The theory of the leadership long cycle in international politics describes the replacement of hegemons with a concentration on technical innovation and says that science and technology are fundamental components of the world political and economic order. They stated that a country at the forefront of technological innovation in the main industry has emerged as a global political superpower. However, it did not examine which nation leads technological innovation in the leading industry and why, nor did it examine the precise mechanisms that contribute to the global political predominance.

In the case of Wallerstein (1974; 1979a; 1979b), in relation to the Kondratiev cycle and world hegemony, the long-term fluctuations of A1 (growth) B1 (decline) A2 (growth) B2 (decline) are as follows: 1) rises and challenges of candidates for hegemony; 2) growth and declines of the incumbent hegemon; and 3) growths and declines of the incumbent hegemon. It has been argued that the response corresponds to 1) the competition between countries, 2) the development of new hegemony, 3) the maturation of hegemony, 4) the fall in hegemony and the rise of challenger countries (Hopkins & Wallerstein, 1982, pp.104-120; Wallerstein, 1984. p.16). In addition, Chase-Dunn and Rubinson argued there are no obvious causal relationship between the capital accumulation rate, long-term fluctuations assessed by economic activity, and competition (hegemonic cycle) between countries. In addition to the long-term wave, they suggested three hegemonic cycles for the Netherlands, the United Kingdom, and the United States, which Wallerstein (1984)'s work appears to embrace these ideas and further develops the prior discussion (Chase-Dunn & Rubinson, 1979, pp. 276-296).

In addition to these discussions, Ding (2021) and Leung (2019) explored General Purpose Technologies, hereafter GPTs, and their strategic usage. Through this, the implications for international security competition given by GPTs in addition to the leading sector were derived (Ding, 2021; Leung, 2019). This approach merely regards technologies as a field of international competition or highlights them as a tool. Thus, they are narrowly focused on

emerging technologies and their application in the leading sector; what is missing is how different technologies establish heterogeneous network structures and how states strategically utilize the asymmetric interdependent networks with network power. What should be highlighted is how certain characteristics of technologies influence states and how states strategically leveraged these features in international security competitions. This allows to delve into a deeper investigation of the relationship between technologies and international relations.

Liberal Approach: Interdependence Theory and Technology

In contrast to the Realists, the Liberalists focus on trade and interdependence driven by technology. In particular, Keohane and Nye (2012) stressed the importance of technology in international relations as "a fundamental source of economic globalization and an essence to create new international institution, and a condition for increasing interdependence" (Keohane & Nye 2012, pp.209-225). The Liberal school also described technology as a driving force for the emergence of new actors, interaction patterns (integration and cooperation), or system structures such as interdependences (Fritsch, 2011; 2014; Eriksson & Newlove-Eriksson, 2021).

Such networks were described as a part of the complex interdependence theory by Liberal scholars. Among these scholars, Keohane (2009) defined the complex interdependence as "a fragmented polity in which there were

multiple actors rather than just states, multiple issues that were not limited to hierarchies, and forces and threats of them were not valuable tools of policies" (Keohane, 2009, pp. 36-37). Keohane's definition showed a state is vulnerable to external pressures when the state depends on foreign imports from other states without substitutes (Keohane, 2009). However, the Liberal scholars also emphasized structural factors, especially, innate power resources of the actor rather than power obtained through network structures. Moreover, they emphasized how interdependence produced mutual vulnerability rather than unilateral one.

The liberal scholars such as Slaughter (2017) emphasized that globalization creates a decentralized network producing a new opportunity for cooperative diplomacy. According to Slaughter, globalization is not a 'chessboard' but a web connecting the network of dots. The art of diplomacy setting a favorable relationship with multiple actors becomes crucial in a such non-hierarchical network. Therefore, power in the network becomes not a 'power over' but a 'power with' (Slaughter, 2017, pp. 161-164). Similar to these liberal accounts, this dissertation heavily focuses on networks. However, this dissertation differs from the liberal explanation with fewer premises about networks. Aligned with Farrell and Newman (2019), this research emphasizes on the network's structure in the social context and further explores how the network restricts what an actor can and cannot do (Drezner

et al, 2021).[12] The structure of networks can make a significant impact on the dispersion of power. In contrast to the liberal school, this dissertation investigates an interdependence which generates the asymmetric structure yielding the hub and spoke relationship in the asymmetric interdependent network rather than an interdependence increasing cooperation or forging a vertical commerce network. That is, in contrast to Keohane and Nye, the mainstream liberal scholar's analysis, the contemporary global economic network is structured as the 'hub and spoke' relationship and this significantly impacts on the power relationships among states. Of course, there are exceptional cases where scholars analyzed these impacts (Drezner et al, 2021; Farrell & Newman, 2019), but this dissertation notes that this 'hub and spoke' relationship was not only formed in contemporary economic networks but also during the times when asymmetric information and communication interdependences were blooming among states and when telegraphs were expanding. Moreover, the asymmetric network at the time emerged due to the expansion of ICTs but existing research did not consider the nuances in ICT's characteristics, failing to provide a detailed analysis of these dynamics. There exists a necessity to analyze how actors weaponize these complex network structures moving beyond the simple interdependence structure.

[12] Furthermore, network power is also emphasized. Keohane and Nye classified sensitivity with that of vulnerability interdependence, and the latter is more consequential since spoke actors in that predicament find it costly to adjust or extricate themselves and thus are highly susceptible to coercion attempts (Keohane & Nye 1977, pp. 10-19). Thus, hub states' network power is in extreme conditions of vulnerability interdependence (Mastanduno, 2021). This dissertation delves into the process and outcome of asymmetric interdependent network strategically used with the purpose of military objective against the potential enemy, spoke state.

What is noteworthy in this dissertation is the relationship between hub and spoke states. This relationship strengthens through the externalities of networks. Here we again observe ICT variables. In accordance with the heterogeneous characteristics of ICTs, the network also gets strengthened asymmetrically. It is not limited to the mere fact that a specific technology, the telegraph technology, has made international relations like a spider web, but what really matters is that certain features of the technology formed the asymmetric network structures and moreover, how actors utilize these networks. The empirical assessment of analyzing the military application of asymmetric networks by hub states allows to a deeper understanding of the behaviors of states during the first networked telegraph era when states shared potential enemies identity to each other.

2.3 Limitations and Implications from Existing Literature

The existing researches examines technology and the behavior of states with three main objectives: 1) to explore the impact of information and communication on bargaining and conflicts; 2) to explain the rise and fall of great powers through technologies with a view of technology as the stage of security competition; and 3) to examine the effectiveness of technologies as economic interdependence.

The above literature provides theoretical insights into the relationship between technology and the state's behaviors. Following these lines of

thought, this dissertation focuses on the impact of ICT-driven networks on the international security competitions among states during telegraph era. The distinctive features of ICT are believed to be a driver for the asymmetric structure of this network hence, this feature must be emphasized. Furthermore, the intent of the analysis is to analyze the behaviors of states in the asymmetric structure formed by the international ICT diffusion.

However, the prior literature which discussed the influence of technology entails the following limitations. From the Realists and power transition perspectives, technology is perceived as a stage and a tool for security competition between states. That corroborates the state's intervention in the technology industry to compete and why it chooses to develop the necessary technology to maintain its military capability. Furthermore, the liberalists and the interdependence theorist emphasize technology as one of the factors that generate interdependence and put another emphasis on the importance of technology from the economic perspective. This provides a comprehensive understanding of the interdependence structure associated with technology and the emergence of new actors. Moreover, they homogenized the distinctive characteristics of technologies and thus, questions of how heterogeneous technological characteristics influence states and how states strategically utilize these characteristics for military purposes have been ignored. This dissertation expands theories that emphasized the digital age and economic interdependence and applies it to military

application of telegraph technology and its network. Thus, the dissertation analyzes the process of military use of asymmetric information and communication networks by states for the international security competitions during the telegraph era.

Moreover, based on the scholarly debates above, the existing literature share some thoughts of the correlation between ICTs and international relations. In contrast, they have different views on the impact of ICTs on inter-state conflicts: whether the onset and escalation of inter-states conflicts bring pessimistic or optimistic consequences on international relations. Existing discussions on international conflicts related to information and communication do not consider contextual factors, identity and technology. In addition, the discussions on technology and international relations understand the importance of ICTs but overlook the characteristics of ICT and also are blind to the military-purpose adoptions of asymmetric networks. Also, they are not concerned with major historical cases and what it can show how technology nature affects a state's behavior and how to use the technology and the technology-driven networks that this dissertation defines as a military application of asymmetric network. This dissertation proposes an alternative explanation for a military application of asymmetric networks to analyze the process of international security competitions. Therefore, the dissertation proposes the theoretical framework to contribute to the literature by filling the missing links in existing researches.

3 Research Question

The existing academic views on communication and conflicts did not consider contexts of identity and technology. That is why existing literatures hold different perspectives on how inter-state communications impact on international conflicts as with either optimistic or pessimistic views. Realist and liberalist approaches to technology and international relations also did not consider the followings: asymmetric interdependent network associated by the characteristics of technology and the process of its usage; and the asymmetric information and communication interdependent network during the telegraph era and its military usage. Thus, the prior discussion on technology and international relations did not include clear explanations of the specific process between ICT-driven networks and international security. Even the existing scholars who explore asymmetric networks are limited to economic aspects in digital era. This creates missing link between the causal relationships of inter-state communication and international conflicts.

Against this backdrop, in order to overcome these limitations, this dissertation attempts to answer the following research question based on the newly suggested theoretical framework and case analysis.

How does the asymmetric information and communication network established by the diffusion of ICTs in the telegraph era affect the onset and result of inter-state conflicts?

4 Composition of Dissertation

This dissertation consists of six chapters. Chapter I briefly discusses introduction including research purposes, literature review, and research question.

Chapter II begins with a theoretical discussion to build a framework to answer the research question. This chapter consists of four parts. First, this study suggest identity and technology variables as an addition to the existing literature of information, communication, and international conflicts. Unlike the cold and post-cold war eras, every state can be the potential enemy to each other during the telegraph era, in 1849-1914. Based on the discussion, the study argues that the pessimistic view is more reliable to analyze for inter-state communications and international security competitions in the telegraph era. Further, the study points out that the previous literature on technology and international relations neglect the characteristics of ICTs and the process that how technology and actors interact with one another. This dissertation builds a typology of ICT with network externalities as a source of threat that creates the lock-in effect and establishes winner-takes-all market. It shows that states can easily monopolize and leverage ICTs to coerce and attack potential enemies. In addition, this research explores the ICTs and military power. The hub state that dominates the information flows removes uncertainty through ICTs, increases uncertainty for the enemy, and creates constant offensive advantages and defense preparedness. Through this, the

dissertation analyzes the logic that the hub state increases military power because the hub state possesses a full access to information flows and exploits critical information. Lastly, the dissertation critically applies the weaponized interdependence theory to the telegraph network case. This theory was built up to analyze asymmetric networks in the digital era focusing on economic sanctions and system levels. The dissertation expands this theory to military application of ICT-driven network by hub states during the first information and communication revolution era. The dissertation explore the military application of the panopticon effect on information flows and the chokepoint effect to information networks. The dissertation utilizes the framework to analyze actor's behavior in asymmetric information and communication networks for the military purpose during the telegraph era. The dissertation proposes propositions based on these critical reviews.

Chapter III describes the research design. This dissertation leverages a mixed-method design to prove the proposition and hypotheses presented in the previous chapter. The dissertation hypothesized the proposition for the statistical analysis. Then, the dissertation introduced empirical cases to explore how hub states leverage their asymmetric controllability to information flows for the military purposes to win international conflicts against the potential enemy. These cases are analyzed by historical case analysis and process tracing with the theoretical framework suggested by the dissertation.

Chapter IV discusses the statistical analysis. I adopted the matching method, because there are sufficient observations and no information on the functional form between the treatment and outcome variables. I coded independent variables as telegraph connections with the hub states and dependent variables related to inter-state conflicts outcomes using the COW Militarized Interstate Disputes data (Version 5.0 and 4.02).

Chapter V conducts case studies with process analysis. This dissertation selected three hub states: Germany-Prussia, the United States, and the Great Britain. This study investigates how the hub states leverage their asymmetric information interdependences to maximize their military power. Through these representative countries, The study analyzed how hub states leverage telegraph technology and asymmetric information networks for the military purpose. It shows the process of causing and winning a war that is difficult to be observed through statistical analysis. Also, the case study shows that hub states monopolize information flows to restrict the access to critical information about adversaries in the telegraph era. Moreover, hub states leverage their power to access denial to information flows and prevent the formation of new networks. These increase hub states' military effectiveness. Therefore, this chapter answers the questions of why and how hub states were able to initiate and win more wars.

Chapter VI is conclusion. I recapped and summarized the empirical findings and theoretical arguments. Then I provide academic and practical

implications derived from the dissertation. Lastly, this dissertation give suggestions for future researches.

Chapter II. Theoretical Discussion and Framework

1. Identity and International Conflicts: the Pessimistic View on ICTs and International Conflicts

Among the existing research on international conflict, two views are mainly classified which put its emphasis on information flow and inter-state communication. As reviewed in the existing research, one view, the pessimistic, claims that the increase of information and communication exacerbates the conflict and the other, the optimistic view alleviates.[13] That is, they extrapolate different results on the same phenomenon, and this is because the context of identity and technology was not taken into consideration.

When considering the identity context, it is more important to exchange information and communicate with an actor that has a certain identity rather than simple information asymmetry, amount of information, and credibility. Over the course of bargaining, the fact that the large asymmetry of adversary and information coupled with large quantity of information is likely to misinterpret each other's intentions due to the information complexity that contains bountiful information with low credibility. Meanwhile, over the

[13] Fearon (1994; 1995); Jervis (1976); Schelling (1960; 1966) are foundational works on signaling in international relations. literatures have arisen that examines how, if war breaks out due to asymmetric information, this asymmetric information can be resolved after war-outbreak by events on the battlefield and bargaining behavior during war (Filson & Werner, 2002; Powell, 2004; Slantchev, 2003; Smith & Stam, 2004; Wagner, 2000; Wittman, 1979). These works usually do use bargaining models, in contrast to the works that examine how states can credibly overcome informational asymmetries prior to conflict breaking out.

course of bargaining process with an ‘ally’ a meaningful bargaining is more likely since the basic credibility is high compared to that of the adversary.

Furthermore, the context of technology should be evenly considered as important. The technological characteristic of ICT is that it revolutionized the volume, distance and speed of content transmission. It is a technology that allows vast amount of rapid information sharing to a receiver who is situated far distance away. Technology as such affects the information flow between states.

Also, on grounds that the bargaining results are influenced by specific timing of information disclosure—at the actor’s expense and capability—strategic utilization of ICT which directly influences such disclosure should be considered (Quek, 2021; Min, 2020). Complexity of information increases, and credibility is gradually lost when the actor distorts the information by strategically using the ICT, therefore the cause of the conflict, information and commitment problems cannot be resolved, eventually exacerbating the conflict.

International conflicts scholars emphasize that the transmission and reception of information, over the course of sending signals, plays the role of expanding ultimate conflicts and emergence of crisis. The state’s decision on when to send the signals and whether or not multiple signals sent by the sender was relayed in accordance with the original intent is influenced by how

quick and secure the information gets delivered. Furthermore, they allow credible information sharing in the midst of uncertain information negotiation crisis and claim that the information asymmetry, which may lead a state to war can be evened out. Therefore, if signals sent to each other contain high credibility, rather than opting expensive war, having a good bargaining and finishing the task would rather be opted. The timing and promptness of information sharing is the main cause of concluding the bargaining soundly where war can be avoided. That is, how actors utilize the ICT which influences the information disclosure timing directly affects the conflict. The effect of utilizing such ICT maximizes when used against the potential enemy state.

That means that communicating and sharing information flow with potential adversary increases both information complexity and increase of incredible information. Basically, communication with an adversary is incredible, and the distortion of information through ICT coupled with rapid information expansion rather expands false information resulting to increase in information complexity.

Existing research did not consider the variables of identity and technology hence, it is not clear which discussion is reliable and therefore, the expectation is not on the same page. Conflict exacerbates or weakens based on the identity of the actor who in a bargain and security competition and how the ICT is strategically used. Therefore, identity and technology

contexts should be added to explore international security competition in the Telegraph era.

Based on the consideration of such the contexts, ICT and the flow of information with the potential adversary increases. Potential adversary in the geopolitical context is shown in the telegraph era, which can also be called the Victorian or Imperial eras from 1849 to 1914. Communication and information sharing with potential adversary is incredible and increases complexity in the telegraph era. Therefore, misperception against each other increases and the commitment and information problem cannot be resolved over the course of states' bargaining process. The strategic utilization of ICT will exacerbate the conflict. The information complexity will further increase while decreasing the credibility. In this situation, inter-state bargaining is more likely to fail. That is why the conflict between states increase when ICT and potential adversary variables are added. The telegraph era is when these start to deepen, as noted by this dissertation.

Therefore, the development and expansion of ICT coupled with the technological variable of strategic utilization of ICT and the identity variable where information is communicated to the potential adversary allow us to recognize that pessimistic view is reliable. Based on this view, during the telegraph era, states relationship is identified as potential adversary and the increase of communication with the enemy relays to the increase of incredible information. Accordingly, the complexity of information increases and so

does the misperception against the opponent where the likelihood of security dilemma increases. Also, the strategic utilization of ICT against potential adversary influences the offense-defense balance in military conflict. Thus, it is a mechanism that deepens the inter-state conflicts.

2. Network Externalities, the Characteristics of ICT, and International Security

The network industry connects production and consumption through tangible and intangible (physical-virtual) network infrastructure [14] For example, railroad industry is a network industry. Railroad's nodes (its tracks, rolling stock, switches, depots) are scattered across a geographic area, and the configuration of the nodes determines where, when, to whom, how much, and how quickly goods can be transported.[15] Network industries can be defined as those where the firm or its product consists of many interconnected nodes, where a node is a unit of the firm or its product, and where the connections among the nodes define the character of commerce in the industry.[16]

Most of the network industries are national key industries, and at the same time, they have been traditionally managed by the public and state due to the economics of scale on the supply side and network externalities on the demand side (Finger, 2019). In particular, exhibit network externality means

[14] Classic examples of network industries are energy industry, railroad and transport industry, postal industry, and information and communication technology industry. Various approaches have explored ICT industries as part of network industries, see Economides 1996; 2005; McGee & Sammut-Bonnici 2002; Gottinger 2003; Shy 2011.
[15] Gottinger 2003, p 2.
[16] Gottinger 2003, pp. 1-2.

that there is a positive correlation between compatibility, complementarity , standards which are related to the size of the network and users' utility. The expansion of ICT-based networks promotes the interconnection of a larger number of nodes, hence increasing the value of the networks to individual users. Successful products and services in a market where exhibit network externalities will gain an installed-base will allow them to stand in a consistently advantageous position in future competition. On this basis, a winner will be able to gain strong market dominance (McGee & Sammut-Bonnici, 2002). According to the principle of increasing return, once a particular product achieves a market share that exceeds a threshold/critical mass in the entire network[17], subsequent market performance becomes winner-take-all as a result of positive feedback (Arthur, 1989; 1990). In other words, the stronger the network externality, the easier it can lead to overwhelming market dominance in a winner-take-all market (Shapiro & Varian, 1999). This presents the possibility of substantial first-mover advantages: being the first seller in a market may confer an important strategic advantage over later entrants because a first mover's technology may become locked in as a standard (Arthur, 1989; Katz & Shapiro, 1986). This phenomenon allows the host state to block domestic monopoly issues and interventions from foreign companies and states in the industry through

[17] The critical mass is defined as actor's compatibility, standards, complements and network size increase.

control over the industry.

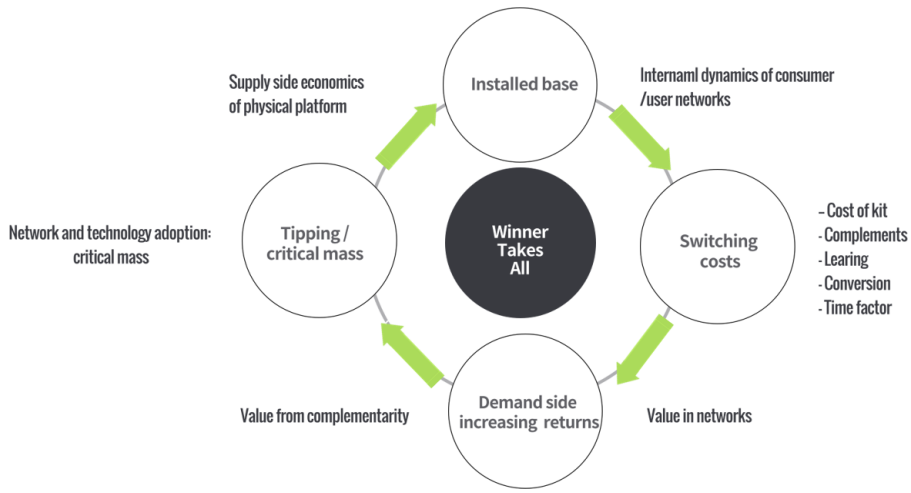

Figure 1: Winner-takes-all market (Based on McGee and Sammut-Bonnici 2002, illustrated by the author)

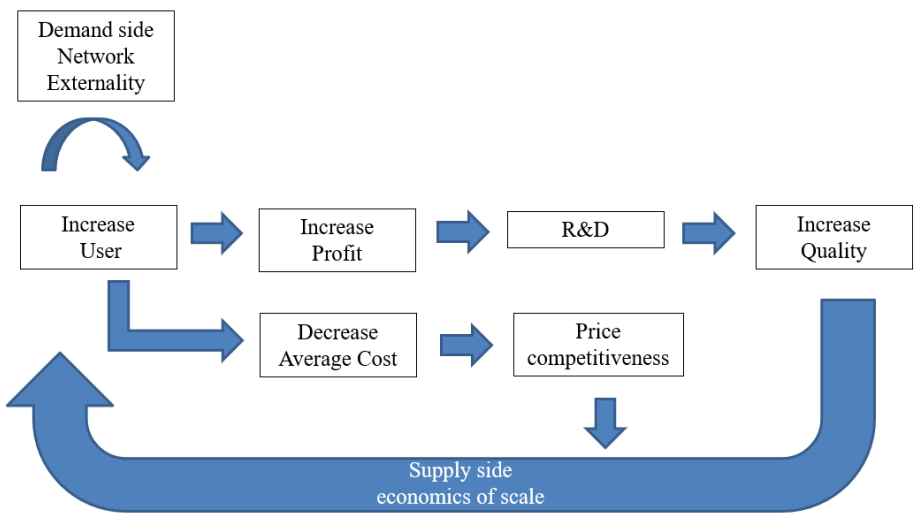

Figure 2: Positive Feedback in Network Industries, illustrated by the author

When the network is established, individual actors will experience lock-in effect. Furthermore, under the appropriate model of network development,

such topology gets strengthened by itself. As the pattern starts to get situated, new nodes have overwhelmingly higher possibility to strengthen the existing inequal distribution pattern rather than damaging them. In layman's term, globalization has created a series of new structural force. Substantial economic activities of economic actors produce self-strengthening network topology where a part of economic medium (or the node) situates itself in a considerably high central position and most of other nodes rely on this. When such status is fortified, it is realistically difficult to substitute or change the situation.

In order to analyze the network industry and international relations, power that derives from the network structure should be understood. The clear standard that separates hub from spoke states is the ICT infrastructure and system but theoretically, the separation transpires in accordance with the location of the network.[18] Generally speaking, the network analysis, while elaborating on the evolution of the whole system in addition to the interdependence and structural influence, examines the international system in a holistic and kinetical method. The concept of 'centrality' is the center of gravity when conducting a research of network analysis. The centrality explains the broader structural effect while providing a meaning of how influential or powerful a certain actor is within the international system.

[18] Winecoff (2020) claims that "A complex network contains a meaningful topology- i.e., a distribution of linkages in the network, such that some units are more connected than others- that endogenously impacts the performance of the network over time (Winecoff, 2020, p. 214)".

Especially, there are multiple methodologies to conceptualize the centrality within the network.

When an actor is directly related to numerous and different actors of the network, the actor may have the ‘degree of centrality’. Furthermore, it could be central since it controls the connector or due to a specific and strategic brokerage. The brokerage actor may have the ‘betweenness centrality’. The important point is that the subtle yardstick called ‘eigenvector centrality’ not only elaborates on the number of ties the actor has but also how well the actor is tied to other soundly actors (Maoz 2011; Winceoff, 2020). According to Maoz (2010), an individual's position within a network is determined by both the quantity of connections they have and the centrality of the individuals they are connected to. Furthermore, evaluating the flow of information and examining the proximity between a ‘closeness centrality’ actor and other actors in the network is beneficial.

Centralities which are accessible to the flow of information is important in the asymmetric network created by the expansion of ICT. The degree of centrality can be understood through the telegraph infrastructure and telegram usage and hubs that have high centrality as such can be determined with the hub of information and communication during the telegraph era. Furthermore, hub states dominate the hubs with high centrality and its systems are ready for utilization. The Great Britain and the U.S cooperated and expanded the network with the private actor and German’s institutionalized military

communication system was ready to directly use them militarily. This will be further elaborated in Chapter V centered on the hub states. Also, network externalities, which is one of the ICT's characteristics, further solidifies the structure and enables to monopolize the information. That is why hub states take superiority on security competition and military strategy while leveraging such asymmetric network.

2.1 ICTs and Network Externalities: Direct, Indirect, and Algorithmic Network Effects

Systemic analysis of conventional network industries has long been used by economists to emphasize the complementarities that contribute to increased returns on scale in consumption, generally known as network externalities, a network effect, or a network effect's complementarity. The benefits per unit increase in direct proportion to the volume of usage. To put it another way, the number of people who utilize a service determines its worth (Economides, 1996). The importance of network effects is a distinguishing characteristic of the network industries, and as such, it is inextricably linked to the proper coordination of the many pieces that make up the networked system. Consequently, network effects are essential to network businesses and digital platforms, the emerging network industries (Montero & Finger, 2021).

To study network externalities, direct network effect, indirect network effect, and recently algorithmic network effect have been proposed (Finger &

Montero 2021). In the traditional network industry, there is a ‘direct network effect’ in which the value of the network is determined by the increase in the number of connected users. In an industry with direct network effect, the value of one network is zero, and if it is a network connected to all potential users, the value of that network is the maximum value. Usually, this direct network externality is applied to all physical infrastructure, such as telegraph wires and submarine cable in the telegraph era. Whether it is an information network or a railroad network, the more customers that share the infrastructure, the cheaper the cost of providing service to each user (Gottinger, 2003).

To investigate ICT industries, other network effects appear besides direct network effects, these are indirect network effects. Indirect network effects occur when the value of a product increases for one user group when a new user form a different user group joins the network. An actor must have two or more user groups or sides to achieve indirect network effects, which is why these are also called two-sided or multi-sided markets. The indirect network effects are prominent in the information and communication industry, which have both physical and virtual network infrastructures and digital platforms which are considered multi-sided markets (Finger & Montero 2021; Shy 2011).

After digitalization in ICT industries, another network effects exhibited, the ‘algorithmic network effect’(Finger 2019; Finger & Montero 2021). Data

in the digital industry plays a fundamental role. Interactions between components of the multi-sided markets are governed by algorithms that are fed with data. In other words, as data accumulates, more sophisticated algorithms are created, and network externalities in the digital industry that generate profits with such data become stronger. In industries where there is an algorithmic network effect, countries or companies aim to acquire more data.

The examination of ever bigger volumes of data by ever more sophisticated and powerful algorithms leads to algorithmic network effects. It is because these algorithms are trained on ever larger volumes of data, generated by ever increasing numbers of users, that they become ever more powerful. According to the European Commission, the algorithmic network effects show on search engines as "a general search service uses search data to refine the relevance of its general search results pages, it needs to receive a certain volume of queries in order to compete viably. The greater the number of queries a general search service receives, the quicker it is able to detect a change in user behavior patterns and update and improve its relevance" (European Commission, 2017).[19] Algorithmic network effects like this are critical in digital marketplaces because as the number of users increases, more data is collected, the algorithm becomes more efficient, and the service

[19] Commission Decision of 27.6.2017, Google Search (Shopping), para. 287. Retrieved from https://ec.europa.eu/competition/antitrust/cases/dec_docs/39740/39740_14996_3.pdf

becomes better for the consumers, all of which attracts more users.[20] The digital economy is driven by these network effects (Finger 2019; Finger & Montero, 2021).

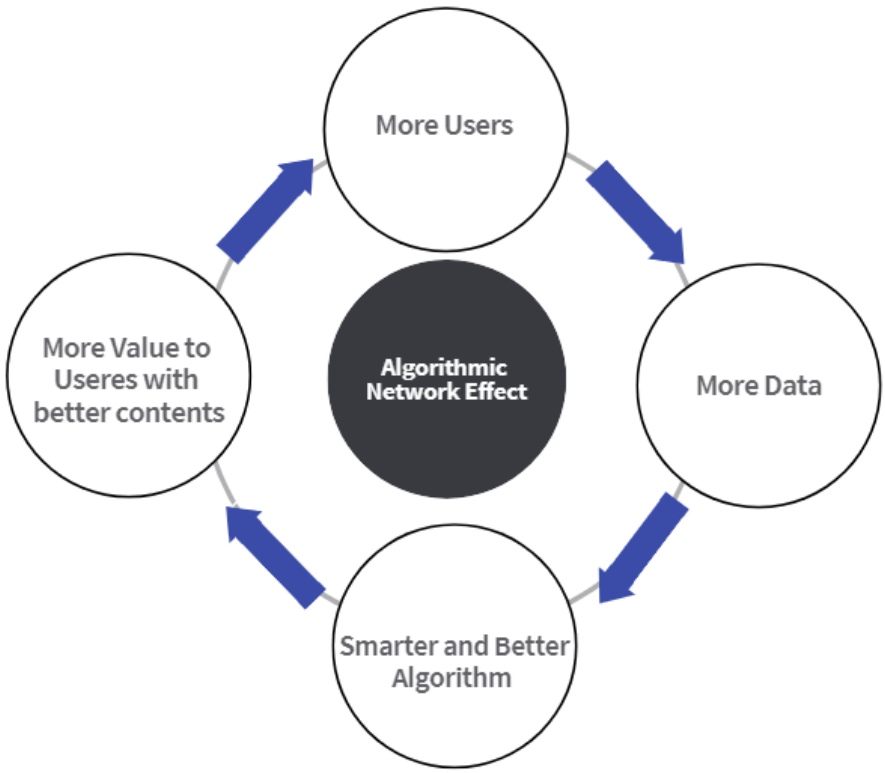

Figure 3: Algorithmic Network Effect, illustrated by the author

These network effects enable overwhelming dominance in the network industry. In particular, actors who increase the size of the industry's network (direct network effect); secure compatibility, complementarity, standards for increasing other groups joining the network (indirect network effect); secure

[20] Uber which is regarded as a 'platform' firm presented itself not as a network but as "a network that becomes smarter with every trip" in the IPO (Uber Form S-1 for the IPO, April 11, 2019). Retrieved from https://www.sec.gov/Archives/edgar/data/1543151/000119312519103850/d647752ds1.htm.

more data (algorithmic network effect) and will monopolize networks and products.

Therefore, the network industry has long been regarded as an area of state control as a national public monopoly (Finger, 2019; Gottinger, 2003). In particular, in the case of railroads which is a traditional example of network industry, it is used as a military purpose as well as economic purpose to connect markets. That is why states securitized the industry and tried to control the network infrastructure and products. This control was possible within the scope of the state's sovereignty. The expansion of the network of the railway industry and the product's flow are limited to domestic territorial sovereignty, enabling state control easier. Under these controls, the state no longer feels a security threat to issues in the industry. Since then, according to technological change and globalization, state control has begun to appear contrary to commercial interests in the industry, and the state no longer poses a security threat in the industry, so it is decentralized and privatized for commercial interests. Through this process, the network industry becomes a commercial market pursuing commercial profits.

The technology trajectory in the ICT industry is mainly developed in accordance with market needs according to commercial purposes in the flow of globalization. Related technologies are spread throughout the global market and the size of the industry is large. While the ICT industry emphasizes potential commercial benefits and spreads with relatively few

security conflicts through the market, in the case of the network industry, sovereignty issues immediately become a problem in infrastructure expansion. Also, it is technically much easier and pervasively expanded through virtual network infrastructure than physical network infrastructure. For this reason, unlike the network industry, the spread of networks and related technologies is internationalized rather than controlled by one country, and the size of the network increases exponentially as the number of users increases exponentially. In the network industry, railroads were deliberately not installed, and in contrast, they were installed to prevent military advancement. However, the infrastructure of the ICT industry has expanded to the meaning of economic and commercial exchanges.

Data moves across borders through the extended network. The network externalities of industries are robust, allowing them to attain critical mass more quickly and bolstering the market power of the first actors to reach critical mass, which can make markets as winner-takes-all market (figure 1). Furthermore, if data were monopolized by other countries or certain companies supported by other countries, it would be a matter of national security, so the state would try to hold sovereign control over network and data. However, the size of the network physically exceeds territorial sovereignty, and sovereign controllability is lower than that of the traditional network industry. Therefore, even though the beginning of the ICT network industry was a market for commercial purposes, the security threat is

increasing as the possibility of monopolizing transnational network and data by a certain actor is also increasing. Accordingly, the state accepts the industry as an area of security and enforces intensive regulation as an extraordinary measure.

For example, in the case of the internet industry and the digital industry, which are part of ICT and network industries, the commercial purpose is stronger and formed global market friendly (Shy, 2011). Also, the spread of the network proceeds virtually and at least in the beginning the sovereignty problem is not very noticeable when these industries internalize. However, network externalities are strong, data flows globally through ICT infrastructure, and control based on the national sovereignty becomes impossible. Therefore, actors with a strong possibility of monopolizing networks and products begin to emerge in the ICT industry, and the state cannot control it, revealing a strong security threat. Then, states begin to consider ICT industries as a security realm and the securitization process occurs. After the securitization process, the network industries are transformed into a market important to national security with strong regulations and response external actors.[21] Thus, when these industries proliferate and are asymmetrically distributed among states, the spoke states

[21] The case of the railroad industry, which is a based on visible network infrastructure, the state controlled it as a security area from the beginning because it had a military purpose and economic integration role for an improved market. In addition, strong control was possible according to the characteristics of the hard network industry. In this network industry, there are no actors monopolizing networks and products, and security threats are weakened. So, the state de-securitizes and privatizes the industry and turns it into a market for commercial purposes, which is dealt with in the realm of domestic political economics.

dependent on the network face a greater security threat. At this time, the hub states are highly likely to use these advantages as leverage for international security competition. The characteristics of the network industry are based on the birth of this dynamics.

2.2 Securitization Process and Threat Perception in ICT of Network Industry

This dissertation seeks to draw international political implications for the nexus of ICT-driven inter-state information and communication networks and international security competitions and explore a process about how the characteristics of the technology and its network affect international security mechanisms and dynamics. Network externalities appearing in the network industry are closely related to national security. Internally, it causes market failure and requires government intervention. Externally, if an external rival actor intervenes in the industry with the relevant effect, the relevant interests are subordinated to the outside. In the end, the winner takes all the market, where the competitive leader is taken away, and no substitutes or alternatives can be found for the profits obtained in the industry, resulting in enhanced vulnerability and weakened sensitivity (Keohane & Nye 1998).[22] In other words, an asymmetric interdependence structure is formed in the industry.

If an external actor has a monopoly position beyond the threshold in the

[22] For more explanations about interdependence in the information age, see Keohane and Nye 1998.

industry, other actors become vulnerable to the industry and difficult to react sensitively. In particular, in the recent platform economy, not only the traditional direct network effect but also the indirect and data-related algorithmic network effects appear. In this part, the failure to transmit data safely intensify this asymmetric interdependent structure. In this respect, technologies and infrastructure that affect network externalities become important. Among them, the submarine cable system is more important in that it transmits data, which is the core of the digital economy.

Eventually, network externalities appear in ICT that makes the information highway possible, and this is worthy of academic discussion in that it has a strong influence on the perception of threats in the international political system. However existing network industry scholars have not yet analyzed the industry in terms of international politics. Rather they have focused on regulations, economics, law, or more domestical context.[23]

What the existing network industry studies commonly emphasize is the market characteristic of winner takes all due to network externalities. An industry in which these characteristics are strongly displayed is the ICT

[23] Existing literature on the network industries mainly focused on theoretical discussions of the network economy with network externalities, and empirical researches with focusing on monopoly and regulation issues in network industries (Arthur, 1989; 1992; Brynjolfsson & Kemerer, 1996; Church & Gandal, 1992; 2005; Church et al, 2018; Economides & Himmelberg, 1995; Economides, 1996; 2005; Farrell & Klemperer, 2007; Farrell & Saloner, 1985; Finger, 2019; Finger & Montero, 2021; Gottinger, 2003; McGee & Sammut-Bonnici, 2002; Katz & Shapiro, 1985; Rietveld & Schilling, 2021; Rohlfs, 1974; Schilling, 2002; Shy, 2001; 2011). Existing studies on the network industry have been developed mainly in the fields of network economic theory, management, political economy, and law. Also, existing scholars mostly focus on after 'modern and digital era', so there is missing era of telegraph as network industry perspective which the dissertation covers. Telegraph era is also regarded as the first information and communication revolution in the ICT industry discussions.

industry. With the advent of the digital economy, the ICT industry has become more important than any other industry. In particular, related technologies and infrastructures enable the digital economy. The effects that cause monopoly in these industries come as a real securitized threat in the international political context of a rival state's preoccupation of important industries. In other words, the source of the security threat to the ICT industry is the threat posed by network externalities. This forces the state to implement an active policy for the industry and even to use extraordinary measures.

One of ICT's crucial infrastructure is the cable. Maintaining the flow of information is because of the infrastructure that relays the information fast and secure. States with well-equipped infrastructure can digest the amount of information soundly, and it is advantageous when delivering information. Among these infrastructures, cable is directly related to the security.[24] Ownership, supply, and cable landings are segments of the submarine cable business. Important aspects of a cable system include its ownership percentage, supply, and cable landings. In other words, the stake structure, threshold, etc. in a single cable launched or proposed to be opened at a crucial site are more significant than the share of the whole submarine cable sector. As a realm of cybersecurity, attacks on the network of submerged cable systems may be immediately handled. The motor of the digital economy,

[24] In the case of the submarine cable, it is an industry that is linked to data and has an external effect on the algorithmic network as well as the existing network externality: indirect network effect. Therefore, the loss of competition in the submarine cable industry means that the other country can control over data flow through the cable and this dynamics has become a security threat.

known as data transmission, is impacted by system issues. Furthermore, in the case of a war in which the cable system owner might purposefully interfere with data, it would be a security advantage for other nations using the cable system. Consequently, it would remove competitors from the cable system or completely control it.

In addition, securing the submarine cable system has become more important than anything else in that data transmission is determined by the structure of one cable system rather than the overall market share due to the nature of the submarine cable industry. Also, the defeat in competition of submarine cable networks affects the transmission of data, which is strategic asset in the digital era (Liu, 2021). Therefore, in the digital economy, the loss of data to other countries has the same effect as the loss of the people, territory, and sovereignty, which were traditional securitized realm.

In the digital era where it is important to maintain and operate the information highway well, the algorithmic network effect related to data becomes more and more important, and the technology and infrastructure that affects it are becoming more important than anything else. Representatively, in the case of the submarine cable industry, which is one of the main interests of this study, the greater the influence in the industry, the lower the cost, the more data is provided, and the service is provided to consumers. In other words, the submarine cable system reinforces network externalities in the digital economy. This discussion shows that the national security threat

perception factor in the securitization process is also based on the characteristics of the industry.

For the telegraph era, network externalities strongly influence threat perception of states as well. When certain actor monopolizes or weaponize ICT, its network may increase others' threat perception because of ICT industry's nature of network externalities. Among these ICTs, telegraph technology innovates speed, volume, and spatial range of content (printed information) transmission, and it was clearly a technology that made diplomacy better. However, telegraph technology increases the complexity of information flow due to the rapid proliferation of a large amount of information, and thereby increases uncertainty.

Therefore, the securitization theory basically refers to the process of identifying an issue as a practical threat and labeling it a security issue. The process of securitization means that an agent makes the judgement on any issues (threats) as a referent object.[25] When an agent speaks of the fact that a particular issue is defined as an existential threat under certain specific condition, and the audience accepts it as a practical threat, the issue that was once common becomes politicized, discourse is formulated, and subsequent securitization is achieved. The ICT, which is originally in the commercial world, through its military usage by states and by its characteristics, serves as

[25] Buzan & Waever (2003). P. 71.

the epistemic ground over the course of becoming the stage of security. Network externality has shown in that as the ICT industry becomes stronger and the products' flow through the network has expanded leading to global expansion. As sovereign control over product flow and network expansion is restricted by territorial sovereignty, the possibility of monopolization of networks and data by certain actor increases, and the country has begun to face security threats. Therefore, this dissertation considers ICT as a part of the international security realm and the process of international conflicts with exploring ICT-driven network in addition to its strategical usage by actors during the security competitions.

In summary, the securitization process and threat perception in the ICT industry can be analyzed through the lens of network externality and asymmetric interdependence. Network externality refers to the phenomenon in which the value of a product or service increases as more people use it. In the ICT industry, this often takes the form of a positive feedback loop, where more users attract more users, creating a larger network.

Asymmetric interdependence refers to the situation where the actions of one actor have a disproportionate impact on the outcomes of others. In the ICT industry, this can occur when a single company or network becomes dominant, creating a situation where the actions of that company or network have a significant impact on the rest of the industry.

The securitization process in the ICT industry refers to the process by which issues related to security become prioritized and seen as a matter of national or international security. This process can be driven by a variety of factors, including the growth of the ICT industry, the increasing interconnectedness of networks and systems, and the increasing reliance on technology in daily life.

Threat perception in the ICT industry refers to the ways in which individuals and organizations perceive and respond to potential threats related to ICT. This perception can be shaped by a number of factors, including the type of threat, the likelihood of its occurrence, and the impact it could have on individuals and organizations.

The interplay between network externality and asymmetric interdependence in the ICT industry can lead to increased securitization and threat perception. For example, the growth of a dominant network can create an asymmetric interdependence, leading to increased concerns about the security of that network. Additionally, the network externality can lead to an increased reliance on that network, further heightening the perceived threat to its security.

This analysis highlights the importance of considering both network externality and asymmetric interdependence when analyzing the securitization process and threat perception in the ICT industry.

Understanding these factors can help to better understand and respond to the complex security challenges facing the ICT industry.

2.3 Characteristics of ICT, Military Effectiveness, and Offense-Defense Dynamics

The relationship between the characteristics of ICT, military effectiveness, and offense-defense dynamics in international relations and international security can be understood through the concept of asymmetric interdependence. As ICTs have developed and become more widespread, it has changed the way militaries operate and has created new opportunities and challenges for both offense and defense.

The characteristics of ICT, such as speed, reach, and accuracy of information transfer, have increased the effectiveness of military operations by providing real-time information to decision-makers and enabling coordination among dispersed forces. At the same time, these characteristics have created new vulnerabilities, such as the risk of cyber-attacks on critical infrastructure.

Offense-defense dynamics refers to the balance between the ability of a state to carry out military operations and the ability of other states to defend against them. As ICT has changed the nature of warfare, it has also changed the offense-defense balance, making it easier for some states to carry out

offensive operations, while at the same time making it more difficult for others to defend against them.

The network externality in the ICT sector can create asymmetric interdependence, where some states have a comparative advantage in using ICT for military purposes, while others may be at a disadvantage. This asymmetry can have important implications for international security, as it can lead to imbalances in power and increase the risk of conflict.

Military Effectiveness, Controllability of Information Flow, Uncertainty and Responsiveness

Social scientists, historians, and practitioners analyzed numerous factors on why military fights more efficiently than other actors and so, conducted countless research on military effectiveness. Military effectiveness is characterized as a capability to convert resources into military power (Brathwaite, 2018; Brooks, 2007; Millet et al, 1986; Talmadge, 2013). More specifically, effectiveness is shown by how well a state can soundly transition the resources to actual power during the war. Therefore, effectiveness is the difference between the potential product of raw resource and the actual performance in combat. Such explanation implies that military might is the yardstick that shows how well a battle could be fought with the available resources. Biddle (2004) explained these combat mission as “the ability to destroy hostile forces while preserving one’s own; the ability to take and hold

ground: and the time required to do so." Furthermore, he subdivided the offense and defense factors of the military strength or capability and said "offensive military capability as the capacity to destroy the largest possible defensive force over the largest possible territory for the smallest attacker causalities in the least time; defensive military capability is conversely the ability to preserve the largest possible defensive force over the largest possible territory with the greatest attacker causalities for the longest time" (Biddle 2004, pp. 4-7).

Recent academic discussion suggests the information capability and the resources that increase the effectiveness are system, technique, allies, and economic power (Beckley, 2010; Brooks, 2007; Biddle, 2010; Meiser et al, 2021; Murray, 2011). Basically, discussion on military effectiveness is centered on the combat function and strategic victory and factors that play in combat function and strategy is viewed as the factor that increase effectiveness.[26]

Intelligence capability of exploiting and monitoring critical information of enemies was the main factor of victory in war for a long period of time. Clausewitz emphasized the importance of intelligence collection in war with 'friction' and 'fog of war' concept. Furthermore, 'responsiveness', an integrated and rapid response against critical intelligence is also emphasized

[26] That is why Biddle (2007) asserts the levels of war have to be considered to analyze the military effectiveness.

(Howard & Paret, 1984; Lindsay, 2020; Meiser et al, 2021). Intelligence eliminates uncertainties on the military operations against the adversary and allows quick response to the situation. Elimination of uncertainties and quick response becomes the key to military effectiveness since it gives direct influence on the strategic move and victories in combat. The actor who controls these information flow will take better military effectiveness.

That is why the ICT and its network, which allow the control of information flow eliminates the uncertainties of war and responds to the ever-changing battlefield situation. In strategy perspectives, this destroys the opponent's offense and defense balance. When critical information can be monopolized by completely accessing to the information flow, although in an unfavorable situation as expeditionary force, enemy vulnerability with no defense preparedness and readiness can be targeted and thereby increase the offensive advantage of friendly forces.

Thus, drawing on these scholars, this dissertation defines military effectiveness as a degree of controllability to access and use information flow for enhancing responsiveness. To maximize the military effectiveness, states have to access to information flow, or even be able to monopolize, and obtain the power to deny access to information flow by other states. Those states advantage on information can eliminate uncertainty while increasing uncertainty to enemies.

Information and Communication Technology Characteristics and Offense-Defense Dynamics

ICT industries are superior in speed, volume, and spatial range of contents transmission and show the strongest network externalities than other industries (Economdies, 1996; Gottinger, 2003; Shy 2011). Also, ICTs are the base of information highway that enable digital industry. ICT industries affect information transfer processes that relate to international political outcomes: by how they change the volume of information transmission over time (volume and speed), and how far (spatial range) by what contents that influence credible to cost and capability.[27]

Historically, ICTs have played an important role in international relations and world politics including non-state actors from the time when the Great Britain and the United States first communicated and exchanged information through the transatlantic submarine cable in 1858 to the digital era connecting the world widely by global information infrastructures (Borgman, 2003; Hunt, 2021; Main, 2001).[28] Global communication and

[27] The timing and sequencing of revealing information during the inter-state bargaining and the contents of what actors explicitly or implicitly communicate to another actor are important. These dynamics determines whether the break of war or not as influencing actors' thoughts about the costs of wars. (Fearon, 1994; Schelling, 1966; Quek, 2021).

[28] More plausible explanations about relationship between global information infrastructure and state's rising as empire, see Hunt 2021. *Imperial Science: Cable Telegraphy and Electrical Physics in the Victorian British Empire.* Cambridge University Press. Main, L. (2001). The global information infrastructure: empowerment or imperialism? *Third World Quarterly*, 22(1), pp. 83-97. Borgman, C. L. (2003). *From Gutenberg to the global information infrastructure: access to information in the networked world*. MIT Press. Besides first inter-continental telegraph network, the first 'inter-state' telegraph network was started from 1849 by connecting Prussia and Austro-Hungarian empire with international treaty of telegraph links (Headrick, 1991; Johnston 2021).

information infrastructures[29] were built along with innovations in the ICT industry. States can overcome territorial sovereignty and time of content transmission by international cable systems.

For example, a telegraph, typical innovation of speed enhancement with overcoming spatial range of content transmission. The proliferation of telegraphs with these characteristics will overcome the distance barrier for communication among states, so it increases communication and information exchange between states. In other words, the international telegraph diffusion has the potential to vary the speed at which actors may communicate and receive information across geographical distance. This, in turn, has the impact of changing the amount of information actors have available to them at any one time. The relative benefits of certain technologies may shorten the amount of time required for transmission while maintaining the same volume. On the other hand, certain technologies could offer advantages in the process of transferring significantly larger amounts of information in the same amount of time. The telegraph offers an unrivaled competitive edge in terms of speed, volume, and spatial range of contents delivery and it also affects diplomacy and military effectiveness.[30] At this juncture, information and communications technology has the potential to affect the bargaining

[29] Throughout the dissertation, the target era is telegraph era and I use information and communication interchangeably when these terms link to network and infrastructure of telegraph technology.
[30] After the development of fiber optic cables, a revolution occurs in speed, volume, and spatial range once again. Fiber optic cables and international relations will be dealt with in detail in Chapter 5. Generally, the period of innovation in speed and volume is divided into telegraph era, telephony era, and fiber optic era, and this paper focuses on the telegraph and fiber optic era. The telegraph technology was the first innovation, and fiber optic is a significant example in that it enables the digital economy.

dynamics by modifying the sequencing and timing of strategic signals. Sequencing and timing of content transmissions are significant aspects of states' attempts to credibly expose their capabilities and costs (Fearon, 1994; Quek, 2021). Moreover, ICTs can affect offense-defense balance by influencing military effectiveness and ICTs may eliminate uncertainty and make it distinguishable whether there are advantages on offense or defense posture.

In the offense-defense balance theory, the weapon system is the main independent variable, and the causal relationship is analyzed regarding its effect on security (Christensen & Snyder, 1990; Evera, 1999; Jervis, 1978). ICT innovation that affects military efficiency and secures uncertainty will affect the onset of conflict. Offense-defense balance theory is the idea that the start of international wars may be explained and anticipated by evaluating the connection between offensive and defensive operations' cost balances. Robert Jervis hypothesizes that states with a reduced danger of exploitation were more likely to be at peace and less inclined to threaten their neighbors. When the offensive and defensive positions are indistinguishable, but the offensive posture has the upper hand, the security threat is described as 'very intense'. Where aggressive and defensive postures can be distinguished, and where defense has the upper hand, the security dilemma is less intensified (Jervis, 1978). More specifically, Jervis explained the outbreak of war and arms race with two factors: offense-defense balance and offense-defense

distinguishability. The offense-defense balance is related to a state's strategic vulnerability, which means that it is likely to launch an attack according to its superiority in attack or not (Jervis, 1978). Jervis sees technological capabilities and geographic location influencing offensive and defensive advantages. In addition, it is also important whether there is intention between attack and defense, and whether it is possible to distinguish between attack and defense. It mainly emphasizes the division according to the weapon system. According to Jervis, these two factors can constitute four typologies, and through this, the intensity of the security dilemma can be identified (Jervis, 1978).

Scholars add the characteristics of military weapon systems and state intentions to the offense-defense balance as factors in the occurrence of conflict to analyze the alliance and security of the post-Cold War era.[31] It has been utilized as a framework for policy analysis (Christensen & Snyder, 1990; Evera, 1999; Garfinkel & Dafoe 2019; Glaser & Kaufmann, 1998; Lavy 1984; Lieber, 2000; Lynn-Jones, 1995). Robert Jervis, a leading researcher of the offense-defense balance theory of security dilemma, contended that the offensive-defensive balance as a strategy to achieve political and military objectives varies depending on whether the offense or the defense is favorable with pursuing survival in terms of security dilemma. It was explained that

[31] Even offense-defense theory expands to emerging security, such as cyber security (Gartzke & Lindsay 2015; Saltzman 2013; Slayton 2016).

offensive supremacy greatly increases the likelihood of armed conflict. As the determining factors, military weapon system and state purpose and intentions were highlighted. Jack Levy and Van Evera, among others, highlighted variables in advanced science and technology (Evera, 1984, pp. 219-238). According to Jack Levy, the offense-defense balance is determined by 'the possibility of acquiring territory', 'the nature of weapons', and 'the advantage of a preemptive strike'. Also, science and technology are currently altering the nature of war, which influences the objectives and strategies of national security policy (Levy, 1984, pp. 219-238). In particular, in terms of asymmetric information and communication network, hub states meet the most of conditions suggested by Levy (1984), and this is one of the main reasons that hub states invite spoke states subordinate to the asymmetric network of hub states to wars.

Scholars like Gilpin have suggested that the advancement of science and technology encourages the adoption of military systems that are more favorable for attack than defense, and works as a factor that triggers the territorial expansion and hegemony of powerful nations (Gilpin, 1981, p. 61). This is because technological developments in the military may alter the offensive-defensive balance by changing threat perception, security threat over vulnerability, and incentives for preventative war or preemptive strike. In recent years, as the trend for cutting-edge technology to be intimately linked to the modernization of the military has grown, the determining factor

is not absolute military might but rather how much scientific technology can be translated into military force. In particular, advances in military science and technology in the areas of mobility, firepower, protection, logistics, communication, and detection are leading to the development of offensive weapons (Glaswer, 1998, p. 7).

In this context, ICTs have a significant impact on the offensive and defensive balance. In particular, in a situation where each other's information is limited, the innovation of ICT will eventually lead to more accurate information about each other and clearer information about each other's status than before. Based on this logic, the connection of telegraph, an innovative technology in speed, volume, and spatial range of information transmission, will affect the removal of uncertainty in the offense-defense balance. The spread of ICT strengthens military effectiveness such as intelligence and battlefield visibility, which makes the offense advantages clearer in the offense-defense balance, increasing the onset of conflicts.

In this dissertation, it is emphasized that the state that dominates the information network maximizes the advantage of a preemptive strike and creates an attack advantage and asserts that it monopolizes the opponent’s critical information even in war, removing uncertainty and increasing the enemy's uncertainty at the same time. That is, they have access to the information flow, allowing them to exploit and manipulate critical information about potential adversaries. This strategic superiority can detect

the enemy's maneuver, strike position, and defensive posture in advance, which affects defense preparedness and increases military effectiveness. Thus, this discussion is extended and applied to the telegraph era where information dominantly flows via telegraph and when potential enemies exist.

Innovation in communication technology allows more accurate information about the opponent to be acquired and directly affects military effectiveness by eliminating informational uncertainty on the operation theater. Moreover, exploiting critical information, which is based on speed-enhanced ICTs and can transmit information without territorial barrier, provides more accurate information on whether the enemies take fully defense-prepared posture or not, and whether it is advantageous in offense or defense. In addition, if this uncertainty is removed, there is a high possibility of militarized disputes (hereafter: MIDs) by those states advantages on offense (Evera, 1999; Horowitz, 2010; Jervis, 1978; Levy, 1984).

In the international anarchy, states do not know exact information about the intentions of the other party, the best option to achieve security is develop one’s own capabilities. However, at the same time, this choice may increase the security threat to the other side and result in advancing other’s military and economic power. This security dilemma represents the difficulty of obtaining credible information.

More precisely, the security dilemma is determined not only by

'misperception' of the other party's intentions (Jervis, 1978), but also by uncertainty about the opposing party's capabilities and costs to be paid in the event of a war (Evera, 1999; Jervis, 1978). In particular, it is uncertain whether the other state is a 'status quo' state pursuing security or a country pursuing expansion. Thus, in reality, even a security action that seeks to defend can be considered an action for an attack. Jervis (1978) explains this security dilemma with the offense-defense theory.[32]

To summarize the above discussions, ICT overcomes spatial limitations and enables rapid communication. This allows some states an access to information flow and manipulate critical information. This may influence military effectiveness since those states control the information flow by taking the advantage of asymmetry through uncertainty and defense preparedness. Even in terms of intelligence, espionage or diplomats were dispatched to the region to transmit information back to their home countries in real time. Thus, a state that is in the hub position in ICT network and even in appropriate utilization of the information, will wage war in a favorable

[32] Offense-defense balance theory has been developed by various scholars. Evera also analyzes international politics through the offensive-defense balance theory (Evera, 1999). The offense-defense balance theory held that all types of countries were the same. Therefore, it is argued that the behavior of the state is determined by the characteristics of military technology. This is challenged with neoclassical realism that emphasizes the characteristics of individual countries, such as the status quo and the anti-status quo (Schweeler, 2006). Christensen and Snyder (1990) argue that alliances in a multipolar system depend on the perception of the offense-defense balance. 1914 recognizes that the attack is advantageous and supports the allies more strongly. However, in cases such as 1938-1939, where the defense is perceived as favorable, the responsibility for deterring the aggressive state is shifted to each other rather than supporting the allies. For a more detailed discussion of the offense-defense balance theory, see Galser and Kaufmann (1998) "What is the Offense-Defense Balance and Can we Measure It?" *International Security*. 22(4). Lynn-Jones (1995), "Offense-Defense Theory and Its Critics." *Security Studies*. 4(4). Christensen and Snyder (1990) "Chain Gangs and Passed Bucks: Predictting Alliance Patterns in Multipolarity." *International Organizatio*n. 44(2). And for critics of offense-defense theory see Lynn-Jones (1995).

position by increasing military effectiveness.

3. Asymmetric Interdependent Networks in international relations and Military Effectiveness.

3.1 Asymmetric Interdependent Network and Network Power

To explore asymmetric network power, one must first know the power that emerges in asymmetric interdependence. This is because the pattern of how power works is similar. The purpose of foreign policy in international relations is basically to achieve national interest by forcing other countries to set policies they do not want to implement or prevent other countries from setting policies that they do not want to take in order to achieve their own interests. The exercise of power between states can also be seen as implementing the policies that other states do not want but their own. As globalization accelerated after the war, a political and economic approach beyond power relations using military force emerged. An attempt to look at a new power relationship between states, starting from the economic point of view, has emerged. In international security and inter-state relations, Keohane and Nye judged interdependence through sensitivity and vulnerability, and interpreted it by paying attention to the power relationship that appears in an asymmetric interdependence relationship (Keohane & Nye, 1973; 1977).

Interdependence has emerged as an important factor in international

politics as globalization accelerates. Two key concepts of interdependence theory are sensitivity and vulnerability. Sensitivity refers to the cost of some external change, and vulnerability refers to the degree of cost to be paid until an alternative to external change is prepared. In other words, sensitivity means that it is temporarily impacted but seeks alternatives at the soonest and shows quick resiliency. Meanwhile, vulnerability means not being able to easily find a substitute or alternative when a relationship or supply is cut off. States with low vulnerability in terms of interdependence have an advantage in the competition. Therefore, the relationship between countries showing interdependence can be defined through sensitivity and vulnerability (Gasiorowsk, 1986; Keohane & Nye, 1973; 1977; Maoz, 2009).[33] This approach easily defines the relationship of like-minded countries in the ICT infrastructure networks such as the United Kingdom and the United States and emerging countries such as China in the digital era.

For example of submarine cable networks is one of the main infrastructure of ICT to enable inter-state communication and information flow. The relationship between the United States, which occupied a dominant position in the submarine cable network, and the emerging China can be understood and interpreted international security competition in the asymmetric network in terms of sensitivity and vulnerability. International

[33] A state that has the so-called vulnerability between states in interdependent relationship can be overpowered by a state with sensitivity. This will be further elaborated in the discussion of asymmetric networks.

relations in the submarine cable are characterized by an asymmetrical power relationship between countries through intrinsically limited resources. States that supply submarine cables have relatively low vulnerability to cable networks. [34] Profits may decrease due to supply disruption in inter-state competition, but soon recover through alternatives, higher prices. If states that depend on the supply of submarine cables do not find other suitable alternatives to submarine cables, it means that submarine cables and fiber optics are vulnerable to data transmission, which means that they have to implement unwanted policies by the power of the submarine cable suppliers. In other words, if a subsea cable supplier intentionally stops supplying to a weak country in the subsea cable field, the threats of not being properly supplied with data transmission are intentionally visualized, which leads to security problems. In this way, the relationship between countries in the submarine cable network is defined through the theory of interdependence. And this asymmetric relationship stands out in the realm of invisible security - political communication - interlinked with the realm of military security.

If we define the relationship between ‘State A’ and ‘State B’ as an asymmetric interdependent relationship, and view that ‘State B’, feeling dissatisfied with this relationship, started to supply submarine cable networks

[34] Unlike other technologies, there exist prerequisites for weaponizing telegraph technology. A telegraph is transmitted via cables. In other words, telegraphs require not only telegraph technology but also infrastructure. In telegraph technology networks, it is also important to have the hub located in the home country. This is because information can be efficiently created in the home country but also because it can prevent information from being stolen. A state that meets these prerequisites may use telegraphs for military purposes, strategically use information asymmetry to increase complexity and uncertainty to spoke states, or attempt to secure such interdependence.

to escape its vulnerability, it is natural that ‘State B’ recent heavy focus on submarine cables has started.

Therefore, during the telegraph era where communication was mainly on the submarine cable, such asymmetric relations deepens even more. The asymmetric structure that was once formulated through network externalities deepens more and the structural security crisis risk is with the spoke state. And the telegraph era shows a structure in which hub states will utilize this asymmetric interdependence in a military setting.

Asymmetric Network and International Security

As globalization expanded, liberalists have repeatedly argued that global networks brought about interdependence, which tends to make coercive strategies less effective. Keohane and Nye elaborated that globalization is correlated to the development of interdependence network and as the ‘structural holes’ are filled in, it is likely for the asymmetry to start getting evened out (Keohane & Nye, 1973; 1987). If a state’s economic and information system gradually gets mixed up, they foresaw that interdependence would function peacefully. Since interdependent relationship mutually bounds the parties of agreement and once attacked, the damage is assured for all members under its auspice hence, saber-rattling

power game was out of the question (Keohane & Nye, 1977; Nye 2016).[35]

The first instance of this information asymmetry was the 19th-century information networks created by the proliferation of telegraph technology (Wenzlhuemer, 2013). Hub states leverage the vulnerabilities of this asymmetric information network to gain an advantage in war. The term 'weaponized interdependence' refers to a scenario in which one actor exploits its position inside an embedded network to obtain an edge in bargaining with other actors within a contained system (Farrell & Newman 2019; Drezner et al, 2021). States with political control over key information and communication hubs of information and communication nodes "can weaponize networks to gather information or choke off economic and information flows, discover and exploit vulnerabilities, compel policy change, and deter unwanted actions" (Farrell & Newman 2019, p. 45.)

However, hub states such as the Great Britain, Germany (especially Prussia) and the U.S in addition to waging active war with the spoke states, they exploited the information. This happened in the telegraph network in 19th century, where we call the first globalization. This was possible because position was situated as Hub state in the asymmetric network. If all states were allies and technology developed equally, Keohane and Nye's discussion would be right. However, the asymmetric communication network in the

[35] Keohane and Nye, Power and Interdependence. Nye, "Deterrence and Dissuasion in Cyberspace

telegraph era had hierarchical structure and hub states were capable of exploiting information. And hub and spoke states recognized each other as potential adversaries and the development of technology was privileged unevenly. Once such asymmetric network structure starts to form, the asymmetry roots down and starts to be maintained in that fashion for long. Hub states during the telegraph era conducted its actions with the geopolitical logic and this brought about conflicts rather than peace.

The fact that the asymmetrical structure which further rooted down continue to exist means that it is not just a one-time exploitation of information, but a security threat for continual exploitation for spoke states. At the end of the day, how the ICT-driven network of hub states gets utilized may determine the emergence of a security threat for spoke states or the increase in number of military conflicts.

3.2 International Diffusion of ICTs and Asymmetric Information Networks: Hub and Spoke Relations

In the 19th century, the telegraph enabled the rapid transmission of information across long distances. After the introduction of telegraph technology, telegraph technology dominated the information flow; hence, information networks emerged (Headrick, 1991; Wenzlhuemer, 2013). Hub states, which control the information flow, and spoke states, which do not, were formed as the information flow increased. As the central node in an

asymmetric information network, a state that monopolizes the information flow can wield significant influence over other states. Hunt (2021) defined the power of the British Empire as the power derived from these networks, while Wenzlhuemer (2013) provided actual evidence of the United Kingdom's network supremacy. Headrick (1991) referred to the power derived from this asymmetric communication network as 'invisible power' and stressed the significance of telegraph technology. In other words, the asymmetric information flow created by telegraph technology in the 19th century resulted in the emergence of new power, and hub states which utilized it soundly were in a position of strategic advantage.[36]

Well-connected and developed states gets to control the global information flow and regions with feebler connections either relies on the controller or gets ostracized (Wenzlhuemer, 2007). Wenzlhuemer believed that London was able to secure its position as the financial hub because of its central position in the global and domestic telegraph networks in the 19th century. Based on the Headrick and Wenzlhuemer's network idea, this dissertation intends to go beyond the economic implications (Headrick 1988; 1991; Wenzluhemer, 2007; 2013). I hypothesized beyond the economic aspect, that the telegraph network in the 19th century contains an international

[36] Usually, the information revolution begins in the 1960s, but the birth and expansion of information networks should first see the spread of electric telegraphy. (Wenzlhuemer, 2007). A telegraph technology with the characteristics of ICT created an information network in the 19th century. This information network was built around the British Empire. In particular, as an instrument of the Empire to control its colonies, the British Empire built a telegraph infrastructure throughout the world. (Hunt, 2021)

security aspect.

For example, in a global ICT network, the hub states' authority of power gets amassed when hub states get to have more nodes in the network due to network externalities or when indirectly intertwined with other networks. As an example to the above, if a state is in the hub position in both information and economic networks, or in the hub position in not only the information network but also in the infrastructure and tools that delivers the information, the hub state can use this to exploit critical information in the information network by pressuring the trade network, and vice versa. So, when a spoke state is subordinated to another connected network, it naturally gets connected to an information network, and the hub state will have more resources of power to leverage. The framework illustrates how asymmetric interdependence networks can become sources of dependency, power, and influence within the international system. In the telegraph technology and its network case, the dissertation applies this to international conflicts especially militarized disputes during the telegraph era. Thus, asymmetric information network creates hub and spoke based on the controllability of information flow. The controllability includes material resources, such as telegraph infrastructure and system.

During the telegraph era, the international diffusion of ICTs created new opportunities for states to enhance their military and strategic capabilities. One of the main features of the telegraph era was the creation of asymmetric

information networks, in which some states were able to centralize and control the flow of information, becoming hub states, while others were more peripheral and dependent on the hubs, becoming spoke states.

This asymmetry in the use of ICTs created imbalances in power, as hub states were able to gain a strategic advantage over spoke states. For example, hub states could use the telegraph to gather information about the military activities of spoke states, as well as to coordinate their own military activities in real-time. In this context, hub states were able to leverage their control over information to gain advantages in international relations and military operations. This gave them a strategic advantage in negotiations, diplomacy, military planning, and even military operations. At the same time, spoke states faced challenges in accessing information and participating in the information flow. This put them at a disadvantage in international security competition.

Overall, the international diffusion of ICTs and the formation of asymmetric information networks during the telegraph era created new dynamics in international relations, with hub states having a strategic advantage and spoke states facing challenges in accessing information and participating in the international system.

3.3 Asymmetric Information and Communication Network and Military Effectiveness

During the telegraph era, asymmetric interdependence on information flow had a major impact on military operations and strategies. Asymmetric interdependence refers to the idea that different actors in a system have different levels of dependence on and influence over each other. In the context of the telegraph era, military organizations and nations had varying levels of interdependence on the flow of information and the communication networks that transmitted it.

The military application of asymmetric interdependence on information flow during the telegraph era meant that states and military organizations could exploit the information flow to their advantage in conflict scenarios. For example, a state with better telegraph infrastructure and capabilities could gather and transmit intelligence more quickly and efficiently, allowing them to respond to threats more effectively and coordinate actions with their allies. On the other hand, nations with weaker telegraph networks could be at a disadvantage, as they had limited access to information and limited ability to coordinate actions with their allies.

Additionally, the use of secret and encrypted messages via telegraph also presented new challenges and opportunities for military intelligence. For example, states could use encryption to protect sensitive information from

being intercepted, but also faced the risk of their encrypted messages being decrypted by adversaries.

Overall, the military application of asymmetric interdependence on information flow during the telegraph era demonstrated the importance of information and communication networks in shaping the outcome of military conflicts. The ability to access, process, and transmit information quickly and efficiently could be a key factor in determining the outcome of military operations and the balance of power between nations. Based on the discussion, this section develops hub states' military application of asymmetric information and communication networks with weaponized interdependence theory.

Hub's Power: Controllability of Information Flow with Panopticon and Chokepoint Effect

As this dissertation have discussed in former sections, asymmetric information and communication networks in the nineteenth century was created by international telegraph diffusion. That was why hub and spoke states were created under the asymmetric network based on the controllability of information flow. Global connectivity derived from the telegraph diffusion creates new opportunities for hub states -great powers in the asymmetric network- to coerce, manipulate, and penetrate the information flow among states. As Hirschman (1945) emphasized the asymmetry of power in

economic interdependence, Farrell and Newman (2019) believed that power gets conceived through market dominance and bilateral interdependence. They further noted on the form of power that is shown in asymmetric interdependence.[37] In the same vein, they found that modern globalization brought about an asymmetric network in which some states are more connected than others (Drezner et al, 2021).[38] Such state elevates itself as the hub of global network and is capable of using the interdependence as a bargaining chip (Drezner et al, 2021; Powell, 2002). In particular, these hub states can leverage hub positions to gather information, block flow of information and finance, assess and take advantage of vulnerabilities, enforce policy changes, and curb unwanted behaviors (Drezner et al, 2021; Keohane 2020). These states enable the weaponization of interdependence in two forms.

The panopticon effect allows hub states to monitor the behavior of other actors in the system. In other words, the panopticon effect emphasizes the asymmetry of information flow by hub actors. This effect provides complete access to information flow that other spoke states have limited access to. In addition, chokepoint effects are utilized by hub states that control the

[37] When State A relies on B which has high market dominance without any substitute in the market, B can use this asymmetric interdependence as a mean of power to enforce its intent. The logic is that states that take the position as hubs in multilateral intertwined networks opposed to the bilateral, they can leverage the interdependence as a weapon.

[38] According to Farrell and Newman (2019), among existing studies of asymmetric interdependent networks, historically, early asymmetric networks have generally been formed by private actors with its corporate motivation to create monopolies or quasi-monopolies in the market. According to historians, the Telegraph network, an example of this study, was also mainly formed by a private actor-- a non-state actor-- for commercial gain as if entering the digital industry today (Headrick, 1990). However, it was later utilized as a tool for imperialism and likewise the telegraph network as a statecraft (Hunt, 2021).

network's key infrastructures, which can limit or remove other actors.

The controllability of information flow can make hub state to discover critical information which is information that affect military effectiveness in terms of ‘responsiveness’ and eliminating ‘fog of war’ which is uncertainty during the wars, such as blinded information on enemy’s strategical movements and strike points. Thus, hub states can utilize their hub positions to gather critical information or cut off information flows, discover and exploit vulnerabilities, compel policy change, and deter unwanted actions for spoke states (Chang & Yang 2020). In the ICT industry, network externalities create a structure that reinforces asymmetric information flow. Asymmetric access to information flow is a vulnerability for spoke states. At this time, when countries use strategies that increase military effectiveness, they become an actual security threat to spoke states. In other words, an asymmetric information network creates a potential threat, and becomes an actual threat when hub countries exercise network power. Hub's network power is based on this military exploitation of asymmetric information interdependence. Although it is a potential threat in itself, it increases military effectiveness depending on how it is used during actual war and becomes an actual security threat to spoke states.

In particular, the dissertation delves into how telegraph network strategically leveraged by hub states affect military effectiveness and actual security. As previously explained, existing discussions of network and

interdependence only deals with benefits and risks in economic aspect which do not properly understand the military aspect of the network strategically used by hub states during the telegraph era. Also, this dissertation explores how the telegraph network is related to the military strategy and beyond structural and static threat to become a real security threat.

Military Application of Panopticon Effect

Asymmetric information network allows the hub state with a panopticon effect in information. Especially in military setting, panopticon effect allows exploitation and manipulation of critical information from spoke states. In addition, military application of the panopticon effect creates and increases uncertainty to spoke states and such asymmetric network changes the offense-defense balance and weakens the defense preparedness of spoke states. Further elaborating on the discussion of asymmetric networks above, this section explores military application of the asymmetric networks by hub states. First military application of the networks is the military usage of Panopticon effect. Since the creation of telegraph network and making other means obsolete, intelligence during the 19th century was generally delivered through the telegraph. Thus, official documents were handled through the telegraph and the espionage and diplomatic reports were drafted and sent through the telegraph network.

Hub states were privileged with an access to the information flow in such

telegraphic background and situated themselves in a position to monitor critical information. As the telegraph technology developed, state's capability to collect intelligence on adversary of third-party intervention improved further. These intelligences provide the snapshot to view the spoke states' hawkish activities against the hub states and thereby overcome the uncertainty. In military context, spoke states' strategic maneuver and intelligence on the critical locations of unit is exploited by the hub states through telegraph network.

Monitoring critical information by monopolizing the information flow is linked to discovering and exploiting enemy vulnerabilities. The discovery and manipulation of critical information about the enemy before and during the war has a positive effect on the defense preparedness of the allies and a negative effect on the defense preparedness of the enemy. This is because the strike point can be manipulated, and the enemy's attack position can be monitored. Information on the enemy's maneuvers and defensive posture helps to conduct warfare effectively.

Hub states that dominate the telegraph network obtain critical information about the other states by exploiting the transmitted information. In addition, telegraphs that transmit quickly across territories enable diplomats and intelligence agents dispatched to the region to quickly obtain important information. This is a strategy that states without such networks cannot utilize. In addition, states that rely on the information infrastructure of

these hub states are exposed to vulnerabilities and suffer damage in terms of their ability to conduct combat in war.

Through the secured critical information, the hub state can intensify the 'fog of war' against the enemy. It is to increase uncertainty about the battlefield. The hub state removes uncertainty with sufficient information power and causes a favorable war or takes an advantageous position during a war. In addition, by securing important information during war, it is possible to intentionally deceive the strike position or rapidly deploy troops while tracking enemies. Spoke states that are subordinate to the hub states are deceived even if they prepare defenses because their information is stolen and information about the other party is blocked, and the offense and defense balance changes negatively, so defensive advantage of spoke states is lost.

In particular, at the end of the 19th century, centered on the Great Britain, the United States, Germany, and France, telegraph networks were formed and most of the telegrams could only be delivered to intended receivers after the scrutiny. That means that the easily accessible analogue-type of information had to go through the hub as telegram. Since most spoke states did not have the ability and infrastructure to operate the network individually, they were dependent on and subordinate to the telegraph network of hub states and as a matter of fact, had no other options.

Thus, the hub state can easily obtain and exploit information against its

opponents before waging war, and that makes them make decisions about war more easily. During the war, the panopticon effect is used militarily to identify the strategic movements of the spoke states in advance and avoid units with fortified defense preparedness. Through this, even if the hub states wage war in the area of the spoke states, it eliminates the uncertainty of information and takes the superiority in offensive posture. Moreover, the spoke states receive distorted information flow, increasing the uncertainty to hub states' critical information and decreasing military effectiveness. Therefore, if the panopticon effect is used militarily, hub states increase its military effectiveness and takes victory of the war while spoke states' critical information is exploited by hub states' telegraph network.

Military Application of Chokepoint Effect

The second aspect of military application of asymmetric network is militarily leveraging chokepoint effect. This is related with the power of hub states to restrict or penalize the use of networks where they have influence over certain states. Because fast inter-state communication was almost impossible without the 19th century telegraph network, hub states controlling the network hub are substantially coercive, and states denied with an access through these hubs resulted to be isolated from the 19th century information network's flow of information. The Great Britain had dominated these networks since the late 19th century, and almost all countries suffered the threat of a chokepoint effect, except for Germany, which controlled the European militarized telegraph

hubs, and the United States, which wielded strong influence on the Atlantic and Pacific telegraph networks in close ties with the Great Britain.

International communication networks at the time were directly related to international commerce and getting chocked in communication networks meant severe impact in trade networks as well (Lambert, 2012). To avoid this risk in the early 20th century, even Germany made an attempt to create a new wireless network (Twerk, 2019). Chokepoint effect, which is a threat to the network itself, poses a greater threat when used in military fashion. Hub states' military usage of the chokepoint effect during the telegraph era was actually implemented in two main ways.

The first military application of chokepoint effect is a soft chokepoint effect. This can also be seen as a network chokepoint, and it prevents entry into the network itself. Using the telegraph network in the 19th century as an example, while waging war against the hub states, it is to isolate the spoke states to an access to information by making the telegraph network unavailable.

Other military application of chokepoint effect is the hard chokepoint effect. The hard chokepoint effect appears in hardware networks. This is an act to block the access to military communication by cutting the actual cable, communication infrastructure. The peculiarities of the cable that physically comprise the telegraph technology and network elaborate on why such action

is considered as a security threat to the opponent. Telegraph technology is mainly transmitted through a telegraph cable system. In other words, physically cutting the cable means cut the hardware information and communication infrastructure and directly blocks from information flow and inter-state communications. It is not to choke the entry into the network discussed above, but to physically prevent access to the information flow and to prevent the delivery of military communications and critical information for the military operations.

For instance, during the Spanish–American War, the United States tried to cut and track the cable, and the cable connecting Manila and Spain was actually cut and informationally isolated. This maximized the invisibility of the battlefield and made it impossible for the commander to command the battlefield. The friction on the battlefield and the fog of war that Clausewitz emphasized are given to the enemy (Howard & Paret 1984). Thus, as Chapter V proved, the United States, as a hub state, was free from this uncertainty while physically isolating Spanish military from information and communication networks. And such asymmetric information network increased the military effectiveness of the U.S while decreasing that of the Spain's which led to the hub state-American victory in the Spanish-American War.[39]

[39] See Chapter V for detail explanation for process of the United State's military application of asymmetric telegraph network during the wars.

In other words, spoke states that depend on hub's states ICT cables and transmit information are vulnerable to military communications during a war. Hub states take advantage of this vulnerability by physically cutting the cable and blocks enemy access to military communications and isolates the command from deployed combat units. This behavior makes the combat difficult and reduces military effectiveness. Therefore, hub states that can use this strategy have an overwhelming advantage in conducting battles.

In addition, if a control over major hubs gets expanded by small number of states, and if they are soon to be hub states, they may have to provide cooperation with each other to take advantage of the weaponized interdependence. States that lack access or control over network hubs will not be able to exercise such type of enforcement. In further elaboration, with historical examples of weaponizing telegraph network shows how similar structural logic, while having several hubs play a key role, has developed through the emergence of highly asymmetric networks.

Therefore, this dissertation shows how hub states, especially the Great Britain, the U.S, and Germany, used the asymmetric information and communication network for panopticon or chokepoint effects in a military setting during the telegraph era, 1849-1914. Thereby, hub states can intensify the asymmetric interdependence on information flow and increase military effectiveness. At the end, hub states lead wars against spoke states with

asymmetric uncertainty of information flow.[40]

4. Proposition

ICTs directly affect inter-state information and communication flows. The diffusion of telegraph technology innovates speed, volume, and spatial range of information transmission and enabled to leverage information flow and inter-state communication beyond territorial sovereignty during the telegraph era. Of course, sovereignty issue was involved with regards to the infrastructure construction but compared to that of the previous transportation revolution—the railway and its network—it was quite free from the influences of territorial sovereignty.

An increase in the amount of information can help eliminate misunderstandings and alleviate conflicts through fast and accurate communication among states. Moreover, it was seen as an innovation in diplomacy tools in that it facilitated quick negotiations and cleared up misunderstandings quickly. Thus, the telegraph technology that strengthens the characteristics of ICT is expected to encourage and promise international cooperation (Finn & Yang, 2010; Nickles, 2003).[41]

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[40] When a control on the major hubs is expanded across small number of states, these states may have to cooperate in order to utilize the weaponized interdependence. States that are deficient to an access or control towards the hubs may not exercise such form of enforcement and sanctions. Due to the fact that hub states can exercise enforcement on others, they have network power. This dissertation presents how a similar structural logic in which several hubs play a pivotal role has developed with the emergence of asymmetric information networks through historical examples of the weaponization of the telegraph technology and its networks from the purview of military application of weaponized information and communication interdependence.

[41] Diplomatic practice before telegraph technology, 'Hand Carry' (from Ancient to Renaissance) The

In contrast, such a positive impact is possible only when information flows among friendly-identity states. When states have a network structure in which they continuously receive complex information and states share potential adversary identity each other, this increases uncertainty in relations between states and creates inter-state conflicts by bargaining failure (Fearon 1994;1995; Leventoglu & Tarar, 2008; Lindsey, 2020; Poweel, 2002; Schelling 1966). This phenomenon is explored by Waltz (1979) and Jervis (1976) known as the 'security dilemma'. The diffusion of telegraph technology reinforces the information complexity and also causes information asymmetry among states sharing identity of potential enemy in the telegraph era. This structural instability urges states to participate in conflicts. The weakness of this structure arises from information asymmetry, so hub states have advantage to utilize the asymmetric information flows. In the telegraph era, hub states win the international security competitions by occupying an advantageous position in the information networks.

Further, this dissertation asserts that causal mechanism of international conflicts id depend on whether the subject of information and communication is potential enemy or not and how certain states strategical use the ICT-driven network. In other words, contexts of identity and technology should be considered in the causal mechanism of information flow, inter-state

introduction of the electric telegraph did more to change the practice of international diplomacy than any other innovation in modern history. For the hand carry diplomacy see Lazzarini (2015), and history of diplomatic practice in terms of ICT, see Tehranian, 1997.

communication, and international conflicts.

Based upon the theoretical discussion, I propose the following proposition to answer the research question.

The international diffusion of telegraph technology creates asymmetric information and communication networks by distinguishing the hub and spoke states based on network externalities. Most of states share the identity of potential adversary to each other in the telegraph era, 1849-1914. The relationship between hub states and spoke states is defined as an asymmetric interdependence in the information flow and inter-state communication. In the asymmetric relation, hub states can leverage the asymmetric network to maximize the panopticon effect and chokepoint effect in inter-state militarized conflicts. Hub states' strategical weaponization of telegraph technology and the technology-driven network creates asymmetric uncertainty to information flow against spoke states This leads to the shift of offense-defense balance and hub states with increased military effectiveness easily decides to declare war against spoke states and advantageously lead the war. Therefore, hub states with offensive advantage are more likely to initiate and win wars against spoke states.

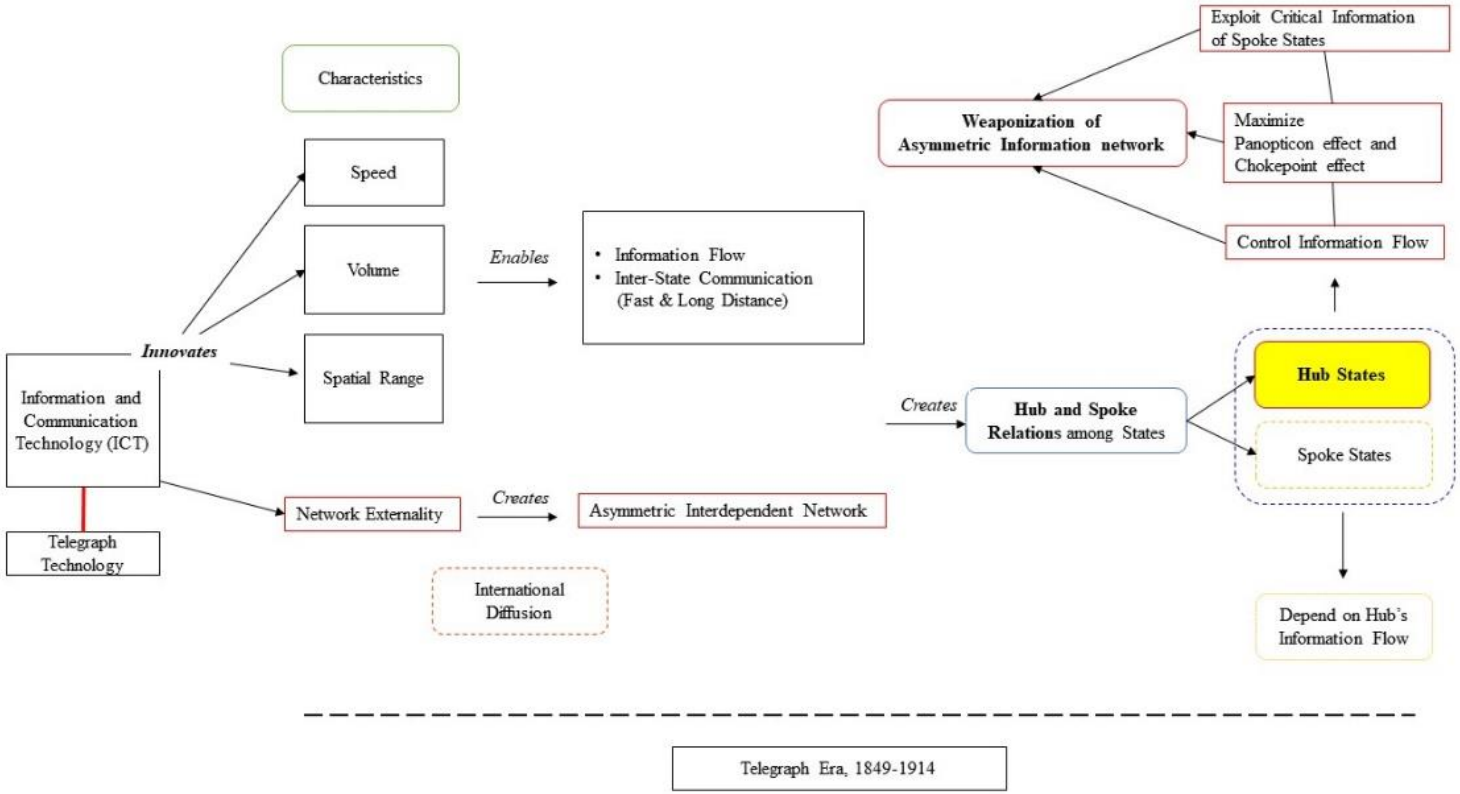

Figure 4: Theoretical and Analytical Frameworks and the Proposition

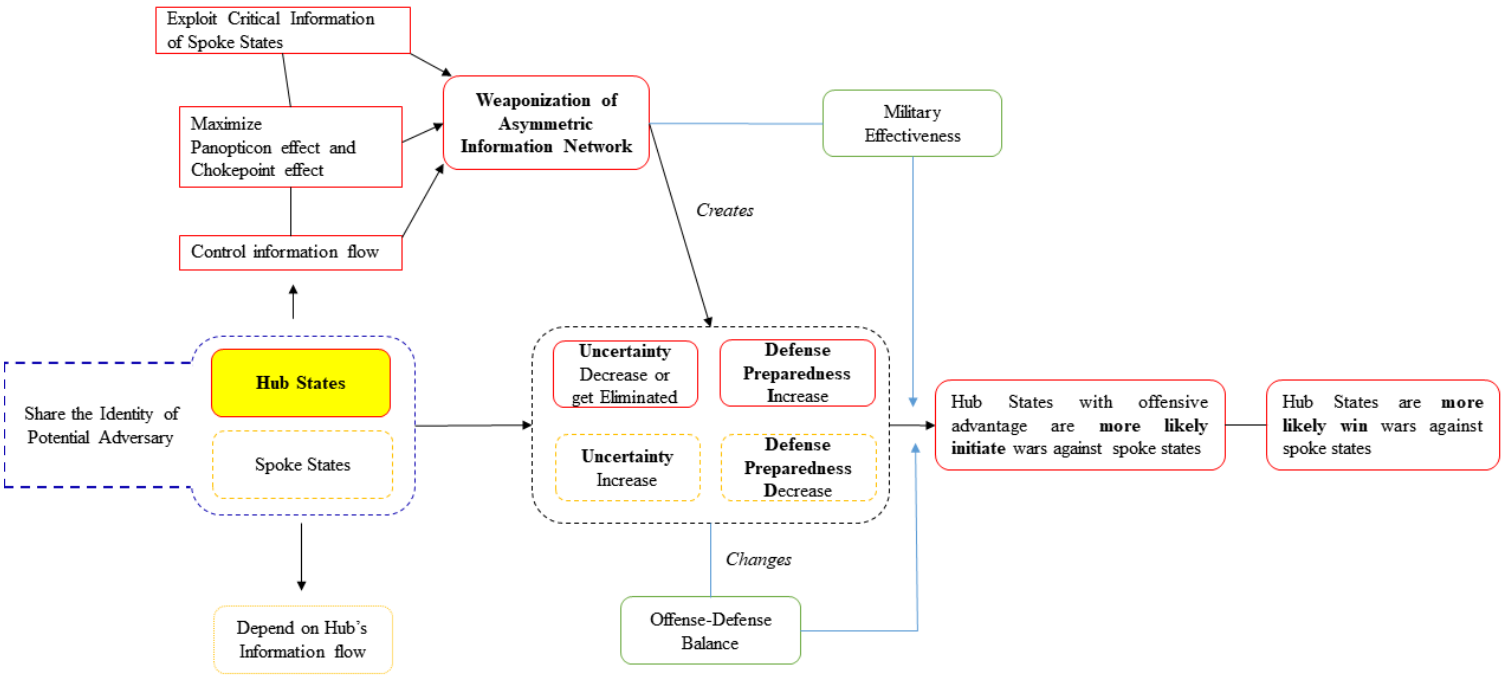

Figure 5: Theoretical and Analytical Frameworks and the Proposition

To empirically prove the proposition, derived from the theoretical discussion, I hypothesize two ways:

H(a.) Hub states are more likely to initiate a war against spoke states seeing military advantages of the panopticon and chokepoint effects derived from asymmetric interdependent networks.

H(b.) Hub states are more likely to win a war against spoke states as they take the asymmetric information and communication network advantages by removing uncertainty for hub states while increasing uncertainty for spoke states during a war.

I leverage a mixed-method research design to prove the above-mentioned propositions and hypotheses. This empirical design includes both process tracing case study and statistical analysis methods. In Chapter III, I further elaborate on the research design.

Chapter III. Research Design

This thesis investigates the impact of telegraph technology on international relations. The dissertation leverages a mixed-methods design to answer research questions. This chapter introduces historical cases, data, and methods.

1. Data and Case Selection

This dissertation is designed to delve into significant examples which transpired over the course of ICT developments, that is, the transnational proliferation of the telegraph from the mid-19th century to just before the outbreak of the World War I. Moreover, it mainly discusses the process of international security competitions that follows after this proliferation and also the outcome of asymmetric interdependent relationship between the network-privileged hub states and the network-underprivileged, peripheral spoke states. To this end, it presents a new dataset that allows to methodically analyze inter-state telegraphs and the asymmetry of the network (figure 6 & 12). The data covers a period coded from 1849 when German city-states, Prussia and Austria Hungary Empire were telegraphically connected and started to exchange international telegraphs in addition to the times when Germany and Austria Hungary Empire inked a treaty in the purview of international cooperation to 1914, just before the outbreak of the World War I and when

Ethiopia and Liberia were connected to the international network.[42]

In addition, the dataset is in accordance with not only the development of the inter-state and domestic telegraph network but also each state's capabilities of utilizing the telegraph in military operations over these periods. In summary, it considers the international network connection, the official international agreement and treaty related to ICTs, domestic-intrastate telegraph network and military application. Further, among states that are in the network's center of gravity, it suggests the states as hub states that can utilize the telegraph for militarized disputes.

[42] Ethiopia's domestic telegraph lines were introduced from Italy in 1890 and started its expansion between 1897 and 1904, connecting major cities. 1914 marks the complete connection to the international communication network for Ethiopia. In 1843, the first long-distance telegraph line from Washington, D.C. to Baltimore was connected in the United States and the first message was sent in 1844. The dataset of this dissertation considers both the connection of telegraph cables and the exchange of telegram but since it looks into the international relations scholarship, the time when the 'international telegraph' got connected and the exchange of telegraphs internationally initiated is considered as the starting point of data analysis. Therefore, 1843 is important on the point that it enabled the first vast distance communication but since the main focus of the dissertation is the inter-state communication connection, it uses 1849 as the main source of data analysis in consideration of the followings: telegraphic lines connected among Germany's city-states, the telegraph exchanged by Prussia and Austria Hungary Empire in addition to the times when they were connected and lastly, treaty inked between Germany and Austria Hungary Empire in the purview of international cooperation. The dissertation views that the international telegraph network is connected through this. Thus, 1849 was selected as the starting point since the data set of this dissertation considers both the 'international' connection of telegraph cables and the exchange of wires. It was the 1858's transatlantic telegraph cable that practically exhibited long-distance telecommunications across the continent. Since then, the telegraph network, as the first global information and communication network, enabled instant communication over vast distances. The maps, data, and methods of this research were built based on the data of previous studies and by adding the author's new dataset (Comin & Hobjin, 2004;2009; Finn & Yang, 2009; Freeman, Borgatti,& White, 1991; Headrick, 1991; Hunt, 2021; Kennedy, 1971; Lew & Cater, 2006; Jones, Bremer, & Singer, 1996; Johnston, 2021; Mitchell, 2007; Müller, 2016; Nickles, 2003; Wenzlhuemer, 2007; 2013; Winkler, 2008).

This section deals with the data and cases covered through the dissertation. After presenting empirical cases, the dissertation accounts for how it recorded the international diffusion of telegraph and its 'global' network.

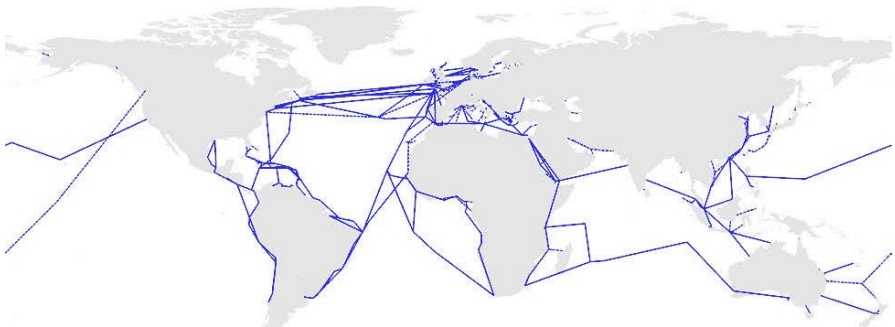

Figure 6: Global Telegraph Network (Based on Wenzlhuemer (2013) and Starosielski (2015), the Author illustrated)

With the invention and diffusion of electronic telegraph, significant acceleration of information transmission was possible by overcoming inter-state and trans-continental communication. The telegraph technology is the first enable technology for the fast and long-distance inter-state communication (Headrick, 1991; Horowitz, 2018). The telegraph technology was based on codes that include transmission units, such as the ground wire or insulation wire installed underground or undersea; and reception units; such as 'Morse codes' that can convert electrical stimuli into spoken language or ciphers, encrypted words. The portable field telegraphs that consist of receivers and insulated wires installed in trucks and other means of transportation were used the most in military operations. The commander-in-charge on the battlefield was able to communicate with the command center by using the telegraph transmitter. Thus, an actor with the upper hand in the

telegraph technology and its network, a hub state in the asymmetric network context, increases the military effectiveness by removing the fog of war (Clausewitz, 2003; Howard & Paret, 1984; Shapiro, 2005; McElwee, 1974; Rothenburg, 1976).[43]

The telegraph network allowed actors to communicate over greater distances at speeds significantly higher than those offered by 19th technology alternatives, because it was compared to that of any other technologies in the telegraph era, the network was properly functioning. Of course, the peculiarity of such network is the emergence of states' survival of the fittest due to the monopoly issue on top of the network externalities. The dissertation theorizes to explore this as the hub and spoke states' asymmetric information interdependence relationship.[44]

The international telegraph networks innovate speed of communication, volume of information flow, and long-distance communication compared to that of other means of communications.[45] As an example, it took 18 hours in 1867, two hours in 1872, and just one hour in 1877 to transmit the telegraph across the Indian subcontinent from Calcutta to Karachi.[46] The international

[43] See discussion and empirical analysis of the military effectiveness and asymmetric ICT-driven network, see Chapter II and V.
[44] See theoretical discussion of Chapter II.
[45] It also had a significant influence on a general-purpose technology that is, the electricity. Prior to the invention of wireless telegraph, telephone, and radio, electricity had never been used for other purposes in information and communication technology. It was not until the telegraph was put into practical use on an international scale that these technologies began to be widely used.
[46] The operation of early electronic telegraph was much slower and less reliable compared to that of the telegraph network based technologies and/or operations which will have improved over decades.

communication networks, which emerged due to the proliferation of the telegraph made instant communication over vast distances possible.[47] From 1860 to 1914, Telegraph network was exponentially expanded.

Figure 7: 1860s Telegraph Network (Telegraph Network figures are based on Wenzlhuemer (2013) and Starosielski (2015), the Author illustrated)

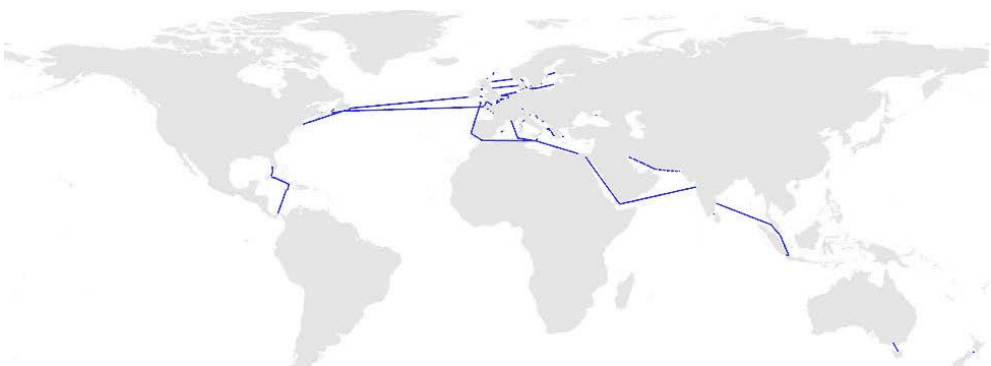

Figure 8: 1870s Telegraph Network

[47] See Wenzlhuemer, 2013, pp. 222–225, Jones, 1985, pp. 26–29 for more detail. Since the establishment of transatlantic undersea cable in 1858 and thereby the materialization of sending and receiving the vast distanced telegraph between continents, the global communication network expanded seriously, and the amount of data to be analyzed increased as well.

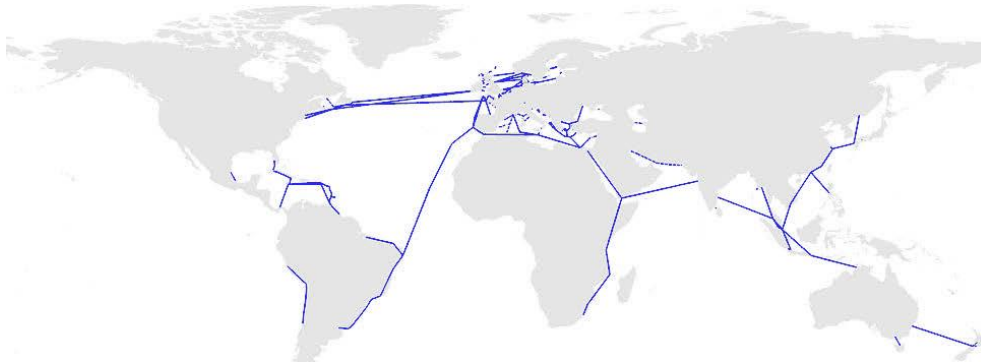

Figure 9: 1880s Telegraph Network

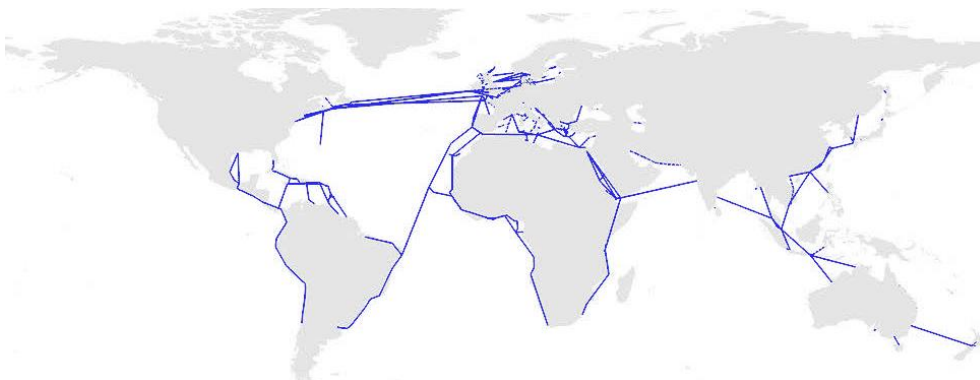

Figure 10: 1890s Telegraph Network

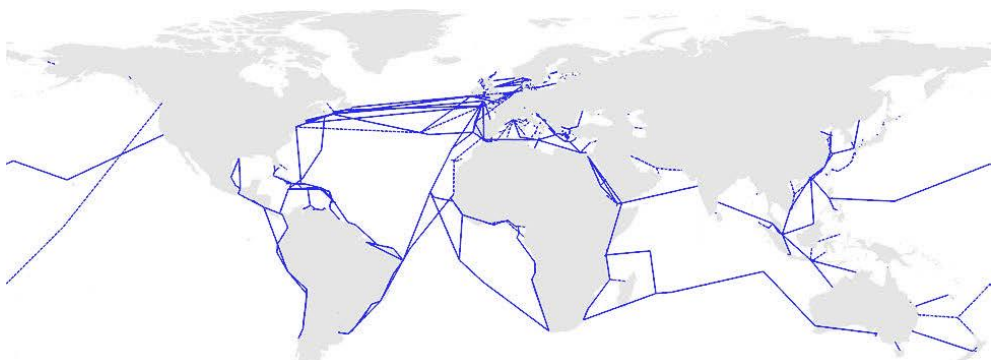

Figure 11: 1900s Telegraph Network

Further proof that international connections startled the volume of information that might be telegraphed over distance at great speed is provided by documentation of early telegraph usage around the world. Using cross-

national statistics from Mitchell (2007), shows a logged count of telegrams reported being transmitted either domestically or overseas in each year following a state's initial international connection. This has been coded to a dataset which will be introduced later.[48] As explicitly shown in Wenzlhuemer (2013) and Starosielski (2015) data and researches, immediately after the international network connection, exponential growth rates of telegraph were recorded.[49] This establishes credence to the fact that the emergence of telegraph caused unprecedented upheavals in terms of the immense savings of time through high-speed communication in addition to the number of states participating in communication. Through this, tracing and exploring the diffusion of telegraph and the resulting actions of state allow us to understand the causal relationship of how information and communication affect the behavior of states and consequently, the international security competition as well. Delving into the diffusion of telegraph technology as well as the asymmetric information network created by it and the process of strategic actions taken by the states shows the causality of international security

[48] In Comin & Hobjin (2004; 2009) the ×1000 v ×0.001 scale used by Mitchell (2007) was incorrectly referenced, where it rectified the digitized version of telegraph usage time series of the Cross-country Historical Adoption of Technology (CHAT) dataset. See https://github.com/onesuncho and https://sites.google.com/view/onesun/ for the Appendix.

[49] In order to collect evidence that a state's incorporation into the global network and its position within affects the percentage of usage, future replications of this study were based on statistical figures such as connection degree centrality or of the relationship which resulted to an analysis on the changes over time of international network's centrality in addition to state's telegraph usage. Existing literature also proved that telegraph effectively and immediately affected the world in other social phenomena such as price volatility in the Atlantic wool market (Lew & Cater 2006; Steinwender, 2018). In particular, Lew and Cater (2006) empirically revealed that global commerce grew when telegraph technology coordinated with tramp shipping. This reinforces the liberals' point of view, but this dissertation shows that the increase in telegraph technology has eventually resulted to an asymmetric network structure where it increased the number of conflicts as certain states, such as 'hub' states, leveraged them for military purposes.

competition, increased amount of information shared and the increase of conflicts between states.[50]

This research design carefully considered the potential confounding variables that influences when the drawing conclusions. Although this study does not argue that the identification of causal relationship is only possible through the statistical and quantitative methodologies used here, but the consistency of data and the results of this dissertation throughout multiple analyses gives credibility to the causal relationships, or at least the nexus among variables, discovered in the dissertation. In addition, the historical case along with the statistical analysis, will further strengthen the argument of this dissertation.

Additionally, if the statistical results prove that the diffusion of ICT increases inter-state conflicts in the telegraph era, then it means that the increasing information flow and information complexity are interrelated because this is mainly because the counterpart to communicate with has a potential enemy identity with geopolitical context in the era. Based on the theoretical discussion of the dissertation, increasing communication and information flow among potential enemies creates information complexity and it may result to wars due to inter-state bargaining failures that is from

[50] This spread of ICT enabled rapid vast-distance communication of states, which strengthens the validity of the hypothesis that the diffusion of telegraph in addition to the behavior between states that cause inter-state conflicts are connected to causal relationships as found in this dissertation.

information complexity with potential adversaries.

Further, spoke states feel intimidated from the potential enemy hub states, since they rely on the new asymmetric information network emerged from the telegraph diffusion. In this respect, delving into the competition by spoke state which does not possess telegraph technology while having a limited access to the information network yet relying on the hub state for access to information flow and communication networks, can also provide an understanding of how that particular state behaves within its structure and conducts weaponization. The causal relationship between ICT and international security competitions is logically solved with a theoretical discussion and empirical analysis. Also, in purview of weaponized the asymmetric telegraph network and hub-spoke relationship, the dissertation conducts the theoretical and empirical analysis of the process of forming such asymmetric structure and the process and outcome of international security competitions in the formed asymmetric interdependent network.

The telegraph technology and its network are a befitting example to verify the proposition and hypotheses of this dissertation because of its characteristics of ICT in network industry. First of all, the telegraph was used to convey the gist of the message since the information was delivered only in writings and as the number of characters in telegraph increased, so did the

expenses.[51] Furthermore, given that the state does not need to completely reform its bureaucracy or military system to deliver information through telegraph, not any revolutionary or institutional change required by the telegraph but its speed can be trusted to account for the immediate change in conflict patterns that occurred after its introduction. Therefore, the data of the dissertation was collected from the moment telegraph was connected between states.[52]

Unlike with other technologies that show the effects after the acceptance of technology and consequent introduction of related systems, a telegraph technology is effective from the moment it is connected with network externalities. As soon as the telegraph technology is globally diffused and telegraph networks are connected internationally, states involved introduce an information and communication network while the asymmetric network at the global level is formed by creating hub and spoke relations among states. Therefore, there is an increase in flow of information asymmetrically shared between states.[53] Moreover, since states gradually adjusted the information

[51] Of course, as ICT develops along with its infrastructure, the price of telegraph becomes cheaper, and the performance gradually becomes better. Additionally, telegraph technology was widely used because it was able to transmit a vast-distance and content immediately, and accordingly, the amount of content transmission increased, see figure of telegram usage graph.

[52] In order to emphasize the technology and international relations, the dissertation deems inter-state telegraph connection important. It classifies the hub and spoke states that are in the asymmetric information interdependent relationship due to matters such as telegram usage and infrastructure connectivity. Moreover, since it is a relation in international arena, variable like cooperation is also considered. From the first inter-state information and communication related treaty called Prussian and Austro-Hungarian Treaty to major international treaties until 1914 are included in the data set for consideration. However, since the data is much smaller than the connection of telegraph network, this will be confirmed when assessing the increase of cooperation. It is because of the assessment that the increase of treaties and registration to international organization will surely affect the relationship of ICT and international conflict.

[53] These historical evidences can empirically prove the impact of the increase in information flow

processing systems in response to the pressures that comes from eye-opening transmission speed of telegraph, decades of post-telegraph cases can be examined through changes in the applicable agency's pace of development which took the advantage of improved technology. Hub states, which successfully militarized these and leveraged those in security competition is delved into.

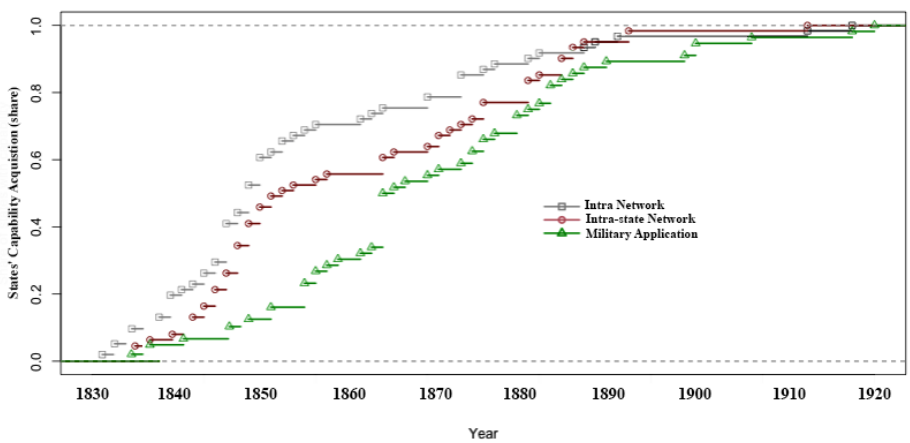

Figure 12: International Diffusion of Telegraph at Intra, Inter, and Military level

For each state's Correlates of War (COW) data from 1849 to 1914, this dissertation established a dataset that codes the year of acquisition of telegraph technology into three phases: domestic network, inter-state network, and military application. The sources used to corroborate the data primarily include telegraph service maps, nomenclature, periodicals, International Telegraph Union, and the publications of subsequently established International Telecommunications Union under the auspices of the United

among potential enemies on the international security competition. Also, in terms of process, hub states' military application of telegraph-driven asymmetric network shows the detail process of international security competition to prove the asymmetric network's strategical advantage for hub states.

Nations, as well as extensive technical, diplomatic and military history that was published in different languages. The diagram in Figure 12 visualizes the diffusion of the telegraph over time at the domestic, inter-states, and military levels. This is based on the acquisition of telegraph management skills at each level operationalized in this dissertation.

Intra-state / Domestic Networks

Telegraph lines were first used for rapid and direct inter-state communications between states. Domestic networks were created and operated by the public and private sectors allowing the public, media, businesses, and state agencies to communicate with each other more rapidly. The main aspect of the domestic networks is not only the geographical distribution of the networks but also the amount of telegraphic traffics processed and whether state agencies were privileged with an access to the network as well.[54] This dissertation assumed that such an approach represents a state's ability to use domestic telegraph networks for official communication and the possibility to use the network strategically for the military purpose.[55] Technically speaking, the year in which the capital city is connected to other cities or borders has been coded for each country.

[54] Mitchell (2007) addressed the issue of inconsistent reporting methods with sources of telegraphic data used in other studies. As Comin & Hobjin (2009) did, They exerted efforts to characterize changes in practical telegraph use with CHAT data set. Local and domestic telegraph network maps exist in various ranges, but there are no archive of changes that occurred every year. Therefore, opposed to meaninglessly demanding the level of accuracy, network data, in reference to a particular region is used.
[55] Chapter V's case study covers the dynamics.

Inter-state network

Direct telegraph network connection among states have become possible since governments and telegraph messenger started to address inefficiencies caused by the international telegraph system in Western Europe which was still in its early stage. Prior to the international telegraph networks, for instance, French-German information and communication network was operated by sending messages to border stations where then messengers took it by hand and crossed the border to deliver them to neighboring states. After the emergence of telegraph technology, rapid construction of telegraph wire in addition to international connection brought about various opinions of such connection among states. With this backdrop, the ITU was established through the collection of multiple bilateral agreements that coordinates technical, commercial, and political conditions of international transmissions. It was the first international organization to have a permanent secretariat, and was launched to facilitate a rapidly growing, interdependent global network. After establishments of the ITU, inter-state telegraph networks started to be institutionalization[56]

For the statistical analysis, this dissertation coded the year when telegraph lines or undersea cables were installed to directly connect the inter-

[56] Institutionalization brought standardization and hub states were able to better leverage the network power based on the network externalities. This will be further elaborated empirically in Chapter V. See Chapter V's background section for more detail explanation.

state networks in a particular territory where no connection existed.[57] As seen in Figure 12, an inter-state telegraph network graph for any year based on this data, allows states to generate time-varying quantum-level indicators of when states with other state's actors have the access to direct or indirect telegraph networks.[58] Through this, it allow to clarify states' connectivity by confirming whether the states' link to international telegraph networks or not.[59] In addition, the asymmetric interdependence on information flow between the hub and spoke states can be confirmed emphatically through the international telegraph network connection.

Military Application

Lastly, due to the importance of the state's ability to declare war and manage them in relation to effective bargaining it is necessary to check when the military obtained telegraph technology and its network for the purpose of

[57] This means that the dissertation coded the establishment of new direct connections between states and then drew indirect connections from the data. For example, the U.K was directly connected to France in 1851, and France was directly connected to Spain in 1854. As a result, the U.K and Spain was coded for not only in 1874 when the undersea cable was installed for direct connection but also the indirect connection in 1854.

[58] The fact that diplomacy continued as a face-to-face business would be useful. The Ministry of Foreign Affairs used to wire encrypted instructions to diplomats dispatched abroad, which delivered diplomatic negotiations or behavior guidelines in accordance with its traditions. A great review of historical cases can be found in Nickles (2003).

[59] The prototype of Inter-state network first appeared in Europe which is the first connection between the Germany's state of Baden and the principality of Hesse in 1846, but this research consider 1846's networks as domestic network limited to the Germany. Even if there a network was connected among states before the first international treaty in 1849, the official interaction is still considered to be the one in 1849 when the Prussia and Austro- Hungarian empire connected by telegraph line. The Prussian and Austro-Hungarian Treaty confirmed the first inter-state interaction concerning telegraph technology and its network. This network remained the largest component of the international telegraph network after its expansion. Other than this, small independent inter-state networks have emerged at the regional level. Argentina, Chile, and Uruguay established a network in 1872 before connecting to Europe via Brazil and Portugal, and in 1879 Central American states established a network, which was incorporated into the international network in 1882.

coordination between field commanders and decision makers To analyze the prospect to leverage the telegraph and its network for military purpose, this dissertation coded the first year in which the military of each state explicitly showed its capabilities or operated telegraph lines for operational purposes after its systematic establishment. Generally speaking, operation capability of military telegraph when in its early stage required minimum power and consisted of the followings: ground vehicles to deliver the to-be-installed insulated lines, naval ships, and devices on the field with reception-transmitter functions at both ends. Also, this approach considers strategic advantages of military application of the militarized networks.

The data in a quantitative analysis part include an example of military using telegraph via domestic networks for unit dispositions, such as the Great Britain's use of communication networks established in colonies during the second Boer War for military purposes, and an example of advanced telegraph command network in other states' territory that shows military capabilities, German troops situating in France in 1870-71. The military use of these networks can be seen as an example of maximizing the panopticon and chokepoint effects, which eliminate their own uncertainties from the war while increasing the uncertainty of their opponents, and also serves as a direct example of the military involvement of asymmetric networks.

This approach also includes examples of telegraph transmitter that were institutionalized by the military, although not to be placed in theater of

operation. This does not mean that the invention of field telegraph itself is already equivalent to a direct telegraph connection among all commanders, commands, commander-in-chief, or other heads of state. However, the coding presented in this quantitative analysis section shows an increase in the telegraph operation ability of armed forces to communicate within its chain of command in terms of military effectiveness (Biddle 2010; Horowitz 1970) and the asymmetric interdependence network advantages. Thus, through its usage, opponent's defense preparedness gets dissolved, and the military effectiveness gets increased by strengthening the offensive advantage. States capable of using the network for military purposes is limited to hub states and has a bigger possibility to lead the tide of war advantageous to them.

Further analysis, this dissertation selected multiple cases of war conducted by hub states that is to be covered in Chapter V's qualitative studies to investigate the process of weaponization of asymmetric telegraph networks during the wars (Seawnght & Gerring, 2008).[60] Based on network analysis and literature review, the dissertation chose the Great Britain, the United States, and the Prussia- Germany as hub states to explore the process and result of military application of asymmetric interdependent network against spoke states in the telegraph era (Drezner et al, 2021; Farrell & Newman, 2019; Headrick, 1991; Hunt, 2021; Johnston 2021; Nickles, 2003; Müller

[60] Also, it explores whether the information network superiority provided by telegraphic operation capability explains the association presented as basic evidence even in part.

2016; Sherman, 2021; Starosielsk, 2015; Wenzlhuemer, 2013; Winkler, 2009).[61]

Thus, in order to analyze whether the theory of this dissertation and the introduced cause works as a mechanism, this research selected archetypal cases that hub states' victory was determined through operation capability of telegraph technology and weaponized asymmetric interdependence. This study also reviews 'untypical' cases including the competition between Germany and France. French frequently used telegram and the telegraph infrastructure was widely constructed. however, it was not effectively used in war. Meanwhile, Germany effectively used the network in war against France which increased the asymmetry and maintained dominance in information.[62] At the end, its institutionalization allowed Germany to advantageously lead the war. The case of Germany's military application the network is an 'archetypal' cases where military application of asymmetric interdependence on information flow was effectively utilized. Also, it delved into whether or not the militarized institutional differences and military application for

[61] For more detail explanations why the dissertation chose these states as hub states, see Chapter V. Another examples of this dissertation's approach may apply are the use of telegraph by the United Kingdom, France, and Russia in the Crimean War (1853) and the use of telegraph by Paraguay, Brazil, and Argentina in the Paraguayan War (1864).

[62] France can also be seen as a hub state, considering only the length of infrastructure and the amount of telegram transmission and reception in the 19th century telecommunications network. However, as a result of adding the military use of the telegraph emphasized by the dataset constructed by this dissertation, France in the 19th century cannot be regarded as a hub state. This is because the military use of France's telegraph network was quite limited to compare to the military application of telegraph networks from British Empire, the United States, and Germany. When network analysis is conducted considering all of the intra network, inter network, and military network, the result is that the hub state is narrowed down to the Great Britain, the United States, and Germany during the telegraph era (Johnston, 2021; Starosielsk, 2015; Wenzlhuemer, 2013; Winkler, 2009).

telegraph technology and its networks during the German Unification war played an important moderating factor for the effect of the telegraph on military effectiveness. Therefore, it assesses the military effectiveness of the asymmetric network used for military purposes theorized by this dissertation. The empirical research proves that the military use of the panopticon effect and the chokepoint effect directly affects international security competition, rather than being used just as a simple economic statecraft.

2. Research Methodology

2.1 Quantitative Analysis: Statistical Description and Matching Methods

For the systemic investigation that international telegraph diffusion's impact on international relations, this dissertation begins with using descriptive statistics and matching methods to analyze the effect of state dyads' acquisition of inter-state telegraph connections on international cooperations and conflicts outcomes. By empirically analyzing the existing causal mechanisms, the dissertation also aims to theoretically contribute to discussions on the relationship between ICT and international security.

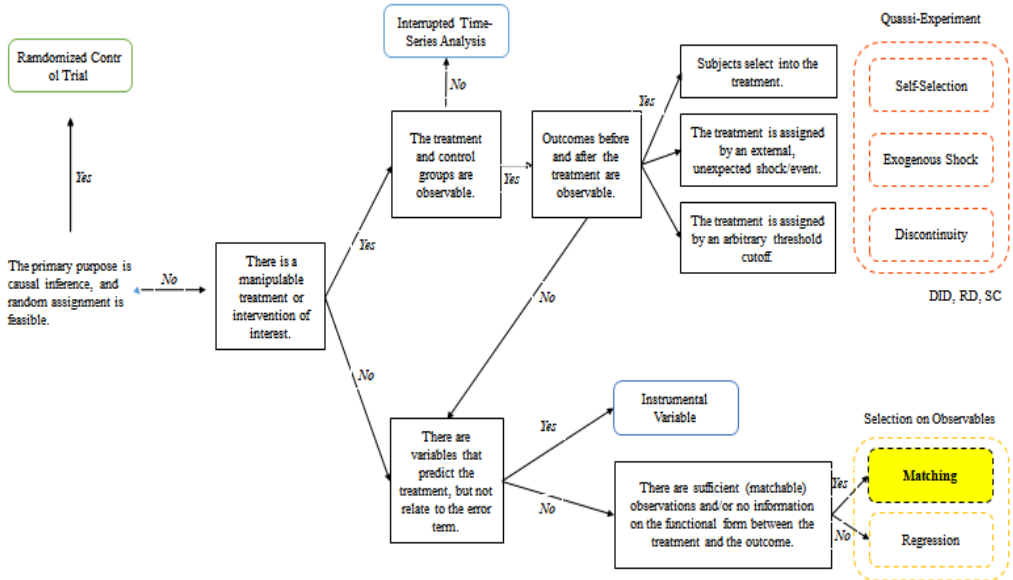

Figure 13: Quantitative Research Design for Causal Inference[63]

As theoretically discussed above, in the literature on information, communication, and international conflicts, there is a general consensus of causal relationship between them. However, the results are not the same by dividing optimistic and pessimistic views, so there is a theoretical gap in the existing literature.[64] To fill this gap, this dissertation further aims to explore the relationship between conflicts and the global proliferation of telegraph and its network using a systematic approach with empirical data. Therefore, the dissertation contributes by methodically analyzing the discussion between the two extremes on how ICT affects existing international conflicts.

In view of the characteristics of ICT based on the offense-defense

[63] Original source is from Park (2021) Korea summer session on causal inference. I participated in the workshop and learn causal inference research design.
[64] In accordance with the difference of the results, the dissertation classifies two views: optimistic and pessimistic. See Chapter I & II.

balance theory and asymmetric interdependence theory, the relationship among states' introduction of the telegraph and conflict results are delved into. To this end, this chapter provides many statistics delineating whether or not and how the results of conflicts between states have changed, assuming that the information flow between two states have increased after telegraph network connection. Then, in order to estimate the correlation between the introduction of telegraph and conflict variables more accurately, matching techniques were used to minimize bias that may arise out of observable confounders and, to strengthen the reliability of causal interpretation. The sampling strategies and methods of this dissertation is from Wenzlhuemer (2013), which dealt with the telegraph network and globalization in terms of the network analysis, Farrell and Newman (2019), which dealt with the asymmetric network and states' behavior, and Kenwick, Vasquez, and Powers (2015), which dealt with the impact of alliance treaties on conflict behavior between two states. The research's baseline sample is based on all years of bilateral relationship, such as the one present in COW data through the years of first direct or indirect telegraph connection of two states, which dates back to 1849, the first inter-state networks were formed which demonstrated the feasibility of speed and long-distance inter-state information and communication network. Therefore, this standard's sample consists of a 'treatment year' in which the two states were first connected by telegraph,

and a ‘control year’ where it includes all the years prior to the connection.[65]

Through statistical analysis, this section aims to measure the changes in behavior of conflict that occurred within both states over the course of the period of before and after the connection of telegraph. Therefore, main analysis unit was defined for the 10 years and plus one year of bilateral relationship. The bilateral relationship with observed year as t in the center, includes the t-5, which is 5 years behind the observed year, to t+5, which is 5 years ahead. In consideration of the possibility that two states may have been influenced by the telegraph for a period of less than 5 years or longer period, this research repeated the analysis in the additional 9 samples. The additional samples' observable period of the bilateral relationship varies from 1 to 10 years, starting before and after the connection of telegraph.[66] Moreover, beyond simple bilateral relationship, a state that takes the hub position in information network and a spoke state that is in subordination is separately

[65] For example, when two states were first connected, Australia and New Zealand appears as a control group before 1876, and as a treatment group after 1876. In addition, China first entered the international telegraph network in 1871, and when two states were first connected, they appear in this sample as a control group before 1871 and as a treatment group in 1871. China’s cable connection was related with sovereignty issues. At the time, China’s undersea cable was inconspicuous and they mobilized all available diplomatic resources to gain Chinese approval. In 1871, the Great Northern Telegraph Company extended the line from Wusong Harbor to Shanghai with no official approval from the Chinese Government (Wei, 2019). As demonstrated in the case study, in reflection of the fact that the state that is subordinate to the information network gets more involved in conflict and has higher possibility of losing in the conflict, shows that the infringement of China’s cable sovereignty was a serious security threat.

[66] This, as suggested by Leeds and Johnson (2017), with regards to selecting the 5 years with different context, responds to the concern that the potential result may be sensitive. In the case of this study, before and after a particular state gets incorporated to the international network, a decision to test the conflict behavior changes over decades gets justified in line with the practical logic. As dealt on the empirical discussion chapters, after the state’s incorporation to the international network, for the first ten years, due to the drastic increase of telegraph usage in home and abroad, the influence to the conflict from the shock that is derived out of communication’s speed can be observed.

examined. In other words, the test is conducted again focusing on hub and spoke relations among states.

Therefore, this dissertation conducted ten analyses by analyzing the twenty years and plus one year of bilateral relationship that includes the observation year and its ten years of before and after, beginning with the three years analysis of bilateral relationship that separated the hub and spoke relationship; additionally, those that were not separated, which includes the observation year and before and after of the one year. In order to ensure that the dispersion of the control group's observation outcome relates to unobserved determinants, and that treatment selection or results do not bias the estimates of treatment effects, the research excluded the analysis units of the treatment group from each sample and the overlapping period of bilateral relations.[67] Moreover, hub and spoke states were classified in accordance with the international telegraph diffusion based on the network analysis and literature review. Also, this analysis explores whether or not the spoke states subordinate to hub states were invited to war by hub states or more wars transpire in other relationships are discussed as well. Then, the dependent variables related to the inter-state conflicts results accounted by the

[67]. However, although the methodological strategies embarks from Kenwick, Vasquez, and Powers (2015); Farrell and Newman 2019; Wenzlhuemer (2013), but still it did not limit the control samples to the period that does not overlap. This increased descriptive statistics' accuracy and increased the sample size while maximizing the possibility that the matching procedure in this study yields a subset of (weighted) control units with optimal covariant balance. Furthermore, zeroed into the military usage of asymmetric interdependent network, that is the hub and spoke relationship among states during the telegraph era, various network analysis result connects to the exploration of international security competition process and its results.

hypothesized telegraph and its network in this dissertation was coded by using the version 5.0 of COW Militarized Interstate Disputes data (Maoz et al, 2018;2019; Palmer et al, 2022).

The number of military conflicts (DV) between the two states that began before and after the observation of each analysis unit was coded to test the relevance (Ha) between telegraph connection and militarized conflicts of hub states and subordinated spoke states, and also between other bilateral relationship.[68] Over the course of before and after observation, this dissertation coded the number of military conflicts intensified to the level of threats and crisis, display of force, use of force, and inter-state war (DVs) between the two states.

The descriptive analysis was conducted by considering the analysis unit samples of treatment and non-treatment during each observation's length of period. That is, the bilateral relationship period consisting of one to ten years before and after the observation year. For each dependent variable, this dissertation compared the frequency of meaningful conflict results that occurred within five years before the procurement of telegraphic operational capabilities to that of the next five years.[69] If the telegraph mitigates the information and commitment problems with adversaries, it can be predicted

[68] In the statistical analysis, the study coded this variable into a version that includes only MID state of initiation and another version that includes both states of initiation and participation.
[69] This study repeated each stage that is described here for each observation period from one to ten years with focusing hub and spoke states.

that the two states' treatment groups will experience fewer conflicts, which supports optimists' arguments. On the flip side, if the telegraph exacerbates this problem, more bilateral conflicts can be predicted, and pessimists' arguments are supported.

In order to verify this proposition, this dissertation classified the period of bilateral relations into the following four categories, namely: no conflicts before and after the telegraph, conflict-increasing, conflict-decreasing, conflict-maintaining, and conflict-free (Jones et al, 1996). After that, the observation distribution across these four categories was verified and compared with that of the observation of the control group. This statistical analysis revealed that there was a statistically significant difference in the observation distribution between the experimental group and the control group, suggesting that the introduction of telegraph or subsequent changing factors after the telegraph affected the outcome of the conflict.

The descriptive statistics were then developed through secondary analysis using nonparametric matching method. In this way, factors that cause the state to choose to procure telegraphic operational capabilities can also solve the selection bias caused by the possibility of being related to conflict behavior and estimate the average treatment effect (ATT) of the treatment group. For instance, due to the increase of bilateral trade in accordance with the flow of a particular period may make both states to “select” treatment group. In other words, a possibility of belonging to the treatment group arises,

since states desire stronger economic ties and so establish more effective communication means, such as the telegraph. This also affects each country independently in changing their behavior during the conflict. This is because states want more or less conflicts due to economic conflicts or interdependence. If telegraph virtually increases the bilateral conflict, all positive and negative effects of commerce on conflict will lead to higher or lower descriptive estimates than the actual telegraph-to-conflict relevance.

In order to estimate the causal effect of military application of telegraph network on conflict behavior more accurately, this research selected a methodology to classify the experimental group with to the factors that lead the state to install telegraphs randomly. The matching method applied in this research copes with the problem by ensuring that the experimental group and the treatment group are balanced against the observed covariates in the selection of the experimental group (Ho et al., 2007; Iacus, King, & Porro, 2012). By pre-processing the sample through valuation of the observations as high or low weights in order to estimate ATTs similar to those obtained if the analytical units were randomly allocated in experimental and control groups, this study draws out ATT interest parameters that show reliable causality while mitigating concerns about uncontrolled bias. This also has the advantage of not having to make parametric assumptions about the function of the relationship between the covariate and the allocation to the treatment group. This empirical analysis afterwards deals with the actual reliability of

negligence assumptions that evaluate whether our parameter of interest represents a causal relationship.

That is, the study made an attempt to confirm that the unobserved covariates associated with both military usage of telegraph and conflict behavior did not affect causal inference. For matching, this dissertation identifies the following variables that can cause direct and indirect telegraph line connection between the two states, which explain change in conflict outcomes that is, the selection as an experimental group.[70]

'Hub and Spoke Relations' (hubspokee.rel.): It is an indicator of the relationship between hub states that possess high network centrality which is considered as the 19th century's information and communication technology by the proliferation of telegraph technology, and strong influence on global information and communication infrastructure and spoke states that must rely on the network to utilize telegraph.[71] 'Decade': An indicator of 10 years of observation year. 'Distance' (dist.): An indicator that shows the distance of two states' territory whether it is 1,000km apart or more (Stinnett et al. 2020). 'Previous International Connection Network' (Inter.): An indicator that shows whether at least one of the two states is directly connected to a third state

[70] Appendix has the results of a model showing that these variables predict experimental treatment. Through future repetition, the study will justify the inclusion of this covariant and seek alternatives.
[71] Ensures that cables controlled by hub states are connected to spoke states and that information and communication usage in spoke states is from those cables. That is, the spoke states' flow of information transpires in networks where hub states have strong presence, and hub states can use this as a leverage to compete in international security race. It is also an indicator that shows the position of hub and spoke states. See https://github.com/onesuncho and https://sites.google.com/view/onesun/ for the Appendix.

before the observation year. And it includes the proximity with international network. This indicator that shows whether at least one of the two states was within 150 miles of the territory of a state directly connected to a third state prior to the observation year. ‘Previous Intra Telegraph network and Operation Capability’ (Intra): An indicator that shows whether at least one of the two states had domestic network or operational capability of military telegraph over a third state before the observation year. ‘An Indicator for Information Communication Technology Cooperation Proxy’ (inter.net.): An indicator that confirms whether the network hypothesis in the observation year was a direct telegraph network presenting that the two states reached a final agreement on telegraph cooperation. ‘The Proximity on Intra Telegraph Operation’ (inramilitary.net.): An indicator that shows whether at least one of the two states was within 150 miles of the territory of a state with operation capability of military telegraph or its Intra-network circulation prior to the observation year. ‘History of Military Conflict’ (mid.): An indicator showing whether two states have participated in military conflict against friendly or enemy state in the past 5 years (Palmer et al. (2015) and Maoz et al. (2019). ‘Form of Alliance’ (alliance.): An indicator showing whether two states forged an alliance with the third state or the same ally prior to the observation year. ‘History of Alliance’ (alliance.hist.): An indicator showing whether two states allied with a new third state or by themselves in the past 5 years (B. Leeds et al. 2002). ‘Mutual Diplomat Exchange’ (diplo.ex.): An indicator showing whether two states mutually exchanged the diplomatic

representation. ‘Mutual Trade’ (trade): An indicator showing whether the commercial exchanges was archived prior to the observation year. ‘External Trade’ (trade.ext.): Categorical variables showing the level of commercial exchange each of the two states has had with the third state prior to the observation year.

Lastly, the dissertation used Python, TensorFlow, and R’s MatchIt package (Ho et al., 2011) to confirm the maximum balance between covariant variables across the experimental and control groups, providing after treatment of the observation period from one to ten years for each sample. Through this, it was possible to estimate the ATT of the two-way systemic connection between each dependent variable of this study for the length of each observation period.

2.2 Qualitative Analysis: Process Tracing Case Studies

This dissertation shows how the contexts of technology and identity work on conflicts between states and especially highlights on the correlations with war. Furthermore, the dissertation notes on both the strategic usage of technology and the asymmetric networks created by technology. To this end, this dissertation attempts to conduct a process tracing case study methods.

Historical case studies are conducted through literature review of the relationship between ICT and international security. Asymmetric networks emerge in the 19th century in accordance with the characteristics of telegraph

technology, and hub and spoke states were differentiated. The dissertation plans to see the process of how hub states use asymmetric networks in a military setting to wage war.

In order to analyze the network industry and international relations, it is necessary to understand the power that derived from the asymmetric interdependence network. ICT infrastructure and institutions are explicit criterion for differentiating hub and spoke states but theoretically, they are divided according to network position. In particular, with the spread of ICT, centralities that are accessible to the information flow is crucial in asymmetric networks. The degree of centrality is determined by the telegram usage and infrastructure and hub states definitely possess the institution to properly use them. Hub states were selected in Chapter V, and also further elaborated. Also, network externalities solidify such asymmetric structure, allowing the monopoly of information flow by certain actors. Based on this, hub states such as the Great Britain, the U.S and Germany which gained superiority in security competition by successfully utilizing the asymmetric information and communication network were selected among the states with highest degree of centrality.

In addition to the theoretical framework for analyzing asymmetric networks, the process tracing case study method (Beach & Pederson 2013; Bennett, 2010; Bennett & Checkel 2015; Bennett & Elman, 2006a; 2006b; Bennett & George, 1997; Blatter & Haverland, 2014; George & Bennett, 2005;

Mahoney, 2015) was selected as an analytic methodology to explore the impact of weaponization of ICTs and asymmetric information and communication networks on the international security competitions during the telegraph era. The process tracing method aims to identify the causal relationship of the event or phenomenon selected for the study. This method can be used as a means to verify existing theories or to explore whether or not the analysis of causal relationship established based on the existing theories is right or wrong. Additionally, it can be used to develop new theories or complement the existing theory. This can also help rectify the hypotheses by identifying the overlooked parameter that exist between the independent and dependent variables and further complement the theory and further use them to explain the results (Beach & Pederson 2013; Bennett, 2010; Bennett & Checkel 2015; Bennett & Elman, 2006a; 2006b; Bennett & George, 1997; Blatter & Haverland, 2014; George & Bennett, 2005; Mahoney, 2015).

When the existing discussion is expanded and applied to the telegraph network, its effectiveness will be identified. Whether or not the utilization of the network was critical over the course of the conflict will be considered as if meticulously sifting or removing some wheat. It studies the conflict between the Hub states, Germany, and France; conflict between the Hub and Spoke, Germany, Denmark and Austria; the U.S and Spain; and as the dominant Hub state, the strategy of Britain and how the network is utilized by individual Hub states to solidify its position on the security competition.

This dissertation intends to analyze the influence of information and communication on the dynamics of international conflict and how states behave in these influenced dynamics. To this end, this thesis selects telegraph technology among ICTs.[72] The characteristics of ICT can be divided into technical and network characteristics. For the technical characteristics of ICT are increasing and expanding of speed, volume, and spatial range of contents transmission. Among many ICTs, the representative technologies that have achieved innovation in these elements are telegraph and fiber optic cable systems. The telegraph technology innovates in these factors and is important as it is the first to connect countries in terms of information and communication. That is why scholars usually see the diffusion of telegraph technology as the first globalization (Allison, 2003; Headrick, 1991; Müller, 2016; Müller & Tworek, 2015; Steele & Stein, 2002; Wenzlhuemer, 2010; 2013; 2015).[73]

In addition, great powers use various methods to lead international security competition in the international system of increased information complexity and uncertainty of other's intension as spreading the telegraph technology. Among great power's behaviors, this dissertation categorizes the use of telegraph technology and analyzes how hub states weaponize their

[72] This dissertation focuses on ICTs as opposed to other systemic technologies because of their characteristics to become more pervasive as their user base develops, a phenomenon known as the network externalities. In contrast to the utility value of expanding gas or water pipelines, telecommunications networks provide their consumers with greater connection when more users are added to the network (Balbi & John 2015; Shy, 2011).

[73] Moreover, fiber optic cables are innovating more strongly than ever before and are important because they enable the digital economy.

asymmetric network for international security.

The weaponization of telegraph technology in Germany, the U.S. and the Great Britain are examples of successful weaponization of telegraph technology and its network for the international security competitions in the telegraph era. These are considered to be a suitable case for the weaponization of telegraph technology and its asymmetric networks to be typified. Thus, the dissertation explores the process and results of military application of asymmetric interdependence on information flows among states. In other words, based on the theoretical framework, the case study analyzes how hub states strategically used the asymmetric telegraph networks and what is the impact of the weaponization on international security competitions against spoke states during the telegraph era through the Germany's unification war, Spain-American War, and the British weaponization of telegraph network and the second Boer War.

Chapter IV. Statistical Analysis

1. Hypotheses

Global information and communication infrastructure was constructed alongside the ICT's industrial innovation.[74] States were able to overcome territorial sovereignty of information flow and conserve time used to deliver the content of information through the international cable system, the representative information and communication infrastructure (Borgman, 2003; Hunt, 2021; Main, 2001).[75] Prior to the settlement of such infrastructure, communication and information exchange between states were not easy. Particularly, intercontinental communication was almost impossible prior to the diffusion of the telegraph infrastructures.

The difficulty of exchanging information and faster communication between states has turned into a problem that made it difficult to resolve the misperception about each other's intentions in a timely manner. That is, the logic is that the lack of information exchange and communication between states can increase the possibility of war by making it difficult to conduct bargaining (Blainy, 1973; Jervis, 1976; 1978; Schelling, 1960; 1966; Sechser,

[74] Throughout this dissertation, information network and infrastructure and communication network and infrastructure were used as inter-compatible terms.

[75] A great review and explanation of the relationship between states emerging as empires and international information infrastructure can be found in Hunt (2021). *Imperial Science: Cable Telegraphy and Electrical Physics in the Victorian British Empire.* Cambridge University Press. Main, L. (2001). The global information infrastructure: empowerment or imperialism?. *Third World Quarterly*, 22(1), 83-97. Borgman, C. L. (2003). *From Gutenberg to the global information infrastructure: access to information in the networked world*. MIT Press. Overcoming territorial sovereignty means that international telegraph diffusion make speedy and long distance inter-state information flow and communication possible.

Narang, & Talmadge, 2019). The lack of communication between states and consequently undermining each other's capabilities in addition to the fact that the delay of revealing the information that warns the cost of a certain action taken means that the information and commitment problems that triggers war will not be resolved (Fearon, 1995; 1997; Min, 2020; Powell, 2004; 2006; Quek, 2021).

For instance, ICT such as the telegraph technology directly affected the transmission speed and amount of information between actors. The dynamics of bargaining can be changed by sequencing signal strategies and changing the timing of signal. This sequence and timing is an important factor of the state to credibly disclose capabilities and costs regarding wars (Fearon 1995; Lindsay, 2020; Trager 2010; Sartori 2002). In this vein, since technological changes increased the information quantity and the transmission speed, the innovation and diffusion of information communication technology directly influence to bargaining dynamics among states.

Telegraph technology and its network served as the standard for interstate communication means during the telegraph era, 1849-1914.[76] The diffusion of the telegraph network was regarded as a symbol for international

[76] The first transatlantic cable system was installed and operated by a British company. After 1858, most of the telegraphs were established and operated by the same company. The U.K, as the sea-based trade nation and also as the economic, industrial, and imperial power of the time, had the most powerful incentive and effective means to control this new technology. Hunt mentioned "the telegraph network is frequently called the Great Britain's nervous system" by describing that information flow into London and come out as a directive. All of these made significant impact on the empire's commerce, circulation of news, the disposition of its Army and Navy, and finally, the government administrative elements. See Hunt (2021) for an explanation on the relationship between communication and powers.

cooperation and peace. After installing undersea cables to accurately transmit telegraphs to other continents in 1858, the Queen of the Great Britain and the President of the United States exchanged congratulatory telegraphs with the hope that the Atlantic telegraph alliance would show inextricable bonds. Moreover, during the Cold War, this direct line between Washington and Moscow became a symbol of hope that innovation in technology for communication between heads of state could resolve conflicts such as the 1962 Cuban Missile Crisis.[77] Although this itself did not bring an end to the Cold War, but still Nye (1991) stressed that arms reduction agreements and negotiations through this played an important role in alleviating the Cold War, while mentioning that the hot line educated two states to learn from each other.[78]

Historical evidence also seemingly posits that rapid transmission of information and communication technology can alleviate the tension that eventually leads to conflict.[79] Furthermore, telegraphs enabled states to communicate and exchange information with each other. In this context, it

[77]See Allison (1971) for the detailed process of Cuban Missile Crisis. Multiple contributing factors were found out after numerous researchers studied the resolution of Cuban Missile Crisis. Among them, the impact of communication technology cannot be ruled out. As the communication technology expanded, negotiations were conducted relatively quicker, and the satellite images and telegraphs were delivered fast and accurate. See Beschloss, 2016; Nye, 1991 for research on the impact of communication technology during the Cuban Missile Crisis.

[78] As similar approach, see Patrick Morgan (1989) "On Strategic Arms Control and International Security." in Edward A. Lolodziei and Patrick Morgan, Security and Arms Control: A Guide to International Policy making 2 (New York: Greenwood Press). p. 301. Freedman (1991) "Arms Control: Thirty Years on" *Daedalus*, 120(1):pp.72-73. Joseph Nye (1991) "Arms Control and International Politics" *Daedalus* .P. 162.

[79] In 1963, the White House commented on the U.S-Soviet hotline as "This age of fast-moving events requires quick, dependable communication in time of emergency. The agreement was a first step to help reduce the risk of war occurring by accident or miscalculation." For more information on the relationship between hot line and Cuban Missile Crisis, see Beschloss (2016).

can be inferred that states delivering reliable information rapidly through international telegraph proliferation, may have a positive effect on alleviating the tension between states that eventually lead to conflict. Therefore, some scholars argue that the information communication technology can ease the conflict (Copeland, 2014; Ejrnass & Persson, 2010; Lew & Cater, 2006; Sartori 2002; Leventoglu & Tarar, 2008).

Meanwhile, there also is an argument that information and communication technology has no effect on conflicts and cooperation between states. Rather, this school argues that the information communication technology exacerbates the conflict (Jervis, 1976; 1978; Lindsay, 2020; Min, 2020; Powell, 2006; Quek ,2021).[80] Moreover, based on the fact that ICT can increase military efficiency, states that continue to innovate this technology can influence the offense-defense balance by acquiring information from other countries through strengthened military capabilities and in a form of intelligence. Additionally, the information complexity between states making it difficult to fully understand each other's intentions also plays a part in this for its structural increase (Jervis, 1978; Lindsey, 2020; Nilsson, 2012).

That is why state in a hub position in the information network can make easy access to the critical information of a spoke state that highly relies on the network asymmetrically and exploit those. Through this, spoke states'

[80] After considering identity and technology context, the approach is more reliable. Limitations and suggestions have been covered by theoretical discussion. See Chapter II.

uncertainty unilaterally caused by hub states before and after war is increased. As theorized in Chapter II, if the identity of subject of communication in such dynamics is an adversary or a potential adversary and the increase of information volume and communication exchanged through the asymmetric network in addition to the strategic utilization of it directly affects the conflict between states.

Therefore, based on the above discussion, this dissertation methodically delves into the hypotheses about the international ICT diffusion and international security competition during the telegraph era with systemically investigated data. The following hypotheses can be established about the diffusion of the international telegraph and international conflicts.

H(a.) Hub states are more likely to initiate a war against spoke states seeing military advantages of the panopticon and chokepoint effects derived from asymmetric interdependent networks.

H(b.) Hub states are more likely to win a war against spoke states as they take the asymmetric information and communication network advantages by removing uncertainty for hub states while increasing uncertainty for spoke states during a war.

2. Hypotheses Testing: Descriptive Statistics and Matching Analysis

This dissertation's statistical analysis part begins with initial set of tests investigate whether militarized disputes occur between states dyad or among states at different frequencies in moments of before and after the connection of telegraph. This section examines the conflict relationship and explores its causality after the connection to telegraph network. The first statistical testing determines whether there is a statistical difference between the distribution of the duration of bilateral relations in the categories of conflict increase, conflict decrease, no conflict increase, and no conflict between the experimental and control groups. After selecting entire states as subject of analysis, the spoke states connected to the hub states are identified through network analysis, then with the same procedure, statistical analysis is conducted in this dissertation with focusing on selected hub states and spoke states.

This statistical analysis reports the p-value of Pearson's $\chi 2$ test, which tested the distribution of each dependent variable for each of the ten length of the bilateral relationship period in the experimental and control group, and summarizes the results as follow.[81] If the p-value reaches a conventional level of statistical significance, and depending on the theoretical discussion and hypotheses presented, preliminary indicators showing the increase or decrease of conflict during the period when bilateral relationship is connected

[81]See https://github.com/onesuncho and https://sites.google.com/view/onesun/ for the Appendix related to the descriptive statistics.

through telegraph can be obtained. The insignificant p-value will be consistent with the null hypothesis H(a)0.[82] The H(b) hypothesis indicating the advantages of war for hub states will be demonstrated mainly in case studies, Chapter V.

According to the ***MatchIt*** package document of Greifer & Stuart, (2021) and Ho et al., (2012), this dissertation used an exact, nearest-neighbor, subclassification, and full matching algorithm for each of the ten time-length samples to best balance the covariant values of the experimental and control groups. Additionally, in order to find the optimal number of subclassification that maximally increases the balance when using subclassification matching, this study produced samples that matched from two to more than fifteen hundreds subclassification. In order to assess and select which matching technique shows the most improved balance across all covariates, this study compared the samples that are drawn as results using various diagnostic statistics across three matching approaches for each duration length sample. Subclassification algorithms have created the most improved balance for each sample. The dataset contains the number of subsets used in each sample and shows that balance has been achieved for almost all covariates in each

[82] This chapter also conducted relevant tests to assess the probability that treatment group's observation of distribution across increased and decreased conflict categories would differ significantly from the null hypothesis, that is, assuming that the telegraph does not affect conflict outcomes. In particular, this study uses a binomial test assuming that the probability of both states experiencing an increase in conflict in the second half of the observation will be equivalent to the probability of experiencing a decrease in conflict within the same period. The results of this test were generally similar to those of the $\chi 2$ test results. For More detailed appendix, tables, graphs, figures, maps, and dataset see https://github.com/onesuncho and https://sites.google.com/view/onesun/

duration length sample, including a diagram on the balance statistics.

Therefore, the weighted method of making the covariates values of the experimental and control groups indistinguishable from each other except for the treatment state was found out, and the average treatment effect on the treated (ATT) value of the experimental group was estimated for each dependent variable. The main analysis of the chapter is a logit model with a quasi-binary link function used to estimate the treatment effect of each dependent variable index while using a subclassification cluster-robust standard error to make the binary index of military conflict occurrence larger than zero for each dependent variable and sample.

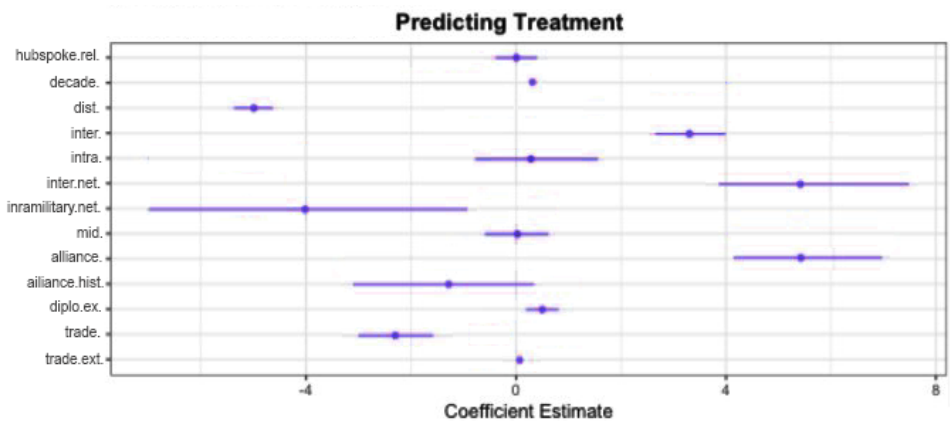

Figure 14: Predicting Treatment: Logistic coefficients and 95% confidence intervals (model treatment)[83]

[83] For evaluating logistic regression models and there are other metrics that are often used instead, such as the Akaike's Information Criterion (hereafter: AIC) and Bayesian Information Criterion (hereafter: BIC). Matching methods are a group of statistical techniques that are used to compare the outcomes of two groups that are similar in terms of one or more covariates, in order to estimate the effect of a treatment or intervention. Logistic regression is one of the many models that can be used in the context of matching methods, for example to estimate the probability of being in a particular treatment group based on the covariates. AIC and BIC can be used to evaluate the fit of a logistic regression model that is used in the context of a matching method, and to compare different models to determine the best one.

This statistical analysis also estimated the robustness through the Least Square Method model (OLS) using the number of significant military conflict outcomes and robustness standard errors as dependent variables. Using the logit model and OLS, this study conducted regressive analysis of the significant results of treatment states using the base package of R, and shows the coefficients for treatment indicator as ATT estimates of odds ratios or linear effects. This chapter shows this as calculated through R's sandwich package for each dependent variable and duration length at a robust 95% confidence interval. Although the inclusion of matched covariates increased the accuracy assessment on effects, in order to cover all models applied in this dissertation, it required boost trapping using computing methods.

AIC and BIC are both measures of the goodness of fit of a statistical model that balance the model's fit to the data with the complexity of the model. The idea behind these measures is to penalize models with too many parameters, as they are likely to overfit the data and perform poorly on new, unseen data. AIC is defined as 2k - 2log(L), where k is the number of parameters in the model and L is the likelihood of the data given the model. The lower the AIC, the better the model is considered to be. BIC is defined as klog(n) - 2log(L), where n is the number of observations and k and L are defined as in AIC. The lower the BIC, the better the model is considered to be. In both cases, the best model is the one with the lowest AIC or BIC value. However, it's important to note that these measures are only appropriate for comparing models that are nested (i.e., differ only in the number of parameters) and that have the same response variable. Figure 14 shows the coefficients of the logit model for the years of bilateral relations selected as the experimental group (an 11 year sample of duration length was used). Thus, AIC and BIC can be useful for evaluating logistic regression models like the coefficients of the logit model for years of bilateral relations selected as the experimental group. These measures can help compare different models and select the best one based on their fit to the data and their complexity. In this particular case, since the sample size is 11 years, the BIC may be more appropriate, as it takes into account the sample size in its calculation.

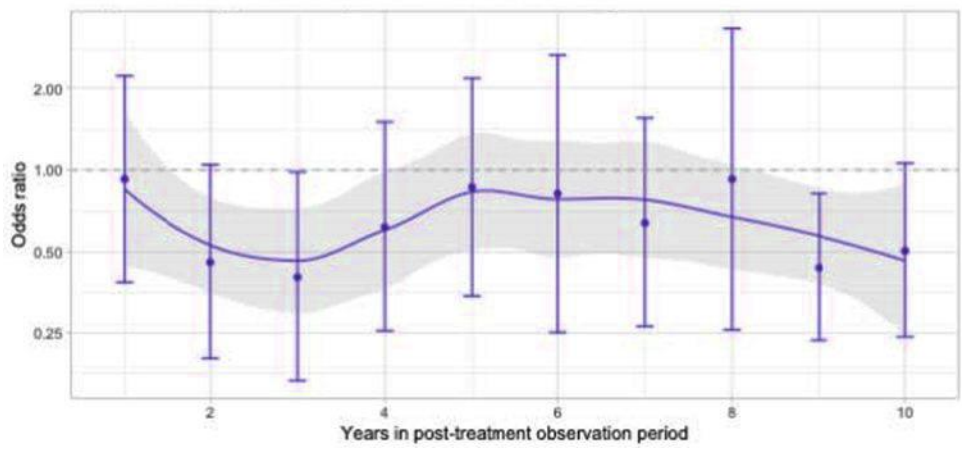

Figure 15: Estimated ATT of a dyadic telegraph connection on engaging in an adversarial MID

The p-values of the $\chi 2$ test for four to seven years after the connection has nearly approached or reached significant levels, suggesting implications more than just coincidence that the two states that are not connected to each other show different behavior with the connected, and that the relative penetration rate of the two states that have experienced less conflicts since the connection.[84] However, after the matching, the correlation was not maintained to a practical degree. As shown in Figure 15, the ATT point estimation with 95% confidence interval in almost all ten samples of various duration length did not differ statistically by more than zero and therefore the null hypothesis could not have been rejected. [85] Consistent and considerably accurate estimation of the effectiveness of the null hypothesis provided strong

[84] If the two states consider military conflicts only which is the origin of conflict, this result is applicable only to six or seven years.
[85]For two, three, nine, and ten years, there was a statistically significant negative effect on the onset of military conflict at 90% or 95% confidence levels, but it was not enough robust effect to rule out the influential cases.

evidence for the existing hypothesis that it rather had no effect on the conflict at all. Despite the potential to increase the amount of interstate communication, the ability to use faster ICT seems to have had little impact on resolving basic information or non-compliance, which causes the adversaries to ultimately engage in military conflict. Therefore, this dissertation focuses on more specific hypotheses and hub states that are suggested in this Chapter. The hub states of the telegraph era, 1849-1914, were the British Empire, the United States, and Germany (Johnston 2021; Müller 2016; Wenzlhuemer 2007; 2013). The same procedure applied to test results of the spoke states connected to hub states was shown to have increased the conflicts. In terms of the escalation of conflicts, it was difficult to determine the escalation of military conflict between the two states without considering the hub and spoke relations among states. The telegraph exchange between adversaries brought them to experience skirmishes that expanded in lower levels more often. To generalize the results of the various technical tests elaborated in the later analysis, the proportion of both states experiencing low level skirmishes after being connected in telegraph was greater than that of the two states that were not connected.

In consideration of both sides experiencing military skirmishes that did not extend to the point of display of force, the differences between experimental and control groups in the $\chi 2$ distribution of the duration of their bilateral relationship across the categories of conflict-increasing, conflict-

decreasing, conflict-maintaining, and conflict-free were statistically significant for most duration length samples. After matching samples to estimate ATT, this study found that after five years of connection, the two states that are connected in telegraph experienced a slight increase in the risk of military conflict, which was statistically significant though the military skirmishes did not escalate beyond display of force or intimidation. When estimating this effect through OLS while excluding outlier over 8th to 10th years after the connection, the two states connected by telegraph experienced an increase in the likelihood of much more accurately estimated military conflict engagement with exceeding 2%. The military conflict did not escalate beyond danger or display of force. [86] Such increased danger did not extend to a higher level of military conflict.

This dissertation interpreted the results in consistent with the theory that adversaries facing difficulties when trying to reliably communicate with each other cannot be solved by technological advancements. That is, communication with potential enemies and strategic use of the technology rather result in an increase in the frequency of conflict, contrary to the increase in cooperation claimed by optimists. Also, the part that the telegraph increases the risk of skirmishes show varying results when solely focusing on hub states. Spoke states that are in subordination to the hub state's information

[86] If a Cook's distance greater than 0.5 was observed, it was classified as an outlier. Rematching samples while excluding outliers to check whether the balance was maintained did not affect the results. This study excluded outliers from the military conflict model of understanding display of force, but the results were slim and the model could not be re-estimated.

network provide the hub with an advantage of offensive superiority and the incentive to cause conflict. This is possible due to the exploitation of crucial information, and it rapidly leads the war to the hub state's advantage. The fact that the conflict does not exacerbate between the two states connected by telegraph when not considering the relationship between the hub and the spoke states during statistical test rather strengthens the H(a) hypothesis that the inducement and frequency of war increases using the exploited critical information of the spoke state that is subordinate to the hub state.

Moreover, this dissertation tested in details the initiation and escalation of conflicts by hub states against spoke states that are still connected around hub states against hub states. In each duration length sample, the distribution of experimental and control groups across conflict-increase, conflict-decrease, conflict-maintain, and conflict-free categories was not statistically different, and the preponderance of telegraph treatment states which experienced less militarized conflicts with third state after telegraph connection was statistically significant at a conventional or quasi-conventional level.

By contrast, in a matched sample, this analysis revealed that the ATT of telegraph connections at the onset of military conflicts in states that are in subordination to hub states was statistically significantly static and increased from the third year after the connection. Figure 16 shows the point estimation and 95% confidence interval for each duration length.

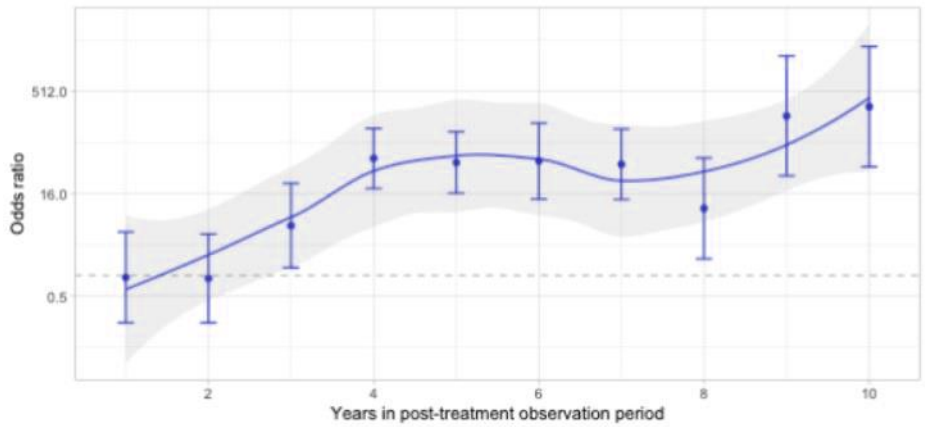

Figure 16: Estimated ATT of a dyadic telegraph connection on engaging in an adversarial MID based on Hub and Spoke Relations

As a result of testing the escalation of military conflicts between the two states against third state, the experimental and control groups showed significant differences in the escalation of military conflicts at all levels except those that led to war in all duration length samples. With the beginning of military conflict, the analysis unit that experienced a decrease in conflict prevailed in the experimental group, while the control analysis unit that increased or decreased conflict was approximately similar. In the matched data, after three or four years of connection, this association was reversed. In other words, the telegraph had a statistically static effect on the risks experienced by the two states in military conflicts leading to each level of expansion, including the war that the hub states waged against the spoke states. [87] This result once again strongly supports the hypothesis that

[87] Similar results were found when testing the beginning of a low level military conflicts, but they were not generally robust enough to exclude influential cases. The result of the military conflict that was not led to the outbreak of war was robust enough to achieve sufficient balance with existing match samples

telegraphic connections of spoke states puts them under hub states, and thereby having a static effect on the frequency of the outbreak of war by the hub states. Thus, the diffusion of telegraph technology and its network caused international conflicts between hub and spoke states, at least statistical speaking. The process and more detail causation are covered Chapter V.

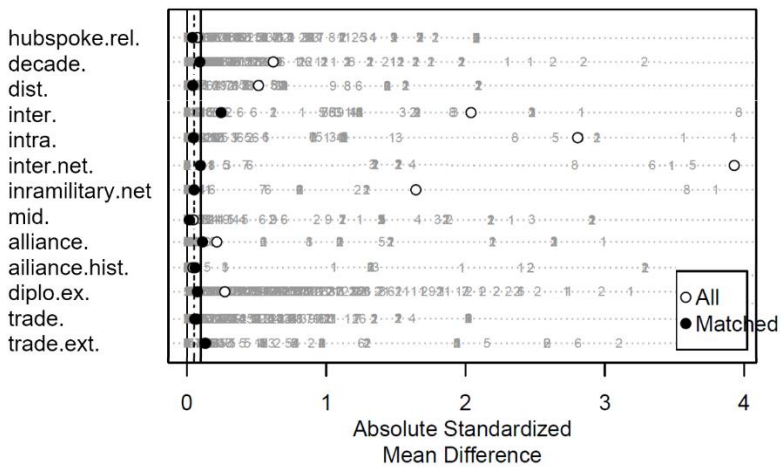

Figure 17: Subclasses (361) ATT - h=1, matched: 906.31754992835[88]

to exclude outliers from rematch samples that excluded outliers.

[88] The figure 17 and 18 after the improvement of balance shows the improvement of the equilibrium of the matched sample for each length of duration sample using a subclassification algorithm, in comparison of the unmatched samples. This is in accordance with the absolute standardized mean difference between the covariate values of the experimental and control groups. Gray numbers indicate an improvement in balance for the corresponding subclasses. That is, the fact that most of these balance improvement values are not within the acceptable scope shows that estimates of treatment effects specific to the subclassification have no practical meaning. The title of the chart denotes the number of subclasses used and a sample of duration length (for example, $h = 1$ represents 1 year observation period over the length of 3 years; $h = 10$ represents 1 year observation period over the length of 21 years), and the number of valid experimental and control observations included in the matched samples after the application of weight.

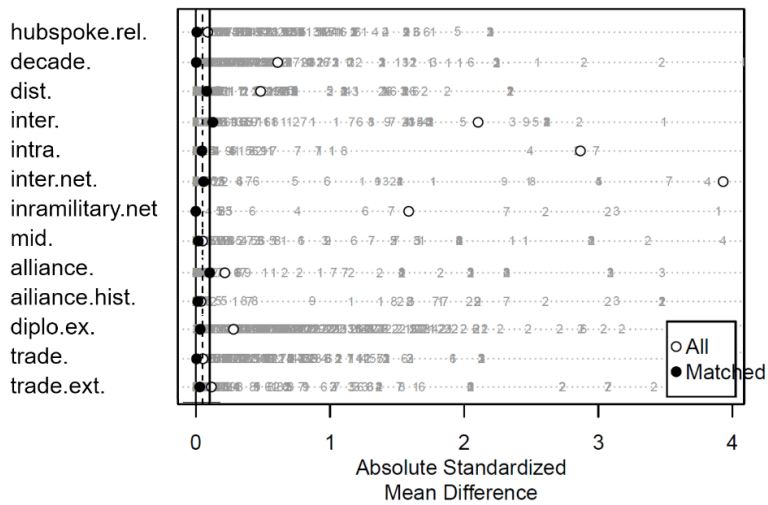

Figure 18: Subclasses (417) ATT - h=2, matched: 1432.42688925579

Moreover, spoke states that rely on hub states' information flow directly experience the information complexity and further experience imbalances of asymmetry. If the hub state is in a position to exploit and utilize the critical information of the other state, the military efficiency of the spoke state is reduced due to increase in uncertainty. Such relationship removes the trust of communication between states due to its uncertainty and increases the onset and escalation of conflicts between themselves.[89] In other words, the diffusion

[89] Of course, there are numerous alternative explanations that have been suggested in existing studies and can be explained statistically. Thus the dissertation suggests alternative explanation and robustness. It presents potential concerns about the choice of research design in this dissertation for future research. First alternative explanation is related to mechanism alternative. In consideration of telegraph serving as a catalyst for groundbreaking shift in global media environment, how can we determine whether the effect dealt on the research are due to the audience cost or not. Moreover, this kind of research need to concern the possibility of the size of network becoming an issue to check the observation was weighted by treatment volume, that is the network history or size in terms of stable unit treatment value assumption violation (Imai, Kim, & Wang, 2021). The technology used in the 1840s (and the telegraph or the system) is significantly different from that used in the late 19th and early 20th centuries to connect the last remaining state communications network to the international network. This itself has the possibility to violate the SUTVA. Thus, the dissertation try to focus on the telegraph era and international security competitions among hub and spoke states. In addition, bias after the treatment, ignorability, and moderators need to be considered. Especially the moderators, the dissertation try to check variables that may have induced the ATT to a smaller subset. The dissertation attempts to clarify these alternatives by mix-methods analysis with clear theoretical framework and data.

of telegraph technology and hub states' weaponization of asymmetric networks causes international conflicts among those states share the potential adversary identity during the telegraph era. Moreover, for the aligned states can communicate with high credibility that makes it easier to coordinate for mutual interests unlike communicate with adversary. Information complexity increase incredible communications among rivalry states, onset and escalation of conflicts increase the states in between because of uncertainty.

Given the possibility that the state of initiation's superiority of information might have endowed them with a first strike advantage, likewise, consideration of whether the correlation between the telegraph advantage and victory could be applied to the initiation and target states that took that specific advantage is possible. In all observations during 1849-1914 with concentration hub and spoke relations and excluding some cases of early stage of German Unification Wars where telegraph was not effectively used due to lack of the infrastructures, there was a general association between the telegraphic advantage and victory in war. 102 cases out of 127 (that is, 80.3%) and most of cases have shown association when the hub states of initiation took the advantage of telegraph. As shown in Chapter V, hub states' strategies that use the asymmetric network of hub states proves the advantages of telegraph network. Based on theory, it is proved through process tracing case study. The positive association between victory and telegraphic operational capability is applied to state of initiation (1) but not to state of target (2) and

the difference in the distribution of victories between hub state (1) and spoke state (2) with telegraphic advantages and considering hub and spoke relations was proven to be statistically significant ($p = 0.0413$).[90]

3. Results and Discussion

When existing international security theorists do not consider the two contexts of identity and technology, they make contradictory predictions about the causal mechanisms of the subject's communication and conflict. This initially motivated the start of this dissertation to explore the nexus between ICT and international security. Scholars in International Relations delved into the problem of information and communication as the cause of war (Fearon 1995; Jervis 1978; Powell, 2004; Lindsay, 2020).

Some of these scholars argue that the causal mechanism of bargaining and the spiral model of war exacerbate and escalate conflicts along with the increase in number of inter-state communications. The other school saw the positive influence of information flow and inter-state communications to international conflicts. To fill such gaps, the Chapter IV of this dissertation explores how the international telegraph diffusion affected the conflicts between states, meaning, whether they exacerbated or alleviated. Based on this, Chapter V of this dissertation dives deeper into the process of conflict

[90] When the test is performed without considering the hub-spoke relationship factor, p-values are reported much higher than 0.05. However, when considering the hub and spoke relationship, the opposite results appear with p value of 0.0413. Thus, the argument is strengthened that spoke states connected to hub states, a potential enemy of the telegraph era, are more likely to be invited into war by hub states and the more likely to be defeated based on the theory of dissertation.

between states and thereby complements Chapter IV. Hence, in consideration of the two contexts, identity and technology, presented in this dissertation, pessimistic view is empirically proven to be more reliable.

Therefore, it showed a difference between the statistical test conducted to all states compared to that of the same process to hub and spoke states selection after random selection. This allows an emphasis to the dynamics of hub and spoke relationship. It is not that a simple telegraph connection is the cause of an international conflict. Rather, due to the spread of ICT that has network effects, asymmetric interdependent network gets formed and hub and spoke states in adversarial relationship gets connected to this which eventually increase international conflicts since hub states strategically use the asymmetric networks against spoke states. Therefore, the H(a) of this dissertation is proven. After the statistical test, process and results in detail will be further proven qualitatively in the Chapter V.

Chapter V. Case Analysis: Hub States' Military Application of Asymmetric Information and Communication Networks in the Telegraph Era

1. Advent of Telegraph era and Background of the Asymmetric Interdependent Networks

The first information and communication network was the telegraph network. This chapter aims to explore the emergence of power in such networks and its military usages. This dissertation identifies the factor that expanded such network as telegraph infrastructure and telegram usage. In order to further elaborate on the international communication network in accordance with the expansion of ICT, understanding the infrastructure that transmits the information content is necessary. Since the state that controls the cable easily controls the network and devise military strategy through them. The diffusion of telegraph technology has certainly caused information complexity, but the degree of information complexity varies from state to state. This created new opportunities for states to enhance their military and strategic capabilities, as well as to participate in global information and communication networks.

One of the key features of the telegraph era was the formation of asymmetric information networks, in which some states were able to centralize and control the information flow, while others were more peripheral and dependent on the information flows from the central nodes. This created a new power dynamic in international relations, with hub states

having a strategic advantage in military, political, and economic affairs, and spoke states facing challenges in accessing information and participating in the international system.

The international diffusion of telegraph technology was driven by several factors, including advances in electrical engineering, improvements in telegraph infrastructure, and the demand for more efficient communication networks. The technology was adopted by states for military, diplomatic, and commercial purposes, and it played a crucial role in shaping the political, economic, and military landscape of the 19th and early 20th centuries.[91]

Overall, the telegraph era represents a significant moment in the history of international communication and information networks, and it provides valuable lessons for understanding the role of ICTs in shaping international power dynamics and the emergence of asymmetric information networks.

The most important aspect of submarine cable is that the network can be utilized for military purposes. In particular, during the telegraph era, positive interdependence that is economically advantageous is right. As with the existing research, by increasing the volume of trade, positive interdependence was strengthened(Lew & Cater, 2006; Poujol & Fourniau, 2005). In the

[91] According to a historical account of telecommunications, large empires have always placed a high value on efficient information flow and have gone to significant lengths to achieve it. For instance, the Romans constructed roads, the Persians and Mongols set up horse relays, and the British provided financial support for mail steamships. However, the flow of information was still restricted until the advent of the modern telegraph. The electrification of information flows marked the beginning of modern telecommunications and resulted in patterns of competition for power and control over this valuable resource.

telegraph era where military conflict was frequent with existing potential adversaries, military pressure through asymmetric interdependence rather strengthened. That is, the 'home-field advantage' that derives out of the network is even more strengthened during the telegraph era where most of the contents were quickly transmitted through telegraph. And shifting the offense-defense balance using this is related to the military effectiveness.

Although there was no modern concept of economic statecraft, but it was used in a military context. According to Hunt (2021), the British Empire constructed submarine cables for the close connection between the Empire and its colonies. As a result, at the beginning of the 20th century, 60 percent of the world's submarine cables were owned by the British Empire or its state-owned companies. It has been argued for a long time that this was a key factor in the British Empire's hegemonic position.

In particular, states with an advantage in telegraph technology networks and well-established infrastructure can benefit from asymmetry in information networks. [92] Germany did not have full advantage of this asymmetry but combined it with its own staff system and utilized it as a

[92] Many experts in the field of Internet security are now discussing the vulnerabilities of so-called "emerging" communication technologies like cloud computing, satellites, and 5G networks, and its implications for the safety of the Internet as a whole. However, the great bulk of daily Internet traffic across international boundaries — including video chats, financial transactions, and even military secrets — is carried through a far older and considerably less glamorous technology: underwater cables. For the last 180 years, corporations and multinational partnerships have worked to perfect the technology behind the cables that run under the ocean bottom and transport data across continents. Over the last several years, major Internet corporations like Facebook and Google have amassed large stakes in these cables. In addition, Chinese state-owned businesses have significantly boosted their construction (e.g., Huawei Marine) and ownership (e.g., China Telecom, China Unicom) of underwater cables in recent years.

military technology. Following the public opinion battle before and after the war with Spain, the United States used its relatively superior information network to isolate Spain informationally. In particular, the only Spanish cable in the Philippines is isolated as the Great Britain blocks a landing station in Hong Kong at the request of the U.S.. The U.S. attacks the other country's information vulnerability to steal and selectively deliver information, and by increasing the complexity of information, the Spanish military cannot solve the fog of war and is overwhelmingly defeated in public opinion war after the war. In the 19th century, Great Britain shrewdly utilized its dominant position in the telegraph technology network to gain advantages from the accessibility of information. By 1913, Britain had a majority of the underwater cabling, with 330,000 km out of 539,000 km, while its closest competitors, the United States and France, had 7,000 km and 46,000 km respectively. As Britain became assured in its invincibility to attack, disruption, and espionage, as well as its ability to disconnect its adversaries from the rest of the world and regulate their communications, it redirected its attention to offensive operations (Headrick, 2001; 2009).

The British Empire, telegraph technology is effectively weaponized as an operational tool of the empire. It exerts influence in Asia by directly intervening in China and Japan, where it was increasingly difficult to control distant India and exert influence at the time. Through this, the construction of new cables also shows the result of further enhancing the advantage of

interdependence. The important thing in the telegraph technology network is the private sector. The British Empire and the United States have successfully used and weaponized private resources as well.[93]

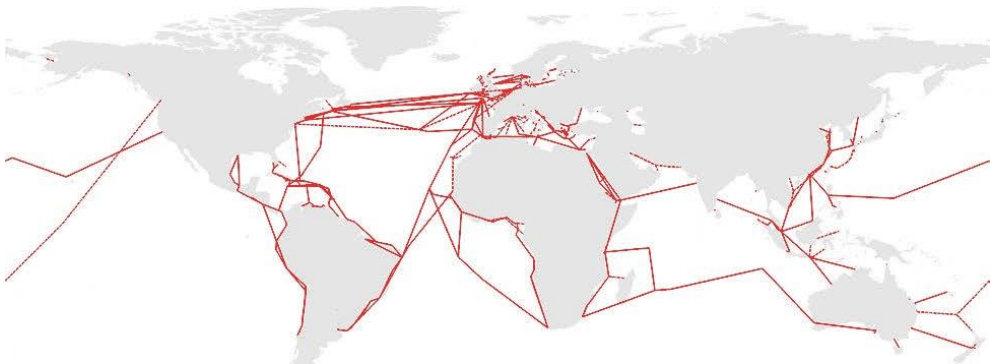

Figure 19: Government-Private owned telegraph networks in 1900s: solid-line refer to government owned cable and dot-line refer to private owned cable (Wenzlhuemer, 2013)

This dissertation notes more that beyond simple economic effects, the spread of telegraph and resulting asymmetric communication networks have dominated networks of flow of information and communication between states. The spread of ICT with network effects makes certain users become the hub of network and creates an asymmetric network structure. This chapter analyzes the process that formulated the asymmetric communication network when the telegraph, the ICT of Victorian era was expanded.

Until this moment, security implications of ICT networks were not adequately analyzed. However, the global communications network during

[93] As figures shows, the private infrastructure was extensive, and the private resources of the hub states could in itself become a security threat to which the spoke 'state' had to rely asymmetrically. As these private resources are used by hub states, the hub states have more and more space to utilize network power, and the spoke states depend more and more on the information and communication networks of hub states.

the telegraph era was in an asymmetric structure where certain hub states dominated the flow of information and spoke states were in subjugation in terms of information. The spread of telegraph technology happened commercially. Centered on British and American corporate leaders, a communication network that crosses the Atlantic Ocean was established and centered on Germany and France, a communication network was established in the European continent. As time went by and so did the possession of state-owned telegraphs, causing sovereignty issues.

Wire cables were installed beyond the borderlines and since the whole concept went from private to public, the cable of other states subjected to the new international law unprecedentedly. As a result, standards were inked through the international agreements and prevented the indiscriminate network expansion. The cable issue now became an ‘international’ one. In July 1850, representatives of Prussia, Austria–Hungary, Bavaria and Saxony met at Dresden to discuss the harmonization of telegraphic communication between them. They founded the Austrian–German Telegraph Union (the Deutsch-Österreichischer Telegraphenverein) and agreed on standardization in three regards: technical, operational, and tariff-related. Furthermore, a number of bilateral treaties harmonizing telegraphic exchange with other European countries were signed. In 1855, the Western European Telegraph Union was founded by France, Belgium, Spain, Sardinia, and Switzerland. Both unions co-operated closely from the beginning. Eventually, in 1865,

representatives of twenty European states met at International Telegraph Conference in Paris and adopted a convention that regulated international telegraphic exchange between the signatories. The International Telegraph Union embarked its journey on May 17, 1865, based on the International Telegraph Convention where 20 European nations inked and adopted to facilitate interconnection of telecommunications services between states.[94]

That is, after the establishment of ITU, the standard was set where it even further empowered the asymmetric network that existed and so did the Hub states' network power. Now, the existing Hub states' network became the standard. Actual telegraph traffic and infrastructure were concentrated in the hub states.

That means such network shapes the condition for hub states to receive access privilege to the information flow and, spoke states' communication that has feeble infrastructure is monitored by the hub states. Therefore, the critical

[94] the delegates from twenty European States – Austria, the Grand Duchy of Baden, Bavaria, Belgium, Denmark, France, Greece, Hamburg, Hanover, Italy, the Netherlands, Portugal, Prussia, Russia, Saxony, Spain, Sweden and Norway, Switzerland, Turkey, Wurttemberg. In early days, Britain and the U.S were excluded. However, the U.S and Britain already possessed the essential element of telegraph technology, submarine cable network, and standards outside the European continent were set around these two countries. Also, the story unfolds with Britain joining the ITU and British standards starting to dominate the international information and communication network. The Britain joined the ITU in 1871 and the United States join the ITU in 1908. This data can be seen at ITU data of 'list of member states' retrieved from https://www.itu.int/online/mm/scripts/gensel8. The international telegraph conference in Vienna in June 1868 established a 'Bureau international des administrations télégraphiques' to standardize and harmonize European telegraphic communications based on Article 61 (Harris, 1969). In the 'international rules of service' appended to the treaty, the Swiss telegraph administration was empowered to create the international bureau, which was finally established in Berne and renamed the International Telegraph Union (ITU). ITU means International Telecommunication Union from 1934. UN specialized agency since 1947. The ITU is the oldest international body and relocated from Berne to Geneva a year later (Wenzlhuemer, 2013, p. 108). For the great explanations of the history of the ITU, see Codding & Rutkowski (1982) and the ITU history portal in the ITU's official website.

information can be exploited. Moreover, hub states can eliminate other states from the network. Cable could be severed physically, or other states can be ostracized from the information flow. That means, by taking advantage of this authority, hub states take the overwhelming position against the spoke states.

Beyond and above the simple telegram usage and length, the dissertation tries to posit how such networks are strategically used by hub states. Unlike existing research selecting France as the hub state as the center of the network, this dissertation notes that even though France had a hub city called Paris, France did not take advantage of the network's high concentration. Germany, the United States, and the Great Britain implemented the military application while France did not. A true hub state is that which freely utilizes this. The Great Britain, the U.S and Germany, as discussed in-depth in this dissertation, are states that have militarily utilized the location of hubs in the telegraph network.

1881		1892		1902	
Node	Degree	Node	Degree	Node	Degree
Paris	14	London	15	Wien (Vienne)	16
London	12	Paris	14	London	15
Wien	12	Wien (Vienne)	14	Paris	14
Marseilles	11	Berlin	13	Budapest	14
Berlin	10	Cape Canso (CAN)	11	Cape Canso (CAN)	14
Lyon	10	Marseilles	10	Berlin	13
St. Louis (US)	9	Lyon	10	Dublin	12
Cincinnati (US)	9	Dublin	10	St. Louis (US)	12
St. Pierre (CAN)	8	Budapest	10	Marseilles	12
Bruxelles	8	Cincinnati (US)	9	Gibraltar	11
Halle (GER)	8	Breslau (GER)	9	New York	11
Chicago	7	Memphis	9	Rio de Janeiro	11
La Havane	7	Lublin (RUS)	9	Pernambuco (BRA)	11
Newcastle (UK)	7	Lisboa	9	Breslau (GER)	10
München	7	Malte	9	Lublin (RUS)	10
Basel	7	St. Louis (US)	9	Lisboa	10
Dublin	7	Saratow (RUS)	9	Malte	10
Mexico	7	Halle (GER)	9	Mariinsk (RUS)	10
Madras	7	La Havane	9	Chicago	10
Alger (ALG)	7	Varsovie (RUS)	9	Montreal (CAN)	10
St. Paul (US)	7			Minsk (RUS)	10
Constantinople	7			Lyon	10
Malte	7				
Stockholm	7				

Table 1: Freeman degree in the global telegraph network, 1881, 1892, and 1902 (Wenzlhuemer, 2007, p. 277)

At that time, important contents were sent concisely by telegraph, and it was mainly used for urgent spying, because it was fast but expensive. According to the network externalities, the country that becomes a hub first can exert overwhelming influence. In other words, the basis of network power comes from the network externalities that ICT has. So, hub states that can utilize the network had a huge advantage.

Electro-magnetic telegraphy increased the speed of information

transmission dramatically. The basic technology consisted of a transmitter unit, conducting wire suspended above land or insulated wire buried underground or laid undersea, and a receiver unit, along with codes like Morse code to translate long and short electric signals into spoken or encrypted language. In military applications, mobile field telegraph units tended to consist of a receiver unit and a reel of insulated wire mounted on a wagon or other means of transport that enabled field commanders to maintain communications with a central station.

Linked into networks that connected primarily public but sometimes privatized telegraph stations and, eventually, important government offices and firms within states and between them, the telegraph enabled users to communicate over distances at speeds significantly higher than contemporary alternatives. Early electro-magnetic telegraphy operated at far slower rates and with less reliability than those that became accessible in subsequent years as both the base technology and operations of telegraph systems matured. Though early telegraphic systems' capacity pales in comparison to later advances, early telegraphy still imposed a major shock on communications speeds by comparison with alternatives. For instance, a message traversing the Indian subcontinent from Calcutta to Karachi took 18 hours to arrive in 1867, 2 hours in 1872, and 1 hour in 1877. Yet, compared with the irregular availability of communication by sea and the difficulty of overland travel in the British Indian case, the telegraph introduced a novel, much lower cost

means of transmitting important information on such routes within a day rather than weeks.

Against this backdrop, this chapter addresses the identification of centers and peripheries in global communications networks in the 19th and early 20th centuries by examining network structure and network usage during international security competitions between hub and spoke states. It focuses on external telegraph traffic in many countries around the world. Aside from data on individual case studies, such aggregate data are information on the asymmetric global information flows currently available as a form of the realization of structural potential. Based on this, rest of the chapter explores cases of the military application of weaponized asymmetric information network during telegraph era. In addition to the discussion of military application of asymmetric ICT networks discussed above, I have analyzed the German unification wars, the Spanish-American War, and British statecraft by focusing these hub states' power derived from controllability of information flow with military application of panopticon effect and chokepoint effect.

2. The Case of Germany

2.1 Germany's Information and Communication Networks in the Telegraph Era

Based on the discussion of previous chapter, Germany was positioned as a hub in the 19th century telegraph network. In other words, as a hub state, it was in a position to utilize network power derived from the asymmetric network where the panopticon effect and the chokepoint effect could be strategically used. In Europe, Germany was positioned as a hub country along with France, and institutions related to communication networks were well equipped. Also, Germany held a wider military communication network than France and was well institutionalized to make good use of the telegraph network for military purposes. For example, not only was the general staff system well-established, but also their military use of information obtained from the telegraph network was well institutionalized, which maximized the panopticon and chokepoint effect.

Through the Germany's case, I analyze the process of how Germany acquired critical information from spoke states through an asymmetric network and how it affected offense and defense balance in terms of military operations. This will show how the asymmetric telegraph network can be leveraged militarily. The amount of telegram usage in the Germany's telecommunication network better reveals Germany's network position. As time goes by, Germany shows overwhelming usage in Europe except for the

Britain’s telegram usage.

In the early 1850s, the Austrian government put pressure on its southern German neighbors and began construction of a main telegraph line across Germany with the opening of a major line linking Berlin with Frankfurt and Aachen in Prussia. In Bavaria, the Munich-Salzburg line was already open to the public and connected to Vienna, and the Munich-Augsburg-Nuremberg-Hof line was under construction to connect Berlin via Saxony. A patchwork of connections was emerging across Central Europe, and soon the need arose to establish a more formalized blueprint for the future development of structured communications networks. By 1850 most German telegraph lines were open to the general public, and in the following decade the amount of traffic through German telecommunications networks increased about 10 to 20 times. Between 1850 and 1860, the number of telegrams processed annually in Württemberg increased from 7,000 to 10,000, in Bavaria from 10,000 to 200,000, and in Prussia from 35,000 to 600,000. The lion's share of these telegrams was private correspondence: of the 121,000 telegrams sent to Prussia's main lines in 1854, about 108,000 were ‘Privat-Depeschen’. On the other hand, network coverage across states remained rather limited. In 1855 there were telegraph offices for about 60,000–65,000 inhabitants in Saxony, 190,000 in Bavaria, 344,000 in Prussia and 634,000 in Austria. The initial lines that were built actually privileged the existing communication channels between the state-approved administrative centers and commercial centers.

Traffic volume developed rapidly along these arteries, but as they did so expose the disadvantages suffered by those excluded from the network (Johnston, 2021). Prussia later expanded its telegraph network extensively and expanded the lines to include lines in Saxony and Hessen. The high cost of construction and operation was considered, but it was eventually passed by the parliament and was useful during the war for German unification (Johnston, 2021).

Germany actively expanded and used the telegraph both domestically and internationally. However, it was limited to Continent Europe. Germany had no authority in transatlantic submarine cable and pacific submarine cable. It was used for military use on the European continent and Germany did not have an advantage over Britain and the United States in intercontinental competition.

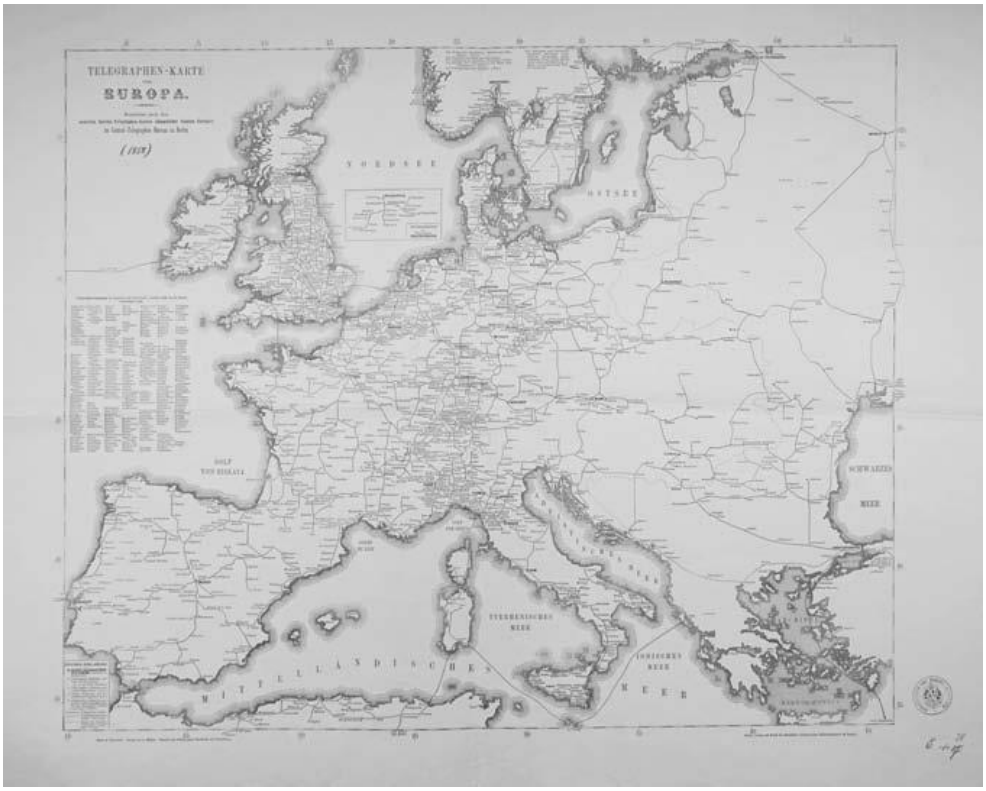

Figure 20: Map of telegraph lines across Europe, produced by the Central Telegraph Office in Berlin, 1858. Reproduced with the kind permission of the Museumsstiftung Post und Telekommunikation (Johnston, 2021, p. 135)

2.2 Weaponization of Asymmetric Telegraph Network during German Unification Wars

The case of asymmetric network's hub state Germany, which weaponized the asymmetric network is a case where Germany militarized the network power and strategically used them against potential enemy going beyond considering asymmetric network as simply just the network center. Since deployed as an expeditionary force, telegraphic network was expanded for convenient exchange and access of information flow while institutionalizing the network for military operation plan.

By recalling the theoretical discussion to explore the onset of German unification wars, rapid communication with the development of ICT exacerbates conflicts in potential adversary or adversarial relationships. The Franco-Prussian War of 1870 has a direct origin associated with the famous Ems telegram and is in marked contradiction to Evarts' optimistic predictions of years earlier. The Prussian leader, Otto von Bismarck removed the polite aspect of the king's refusal, making it look even more blunt and insulting than the original telegram. He then passed on a new version of the encounter to the media. As a result, the French government declared war on Prussia.

This example shows that a telegraph can quickly propagate an incorrect version of an event. Indeed, the misleading explanation Bismarck gave to the press was delivered more quickly than the completer and more accurate version sent to Paris by the French ambassador through diplomatic channels. Moreover, Bismarck's sensationalized account of the insulting encounter received more press attention than the truth and was more innocuous. Furthermore, Bismarck's abbreviations became less accurate than the longer the explanations he received. It turns out that the brevity necessary for a telegraph is not the accuracy of truth. Finally, from his position of power, Bismarck proved quite successful in manipulating information flows to foment hostility between France and Prussia. The telegraph shows all actors that simply using fast communication techniques can be detrimental to conflict.

As a trigger for conflict, telegraph technology and its network determine whether a crisis escalates into a war depending on how the actor uses the technology and its network.[95] Prussia had a well-established system to utilize its own telegraph network during the unification war. Several features of Prussia's military organization and civil-military relations helped Prussia adopt and employ the telegraph. Helmuth von Moltke supported the telegraph and implemented the adoption decision. Resources and a disciplined organization that evolved over time were major benefits that gave Prussia an advantage in the military telegraph.

Moltke was the first European general to dedicate his entire communication to the electric telegraph, reducing notification delays and, in two cases, the Danish War of 1864 and the Austro-Prussian War, coordinating the opening maneuvers of combat from his Berlin office.[96] The Prussian general staff provided resources for a strategically rationalized and institutionalized military telegraph service with the Moltke's leadership. Cycles of experimentation, battlefield experience, and reform helped develop these capabilities over time as pillars of the Prussian military communications system (Hall & Preston 1988). Prussia's first telegraph engineering unit, created in 1859, was able to lay up to seven miles of wire and ground cable

[95] Based on the theoretical discussion in Chapter II, telegraph technology diffusion creates asymmetric information and communication network with network externalities.

[96] In an era when most field commanders felt chained by the telegraph ('there is nothing worse than campaigning with a wire in your back,' an Austrian general famously remarked in 1859), Moltke "immediately recognized the potential of the telegraph to coordinate vast 'encirclement battles' or Kesselschlacten by multiple pincers" according to Wawro (2003). p. 47.

on the battlefield.[97] After deploying service at Schleswig-Holstein, the Prussians expanded this capability to include four mobile, battery-operated telegraph troops, each capable of laying 30 miles of wire at the speed of infantry marching. Heavy and often faulty cables in the Seven Weeks War made the telegraph unreliable for use by field commanders to send tactical commands. In 1869 Prussia's staff officers adopted a three-year sweeping reform recommended by a committee to review military telegraph capabilities. In addition to technical and organizational updates to the field telegraph divisions, Prussia created and exercised telegraph divisions prepared to operate in the rear of the Prussian Army to capture, repair, and exploit the existing telegraph infrastructure available to the expeditionary force. This was the army used in France in 1870.

In addition to the strengths of Prussia's military organization in terms of telegraph adoption and doctrine, strong military institutions and command institutions also helped to direct military operations toward their intended political ends, helping to minimize the uncertainties of conflict rather than exacerbate them. The Prussian general staff adopted a rigorous system of officer training, strategic and organizational analysis, war games and exercises (Huntington, 1957). This supported the development of competent

[97] McElwee (1974), p. 119, describes a "ponderous" effort by the Prussian commander Bazaine to control the movement of his troops at Spicheren from the telegraph station at St. Avold. According to Guérin (1872), the military telegraph service lines never stretched beyond 10 miles during the Austro-Prussian War, as the military wires were always connected to the civilian network. English-language sources with comparable information on the service's 1866 capability.

members inherent in a strong culture of military discipline and the emergence of decision-making rules and practices optimized for effective command and control on the battlefield. Officer corps effectively not only learned how to optimize the use of telegrams within military organizations, but also established the practice of incorporating redundancy into communications with careful anticipation of technical or personnel failures. The regiments of the Prussian Army were embedded in a broader institutional environment in which military commanders and civilian leaders regularly engaged in powerful debates about the political and military benefits of strategic options. Otto von Bismarck and the Prussian diplomatic corps also adopted the telegraph as a crisis communication channel.

As such, Prussian institutions were well positioned to adopt high-speed communications capabilities that underscored their fundamental strengths in strategic planning and execution. In other words, Prussia was able to increase military efficiency by using telegraph technology as a weapon. Unlike other countries, Prussia was able to weaponize telegraph technology to increase military efficiency. Germany's well-established military organization and system served as the basis for effective use of telegraph technology and increased military efficiency. This background makes Prussia to use its hub position well in the militarized disputes.

In contrast with Moltke’s innovative attitudes and Prussian institution’s ability to implement adoption decisions, the Austrian and French cases show

how institutions allowed military leaders to act as 'inhibitors' that limited the adoption and integration of the telegraph into communications systems (Jungdahl & Macdonald, 2015). In Austria, the Austro-Hungarian military telegraph office, established in 1853, became very similar, at least in form, to the Prussian telegraph office in 1866.[98]

However, the official system has not led to effective use. Austro-Hungarian officers avoided using telegraph services on the battlefield because they were convinced that cavalrymen could not be replaced by transportation corps. This technological conservatism was reflected in the organizational culture.[99] Austrian military magazine No. 1860 shows that "It's impossible to predict how much longer telegraphs in or close to the front lines will be operational. At any time, telegraphic traffic may experience a disruption, a lengthier interruption, or a complete and permanent suspension."[100]

Spoke states that rely on the telegraph suffer here. This is because Germany, a hub state that controls information in an asymmetric interdependent network, can have a military application of panopticon and chokepoint effect during war. So field telegrams were used extremely rarely in engagements with the Prussians. Austrian General Ludwig von Benedek's

[98] The Austro-Hungarian army's telegraph system was formally similar to the German system, but it was not used properly compared to Germany in terms of military utilization, so it could not use the panopticon or chokepoint effects at all.
[99] The Austro-Hungarian army established a 'Railroad and Telegraph Regiment' in 1883 in order to enhance its lines of communication in support of fast mobilization plans. Following the economic collapse of 1873, Austria nationalized its railroads. See Rothenberg 1999, pp. 109-112.
[100] 44L. v. M., "Über den Einfluss der Eisenbahnen und Telegraphen auf die Kriegsoperationen," Österreichische Militärische Zeitschrift 2 (1860). pp. 148-54. Original translation.

aversion to telegraph employment combined with outdated tactics further reduced Austrian effectiveness against Moltke's innovations in operational planning, logistics, telegraph communications and tactics. [101] That was a dilemma. This is because if Austria uses the telegraph network in field operations, it is dependent on Germany and leads to military use of the Panopticon effect, and critical information is exploited, otherwise it is defeated in an old-fashioned war. This dilemma was a common dilemma faced by opponents during the German unification war.

In the mid-19th century, France was slow to recognize the advancements made by Germany in the field of military communications and adopt similar changes. The conflicts in Algeria, Morocco, and Italy brought attention to the significance of incorporating telegraph technology into military operations, however, French leaders were reluctant to follow the examples set by other nations. Until 1868, France was the only military power without a regular military telegraph service. In 1868, the country took its first step towards modernizing its communications systems by investing in telegraph experiments and organizing four divisions into telegraph brigades, although they received limited resources and equipment. After their defeat in the Franco-Prussian War of 1871, it was acknowledged that the French army's mobilization efforts were inadequate, but the establishment of a well-

[101] See Rothenberg 1999, pp. 59-68 for a discussion of the Austrian general staff's lack of strategic thought.

organized telegraph engineering service was praised.

Despite these efforts, as in Austria, French institutions have failed to support the adoption of ICT technological innovations with the timeliness to make the more focused investments needed to integrate telegraph technological innovations in a way that can deliver strategically important payoffs. When the Franco-Prussian War broke out, the French telegraph network was defenseless against the Prussian response, and the newly created telegraph unit quickly fell into German hands.

Prussia exploited critical information about the enemy as well as the operational situation transmitted from moment to moment, and through this, it overpowered spoke states such as Denmark and Austria. Also, in the case of France, it was strong, but as a hub, it could not use the panopticon and chokepoint effect at all. It failed to do a military application for the telegraph network. Thus, the military effectiveness was high in Prussia, and it was able to lead the war with advantageous position with fruitful critical information and its strategical usage. In summary, the Prussian institutions involved in the adoption and use of the telegraph had many advantages over those of their adversaries and effectively exploited asymmetric networks to win a number of wars.

2.3 Results and Implications

The German Unification War has been associated with the telegraph from the beginning. It was triggered by the leak of the EMS telegram. An important point is the use of Germany's military communications networks. Germany has the capabilities to exploit weaponized interdependence of information flow. Germany manipulated critical information based on its information superiority over Denmark, Austria, and France. Defense preparedness was strengthened where they attacked by obtaining maneuvering information on Denmark, Austria, and France in advance. In addition, the manipulation of critical information increased uncertainty on the battlefield. Germany led the war effortlessly without this uncertainty.

For rapidly delivered military communications, it was maximized through the general staff system. And in order to maintain this information superiority, the technical chokepoint effect that hinders or cuts off new cable construction or blocks information to block outside intervention. In Austria, in particular, information delivery was old-fashioned and exploited by the German panopticon.

Germany's military application of asymmetric information and communication networks during the German Unification Wars was based on two types of weaponized interdependence: the panopticon effect and the chokepoint effect. The panopticon effect refers to the ability of a state to

observe and monitor the activities of other states, thereby creating a sense of transparency and accountability. Germany utilized its telegraph network to gather intelligence about the military activities of Denmark, Austria, and France and monitor their movements, creating the panopticon effect and chokepoint effect. Military application of these allowed Germany to respond quickly to changing circumstances on the battlefield and maintain a situational advantage over its enemies. One example of the use of the telegraph network for intelligence gathering was the Battle of Wörth in 1870, during the Franco-Prussian War, where Germany was able to coordinate its movements and respond to the changing conditions of the battle in real-time. The telegraph network allowed Germany to receive updates from scouts and adjust its tactics accordingly, giving it an advantage over the French forces. Another example was the Battle of Königgrätz in 1866, where the Prussian army was able to coordinate its movements and respond to the changing battlefield conditions in real-time, leading to a decisive victory. The telegraph network allowed the Prussian army to receive updates from scouts and adjust their tactics accordingly, keeping them ahead of their enemies.

The chokepoint effect refers to the ability of a state to control critical nodes in a communication network, thereby restricting the information flow and limiting the ability of other states to take action. Germany utilized its telegraph network to control the information flow and limit the ability of Denmark, Austria, and France to coordinate their actions and respond to

changing circumstances. This gave Germany a significant advantage on the battlefield and helped it achieve its military objectives. One example of the use of the telegraph network for controlling the information flow to isolate enemy was the Battle of Sedan in 1870, during the Franco-Prussian War, where Germany was able to restrict the information flow between the French military and limit their ability to coordinate their actions. This allowed Germany to gain a decisive advantage and achieve a major victory in the war as well.

Thus, Germany won 55 battles out of 62 in the Second Schleswig War (1864), Austro-Prussian War (1866) and Franco-Prussian War (1870-1871). The battles that were particularly lost were where German telegraph cables were not laid (Battle of Villersexel, Battle of Trautenau, Battle of Langensalza) or naval battles (Battle of Heligoland). Even in the lost battle, Germany did not suffer much damage, because it monopolized information flow and quickly avoided unfavorable situations. The German unification war case verifies the proposition of this study. Germany started the war with full access to information flow and Germany could easily have won by the military application of the panopticon and chokepoint effects.

Denmark, Austria, and France could not have overcome disadvantages and pressures from the Germany's telegraph network. Because of the asymmetric interdependence on information, it was inevitable to use the German telegraph network, but if the network was used, the military use of

the panopticon and the chokepoint effect came in, and critical information was stolen and isolated from the information network. If they did not use the network, they would be overwhelmingly behind in information warfare like Austria. In other words, while Germany's enemies did not make good use of telegraph technology during the war, Germany made good use of its hub position in the telegraph network and won.

3. The Case of United States

3.1. The United States' Information and Communication Networks in the Telegraph Era

The United States had sufficient telegraph infrastructure to leverage for international security competitions during the telegraph era. The rapid expansion of the telegraph network in the late 19th century allowed the United States to establish a dominant position in international communications. By the late 1800s, the United States had one of the largest and most advanced telegraph networks in the world, connecting major cities and facilitating the exchange of information across long distances.

The United States telegraph network was growing rapidly in the late 19th century, with the number of miles of telegraph lines in the country increasing from approximately 33,000 in 1865 to over 200,000 by 1900. Also, the United States has advantage to leverage private resources. The United States government made significant investments in the telegraph network, recognizing its importance for national security. For example, in 1866, the United States Congress passed the 'Telegraph Act', which provided government subsidies to telegraph companies for the construction of telegraph lines along military and postal routes.

The telegraph network helped the United States in various ways. The telegraph network allowed for the rapid exchange of information and facilitated communication and coordination between government officials,

military leaders, and other key stakeholders. This improved the speed and efficiency of decision-making and helped to ensure that the United States was able to respond quickly to international security threats and events. Furthermore, the telegraph network was instrumental in the nation's rise as a world power and played a crucial role in the country's ability to shape international relations and compete in international security competitions. The instant transmission of messages allowed for the rapid exchange of information and facilitated diplomatic negotiations, military strategy, and trade negotiations.

From April 22 to August 12, 1898, the U.S. and Spain fought a war over Cuban independence. Initially both countries attempted to avert war; however, U.S. public outrage over Spanish atrocities sensationalized through yellow journalism and the sinking of the Maine ultimately led to the U.S. intervention in Cuba. At this point, it is also seen that the development of ICT has caused conflict. Like Ems telegrams, fake information about potential enemies that spreads faster than the full story is shown by technological advances. President William McKinley desired a quick war with limited conflict to avoid wasting American lives. Military strategists realized that Spain's Navy was its center of gravity, so the U.S. targeted the Spanish fleets in the Caribbean and in the Pacific (Gleijeses, 2003; Grenville, 1968; Offiner, 2004; Paterson, 1996). At this time, the communication network of the United States gave access to the Spanish army's critical information, which was

manipulated and used to break the Spanish army's offensive balance. In particular, the asymmetric information interdependence between the US and Spain was more prominent in the Philippine campaign.

3.2Weaponization of Asymmetric Telegraph Network during the Spanish-American War

Various causes of the Spanish-American War have been suggested, such as nationalism and the desire to join the club of great. However, this is only a reflection of the pretext and domestic public opinion, and strategic consideration is needed in actually choosing a war powers (Barnes, 2010; Fry, 1982; Leuchtenburg, 1952; McCartney, 2006; Offner, 1998; Peceny, 1997; Trask, 1996). The U.S. President Cleveland and his successor, republican president William McKinley, had no intention of going to war until the beginning. However, while the U.S. has a position as the hub of the telegraph network, Spain is a spoke state that relies on cables from other countries in the telegraph network, in a situation where it is very difficult to communicate with the Philippines except for the Manila-Hong Kong cable (Headrick, 1991). In other words, the U.S. had an advantage in the telegraph network and successfully used it in weaponization and war to maximize the panopticon and chokepoint effect, and waged war with an overwhelming advantage in information.

After linking the first transatlantic cable to the British Empire, the United States expanded its telegraph infrastructure around the Pacific. At the end of

the 19th century, the telegraph infrastructure centered on the Atlantic and Americas extended to the Pacific. The United States gained easy access to cable through successful cooperation with the private sector, and internationally, through cooperation with the United Kingdom, it secured an entire cable network. Spain, on the other hand, had significant weaknesses in its European-centric intelligence network, and was relatively unable to conduct military operations, especially in the Pacific. Thus, due to information asymmetry, the weaponization of telegraph technology in the United States has increased the complexity of information, placing enormous constraints on Spain's activities (Trask, 1996). In fact, at the siege of Valais, the Spanish army did not know that the war was over, and the fighting lasted until June 2, 1899, while the United States withdrew on December 10, 1898 with the Treaties of Paris. It clearly shows information asymmetry (Foner, 1968).

The Philippines seemed strategically tougher than that of Cuba's to the U.S., as it was a long-standing Spanish colony and the U.S. had to go in an expedition farther than Cuba. However, despite such circumstances, the war unfolded in America's favor. The islands' only link to the outside world was the Hong Kong-Manila cable laid by the Eastern Extension Company under an exclusive concession obtained from Spain a few months before the war (Grenville, 1968; Paterson, 1996). In other words, if the U.S. created a hard chokepoint effect, such as physically cutting the cable, the Spanish forces in

the Philippines would be physically isolated from the information network. In addition, the American fleet received real-time information on the strategic maneuvers of the Spanish fleet, cut Spanish cables and isolated its forces from the information network. The exploitation of critical information gave the Spanish fleet confusion about where to attack and defend like ‘fog of war’ coined by Clausewitz, and the American fleet could hit the enemy's weak spots with relative ease and increase its defense preparedness.

This vulnerability of information turned public opinion against the Spanish army. In addition, due to the military use of the panopticon effect, the uncertainty of information was strengthened, and as they continued to fight in the fog of war, their vulnerabilities were attacked by the U.S.. This is also related to the military effects discussed above, but information asymmetry makes a much more overwhelming difference. The U.S. entered the war by succeeding in weaponizing telegraph technology and won the war by taking advantage of information asymmetry. At the time, French cables around the Philippines and Cuba were neutral and underused, but while Britain helped the U.S. with its cable and telegraph transmissions, Spain did not gain that advantage. In particular, the Hong Kong-Manila cable was allowed to be used by Spain, but after protests from the U.S., Britain cut off the end of the Hong Kong cable so that it could not be used altogether. In this situation, the intelligence war continued, and Spain in the Philippines was isolated by receiving asymmetric information. The panopticon effect was strongly

expressed, and systematic technology was used for weaponization. The U.S. used telegraph technology to address the vulnerability of its information network. At the same time, they used it as a weapon to press Spain with the internal and external environment of the war and achieved a great military victory. Furthermore, the U.S. later tried to strengthen asymmetric interdependence through undersea cable management, which sparked a new competition among the great powers.

In summary, the United States' military application of asymmetric information and communication networks during the Spanish-American War was based on two types of weaponized interdependence: the panopticon effect and the chokepoint effect. The United States utilized its telegraph network to gather intelligence about Spanish military activities in the Philippines and monitor their movements, creating a panopticon effect. This allowed the U.S. to respond quickly to changing circumstances on the battlefield and maintain a situational advantage over its enemies.

One example of the use of the telegraph network for intelligence gathering was the Battle of Manila Bay in 1898, where the US Navy was able to coordinate its movements and respond to the changing conditions of the battle in real-time. The telegraph network allowed the US Navy to receive updates from scouts and adjust their tactics, accordingly, giving them an advantage over the Spanish fleet.

The United States utilized its telegraph network to control the information flow and limit the ability of the Spanish military to coordinate its actions and respond to changing circumstances. This gave the U.S. a significant advantage on the battlefield and helped it achieve its military objectives. One example of the use of the telegraph network for controlling the information flow was the Battle of San Juan Hill in 1898, where the US Army was able to restrict the information flow between Spanish forces and limit their ability to coordinate their actions. This allowed the US Army to gain a decisive advantage and achieve a major victory in the Philippines theater of the war.

Therefore, the United States' military application of asymmetric information and communication networks during the Spanish-American War was based on two types of weaponized interdependence: the panopticon effect and the chokepoint effect. The U.S. utilized its telegraph network to gather intelligence, monitor its enemies, control the information flow, and respond quickly to changing circumstances, giving it a significant advantage in conflict, and shaping the outcome of the war in the Philippines theater. Examples of battles that utilized the asymmetric information and communication interdependence include the Battle of Manila Bay and the Battle of San Juan Hill.

3.3 Results and Implications

The United States was dominating information flows about Spain and manipulating critical information. The panopticon effect identified Spain's maneuvering position and strengthened defense preparedness. The point where the US chokepoint effect was strongly demonstrated is the entire Philippines. It physically cut the cables to make military communication impossible, and also isolated Spain internationally and politically through public opinion wars. Panopticon and chokepoint effects increased uncertainty about the battlefield situation of the Spanish army, and the United States easily fought the war by removing uncertainty. Spain's information delivery was very slow and was censored by the United States. Spanish information passing through American cables was blocked. This increased uncertainty on the battlefield of the Spanish expeditionary force and lowered defense preparedness.

The United States used its advantageous cable network to isolate itself in information and led the war to its advantage. The U.S. Congress was concerned about the expansion to the Philippines, but the war was easily resolved by taking control of the Manila-Hong Kong cable (Foner, 1968; Gleijeses 2003; Headrick, 1991; Offner, 1999; 2004) . The United States had the capabilities to exploit weaponized interdependence of information flow while Spain was a spoke state that could not secure its own information and communication network and totally depended on hub states' network, so

Spain was in a position to be exploited of critical information by hub states.

The United States took 22 victories out of a total of 27, with few casualties in the battles it lost. This is because they made a detour during a clash with the large army. And before and after the war, the United States secured victory through information warfare and public opinion warfare by utilizing its overwhelming information network. The case of the unification war in the United States verifies the proposition of this study. The United States starts war with full access to information flow and the United States could win by the military application of the panopticon and chokepoint effects.

4. The Case of Great Britain

4.1 The Great Britain's Information and Communication Networks in the Telegraph Era

The Great British telegraph network was completed through close cooperation with private actors. Telegram usage and cable system, which was telegraph infrastructure, were mostly owned by the Great Britain and its allies, and the telegraph industry grew explosively centered on the private sector, just like the growth of the digital industry today.[102]

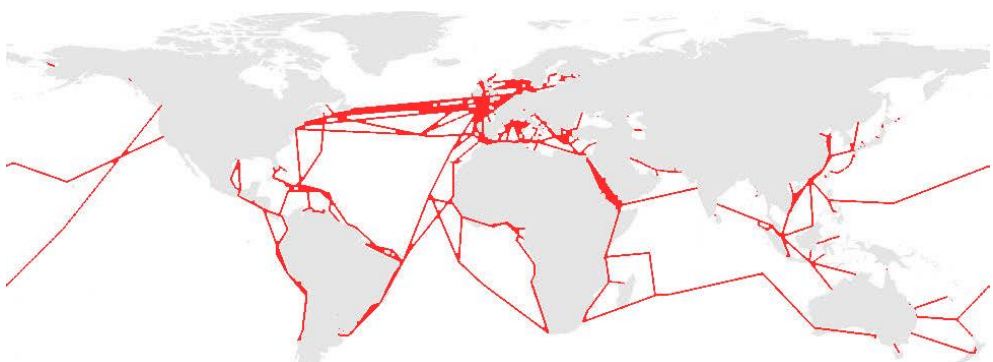

Figure 21: Telegraph Network of the Great Britain including private telegraph cables, 1900-1914 (Based on Wenzlhuemer (2013) and Starosielski (2015), the Author illustrated)

As a hub state in the telegraph era, the Great Britain was in an advantageous position to weaponize the asymmetric network. Considering that trade networks at the time were also mostly affected by communication

[102] In terms of military effectiveness and telegraph networks, hub states' military effectiveness can be maximized when there is an institution that can effectively utilize telegraph technology and its network. the network position is important when using such interdependence. Then, the states compete to secure these network positions. It is also a statecraft, a weaponization type that is applicable to empire overseas colonies, such as Great Britain. Telegraphs allow Britain to take immediate action on colonies far away from the British Empire which helps to maintain the same level of control in overseas colonies as domestic control. The British Empire made the best use of telegraph technology with railroads.

networks, Britain's network power was stronger than any other state, and various scholars proves it using actual data (Headrick, 1991; Lew & Cater 2006; Poujol & Fourniau, 2005; Wenzlhuemer, 2010; 2013).

The physical network was also strong in the UK, but the physical size of the network increased over time. As shown in the table below, the length and share of submarine cables, an infrastructure that delivers information and enables communication between countries and continents, was enough to be considered a monopoly.[103]

Furthermore, in 1877 more than half of all government cable lengths were run by Britain or the British Indian administration. More than 88% of privately owned cable lengths were operated by companies operating out of London. Headrick and Griset (2001), using other sources, showed that this situation has hardly changed until after 15 years.[104] According to data compiled by the US Navy in 1892, 63.1% of all ocean cable lengths installed in 1892 was owned by British companies. Together with the UK government cable, this amounts to 66.3% of networks in the hands of the UK. Hedrick (1988) also noted elsewhere that British companies had installed all British

[103] It can also be identified in an appendix showing the total length of submarine cables that existed between 1865 and 1903 and the average annual growth rate of the network. The information in the table is calculated based on 'nominal' data and does not take into account cables and connections between the various islands that cross rivers and river mouth. Also, there may be some bias due to the lack of information about the exact date a particular cable went down. However, distortions due to these inaccuracies are minor and do not affect the validity of claims that rely primarily on the ratio of private and government cable lengths. Cable lengths were converted from the original data to kilometers for comparison (Wenzlhuemer, 2013).
See https://github.com/onesuncho and https://sites.google.com/view/onesun/ for the Appendix.
[104] Headrick and Griset 2001. p. 560.

cables and most non-British cables in the world by the time the 'International Cable Convention' was signed in 1885 and owned 24 of the world's 30 cable vessels (Headrick, 1988, p. 115). This data emphasizes the central role that the British Empire played in worldwide telegraph communications in the 19th century. This was caused by a combination of several factors. The availability of capital and an early symbiosis with railways, one of the key technologies of the Industrial Revolution, led to the early emergence of a cohesive domestic telegraph network in Britain. Across the Atlantic, close business ties with British India, a remnant of British colonialism, created immediate communications needs along the east-west axis. These commercial demands far outweighed those made by the administrative and strategic communications needs of the British Empire. The capital accumulated from successful investments in transatlantic cable and the nationalization of the U.K. domestic networks has enabled British companies to respond quickly to these demands. The U.K. government has supported companies in doing this in many ways (Wenzlhuemer, 2013).[105]

[105] It is therefore not surprising that the structure and growth patterns of global cable networks largely reflect the changing dynamics of British imperialism and business interests. Unfortunately, there is no comprehensive information about the actual use of submarine cable networks and global information flow patterns. These data exist only in isolated cases and routes (as seen in the telegraph information flow between India and Europe) or at an aggregate level related to a country's general external traffic volume. The growth pattern of the global submarine cable network can only be tracked by examining infrastructure growth, as was done in the previous paragraph (and this is unlikely to change anytime soon). However, it is possible to track what effect the expansion of the network has had.

	Private		Government		Total	
Year	Abs. (km)	AAG (%)	Abs. (km)	AAG (%)	Abs. (km)	AAG (%)
1865	1,282	n.a.	3,119	n.a.	4,400	n.a.
1870	46,007	104.7	4,858	9.3	50,865	63.1
1880	131,975	11.1	10,762	8.3	142,737	10.9
1890	221,477	5.3	23,852	8.3	245,329	5.6
1903	332,056	3.2	74,250	9.1	406,307	4.0

Table 2: Length of submarine cables under private and government management, 1865-1903 (Wenzlhuemer, 2013, p. 119)[106]

	Number of cables		Length of cables		Length of wires	
Ownership	Abs.	%	Abs. (km)	%	Abs. (km)	%
Private	149	26.19	110,282	93.06	121,372	91.96
Government	420	73.81	8,227	6.94	10,607	8.04
Total	569	100	118,509	100	131,979	100

Table 3: Private and government ownership of submarine telegraph cables, 1877 (Wenzlhuemer, 2013, p. 120)[107]

The UK, which has a system that can make good use of private resources,

[106] Table 2 shows the rapid expansion phase between 1865 and 1880, peaking in the five years prior to 1870. During this period, the average annual growth rate based on the cable length of the entire submarine cable network reached more than 63%. Over the next decade, growth was still impressive at nearly 11% per year. The average growth rate between 1880 and 1890 was only half of the data and fell to less than 4% during the cross-linking phase between 1890 and 1903. The table also clearly shows how many global submarine cable networks were actually built and operated by private companies during the observation period. Before discussing this in more detail, Table 2 shows that government involvement in network expansion has remained very stable over the entire period, while private companies make large initial investments and then scale back their activities over time. The average annual growth rate of government-owned cable lengths varied by less than 1% at all four measurement points, while the private growth rate started at over 100% per year and dropped to just over 3%. This supports the point that private telegraph companies respond to real or perceived telecommunications needs, while government ventures often fill unprofitable gaps in networks or provide alternative routes for administrative or strategic purposes.

[107] Table 3 shows the percentage and length of cables operated by private companies and government in 1877. Of a total of 569 operational cables, the government operated 420, nearly three-quarters of all cables. But in terms of length, only 8,227 kilometers of cable and 10,607 kilometers of wire were in the hands of public. This accounted for only 6.94% and 8.04% of the total length, leaving the largest share to private companies. These data clearly support that while most private companies focus on relatively unprofitable long-distance connections (the edge path of global telegraph communications), governments provide less profitable but equally important regional branch lines.

occupied a dominant position in the network. This chapter explores how the British Empire used its asymmetric communication network militarily to gain an advantage in the international security competition and what grand strategy or statecraft it used to maintain the network through available data.

4.2 Weaponization of Asymmetric Telegraph Network during the Second Boer War

The Great Britain already had a significant influence on the telegraph technology network in the late 19th and early 20th centuries. The Red Route, which physically connected British colonies, as well as a cooperative project with the United States, exerted an overwhelming influence on the submarine cable market commercially. Britain was equipped with the ability to weaponize telegraph technology in a variety of ways. In particular, the U.K. made great efforts to consolidate the weaponized structure of interdependence and its structure by using cable cutting and information stealing for military effectiveness and producing a strong information asymmetric structure. Through this, it was possible to secure the asymmetric advantage of information in the information network, and by leveraging it, it was able to exert overwhelming influence on countries that were not included in the network. Typically, during the war between the United States and Spain, information was provided to the United States advantageously while blocking the only cable in Spain, or when conflict with Britain occurred, information

was spread to increase the complexity of information. And the British policy toward Asia indirectly gave the governor or ambassador a great deal of authority, but they wanted to exert direct influence through the rapid spread of telegraph technology. In this way, Britain weaponized telegraph technology to adjust Asian policy, especially in real-time management of important colonies such as India and began to exert direct and rapid influence on China and Japan.

The Great Britain, the United States, France, and Germany were the major participants in the cable-laying boom of the first decade of this century. As usual, the British were first. And their first consideration, after the shocks of the turn of the century, was to turn their cable network into an invulnerable global communications system. This took two forms: completing their network of strategic cables and perfecting their contingency plans in preparation for war.

One very obvious gap remained in the world cable network that radiated out from Britain in 1900: the Pacific Ocean. The Pacific cable project did not originate in colonial defense committees concerned with strategic questions but among Australians and Canadians who felt isolated at the very edge of the British world. They could not do anything about it, however, without Britain's help.[108]The Britain had dominant position in the telegraph network. Based on

[108] On the Pacific cable, see George Johnson, ed., The All-Red Line: The Annals and Aims of the Pacific Cable Project (Ottawa, 1903).

the hubs, the Britain leverage information flow to access and exploit critical information.

Country	Lines per Area	Wires per Area	Bureaus per Area	Bureaus per Pop.	Int.Mess. per Pop.	Ext.Mess. per Pop.
Algeria	14.66	12.21	4.59	43.29	119.66	4.42
Austria	95.31	89.59	96.38	83.81	85.41	86.59
Belgium	186.23	295.65	202.70	66.29	140.31	174.58
Bosnia-Herzeg.	48.13	37.20	12.95	31.93	29.82	83.18
Brazil	2.51	1.40	1.05	35.67	19.76	0.86
Bulgaria	45.34	28.17	12.32	24.46	74.92	17.27
Cochin-China	11.91	5.54	1.67	9.21	21.89	5.98
Denmark	86.55	91.45	68.41	81.26	76.62	217.54
Dutch Indies	3.94	1.73	1.17	5.01	3.31	3.09
France	224.78	250.71	129.05	135.99	300.94	71.63
Germany	203.36	222.21	239.57	173.95	163.05	77.22
GB & Ireland	200.58	448.86	193.47	112.48	565.85	92.58
Hungary	60.68	90.45	53.47	74.67	67.37	57.38
India	20.12	19.64	7.27	7.05	5.36	1.08
Italy	125.18	117.40	108.78	74.49	80.42	25.52
Japan	61.57	74.62	22.77	14.58	89.45	3.74
Luxembourg	202.26	101.84	346.49	287.85	44.44	198.00
Montenegro	47.30	17.48	11.12	28.04	54.67	24.50
Natal	35.84	27.11	14.30	99.02	1099.42	38.34
Netherlands	159.70	175.76	160.49	77.57	153.04	177.43
New Zealand	38.34	31.65	19.36	482.36	1341.08	52.77
Norway	31.93	32.87	13.65	154.45	178.57	137.31
Portugal	77.59	50.87	25.44	35.14	49.28	75.46
Romania	37.43	28.73	20.26	45.41	80.89	37.87
Russia	6.31	5.63	0.66	8.67	33.95	7.27
Senegal	7.68	2.71	0.72	11.84	23.85	2.94
Spain	55.13	38.02	15.63	32.77	58.70	22.89
Sweden	17.61	15.88	25.02	165.08	81.36	86.45
Switzerland	142.79	133.21	269.39	254.88	134.85	253.69
Tunisia	25.66	17.32	4.72	30.97	49.58	93.49
Victoria	38.81	23.92	10.35	148.85	359.99	87.99
Western Union	34.49	50.19	15.67	120.49	231.02	7.66

Table 4: Indexed data on network structure and use of electric telegraphy in selected countries, 1900 (selected European average = 100) (Wenzlhuemer, 2007, p. 1735)

	Lines/Area				Wires/Area				Bureaus/Area				Bureaus/Pop.				Int.Mess/Pop.				Ext.Mess./Pop.			
	1870	1880	1890	1900	1870	1880	1890	1900	1870	1880	1890	1900	1870	1880	1890	1900	1870	1880	1890	1900	1870	1880	1890	1900
Austria	96	144	88	95	114	133	86	90	84	103	100	96	84	96	91	84	61	68	57	85	91	72	85	87
Belgium	257	235	221	186	310	386	369	296	348	319	255	203	139	116	89	66	191	167	145	140	173	201	206	175
Denmark	87	111	113	87	84	103	109	91	88	87	78	68	127	118	99	81	84	107	87	77	210	261	206	218
France	138	161	177	225	142	165	197	251	138	126	147	129	128	123	146	136	91	196	259	301	52	74	83	72
Germany	115	162	185	203	137	206	222	222	153	226	258	240	138	184	203	174	99	114	123	163	125	79	78	77
Great Britain	n.a.	166	156	201	231	269	337	449	314	210	193	193	203	131	116	112	n.a.	343	536	566	n.a.	91	96	93
Greece	62	88	114	n.a.	26	40	48	n.a.	17	21	22	n.a.	38	44	46	n.a.	50	80	120	n.a.	14	49	59	n.a.
Hungary	59	56	57	61	65	70	51	90	40	38	46	53	51	54	61	75	59	47	44	67	12	65	52	57
India	10	10	16	20	6	9	18	20	1	4	7	7	1	5	7	7	2	3	4	5	0	1	1	1
Italy	104	110	117	125	113	126	120	117	86	95	108	109	66	69	78	74	51	84	81	80	38	32	25	26
Japan	n.a.	22	33	62	n.a.	17	33	75	n.a.	6	7	23	n.a.	5	5	15	n.a.	23	33	89	n.a.	1	1	4
Netherlands	159	143	153	160	199	182	188	176	165	146	182	160	96	81	95	78	207	215	159	153	255	230	217	177
Norway	34	34	23	32	19	22	15	33	10	10	9	14	118	111	102	154	108	120	154	179	131	136	124	137
Portugal	56	60	74	78	39	52	56	51	30	26	35	25	46	38	53	35	31	45	58	49	22	47	74	75
Romania	48	40	33	37	23	22	25	29	12	15	19	20	20	33	43	45	59	62	63	81	41	40	36	38
Russia	4	5	5	6	3	4	4	6	1	1	1	1	14	24	21	9	18	29	27	34	8	10	7	7
Serbia	n.a.	55	59	n.a.	n.a.	28	35	n.a.	n.a.	15	20	n.a.	n.a.	30	32	n.a.	n.a.	41	76	n.a.	n.a.	27	27	n.a.
Spain	40	40	48	55	34	35	38	38	9	9	18	16	18	18	37	33	32	43	60	59	16	23	29	23
Sweden	26	32	19	18	24	29	18	16	15	22	18	25	104	143	122	165	69	69	67	81	69	79	79	86
Switzerland	218	195	168	143	172	168	150	133	304	325	266	269	327	325	273	255	309	282	223	135	252	287	280	254
Western Union	n.a.	28	n.a.	34	n.a.	29	n.a.	50	n.a.	17	n.a.	16	n.a.	177	n.a.	120	n.a.	294	n.a.	231	n.a.	n.a.	n.a.	8

Table 5: Indexed data on network structure and use of electric telegraphy in selected countries, 1870-1900 (selected European average = 100) (Wenzlhuemer, 2007, p. 1738)

Military Application of Asymmetric Network and its Military Effectiveness during the Second Boer War

In the Boer War, defense preparedness was increased and attack superiority was maximized by isolating the other country from the information network through the military application of asymmetric information network and monopolizing critical information during the war. Through this, they identified the movement route of the enemy and effectively responded to the enemy armed with guerrillas and machine guns (Robinson, 2008).

The situation and use of cables during the Boer War were as follows. At the time, there were two cables connecting South Africa and Europe, one up

the east coast from Durban to Delagoa Bay, Mozambique, Zanzibar, and Aden, the other from Cape Town to Mossamedes, Loanda, Sao Tome, and on up the west coast of Africa. On October 3, in an effort to block communications between Africans and their potential allies in Europe, the war office censored telegrams between the Cape and Natal on the one hand, and the Transvaal and the 'Órange Frée Stàte' on the other. This was a makeshift, as Africans could still communicate through the Portuguese colonies (Pretorius, 2000). On October 14, two days after the start of the war, Army Headquarters conducted inspections in Cape Town and Durban, as well as in Zanzibar and Aden. It banned all coded telegrams except those between foreign governments and consulates in Africa. Five days later, the British postmaster extended the ban to include government telegrams, and the International Telegraph Office in Bern was officially notified of this.[109] This was perfectly legal with the consent of St. John Paul II. At the Petersburg Conference of 1875, all states had the right to withhold any message passing through their territory (Herbert, 1990; Robinson, 2008).

On October 25, following an investigation by the German government,

[109] The censorship during the Boer War is documented in two collections of documents: (1) Great Britain, War Office, Intelligence Department, "Telegraphic Censorship during the South African War, 1899-1902," (June 1903), and (2) "Memorandum on the Censorship of Telegrams to and from South Africa on the Outbreak of Hostilities with the Transvaal and Orange Free State" (November 1900). Both documents can be found in the Public Record Office in WO 33/280 and FO 83/2196, respectively. Additionally, Lieutenant Colonel Thomas G. Fergusson's book, "British Military Intelligence, 1870-1914: The Development of a Modern Intelligence Organization," provides further insight into the topic (Fergusson, 1984). See also, Fergusson, T. G. (1984). British Military Intelligence, 1870-1914: The Development of a Modern Intelligence Organization. London and Frederick, MD. Pp. 215–23. (Headrick, 1991; McCrachen, 2015).

the ban on government codes and cryptographic telegrams was lifted. On November 17, the British government once again sent a new notice to the Inter-Parliamentary Affairs Bureau banning all ciphers and cryptic telegrams. The British did not trust the other governments, even though they secretly allowed the Portuguese and American governments to pass the coded telegrams. Other powers were quick to protest. Both France and Germany complained that British action hurt their legitimate commercial interests in South Africa. At the request of the German ambassador, Britain made an exception for Germany to communicate by code with the governor-general of German East Africa. It also censored cables to and from the French base in Djibouti and telegrams from Sierra Leone.

The British government has taken other steps. On January 6, 1900, the Secretary of the Interior issued a writ against the Post Office. The contents are as follows. Until further notice, all telegrams passing through London's central telegram office are subject to censorship, specifically to secure telegrams sent for the purpose of supporting South Africa and the Orange Free State.

It was during the Second Boer War at the time and was to isolate Britain’s enemies from intelligence networks in response to other countries’ assistance in the First Boer War. A soft chokepoint effect was used during the war. Being the target of this censorship means that countries such as Portugal and France, which participated in the Boer War on the opposite side of Britain at the time,

also became the target of weaponization of an asymmetric communication interdependence network as spoke states in the African information network. Hub states that seize cable networks can not only disrupt communications between spoke states' overseas territories, but also prove that they use them militarily. Even if it was considered a great power at the time, if it relied asymmetrically on information from a global communication network hub country such as the U.K., it could be subjected to exploitation of critical information and pressure using the information network as leverage.

Figure 22: Cables around Africa, 1879-1901 (Headrick, 1991, p. 74)

Prior to the start of the Boer War, the Great Britain was not prepared

much. At the time, British intelligence noted increased Boer military preparations, but the proposal to increase defense spending was rejected. When war began with the Boer army in October 1899, Britain was ill-prepared for war. Even the Boers, using their home ground, were armed with guerrilla tactics, machine guns, Krupp artillery, and Mauser rifles, making them as strong as other European nations (Headrick, 1991). The Great Britain has overcome this limitation with the telegraph network. Hostile state, including the Boers, were asymmetrically dependent on Britain's information and communication network, which became the basis for British military operation during the war. The Boers could have won tactical victories with guerrillas, but tactical victories did not lead to strategic victories because they were strategically excluded from the communications network, that is, had no access to the information flow itself. In contrast, the British ensured that each tactical victory was tied to key battle victories, even if they lost a few battles tactically.

The British military used the panopticon effect in the military setting to counteract the Boers' guerrilla warfare, and militarily used the chokepoint effect to isolate the Boers from the communications network and prevent them from accessing information flows. So, even if the Boer guerrillas succeeded, they did not lead to a strategic victory because they did not link up with Boer forces elsewhere (Farwell, 2009; Pretorius, 2000; Robinson, 2008). On the other hand, the British Army exploited critical information

about the Boers despite being poorly prepared, raised their defense preparedness, eliminated uncertainty on the battlefield, and led the war efficiently.

During the Boer War with South Africa, which lasted from 1899 to 1902, Britain censored communications between South Africa and Europe, as well as between other European countries and their sub-equatorial African colonies. Although this censorship was justified by military necessity in times of war and was quickly lifted once the war ended, it undoubtedly demonstrated the power of communications control in wartime (Headrick, 2010).

In brief, the Great Britain's military application of asymmetric information and communication networks during the Second Boer War was based on two types of weaponized interdependence: the panopticon effect and the chokepoint effect. The British utilized their telegraph network to gather intelligence about Boer military activities in South Africa and monitor their movements, creating a panopticon effect. This allowed the British to respond quickly to changing circumstances on the battlefield and maintain a situational advantage over their enemies.

One example of the use of the telegraph network for intelligence gathering was the Battle of Spion Kop in 1900, where the British were able to coordinate their movements and respond to the changing conditions of the

battle in real-time. The telegraph network allowed the British to receive updates from scouts and adjust their tactics, accordingly, giving them an advantage over the Boer forces.

The British utilized their telegraph network to control the information flow and limit the ability of the Boer military to coordinate its actions and respond to changing circumstances. This gave the British a significant advantage on the battlefield and helped it achieve its military objectives. One example of the use of the telegraph network for controlling the information flow was the Battle of Ladysmith in 1900, where the British were able to restrict the information flow between Boer forces and limit their ability to coordinate their actions. This allowed the British to gain a decisive advantage and achieve a major victory in South Africa.

In conclusion, the Great Britain's military application of asymmetric information and communication networks during the Second Boer War was based on two types of weaponized interdependence: the panopticon effect and the chokepoint effect. The British utilized their telegraph network to gather intelligence, monitor their enemies, control the flow of information, and respond quickly to changing circumstances, giving them a significant advantage in conflict and shaping the outcome of the war in South Africa. Examples of battles that utilized the asymmetric information and communication interdependence include the Battle of Spion Kop and the Battle of Ladysmith.

4.3 Results and Implications

Britain was able to lead the international security competition advantageously through the military use of the asymmetric telegraph network. To sustain this advantage, steps have been taken to strengthen the network. First of all, the cable was expanded in earnest with a private actor who wanted to gain commercial benefits. In other words, it was a public private partnership to maintain the asymmetric network. This strategic cable network became the basis for the Great Britain's strategic competition and states that rely on asymmetric telegraph network used wireless during the Boer War but could not have overcome the Great Britain's powerful asymmetric information network (Fordred, 1997; Robinson, 2008).

The 'pacific cable' is a strategic cable laid right after the Boer War. Various strategic cables were subsequently laid, the first of which was the new cable from Cape Town to St. Louis, completed in early 1900. Although the cable was not part of the Great Britain's 'red route', it was considered much safer than the other three along the African coast, prone to natural destruction and vulnerable to foreign interference. And in 1901 and 1902, cables were laid across the Indian Ocean to Singapore, as well as alternate routes to India, the Far East, and Australia in case Britain lost control of the Mediterranean. In particular, the British Empire was able to actively intervene in Asian affairs after connecting a cable to China, exerting a strong influence in Asia before World War I. By 1902, Britain had the world's major

commercial cables as well as strategic cables that made communications with key colonies and naval bases virtually unassailable. In a world on the verge of war, strategists drew up far more elaborate contingency plans, and were particularly concerned about defensive and offensive actions (Headrick, 1991).

The first of the committees to pay attention to cable after the Boer War was the Inter-Departmental Committee on Cable Communication. The first report of August 8, 1901, dealt with the problem of telegraph rates between England and India. The second report on March 26, 1902, took into account all other issues. It restated the basic principles of the Great Britatin's cable policy. It emphasized that it was desirable to have one cable reaching the territory of a neutral country friendly to Britain, and that there should also be cables following normal routes built according to commercial considerations.[110]

It also reiterated many of the previous cable committee's recommendations, including the importance of completing the British network in the Indian Ocean, the Eastern Group's contribution to British security, and the need to maintain private business interests. Essentially, the committee was satisfied with the security of British cable communications

[110] "We regard it as desirable that every important colony or naval base should possess one cable to this country which touches only on British territory or on the territory of some friendly neutral. We think that, after this, there should be as many alternative cables as possible, but that these should be allowed to follow the normal routes suggested by commercial considerations." As cited in Headrick (1991) and Kennedy (1971).

(Headrick 1991). Also, the committee started discussing how to use it for military purposes.

In August, 1904 the Admiralty issued a “Memorandum on the Protection of British Submarine Cables, and on the Destruction of an Enemy’s Cables,” It was about a chokepoint effect against a potential British adversary. In case of emergency, the cable is cut to isolate the enemy from the communication network. The “Censorship of Submarine Cables in Time of War” prepared by the War Office in 1904 and the Report of an Inter-Departmental Committees in 1908, strategically began to consider establishing secret censorship of submarine cables in the event of a national security threat.

‘Submarine Cable Communications in Time of War’, issued on December 11, 1911, by the ‘Standing Subcommittee of the Committee of Imperial’, made other nations more dependent on British communication networks. It also provided detailed instructions on how to intercept German communications without attacking a potential neutral country such as the U.S. In other words, it acknowledges the German threat and cuts the communication cable to try the military application of chokepoint effect. In this way, the Great Britain not only made it possible to exploit critical information through the military application of panopticon effect in case of escalation of crisis with the network already established after the Boer War,

but also specified how to take the chokepoint effect in practice.[111]

As analyzed by the historians, the Britain had finally achieved the ultimate goal of its communications strategy. Its own cable network was invulnerable to attack or interfere and had the ability to scout enemies or isolate them from the rest of the world. It was an important weapon in the world's future warfare (Headrick,1991; Müller, 2016; Nickles, 2003; Wenzlhuemer, 2013).

The Great Britain's cable network had limitations as well despite plenty of advantages from the asymmetric networks. The British connected the colonies through the Red Route, but this led the competition to an advantage with the panopticon and chokepoint when competing with external enemies but made internal control of the empire more difficult. This is because rebellion within the Empire intensifies through the intelligence network the British have built. In other words, the British Empire's information network, as an international asymmetric information network, benefited a lot, but had a negative impact on internal problem control.

Despite the limitations of colonial management, in terms of international security competition, the Great Britain's telegraph network had very high

[111] For example, in general, if France and Russia allied themselves with Britain, it was believed that the alliance would be able to practically isolate Germany from the rest of the world outside Europe by cutting the cables to the Azores, Tenerife, and Vigo, as well as the three cables that landed on the island of Yap. Having a good relationship with the British Empire was an overwhelming advantage in the information network at the time, as the British Empire controlled almost all cables through Africa. The real advantages include hard chokepoint effects such as cutting cables and panopticon effects such as surveillance and exploitation of critical information.

military and strategic utilization. Hub countries that seize cable networks can not only disrupt communications between spoke countries' overseas territories, but also prove that they use them militarily. Even if it was considered a great power at the time, if it relied asymmetrically on information from a global communication network hub state such as the Great Britain, it could be subjected to exploitation of critical information and pressure using the information network as leverage. The Great Britain, quickly realizing this, sought to collaborate with the private sector, strategically expand the telegraph network, and maintain an asymmetric information and communication network during the telegraph era, until early 20th.

5. Results of Military Application of the Asymmetric Telegraph Network

Therefore, Innovation and diffusion of ICTs advance speed, volume, and spatial range of information transmission and this feature creates increasing information complexity. Increasing information complexity create uncertainty in international dynamics. Under these circumstances, states weaponize telegraph technology for the military purpose in two ways: panopticon and chokepoint effects. Weaponization of telegraph technology increase threat perception which cannot or do not weaponize telegraph technology, thus other states try to secure telegraph technology. The hub states are more likely to initiate and win the wars with military application of the

weaponized ICT with panopticon and chokepoint effect. In the result, hub countries won 102 victories out of a total of 127 battles in the target cases. Considering that the hub states were mainly on expeditions and that the enemy was in defense preparedness to begin with, the military weaponization of information networks enhances the military effectiveness of the hub states.

In the 19th century, the telegraph allowed for the fast transfer of information across vast distances. Telegraph technology dominated the information flow after its invention and diffusion; hence, a worldwide information and communication network evolved (Headrick 1991; Wenzlhuemer, 2013). It was not the only favorable element that some experts observed. This has resulted in the formation of a new network that is asymmetric. The new asymmetric network distinguished hub and spoke nations. The hub nations have complete access to the information flow. As the information flow has risen, hub states, which govern the information flow, and spoke states, which do not, have developed. As the center node of an asymmetric information network, a state that monopolizes information flow may have considerable influence over other states. According to Hunt (2021), the British Empire's strength is drawn from these networks. Wenzlhuemer (2013) gave concrete proof of the United Kingdom's network dominance. Headrick (1991) suggested the ‘invisible power’ to explore the power generated from this asymmetric communication network. In other words, the asymmetric information flow provided by telegraph technology in the 19th

century led to the rise of new power, and hub states who employed it well were in a strategic advantage position. Thus, hub states lead wars effectively based on the military application of asymmetric information and communication networks during the telegraph era.

Chapter VI. Conclusion

1. Argument Recap and Summary of Findings

Within international security scholarship, information flow and inter-state communication have been treated as important factors to analyze causes and effects of international conflicts in terms of bargaining, spiral models of war, the impact of technological changes on wars and so on. However existing literature did not take identity and technology contexts into account, so existing theories see impacts of information and communication on international conflicts differently by two views: optimistic and pessimistic views.

The fact that the pessimistic view presents more grounds than that of the other shows two additional contextual elements in this dissertation. First of all, exchanging vast amount of information with the potential enemy increases the information complexity and thereby ratchets up the possibility of misperception. The possibility of bargaining failure likewise increases in the similar context. Additionally, the strategic utilization of ICT and its networks brings about conflict between states rather than increase in cooperation. That is even more evident in hub and spoke relationship. Opposed to the peaceful mood when telegraphs were first connected, the historical cases and empirical data confirms that the more a state gets connected to hub state, the more conflict transpires between states.

The spread of ICT creates asymmetric network, resulting to a classification of states as hub or spoke. The power obtained through network leveraging poses direct threat to spoke states and hub states easily takes strategic advantage over spoke states. Easy assessment of potential enemy's vulnerability during the era dominated by geopolitical logic meant military offense advantage in times of security dilemma on top of hub states' easier declaration of war. It further means that hub states will obtain desired outcome in war. Based on theoretical discussions of the dissertation, hypotheses were proved using the telegraph technology which is the empirical example of ICT that increases the actual information flow and communication between states.

Furthermore, the mainstreams in the purview of technology and international relations, which is technology driven power transition, economic interdependence that was enabled by technology, and discussions were reviewed critically. Realism-centered technology and international relations theories is in callous disregard of technology's difference, its heterogeneous characteristics. Furthermore, it analyzes ICT technology's specific characteristics and ICT-driven network in order to surmount the limitations that is blind to how a certain state utilizes a technology that has network externalities. This dissertation importantly weighted the characteristics of ICT which creates the hub and spoke relationship by deepening the asymmetric interdependence through network effects. What really matters is the characteristic of technology because not all emerging

technology and leading sector brings about a security problem. Thus, the dissertation suggested the theoretical framework that analyzes the state behaviors and also analyzed them as the empirical cases.

Moreover, it delves into the interdependence on information flow that determines the consequences of militarized disputes, going above and beyond the existing scholarship that emphasizes the economic interdependence. Besides, existing studies focuses on the digital era after the Second World War, this dissertation stresses the fact that asymmetric interdependence was already in existence during the telegraph era which is the first-ever ICT revolution of the world. During the telegraph era, complex interdependence of Keohane and Nye was not as evident as the times of their research. The asymmetric ICT network during the telegraph era was not complex and the information flow and communication between states were primarily conducted and depended on inter-state telegraph networks. Therefore, asymmetric information interdependence can be found through an analysis of the telegraph network. Through the telegraph technology, empirical research of asymmetric interdependence network was possible. And eventually, the asymmetric interdependence on information flow was found to be due to the international diffusion of ICT that contains characteristics of network externalities.

Furthermore, it delved into the asymmetric interdependent network's use in military. The technological characteristics of ICT and network externalities

creates hub and spoke states—a relationship that has asymmetric interdependence with regards to the access to information flow. Hub states can control the information flow and strategically use the panopticon effect and chokepoint effect. This increases the uncertainty of hub states' potential enemy and especially spoke states subordinate under the asymmetric network while decreasing hub states' uncertainty. Therefore, the offense-defense balance shifts and the hub state with increased military effectiveness easily decides to wage war against the spoke state and advantageously leads the war. While proving the aforementioned, the dissertation delved into the process of ICT and ICT-driven network and influence on the international security competitions during the telegraph era. The analysis was conducted complementing both the qualitative and quantitative methodologies mutually.

In summary, international telegraph technology diffusion increase information flow and it creates 'hub' states and 'spoke' states based on network externalities and hubs' controllability of information flow. The relationship between hub states and spoke states is defined as an asymmetric interdependence on information flow. In the asymmetric relations, hub states can leverage power of control to information flow for maximizing panopticon effect and chokepoint effect with their information and communication resources. Along with military application of the effects, the hub state with offensive advantage is more likely to (a) onset militarized dispute and more likely to (b)win in the telegraph era.

Based on the statistical and process tracing case analysis, hypotheses are accepted H(a.+)Those states link to hub states are more likely to be exposed to the militarized panopticon effect and chokepoint effect by hub states. Thus the states are more likely to be invited militarized dispute from hub states. H(b.+) is also confirmed. When hub state use panopticon and chokepoint effect for the military purpose, hub states are more likely to win. Therefore, the proposition of the dissertation proved. The dissertation's theoretical and analytical frameworks and the proposition is shown figures 4 and 5.

2. Academic and Practical Implications

The main argument and proposition of this dissertation is as follows. The international diffusion of ICT in the 19th century has led to the formation of inter-state asymmetrical information and communication network by distinguishing hub and spoke states due to network externalities of the technology. Hub states can control the information flow and strategically use the panopticon and chokepoint effects while spoke states depend asymmetrically on hub states' information network and they share the identity of potential adversary during the telegraph era, 1849-1914. Through such privilege, uncertainty of spoke states increases while hub state's own uncertainty decreases or gets eliminated. This also leads to the change of offense-defense balance between states and hub states with increased military effectiveness coupled with ample amount of information easily decides to declare war against spoke states and advantageously lead the war. Therefore,

hub states with offensive advantage are more likely to initiate and win wars against spoke states.

The findings of this dissertation could discourage the optimists who claim that states can restrain from MIDs that may lead to war when given an access to more direct lines of communication and increasing inter-state communications. Sharing the common ground with pessimists' viewpoint, this dissertation becomes more reliable when one considers the suggested two contexts, identity and technology. Furthermore, emphasizing the hub state's power that derives out of asymmetric network and its utilization for military purposes, spoke state subordinate to the hub state is invited to more wars and mostly defeated, as hypothesized in this dissertation.

The analysis of the dissertation further discovered that the impact of ICT on conflict outcomes may be a combination of ambivalent values for those who seek to use national security to avoid the cost of conflict. The telegraph technology provides different kinds of effect on conflict escalation, coordination within the alliance, and political and military variables for military effectiveness. More specifically, hub states, by leveraging the panopticon and chokepoint effects, wage war in an advantageous position against spoke states and exploit crucial information, which raises the uncertainty for spoke states that eventually lead them to defeat. the unavoidable risks involved by escalating military conflicts to a higher level. In a world where faster technologies are accelerating decision to execution

and action to response cycles, the unlimited risk of conflict spirals seem to increase uncontrollably.

In contrary to this prediction, this dissertation revealed that increased communication speed between adversaries would rather encourage the escalation of conflict than restrain them. this is more strongly manifested in the relationship between the hub and spoke states. Leventoglulu and Tarar (2008) utilized various models to predict the relationship between the speed of bargaining and the reduction of war, however, their findings were only partially conclusive. The authors posited that external hindrances, such as communication technology and geographical barriers, can prevent a quick response to an opponent's proposal and trigger the outbreak of war (Leventoglulu & Tarar, 2008, p. 536). This viewpoint is also echoed by Powell (2004), who argued that hindrances impacting the ability to respond quickly can lead to conflict. Although most explicitly proposed, this prediction was not supported by evidence, which this dissertation provides.

Additionally, it in terms of the escalation aspect, there was a difference between not considering the hub and spoke relationship and considering. The conflict did not escalate when the hub and spoke relationship was not considered, but the conflict escalated when considering that the hub state was in an advantageous position to exploit information and that most states were potential enemies at the time. In other words, the hypothesis and proposition of this dissertation is even more supported through the statistical result that

escalation exacerbates when focusing on the asymmetric relationship between the hub and spoke states while escalation does not exacerbate when not considering this relationship . Through this, this dissertation confirms that the asymmetric relationship between hub and spoke states directly affects international security competition. The existing research on the asymmetric relationship emphasized more on the economic aspects, but rather, it plays as the key factor in determining the cause and effect of military conflict.

The international diffusion and innovation of ICTs were considered a tool of diplomacy. However, in the context of adversarial relationship and military use of asymmetric information networks, they become a main source of inter-state conflicts. Exchanging information through the telegraph in a state of alliance exacerbates the relationship with third state.[112] The case study shows that the telegraph and telegraph-driven networks provide a motivation for hub states to strategically accelerate the level of combat or for other pre-emptive strikes. The second hypothesis H(b) is proven with this. As demonstrated by case study, the telegraph made it possible for units to operate in line with the commander's intent based on with relatively real-time order and management. Also, in process tracing case study, the hub states exploit crucial information of a potential enemy spoke state via asymmetric

[112] Increased opportunities for high-speed communications within alliance networks via the telegraph escalate the risk of conflict initiation to a similar extent in all levels of military crisis. In conflict motivation perspective, rather than suggesting that the telegraph induces any structural change that runs toward the extreme in the conflict expansion spectrum, it can be seen that it could have increased the opportunity for allies to cooperate and coordinate foreign politics through telegraph networks

information and communication network and took advantage even before the onset of war. And therefore, hub states wage war with the spoke more easily while mostly taking the victories through the military application of panopticon and chokepoint effects. As a result, hub states took 102 victories out of a total of 127 wars during the telegraph era.

Thus, within international interaction between adversaries and allies, the ICT innovation telegraph, which shows advantage of speed, has created an opportunity for states to choose or control more effective foreign policy behavior. In addition, it monitors and exploits the crucial information of spoke state that is in adversarial relationship—panopticon effect in the military setting—and by directly severing the cable or isolating from the network—chokepoint effect in the military setting—leads advantageously in war.

This conclusion is significantly different from that of the existing arguments predominantly found in the literature on whether or not interstate communication affects international conflicts. On the other hand, technological skeptics—considering Schelling's hypothesis on the US-Soviet hotline included—do not consider faster communication technology as a significant factor in conflict process. On the flip side, some explanations point to the rapid shift of modern technology as the main reason for triggering flashpoints such as the Cuban missile crisis or the most serious armed conflict in history, the July crisis in 1914. Moreover, they emphasize technology as the main solution to the problem set. The analysis of this dissertation suggests

that it would be meaningful for subsequent researchers to be more interested in the method that determines the way and effect where actor and structure jointly affects the ICT conflict dynamics. Furthermore, it emphasizes the different characteristics of technology, the heterogeneity. Beyond the leading sectors and general purpose technologies, it emphasizes the technological characteristics of ICT that has a network externalities. That is, the spread of ICT forms an asymmetric information and communication network, where hub and spoke states are classified accordingly, and finally produces the leverage of asymmetric networks as a weapon in international security competition.

This dissertation also has practical implications mainly for strategical competitions during the digital era. As argued in the dissertation, diffusion of ICT create asymmetric network based on network externalities, and this makes security threat to those spoke states depended on hub's network. In particular, the dissertation can give some implication for strategical competition between potential enemies including the U.S.-China strategical competition in digital era. I prove that asymmetric interdependence on information with potential enemy is security threat. The United States, the data flow hub, has strategical advantage to leverage data and create asymmetric interdependence on data flow to other states. Information flow with the enemy in asymmetric network setting may return as a security threat. It is the weaponization that threatens the monopoly of data, similar to that of

the information asymmetry in telegraph era. Based on this, China was asymmetric position in data flow which is information in the era of digital economy. To overcome the asymmetric interdependence on the data flow, China tried to decouple the United States which is global hub on data flow in the digital era. Since both are potential enemy to each other, the United States also decoupled due to China the potential enemy work toward global hub.

China started the decoupling in the initial stage, and the U.S. is currently undergoing decoupling due to hawkish hub expansion of China. According to the dissertation states connected to hub states got involved to conflicts and lost in wars. China, as a non-hub state and aspiring to be the hub state, conducts decoupling in order to disentangle itself from the asymmetric relationship with a potential enemy which is even considered as a hub state in the network. That is, since China attempts to conduct decoupling and expand itself as a global hub state, the U.S likewise conducts decoupling and attempts to solidify its position as global hub.

Foreign policies are implemented based on accurate situational awareness. Hub states behavior pattern towards the asymmetric network during the telegraph era is similarly shown during the digital era. In the foreign and security policy perspectives, especially with regards to the data security and network hub, the recent submarine cable issues are noticeable in terms of international security with network externalities and asymmetric interference on data flow.

International security competition in global information cable network is getting intensified as the U.S.-China competition intensifies. In particular, great powers strategically approach to submarine fiber optic cable systems which is a major global information infrastructure (Farrel and Newman 2019; Bueger and Liebetrau 2021; McGeachy 2022; Mori 2019; 2022; Sherman). Since the 2010s, government intervention in submarine cables has increased. Particularly, in the Indo-Pacific region, Australia is blocking Chinese cable connections, the United States is removing Hong Kong from its cable network, and China is aggressively expanding its cable system in the Indo-Pacific region. The fiber optic cable era has become a place for various actors to appear and compete variously.

Submarine cable development era can be classified three era: telegraph era, telephone era, and fiber optic era. Figure 23 shows usage and length of submarine cable system each era.

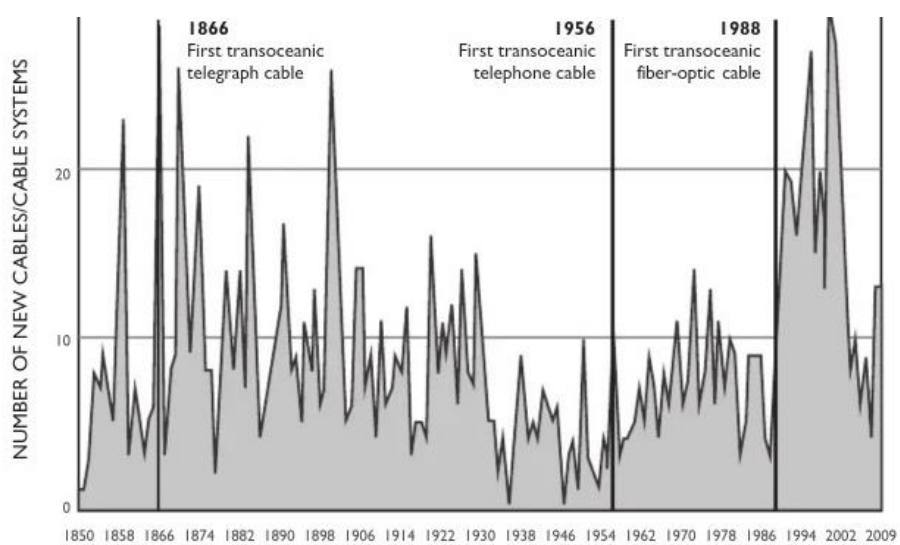

Figure 23: International Submarine Cable Construction (Starosielski, 2015, p. 9)

In the telegraph era, issues such as cable cutting or cable wiretapping and espionage for military purposes and technical problems with connection such as disconnection caused by disasters and accidents have emerged. In this era, sabotage and espionage to submarine cables used as means to achieve national security goals.

In contrast, new dynamics has emerged in fiber optic era. The external threat to submarine cables is still critical, but now it is more important to have control over the cable systems(McGeachy, 2022). Who and how to connect the submarine cable network and connectivity itself become important. Furthermore, as linking data which is a national strategic asset (Liu, 2021)[113] and forms the basis of the digital economy, submarine cable systems have become more important and become a security purpose itself (Vatanparast ,2020). As 5G demands faster and resilient, the subsea cable system become more important in terms of data security (Goodman & Wayland 2022). Data and submarine fiber optic cable system which can transmit data well become one of the most important strategic resources.

Furthermore, geological prospecting is a pre-requisite for infrastructure development. It provides elementary knowledge of understanding the region. At the end, it is an international securitized issue which is inextricably linked to sovereignty issue. As of early 2023, there are 1.4 million kilometers of

[113] Liu (2021) stresses data's non-rivalry and non-excludability in data politics.

submarine cables in service globally. And 131km-long, short 'CeltixConnect' cable between Ireland and the United Kingdom to 20,000km Asia America Gateway cable. Total cables are tallied at 552, including those scheduled to be completed (TeleGeography 2023; ITU 2023). The network from such hardware is important in terms of security perspective. It is because of its linkage to sovereign issues and simultaneously to security issues of data flow network in software perspective (Heleberg, 2021; Miller, 2022). With regards to the submarine network, it is evidently difficult to analyze with existing international relations theory. Through the theoretical framework of this dissertation, security issues arising from submarine cable network's increased asymmetry from network externality effects as well as the classification of hub and spoke states in that particular network can be further looked into.

Therefore, data and submarine cable networks have become referent object in national security context (Bueger and Liebetrau 2021; McGeachy 2022; Gjesvik 2022; Komiyama and Tsuchiya 2021; Mori 2019; Sherman 2021; Hillman 2021; Watson 2021).[114] Cable systems, the infrastructures that enables the digital economy, have strong network externalities. Therefore, if a certain actor monopolizes whole system, the actor can control data the strategic asset transmitted by the system. This will enable a variety of strategies based on better algorithms in the digital economy. In other words,

[114] Sherman(2021) The U.S. Should Get Serious About Submarine Cable Security, Council on Foreign Relations, September 13, 2021. Watson (2021) Undersea Internet Cables in the Pacific. At this point, Submarine cable is more like to be traditional referent objects such as territory, people, sovereignty.

the competition for submarine cables affects the strengthening of network externalities in the digital industry.

Based on the fact that data becomes more important than anything else in the strategic competition between great powers in the digital age(Liu 2021; Ding & Defoe 2021)[115], it becomes more important to eliminate rivals and influence the submarine cable system that can transmit data quickly and accurately. So, the logic of security appears before connection in global information infrastructure, so states start to exclude or strengthen controllability over the undersea cable networks. In this context, states securitized the industries and leverage private resources at the international level (Gjesvik, 2022).

In the digital economy, where it is more important to control more data and transmit data safely and quickly, the submarine cable that makes this possible is more important than anything else. In the submarine cable industry, when one actor makes a complete submarine cable system, when another actor wants to connect to the cable system, the same equipment and data processing methods must be matched, and the landing station is affected by territorial sovereignty. It is also affected by the laws of the respective country. Also, based on the fact that the more data is transmitted, the more algorithmic network externalities appear in the digital industry, the more data transmitted

[115] For more detail about data as a strategic asset in data politics and security, see Liu, 2021; Ding & Defoe, 2021).

through the submarine cable, the better the algorithm and better service the country owning the system can provide. This has an impact on AI competition, a new general-purpose technology and winner will take hub position of asymmetric data flow network.

A state should be compatible in order to become a hub state that maximizes the network external externalities. ‘Global pivotal state’ is none other than a compatible hub state that connects the diverse asymmetric networks. Hub states are not as numerically privileged as that of the past. Diverse hubs can co-exist in diverse areas. That is how the ‘under-institutionalized on the global state’ challenge can be overcome. It is even more important to take the position of hub during the times where complex interdependence is deepened and more network is connected. Contrary to the telegraph era, multiple hub positions in different networks are available.

Former spoke states should proactively utilize diverse ‘mini-lateralism’. Among them, the Republic of Korea’s technological and cultural prowess is powerful. The condition is set to get connected to multiple networks. A friendly state with soft power and technology that builds a compatible-open network will emerge as the next hub state in the digitalized and networked era.

3. Suggestions for Future Researches

This dissertation left some areas unexplored ICT-driven network and international security and these to be researched in the future. To being with is the threat perception. It poses a threat if a certain state monopolizes or controls an industry or technology that has network externalities. This is proved theoretically but the process of actual security application should be delved into. Through interviews with policymakers and discourse analysis, topics that audience considers a security threat will be narrowed down and these will be compared to the topics that were narrowed down through machine learning-natural language processing (NLP) methods based on a large amount of data. Then based on the matched topics, identify when the topics changed and compare this specific timing with when a particular state obtained the asymmetric network. Through this, threat perception can be partially identified.

Additionally, comparative political research of becoming a hub state is necessary. This dissertation emphasizes the characteristics of ICT and how hub-spoke relationship is born in accordance with the spread of ICT. Moreover, it stresses how the hub state leverages its power to advantageously lead the international security competition. Follow-up research requires a comparative political analysis of which specific conditions, like institution, regime types, and other factors emphasized in the comparative politics' scholarship, met with such the diffusion of technology makes a state as hub.

It is also necessary to delve into the period when ICT got diffused and if there were any cases of late comers becoming a hub state and the reason behind why.

Research on how states strategic competition is conducted and on exploration of what an asymmetric interdependent network means in the digital era are required. However, this dissertation focused on the military usage of asymmetric information network during the telegraph era only. As an extension of this dissertation, the above suggestions throw implications to technology and IR, and international security that comes from the asymmetric interdependence.

Lastly, throughout in history, asymmetric network emerged in diverse forms after the states started to connect to one another. This is connected to the 'status' in IR discussion. Through the status theory, states' behaviors for asymmetric network can be analyzed. When security competition is explored through the status competition between the network hub club members and not, covert power relations will be revealed, and further study of state-to-state's 'emotional' issues can be delved into.

The Republic of Korea has already established technological and cultural foundations. It is now time for the country to enter the hub network and utilize it strategically. Further advancement in the fields of science, technology, and international relations can be achieved through

complementary research on the following topics: the process by which states become involved in competition, the formulation of asymmetric networks during the digital era in light of algorithmic network effects and the resulting security threats, and the network externalities inherent in network industries.

In summary, if a research of the combination of the followings: threat perception and securitization theory; natural language processing analysis of machine learning which explores the policymakers and audiences' change in perception; asymmetric interdependence network and status discussion; and the use of weaponized asymmetric interdependence network emphasized by previous dissertations; then, this will not only provide implications of the security policy direction that should have been pursued by states and strategical competitions currently emerging among great powers in the digital era, but also to technology and international relations academia. These researches are indispensable. This dissertation will serve as a basis for future sustainable scholarship in the areas of technology and international relations, both theoretically and empirically. The dissertation sets the foundation for further exploration by examining asymmetric interdependent networks and international security competitions.

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Abstract In Korean

국가 간 통신 네트워크와 국제분쟁의 상관성 연구:

전신의 시대(1849-1914), 국제안보경쟁에 미치는 정보통신기술과 비대칭 정보 네트워크 무기화의 영향 분석

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본 연구는 과학기술과 국제정치의 관점(perspective)에서 망(network) 산업 정보통신 기술(Information and communication technology)이 형성한 비대칭 상호의존 네트워크가 주권과 국가 간 분쟁에 미치는 영향을 탐구하는 연구이며, 다음과 같은 명제를 증명한다. 19세기 정보통신기술이 확산되며 비대칭 정보통신 네트워크가 형성된다. 그리고 전신의 시기(telegraph era, 1849~1914)의 국가들은 잠재적 적(potential adversary)이라는 정체성(identity)을 서로 공유한다. 해당 시기에 전신 기술의 네트워크 외부효과로 정보통신 네트워크에서 허브(hub)와 스포크(spoke) 국가가 구분된다. 허브 국가는 정보흐름(information flow)을 통제할 수 있으며 판옵티콘 효과(panopticon effect)와 쵸크포인트 효과(chokepoint effect)를 전략적으로 사용 할 수 있는 반면, 스포크 국가는 허브 국가의 정보 네트워크에 의존한다. 허브 국가는 비대칭 정보 네트워크의 이점을 통해 자국의 불확실성(uncertainty)을 감소시키거나 혹은 제거하며, 잠재적 적이자 비대칭 네트워크에 종속된 스포크 국가의 불확실성을 증가시킨다. 이로 인해

국가 간 공수균형 (offense-defense balance)은 무너진다. 그리고 군사효율성 (military effectiveness)이 높아진 허브국가는 충분한 정보를 바탕으로 공격의 우위를 점한다. 그래서 허브 국가는 스포크 국가에 대한 전쟁을 쉽게 결정하고 먼저 시작하는 경향이 있으며 해당 전쟁을 유리하게 이끌며 주로 승리를 한다.

본 연구의 첫 번째 목적은 국가 간 비대칭 정보통신 네트워크 (asymmetric information and communication network) 가 국제분쟁에 미치는 영향을 탐구하는 것이다. 19세기 전신 기술의 세계적 확산은 국가 간 빠른 소통과 장거리 통신 그리고 초국가적 정보흐름을 가능하게 해주었다. 본 연구가 주목하는 전신 기술과 전신 네트워크는 네트워크 외부효과가 나타나며, 정보통신의 속도와 양, 공간적 거리를 혁신한다. 본 연구는 이러한 전신 기술의 확산에 따라 만들어진 비대칭 상호의존 네트워크에서 나타나는 국가 간 허브와 스포크 관계 (hub and spoke relations)와 그들의 안보 경쟁 및 분쟁 동학에 주목하고 이를 탐구한다. 본 연구의 두 번째 목적은 기존의 세력전이 이론(power transition theory), 상호의존 이론 (interdependence theory), 그리고 국제분쟁 이론 등이 비대칭 정보 네트워크와 국제안보경쟁의 관계를 분석 및 해석하는데 있어서 나타난 문제점을 극복하여 이론적 기여를 하는 것이다.

본 연구의 목적을 달성하기 위해 양적방법론과 질적방법론을 동시에 활용한다. 좀 더 구체적으로 매칭(matching) 기법을 활용한 통계적 방법론과 과정추적 역사적 사례연구를 통해 분석하였다. 이를 위해 본 연구는 19세기 문서와 전신 네트워크 데이터에서 수집한 새로운 데이터 셋을 구축하였다. 허브 국가와의 전신 연결과 국제분쟁 발생 수를 검증하여 상관성을 판단하고

전쟁 결정 과정과 전쟁 진행 과정을 분석하며 전신 네트워크 무기화(weaponization)의 유용성을 판단한다. 본 연구에서는 기존 문헌 검토와 네트워크 분석을 통해 허브와 스포크 국가들을 선정하였다. 이러한 과정은 전신의 시대 허브와 스포크 관계에 대한 포괄적 이해를 제공한다. 본 연구는 선정된 허브 국가들인 독일-프러시아, 미국, 대영제국 전신 네트워크의 군사적 활용을 분석하였다.

본 연구의 분석결과는 다음과 같다. 허브와 스포크 관계를 고려했을 때 전신네트워크의 확산과 국제분쟁은 상관성은 통계적으로 유의미하다. 통계적 분석에 따르면, 허브 국가와 연결된 국가가 많을수록 더 많은 전쟁이 발생하고, 대부분의 전쟁은 허브국가의 승리로 이어지는 것을 입증한다. 또한, 과정추적 사례연구를 통해 비대칭 정보통신 네트워크에서 비롯된 허브 국가의 비대칭 상호의존 무기화가 국가 간 분쟁의 발생과 승리를 결정하는데 영향을 미치는 것을 보여주었다. 결론적으로, 본 연구는 전신의 시대 정보 네트워크에서 나타나는 비대칭 상호의존 관계가 국가 간 공수균형(offense-defense balance) 동학을 변화시키고 국제분쟁의 시작과 결과에 영향을 주는 과정을 보여주며 그 인과성을 증명한다.

주제어 : 기술과 국제정치, 정보통신기술(ICT), 비대칭 네트워크, 무기화된 상호의존, 비대칭 네트워크의 군사적 활용, 국제안보, 네트워크 산업, 네트워크 외부효과, 전신 기술, 주권

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