Network Control in a Globalized World:
How Visa and Swift's Founding Structures Serve Their Stakeholders on the International Stage

By Thomas C. Cowan

Submitted to the
Department of Science, Technology, and Society
in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science

at the

Massachusetts Institute of Technology

June 2017

Signature redacted

Signature of Author.....
Program in Science, Technology, and Society
May 12, 2017

Signature redacted

Certified by..... .....
William Deringer
Leo Marx Career Development Assistant Professor of Science, Technology, and Society

Signature redacted

Accepted by..... .....
Jennifer S. Light
Professor of Science, Technology, and Society
Professor of Urban Studies and Planning
Department Head, Program in Science, Technology, & Society

Network Control in a Globalized World:
How Visa and Swift's Founding Structures Serve Their Stakeholders on the International Stage

By

Thomas C. Cowan

Submitted to the Department of Science, Technology, and Society
on May 12, 2017 in Partial Fulfillment of the
Requirements for the Degree of Bachelor of Science in
Science, Technology, and Society

ABSTRACT

The Visa credit card network and the Society for Worldwide Interbank Financial Telecommunications (Swift) network both provide a backbone for financial interchange across the world. Visa's network connects consumers, merchants, banks, and processors to ease the purchases of millions of consumer-facing products worldwide. Swift's interbank network connects banks, corporates, and other financial institutions to ease the flow of high-value, highly-secure international financial transactions. Both networks grew to become industry incumbents in the second half of the 20th century, connecting nearly every country on earth. However, the globalized networks differ in their organizational structures: Visa utilizes a centralized, U.S. focused, hub-and-spoke model; Swift uses a decentralized, transaction-volume neutral, point-to-point network. Although Visa's centralized network fosters innovation, standardization, and security, its U.S.-centered hub pulls the organization from global neutrality and aligns it with the United States on global issues. Meanwhile, although Swift's decentralized network nurtures technological localization—at the expense of technological standardization—its transaction-based global governing structure promotes a relative international neutrality among global organizations. This contrast between Visa and Swift—both networks that balance local and global, centralized and decentralized, and technical and non-technical tensions across the world—reveals the structural effects of worldwide networks, and how network system design impacts global stakeholders in the societies that they touch.

Thesis Supervisor: William Deringer
Title: Assistant Professor of Science, Technology, and Society

1. Introduction

When a customer swipes a card in the checkout line or a bank wires money across the world, the underlying financial plumbing enabling the transactions is rarely highlighted and often pushed to the background. When a customer swipes—or dips—their card at the point of sale, their payment information is sent to both the acquiring and issuing bank, and run through Visa's fraud detection software—in under two seconds.[1] When a financial institution transfers money across Swift—whether a simple wire transfer, an equity purchase, or a corporate transaction—the organization verifies and sends the message over the most secure trusted third party network in the world.[2] Both networks grew from small side projects of major companies to becoming two of the most engrained organizations in global financial exchange. Visa began in northern California and subsequently expanded across the world—though kept its central technical and decision making hub where it began, in California. Swift began as a regionalized international network in Europe and the United States, and upon expansion across the world, it focused on trying to maintain a relative transaction-based neutrality. The Visa and Swift networks provide a lens through which to view the impact of global networks, and how their differing structures both help and hinder their stakeholders' abilities to transfer information across the world.

[1] "Visa Speeds Up Checkout Times," Visa Incorporated, last modified April 4, 2016, http://investor.visa.com/news/news-details/2016/Visa-Speeds-Up-Checkout-Times/default.aspx.
[2] Susan V. Scott and Markos Zachariadis, *The Society for Worldwide Interbank Financial Telecommunication (SWIFT): Cooperative governance for network innovation, standards, and community (Global Institutions)* (New York: Routledge, 2014), Kindle edition, Introduction.

1.2 Networks in Society

From the U.S. Postal Service networks, to the electronic telegraph system and telephone lines, to the modern internet, network systems connecting people and directing information flow have been a part of America since its founding. U.S. mail routes along Route 1 formed an initial information alley along the east coast, over which the country communicated and unified in its early years. President Lincoln championed the expansion of the telegraph across the nation during the Civil War, allowing troop movement and battlefield strategy decisions to be centralized to the War department in Washington. Finally, the invention of the internet connected society across countries and cultures, creating unfettered access to information across the world. Through the evolution of technical networks, technical systems of nodes and pathways have not only challenged economic incumbents and stimulated innovation, but the networks have redefined local and global sovereignty—simultaneously localizing global challenges and globalizing local ones.

In 1867, Edward Calahan invented the stock ticker, which was a mechanical printing telegraph that displayed the shortened name of the stock (the ticker symbol) and its current trading price; its network connection to other exchanges, including Chicago and London, transformed Wall Street trading.[3] As Alex Preda writes in *Social Studies of Science*, the telegraphic network distributed trading information, standardized prices, and created one globalized financial market. The implementation of the point-to-point ticker network disrupted the traditional human-centered trading floor of Wall Street—and rippled across different

[3] Alex Preda, "Socio-Technical Agency in Financial Markets: The Case of the Stock Ticker," *Social Studies of Science*, Vol. 36, No. 5: 1, accessed May 11 2017, http://www.jstor.org/stable/25474473.

economic sectors, transforming each industry upon adoption of network technology. As networks have increased in complexity, speed and capability, they have created, destroyed, and altered industries upon each iteration—from the telegraph, to the phone, to the international financial network, and finally to the Internet. As Manuel Costells argues in *The Rise of Network Society,* economic connectedness has transformed companies, supply chains, nation-states, and societies as a whole, weaving the economies, livelihoods, and beliefs of the world closer together with each network innovation.[4]

As global networks have connected countries and cultures across the world, network ownership has been constantly evolving and oscillating between the poles of private and public possession. Networks are jointly owned by all nodes and by none of the nodes at the same time, attaching the benefit and burden of the shared resource to each message in the system. The tension of network ownership breeds the question of control—whether it remains at the central hub, or is dispersed to each node.[5] Lincoln's telegraph network was centered in the War Department at Washington, distributing the tentacles of its power to the generals at each front. The internet, by contrast, diffuses its power across the world to countries, service providers, and end users, creating a communal control of the most pervasive network in history. Visa and Swift match this pattern, with Visa's centralized hub in California contrasting directly with Swift's distributed and regionalized system.

Manuel Castell's "global interdependence" network—connecting countries and economies—highlights the reliance and coupling that nodes in global networks have on one

[4] Manuel Castells, "The Rise of Network Society," (Cambridge, MA: Wiley-Blackwell, 2009), 3.
[5] Castells, "The Rise of Network Society," 3.

another. Locales depend on these international systems for global connection, while the large systems are defined by the sum of the local actions. The battle for local control of large networks is not a new one—ranging from Lincoln seizing local telegraph lines in Washington for use in the Civil War, to the Swift network implementing regional benefits and regulations. In the cyber-sphere, The United States champions free and open internet, while China and Russia implement local firewalls to control the global network. The tension between local nodes and the global system is a core challenge that networks balance—whether they send and receive dots and dashes, financial notes, or website packets.

The complexities of globalized network systems have shown that network design and structure is integral to maximize the world's use of each system in each time period—and as society has changed, stakeholders have manipulated the technology to match their needs. Whether a hub-and-spoke system, such as Delta's Atlanta-based network, or a point-to-point system, such as the telephone network, both designs shape the use-case and utility that each network contributes to its stakeholders.[6] Economic connectedness and interdependence, lack of tangible network sovereignty, and local versus global tensions are each helped and hindered by specific designs of networks, requiring representation and organization to create structure that matches network use. Visa's low value, high volume financial transfer network leverages the hub-and-spoke model, increasing technological efficiency and security at the expense of regional flexibility. Alternatively, Swift's high value, low volume interbank transfer network uses

[6] Mark S. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology*, Vol. 78, Issue 6: 1360, accessed April 24, 2017. http://www.jstor.org.libproxy.mit.edu/stable/2776392

its point-to-point focused model to allow flexibility and localization at the expense of technological efficiency.

The history of the creation of Visa and Swift highlights the design configurations for both networks; in each case, the stakeholders shaped the network structure to maximize system use while meeting the evolving geopolitical challenges of operating as global systems. Visa and Swift were founded with opposing structures that were designed to optimize use for their respective stakeholders; as the initial designs have evolved, the core structures have governed the global values and decisions the networks have made in the decades since their founding.

1.3 Visa's Background

Before Visa became the world's largest retail electronic payments network—processing over 71 billion transactions in 2015—there were predecessors that led up to the idea of creating a universal charge card product.[7] Prior to the 1958 implementation of the BankAmericard credit card in California, numerous companies had created specific revolving credit products as customer loyalty programs. Examples included department store credit lines in stores such as Sears, oil and gas charge cards operated by national chains, and airline industry cards that used airline miles and other coupons to attract credit customers. Bank of America's BankAmericard (which would eventually become Visa) sought to offer customers a single credit card that had universal acceptance independent of location and industry—and because of their vast market share in California (serving over 60% of the state's residents), they could do it.[8]

---

[7] "Visa Inc. Reports Strong Fiscal Fourth Quarter...," Visa Incorporated, last modified November 2, 2015, http://investor.visa.com/news/news-details/2015/Visa-Inc-Reports-Strong-Fiscal-Fourth-Quarter-Adjusted-Earnings-Per-Share-Growth-of-14-and-Full-Year-2015-Adjusted-Earnings-Per-Share-Growth-of-16-and-Announces-a-New-50-Billion-Share-Repurchase-Program/default.aspx.

[8] David L. Stearns, *Electronic Value Exchange Origins of the Visa Electronic Payment System* (London: Springer, 2011), Kindle Edition, chapter 1.

Throughout the early 1960's, BankAmericard continued its rapid expansion from Northern California down to Los Angeles, focusing more on consumer growth and brand recognition than profitability of the initial fraud-prone cards. By 1968, Bank of America had licensed the cards to banks across the United States, and the complex system of franchises across the nation became inefficient to the point of near failure. Finally, at a bank meeting in Ohio, a small branch manager named Dee Hock proposed a system overhaul, with a separate communal entity owned by all of the banks. In 1970, Hock created National BankAmericard Incorporated (NBI)—and he would later become Visa's first CEO.[9]

Having created NBI, Hock and his small team in California began to make plans for the development of an automated system for financial transactions across the country. In 1973, NBI contracted to IBM the implementation of NBI's BankAmericard Authorization System Experimental (BASE), initially created in two parts: BASE I and BASE II.[10] BASE I provided transaction authorization, which granted the initial permission for the customer, merchant, merchant bank, and customer bank to engage in the transaction based on numerous indicators such as customer identity, purchase amount, and location. The BASE II system provided electronic clearing and settlement, crediting and debiting the merchant and issuer bank accounts to complete the transaction. The system initially processed all transactions between the hours of 5PM and 5AM Pacific Time, performing net daily transfers between banks; this electronic system reduced processing time from 6-8 days with paper receipts to just 12 hours.[11]

---

[9] Dee Hock, *VISA and the Rise of the Chaordic Organization* (San Francisco: Berrett-Koehler, 2005), Kindle Edition, Chapter 17; "History of Visa," Visa Incorporated, last modified 2016, https://usa.visa.com/about-visa/our_business/history-of-visa.html.
[10] Hock, *VISA and the Rise of the Chaordic Organization*, Ch. 12.
[11] Stearns, *Electronic Value Exchange*, Ch. 5; "History of Visa"

As the U.S. market continued strong growth, NBI pushed internationally, extending to Europe and Asia. In 1974, the International Bankcard Corporation (IBANCO) was formed, and NBI became the U.S division of IBANCO. This eased international expansion of BankAmericard and shifted some of the organizational control from the U.S. to parties across the world. In 1976, in an effort to bring the brand to the international market, the BankAmericard was renamed Visa card, to highlight its global focus and capital flow between countries. By 1986, the network shifted its transactions volume from the U.S. dollar to include twenty other currencies as well—and today processes in almost every major currency in the world.[12]

In the end of the 20th century, Visa continued its strong growth trend, processing over $1 trillion in 1997, and by 2000 had issued over 1 billion charge cards.[13] In 2007, Visa restructured and consolidated its offices across the world in preparation for an initial public offering. In March 2008, Visa Inc.'s initial public offering raised over $19.7 billion, setting the record for the largest IPO in U.S. history at that time.[14] The new public company had its headquarters in San Francisco and Foster City California—just 200 miles from where the original "drop" occurred in Fresno, California. In 2016, Visa acquired its sibling company Visa Europe for over $23 billion, solidifying the center of the global payments network to northern California.[15]

---

[12] "History of Visa"; Hock, *VISA and the Rise of the Chaordic Organization*, Ch. 14.
[13] "History of Visa"
[14] Sam Zuckerman, "Visa shares soar after biggest U.S. IPO ever," *SFGate*, March 20, 2008, accessed May 11, 2017, http://www.sfgate.com/business/article/Visa-shares-soar-after-biggest-U-S-IPO-ever-3290871.php.
[15] Elizabeth Dexheimer, "Visa Agrees to Buy Visa Europe for as Much as $23.4 Billion," *Bloomberg*, November 2, 2015, accessed May 11, 2017, https://www.bloomberg.com/news/articles/2015-11-02/visa-agrees-to-buy-visa-europe-for-as-much-as-23-4-billion.

1.4 Swift's Background

Prior to the founding of Swift, banks used the telex network as the primary method for international financial transfers. The telex system was a printer network that sent and received text messages over phone lines. German engineers produced the first teleprinter in 1933, which at that time ran over dedicated telegraph lines. The telex network expanded rapidly, reaching over 30 countries worldwide, and serving an estimated 1 million users across the globe.[16] Although this was one of the first computerized networks of its time that banks used heavily, it had three main drawbacks that eventually led stakeholders to pursue other solutions: it lacked standardization, security, and capacity. The messages had no standard message form, and as a result, a typical value exchange between banks required an average of 10 telex messages.[17] Because the telex network ran unencrypted data over public telephone lines, financial data could be intercepted and misused. Finally, system capacity constraints limited the expansion opportunity of the network; the lack of system modularity (the separation of the system into smaller, more adjustable sub-systems) restricted system growth. With these needs in mind, banks set out to address the increasing message demand with a more standardized, secure, and flexible network that still had the distributed nature of the Telex system.

In 1973, 239 banks from 15 countries came together and formed the Society for Worldwide Interbank Financial Telecommunication (Swift). The headquarters of the network was located in Brussels, Belgium to balance the power duopoly between London and New York, which highlighted the network's neutral-focused foundation. As the founding members

[16] Origins and Development of SWIFT, 1973-2009, 464.
[17] Scott and Zachariadis, *SWIFT*, Ch. 1.

debated network protocols and messaging systems, disagreements between technological infrastructure were common, as any technical solution adopted would benefit one region at the expense of another. After years of deliberations, the communal opportunity of savings and connectivity of the network motivated the members to cooperate together and advance of the system. Finally, on May 9, 1977, Prince Albert of Belgium sent the first message over the new Swift network.

When the network went online in 1977, it had already grown to include over 518 financial institutions from 23 countries.[18] By 1980, the network expanded to Asia, opening up banking nodes in Singapore and Hong Kong. Swift added connection to global central banks in 1983, which solidified the system's prominence as the financial backbone for high value international transactions. In 1987, the network's founders voted to expand into the securities market, allowing brokerage firms onto the system. By the end of the 1980's, Swift became the default medium of financial transfer, and gained a near complete monopoly share connecting banks. The system continued to expand its user base beyond banks to include other financial institutions such as mutual funds and even large investment grade companies.[19]

As Swift continued to grow through both nodal additions and traffic volume, engineers at central headquarters in 1991 in Belgium noted that that the technological backend of the system would require an upgrade to meet the new demands of the system. The major upgrade, deemed the Swift II project, was a shift to packet switching technology, which breaks messages into small bits, sends them over the network via multiple pathways, and then reassembles the

[18] "SWIFT History," Swift, last modified 2017, https://www.swift.com/about-us/history; Scott and Zachariadis, *SWIFT*, Ch. 1.
[19] "SWIFT History"; Scott and Zachariadis, *SWIFT*, Ch. 2.

message again at its destination; the internet is the most common example of this technical application. Prior to the upgrade, Swift I had become regionalized both in management and technologically, developing localized protocols utilizing patches that allowed global communication. On June 4 1991, Swift II was implemented—and four of the main European processors shutdown, creating one of the longest blackouts in Swift history. The failure of the standardized, system-wide upgrade highlighted a timeless challenge of the Swift network: how to balance the focus of localization and neutrality with the technical standardization and security needed for global efficiency.[20]

Since the Swift II failures in 1991 and 1993, the organization has continually upgraded its systems and expanded its networks to meet increasing nodal and transaction demands across the world. It introduced a new application interface called SwiftNet that eases network connection at nodes; recently, the system has also implemented sanctions enforcement software to ensure appropriate adherences to international law, as well as fraud detection software to ensure the safety and security of transactions across the world. The network also created the Sibos and Innotribe conferences, which are annual events held in different cities across the world to discuss system innovation and global system-wide challenges. In 2016, the system connected over 11,000 financial institutions across the world at an availability rate of 99.99% uptime, highlighting the continual balance that Swift has sought of regional neutrality with global technical standardization and efficiency.[21]

[20] Scott and Zachariadis, *SWIFT*, Ch. 2.
[21] Scott and Zachariadis, *SWIFT*, Ch. 2.; "SWIFT History"

2. Centralized vs. Distributed Networks

After providing a brief overview and historical context of Visa and Swift, we now move to exploring the comparison of the two networks and how the needs of their stakeholders shaped the structure of the networks themselves. This section first focuses on the primary differences in initial growth that the two networks experienced and then explores the difference in decision power inherent in the organization structures of the two networks. Both networks contrast two of the major managerial structures used in international organizations and show how each is advantageous for specific global challenges. Although the Visa and Swift networks have both become the dominant players in their respective sectors of the financial transaction market, they achieved power via different means of growth. Visa dominated one local region (northern California) and expanded its reach geographically; Swift began as an international network, and grew through transaction volume and product type.

In 1958, 65,000 residents of Fresno California received preapproved BankAmericard credit cards in their mailboxes.[22] The "drop" as it became known in the industry, allowed the company to flood the local market with the credit cards, and test the viability of a universal revolving credit card on "typical" consumers. By focusing on specific locations and regions initially, NBI was able to educate customers, merchants, and banks quickly on the financial product and achieve initial market dominance as it continued its expansion. By leveraging the "drop" method, the network was able to take large amounts of market share in very localized regions to ward off competition. As the card program and brand expanded across the United States and eventually the globe, the initial origin and root of the network remained in Northern

[22] Stearns, *Electronic Value Exchange*, Ch. 1.

California. Over half a century later, the now publically traded company Visa is headquartered in San Francisco, just 200 miles from where it began.

On May 3rd, 1973, 239 banks located in 15 countries formed the Swift network in Belgium, becoming a well-recognized network to ease capital flow across the world.[23] From its founding, Swift connected the different corners of the globe—but with few nodes, limited transactions, and simple messaging types, its use was limited in scope. Over time, as technology advanced from Telex to modern networking protocols, message type and capability expanded to meet the communication and technological demands of its users. What began as a hub-and-spoke network of switches carrying simple standardized messages became a complex, point-to-point network carrying buy orders, wire transfers, stock issuances, and more—all the while connecting over 10,000 institutions across the world.

As the two networks expanded and evolved over time, their core founding structures endured—Visa's initial hub remained at the networks center, while Swift's decentralization focus paralleled its nodal expansion across the world. Visa began as an industry cooperative based in California, and although the network expanded to over 200 countries worldwide, the west coast has remained a central "node" in the management structure—from Dee Hock's tight grip on initial management to the post-IPO headquarters in the Bay Area.[24] In Swift's case, the transactional and regional based representational power of the cooperative society grew with the transaction volume, allowing the network to become the "Financial United Nations,"

[23] Scott and Zachariadis, *SWIFT*, Ch. 1.
[24] "Visa Inc. at a Glance," Visa Incorporated, last modified 2015, https://usa.visa.com/dam/VCOM/download/corporate/media/visa-fact-sheet-Jun2015.pdf

comprising equal transaction-based representation while still allowing for major stakeholders to exert influence.

The contrast in organizational structure between the two companies is where we now turn, focusing on the specifics of Visa and Swift, and how the stakeholders in each organization shaped the network structure to their specific needs.

2.1 Visa's Network and Management: Centralized

From its founding, Visa's network balanced the need for communal distribution with the efficiency of centralized technology and management. For a globalized network to become ubiquitous and accepted across nations and cultures, it requires a level of localization, flexibility, and cooperation. Although Visa has allowed relative regional autonomy, its powerful center often implements managerial decisions and technological innovations that impact the entire network. The centralization of Visa's organization is highlighted though three main aspects of the system: the centered nature of the BASE operating system, the power of having one global brand, and the controlling legacy of the company's founder and CEO, Dee Hock. All three characteristics of the Visa network show the efficiency of the hub-and-spoke model at the expense of relative autonomy and localization of nodes across the world.

2.1.1 The Centralized BASE System

NBI's BASE (BankAmericard Authorization System Experimental) network system provided the technical backbone for the network, forming the central hub through which transactions flowed. NBI's BASE I provided the authorization services for the merchants and cardholders, comparing metadata such as location, amount, merchant type, and other sale data

to ensure correct use of the cards.[25] BASE II system was designed for clearing and settlement of transactions, which is the actual process of monetary exchange between the issuer, acquirer, and merchant.[26] The BASE system consolidated the network, creating not just a centralized node for financial transaction flow, but also a central location where corporate strategic decisions were made as well.

Since the BASE II system roll out was set for November 1 1974, NBI's headquarters mandated that all processors must comply with the new system by that time. As a result of the hard deadline, many processors couldn't get online in time, and had to mail in their drafts in during the busy Christmas season.[27] These technical decisions at the center forced the processors and endpoints to continuously upgrade the nodes for the newest technology; as time and technology progressed throughout the second half of the century, Visa's technological hubs continued to centralize the network. The original hub-based design of the network grew with the transaction volume, becoming a stronger center as security challenges, technical cost, and managerial efficiency encouraged continued centralization of the system. Today, in addition to management headquarters in California, Visa has just two network nodal centers (OCE in Virginia and OCC and in Colorado) through which all transactions go—whether in San Francisco, Singapore, or South America.

After the success of BASE I and II, that automated the authorization, clearing and settlement of inter-bank transactions, Dee asked his NBI board for funding for his BASE III and IV systems he had envisioned. The idea for BASE III was to provide a standardized banking

[25] "Outsmarting Fraudsters with Advanced Analytics," Visa Incorporated, last modified 2016, https://usa.visa.com/visa-everywhere/security/outsmarting-fraudsters-with-advanced-analytics.html
[26] Stearns, *Electronic Value Exchange*, Ch. 5.
[27] Stearns, *Electronic Value Exchange*, Ch. 5.

software that banks could use locally between branches and for processing purposes; numerous banks came forward requesting the production of such a product to distribute the R&D and technical burden of the software across the industry. This aligned well with Dee's personal vision of having the one centralized network used for every part of the credit card transaction—so he pushed hard for the systems production, achieving extra funding multiple times from his board as the project grew in scope.

However, unlike other centralization initiatives that had succeeded and defined Visa's progress in its early days, BASE III never achieved the user traction needed to sustain the project. Because it was designed as software to be used within each bank, members requested specific requirements for the software that became increasingly specific upon each iteration. For example, this hyper-localized software was designed for both cardholder processing *and* merchant processing—though most nodes planned to use only one of the two packages.[28] Eventually, the software became so overly localized and complex that the benefit of standardization wore off, and banks ended up with bloated software packages that were more complex than their own systems. [29] BASE III provided the centralization guidelines that Dee needed: although the network may have been centered around their California office and his specific decisions, BASE III showed that some degree of autonomy between the branches and nodes was imperative to the nature of the cooperative organization.

BASE IV suffered a similar fate to BASE III, riding the optimism of the strong success of BASE I&II, yet never caught on to reach wide-spread adoption. BASE IV represented Dee Hock's

[28] Hock, *VISA and the Rise of the Chaordic Organization*, Ch. 17.
[29] Hock, *VISA and the Rise of the Chaordic Organization*, Ch. 17.

"ultimate" goal of a globalized system for electronic value exchange—transactions not only including credit lines, but also debit lines, investment transactions, and deposits, all in one standardized system.[30] Just as the localization needs of BASE III led to its failure, the BASE IV system met similar hurdles; one of the biggest of which was that BASE IV would have spanned numerous divisions of these banks, including not just the relatively small credit departments, but also the large deposit branches and investment arms. BASE IV provided another boundary for Dee at the helm of Visa's network, reminding him that although standardization and centralization are both key components at the core of the network, with any globalized enterprise, there is a line of localization that must abided by.

As payment technology has evolved past the BASE system to also include cellphones and online transactions, Visa has implemented new technologies such as card tokenization to increase the security of global the system. Tokenization provides another example of the centralization of the technology in the network; it is the process which replaces real card information on a website or at a merchant with a digital "token" that is mapped inside Visa's network to the real card number. For example, if a customer uses Amazon, the website will store the token, and send it to Visa instead of the real number; in Visa's data centers, the token is then mapped to the real card number. Thus, if Amazon's systems were compromised, unusable tokens (instead of full numbers) would be obtained. Tokens may also be used by brick-and-mortar stores and point of sale substitutes such as Apple Pay and Samsung Pay. Although this technology has improved security and increased the protection of personal data,

[30] Stearns, *Electronic Value Exchange*, Ch. 7.

it has again advanced the centralization trend of Visa's network: after tokenization, even fewer nodes of the network have the credit card numbers, information, and power.[31]

2.1.2 The Emergence of VISA's Single Brand

The story of how the Visa's name was chosen and implemented highlights the centralized power of the network—and how even today that control remains at the company's California hub. At Ibanco's headquarters in 1973, Dee issued a challenge to his employees in California: there would be a naming competition, and a $50 check would be given to the person whose idea was chosen. The name decision happened locally at the network headquarters—with limited input from external nodes—and was later pushed to the rest of the network across the world. After the name was finally selected from hundreds of others, no one could figure out who had actually come up with it—the name "suggested itself," and the $50 went unpaid.[32]

The name was then distributed across the world. Some regions embraced the standardization as a solution that finally solved merchant and consumer confusion. Others, however, met the name change with friction; for example, Bank of America in the U.S., and multiple banks in Japan. Bank of America lost the old card name (BankAmericard) to Visa, and was concerned about brand loyalty; however, Dee convinced them that the standardization of the name would result in such substantial sales increases that the name would be less important (he was right). Banks in Japan were resistant because the region's "Sumitomocard" had such strong brand affinity in the region, and merchants and customers would have to change over to the new name; merchants in the country had over 20,000 electric

[31] "All You Need to Know about Tokenization," Visa Incorporated, last modified 2016, https://usa.visa.com/dam/VCOM/download/security/documents/visa-security-tokenization-infographic.pdf
[32] Hock, *VISA and the Rise of the Chaordic Organization*, Ch. 11.

"Sumitomocard" signs that had to be remade for the new Visa brand. Although the Visa named seemed forced from headquarters, the standardization it brought ignited Visa's traction in the market and helped it become the dominate player in the market.

Since its introduction decades ago, the Visa brand has become a household name. The shift to purchases over the internet has led to Visa becoming one of the most well-known brands in the world. During online purchases, customers are asked for brand of the card, and not the issuer bank; as a result, the brand power at the center of the network has increased at the expense of bank brands at each node. This shift contrasts a brick-and-mortar transaction when the physical card is used, because the issuing bank is more prominently displayed on the card than the Visa brand is. ApplePay and SamsungPay have accelerated this shift, through partnering with Visa and MasterCard and pushing banking brands to the backend of transactions.

As consumers have shifted to utilize card-not-present (CNP) transactions, such as an online purchase or an UBER ride, they interact with Visa's brand substantially less than in the past. Previously, every transaction has resulted in a consumer interacting with the Visa brand; with an Amazon purchase or an UBER ride, the card is saved once and then subsequent purchases are made without customers interacting with the card. To fight this commoditization of the transaction market, Visa has continued partnerships with popular cultural events to increase brand awareness. For example, it is a major sponsor of FIFA, the Super Bowl, and the Olympics; through 2020, it has exclusive purchasing rights in the Olympics—meaning that customers *have* to use a Visa card to purchase anything at those events. The brand shift that

Visa is undergoing continues to move the power to the center and core brand at the expense of the other members of its network such as the banks, processors, and merchants.[33]

2.1.3 Dee Hock's Centralized Management

Since its founding, Visa's management structure has balanced the efficiency and power of centralization with the localization needs of being a global network. Founder Dee Hock coined a term for his management style at Visa: "chaordic"—which emphasized lack of formal organization and structure, while still lauding initiative by individuals as they emerged from the flat structure. The organization balanced this hub-and-node tension by fostering competition among cooperative members, and by bringing them together to solve network-wide problems. For example, in the beginning of the organization, banks at each node were slow to implement upgrades for their certificates of sales volumes. In 1971, Dee began publishing each bank's fee structures and transaction volumes for every member to view; since banks were ranked and competed with one another, system efficiency improved dramatically. The recognition of strong performance was more motivating to members than any regulation or stipulation passed by the central hub of the organization.[34]

The organization's focus on distribution of power between members, regions, and countries effectively distributed control so no one member held overwhelming power in the network—except for one person: Dee Hock. The checks and balances of the system ensured that no member held too much power, but also created a level of complexity and inefficiency that effectively delegated daily management decisions to the central node, Dee Hock. John

[33] "Visa International is the Exclusive Payment Card...," International Olympic Committee Digital Properties, last modified 2017, https://www.olympic.org/sponsors/visa.
[34] Stearns, *Electronic Value Exchange*, Ch. 3.

Totten, an engineer for the original BASE system, recalled Dee's common line of "titles aren't important around here as long as I'm CEO."[35] Although the physical network may have had a few hubs, Visa in the early days had just one—Dee—who held the personal connections with each bank and the centralized vision for what the network could become. The decentralization of the network created the appearance that it was not dominated by a single player or vision, but in reality, Dee was at the center, constantly pushing the network and challenging it to match the vision that he held for a truly globalized, universal, and automated payment system.

Dee Hock's mass of power at the center of the network allowed him to control the network's expansion and growth; throughout the first several years of Visa, Dee manipulated stakeholders and members of the organization to cooperate for the advancement of the system as a whole. For example, in 1982 during a board meeting in Bermuda, Dee learned the flight schedules of each board member and planned the interchange transaction vote for *after* the 20% of the board who opposed it had left. As a result, the vote passed, and POS terminals across the nation were rolled out in record numbers.[36] Another example of Dee's authoritative power comes from the establishment of Visa's east coast offices in McLean, VA: after having employees suggest multiple east coast cities (including Charlotte, NC), Dee immediately decided on McLean because it would allow for a Washington, D.C. address on the company's letterhead. In the early days of Visa, numerous decisions were made like this: Dee makes the decision, it is final, and the company and members are later notified.

[35] Stearns, *Electronic Value Exchange*, Ch. 4.
[36] Stearns, *Electronic Value Exchange*, Ch. 7.

The fee that the entire Visa transaction runs on—the interchange reimbursement fee (IRF)—provides another example of Dee's power in the network. The IRF is the discount that merchants pay to the acquirer, network (Visa), and subsequently issuer for the use of the card. This IRF can range in amount—usually between 2-3% of purchase value—based on variables such as the merchant, location, card type, and processor type.[37] NBI employees studied the prices in the market and the elasticity of demand of consumers to determine the best price, and subsequently presented the data to Dee. Dee Hock instinctively chose 1.95% because it seemed close to what the acquirers had been paying and because the exactness of 1.95% suggested that it had been highly calculated and highly thought out.[38]

Since its founding in California, Visa has expanded across the globe to connect customers, merchants, banks, and processors and ease financial transaction flow across the world. The nature of the BASE system emphasizes the hub-and-spoke design of the network, forcing every global transaction through two central nodes. The Visa brand has become one of the most highly valued brands in the world, shifting power from the banks and processors in the network to the branded center of the network. Finally, Dee Hock's legacy as founder and CEO of the company created a centralized management system that has lived on past his tenure, its backbone still found in the publically traded company at present.

[37] "Visa USA International Reimbursement Fees," Visa Incorporated, last modified April 16, 2016, https://usa.visa.com/dam/VCOM/download/merchants/visa-usa-interchange-reimbursement-fees-2016-april.pdf
[38] Stearns, *Electronic Value Exchange*, Ch. 3.

2.2 Swift's Network and Management: Distributed

2.2.1 Distributed Technologically

The Society for Worldwide Interbank Financial Telecommunication was founded in 1973 as a decentralized financial messaging network between financial institutions across the world. Engrained in both the technological and managerial structure of the organization was the regional and localized focus that still defines the network today. As Swift grew over the decades from just 239 banks originally to over 10,000 institutions worldwide, it overcame challenges in its history—organizational, technical, and geopolitical—that helped define its identity as a distributed network designed with regional flexibility for its stakeholders.

During its initial decade of growth, the combination of the transition from the prior TELEX network and the competition of the MARTI network helped drive Swift forward and helped the initial banks chart the network's distributed identity. As Swift continued to expand, its stakeholders struck a balance of competition and coopetition, consistently battling for customers in the sector while still collaborating to solve the networks problems. Finally, Swift's annual conference SIBOS highlights the global culture of collaboration, centralizing the people of the network once a year to discuss network improvements, Swift's role in the sector, and the future of financial value exchange.

2.2.2 TELEX, Belgium, and MARTI

The first major example of Swift's distributed network structure focuses on the initial technology that it was built from. Before Swift, the financial standard for interbank communication was the telex system; although it was inefficient and slow, it offered a distributed network model that European banks liked because it was customizable to their

individual needs and specifications. The banks then formed organizations such as the European Banks International Company (EBIC) and the Associated Banks of European Corporation (ABECOR) to solve the technological inefficiency, but mirror the distributive structure. It was from these organizations that the Message Switching Project (MSP) and the idea of a distributed banking network gained traction. America had already created its own banking network, FedWire, but it was maintained by the central hub of the federal government; Swift's power would not reside with one overseeing governing body, but would distribute the decisions directly among the users themselves.

Although Swift was officially formed as a cooperative society in 1973, the network itself was yet to be built. Some political questions had been answered—such as founding the society in Belgium—but the technological standardization battle was just beginning. The standards debate ranged from server choice, to software package decisions, to storage capacity and location. The location of the founding was not random: in fact, after much friction between different banks and regions, it was decided that Belgium would balance the power struggle between New York and London; thus, even before the network had sent its first message, it lay the path for power decentralization. The 239 banks from across Europe and America agreed on a high level that the cooperative network would benefit everyone, but the power struggle lay in how the technological standards would be decided between the banks, countries, and regions.[39]

While Swift endured standardization disagreements and technical debates, a competitor network was being built. The First National City Bank (FNCB) founded its own

[39] Scott and Zachariadis, *SWIFT*, Ch. 1.

network in 1973, called the Machine Readable Telegraphic Input (MARTI) network. Since the system was developed by the FNCB (now Citi), it was customized for Citi's systems and protocols used in New York.[40] The FNCB announced a deadline that by April 1975, banks should adapt the MARTI system for communication with the FNCB; this centralized, standardized, top-down approach to the network was met with strong opposition by the banking community. The Swift society had been formed to build a network that distributed power and representation, and the new concern of the MARTI network quickly ignited cooperation within the banking society.

Although the standardization of telex lay the groundwork for the decentralization of Swift, the competition with the MARTI network empowered it. With MARTI, the FNCB would have not only issued the technological standardization protocols, but they could have controlled the pricing, revenue, and message types for the entire system. Unlike the future point-to-point network that would emerge for Swift, MARTI would have created a hub-and-spoke network, with the FNCB at the center technologically *and* managerially. The competition from the MARTI network helped the main banks organizing Swift to focus directly on the technological decisions core to the networks regionalization; following anti-MARTI inspiration, the system was to be a store-and-forward network: having no centralized database, the network allowed for intraregional communication with no single location storing every message. Both the early telex network and the MARTI network competition encouraged Swift

[40] Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," *Business History,* Vol. 54, No. 3: 465, accessed May 11, 2017. http://dx.doi.org/10.1080/00076791.2011.638502.

to pursue its roots of cooperation—and set the groundwork for the eventual growth of a decentralized global network.

2.2.3 Co-opetition

Having laid down the groundwork for a decentralized financial network, major banks in the organization—including Lloyds, Chase, Citi, Barclays, Deutsche Bank and more—began the ever-present tension between cooperation and competition. This "co-opetition"—a term which managers at the Swift network began using to describe the organization—balanced the cost-efficiency and network effect that the stakeholders sought with the cutthroat competition that the banking sector is known for. The headquarters in Belgium houses not a typical board table with one "head"; inspired directly from the physical United Nations structure, the boardroom instead has a circular room with 30 chairs, all facing each other, to hash out decisions as equals.[41] Those representatives at the table are chosen through regional representation and transaction volume, pulled from their daily competition of pitch books and spreads to cooperate together and innovate a system that benefits them all.

Since Swift's founding in 1973, co-opetition has lived on through generations of employees, having become engrained in the culture of the decentralized network. Having had the technological foundation cemented in as a distributed network, individuals at the network have consistently aimed to mirror that technical underpinning to create a culture of global inclusivity. For example, as a former operations member remarked in Belgium in 2012, "operational excellence is achieved by people not hardware, software, or fences around

[41] Scott and Zachariadis, *SWIFT*, Ch. 2.

properties."[42] It is the people who interact with the network nodes and system protocols that continuously strike the balance of co-opetition, working together to improve the system while still challenging each other for customer business. It is this balance of flexibility of the people in the network that allows it to regionalize and bend to accommodate different cultural and technical needs across the world. As Swift CEO Gottfried Leibbrandt stated in 2012, "if we go to India, that means we become Indian."[43] The flexibility of the people and the technological network create a level of cooperation and worldwide competition unique to such a globalized organization.

The decentralization and distribution of Swift across regions were key reasons why the Swift network quickly became the default method for interbank financial transaction. By 1986, it was called an "obligatory passage point," meaning that in order to do business as a major player in the banking sector, a bank *had* to join the network because of no alternatives.[44] Since the customers are the same as the producers in the Swift network, typical monopolistic price gouging and market control don't apply. However ironic it is that a purposely decentralized network became a monopoly, it has clearly proven that an industry model such as this for a network is not only possible, but adaptable to globalized pressures.

The regionalized organizational power of the banks in the network hit multiple obstacles since the first message was sent in 1975, most notably the decision whether to admit non-bank members in the network—including brokerage firms, investment funds, and corporations. Investment banks enjoyed having complete control and ownership of the network, and were

[42] Scott and Zachariadis, *SWIFT*, Ch. 2.
[43] Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," 475.
[44] Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," 475.

hesitant to open it up to other stakeholders who may have differing uses than just interbank transfers. After internal studies and extensive discussions, the members voted to accept clearing institutions, brokerage firms, and exchanges into the global network. Swift no longer just spanned banks, countries, and regions, but it now crossed different markets and distributed power to a new set of stakeholders. In 1998, after years of pressure, Swift expanded membership to investment grade corporates as well. Corporates were delegated to a separate governance category, called member administered – closed user groups (MA-CUGs), that connected to the network via specific banks, instead of directly to the network.[45] Swift for corporates utilizes corporate-bank relationships to create yet another branch of decentralization for the network—which has grown to over 10,000 organizations worldwide.[46]

Swift's decentralized co-opetition model aimed to create a globally neutral organization, spanning over 200 countries and territories. The constant regional friction and cooperation between stakeholders was designed to limit the possibility for any central authority to hold disproportionate power. As Swift chairman Yawar Shah stated, "Neutrality is in Swift's DNA!" Whether from the people, the technological structure, or the managerial structure, Swift aspires to not be a simply westernized organization with extremities reaching across the world, but to be an unbiased interconnected point-to-point network. As CEO Gottfried Leibbrandt stated, "[Swift] is a not a western firm that goes east. It is a global firm."[47] The network was founded as an international, relatively decentralized organization with a global focus; this

[45] Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," 474.
[46] "Understanding Swift for Corporates," J.P. Morgan Treasury Services, last modified 2012, https://www.jpmorgan.com/cm/BlobServer/Swift_For_Corporates.pdf?blobkey=id&blobwhere=1320633877670&blobheader=application/pdf&blobheadername1=CacheControl&blobheadervalue1=private&blobcol=urldata&blobtable=MungoBlobs.
[47] Scott and Zachariadis, *SWIFT*, Ch. 5.

contrasts to most global organizations that expand by dominating a specific region and then expand geographically.

With the decentralized and neutral focus of the organization, Swift is responsible for the network, standards, and products that the organization creates for its stakeholders—but *not* the content of the messages sent across the network. Swift claims to be similar to an internet service provider, forwarding information from node to node, without responsibility for the nature of the packets being forwarded. When those packets contain financial information fraudulent or illegal activities, how are those acted upon and enforced? Though it is not a telecomm company nor a bank, the *distributed* and *global* network raises regulatory questions unique to the organization. The co-opetition of Swift allows for distributed expansion, monopolistic benefits, and relative neutrality that has accelerated its expansion and power, and proven the potential of decentralized firm structure as globalization continues.

2.2.4 SIBOS

The final example of the decentralized nature of the Swift network comes from the annual event that it has held since 1978: Swift's International Banking Operations Seminar, SIBOS. It was founded as a small user forum allowing the back-office members of the organization to assemble from all over the world to discuss technical network challenges and protocols. Over time, SIBOS grew to become a major conference in the financial transactions sector, held in a different city each year to highlight the lack of centralization of the organization. Members from the nearly 200 countries that Swift connects come together to not just discuss network standardization and financial software products, but to engage with speakers and forums to discuss the continuous innovation of the network. Conference themes

in the past have ranged from Hong Kong's "Collaboration and Innovation Dominate," to Nice's "The Competitive Edge," to Toronto's "Regulation, Future of Money, Changing Technology, Worldwide Shifts."[48] Each year, the conference focuses on the cooperation side of the co-opetition focused network, bringing different cultural mindsets together to improve the current infrastructure and innovate the future one.

SIBOS's concentration of individuals from across the world for the betterment of the network highlights the global collaboration of Swift's people. One of the common proverbs of Swift is a quote from Alexander Graham Bell, "Great discoveries and improvements invariably involve the cooperation of many minds"; SIBOS occupies the center of this cooperation, consistently relocating every year and spurring collaboration across the network.[49] It has become the "premier" forum for the entire industry—whether focusing on payments, fintech, networking, or currency—that has created a "following" in the financial transaction world. As one conference participant stated, at SIBOS, "[you] would do in three days what you could do in four months. Everybody's there."[50] SIBOS's participants range from the software and technology focused back-end engineers to fintech startups to CEOs of major banks—all brought together by the network.

From its flagship year in 1978, SIBOS created an environment for people across the network to challenge each other to innovate and meet the ever-changing demands of technology. These challenges have often come from event speakers and stakeholders, who remind the audience of the constant challenge of innovation that lies ahead. For example, at

[48] Scott and Zachariadis, *SWIFT*, Ch. 2; Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," 476.
[49] Scott and Zachariadis, *SWIFT*, Ch. 2.
[50] Scott and Zachariadis, *SWIFT*, Ch. 2.

the SIBOS Stockholm conference, a computer hacker showed security flaws in the network and proved that he could break in![51] In SIBOS Atlanta, Head of Treasury Services at J.P. Morgan pushed the network for *true* straight through processing (STP), stating that "the amount of customization in this industry, and the lack of standardization across countries and across market infrastructures, truly amazes me...As an industry, we are a very, VERY long way from *Swift*."[52] It is these speakers that energize SIBOS at the center of Swift, highlighting the decentralization, while pushing members to cooperate in new ways.

As a backbone of the globalized financial transfer market, Swift has shown a remarkable ability to balance standardization with localization, remaining decentralized enough to be adaptable across the world. Whether from its origins in TELEX, its competition with centralized MARTI, its balance of co-opetition, or the centralization of the SIBOS conference, Swift balances the equilibrium of remaining locally focused in a globalized network.

3: Globalized Challenges of Organization Structure

As Visa and Swift evolved and expanded across the world, their founding technological and managerial structures proved durable over time, shaping their developmental trajectories as they extended to a global scale. Visa's top-down, centralized corporate structure has allowed the organization to innovate new products and services at a fast pace, and efficiently implement advancements across the worldwide network. Alternatively, Swift's distributed network lacks the efficient technological innovation that is possible with centralized technical hub; as a result, the message system is relatively slow to match the continually changing

[51] Scott and Zachariadis, *SWIFT*, Ch. 2.
[52] Heidi Miller, "Asking Tough Questions of Swift," *Global Treasury News*, November 1, 2004, accessed May 11, 2017, https://www.gtnews.com/articles/asking-tough-questions-of-Swift/.

technical demands of the network's stakeholders. Both networks balance the demand for technological efficiency and standardization with regional flexibility and localization—Visa focusing more on the former, and Swift on the latter.

Geopolitically, the two networks align with their stakeholders in differing ways, creating a tradeoff of bias and neutrality that both helps and hinders network operation. Global sanctions enforcement by both networks provides a lens through which to contrast their differing global structures. Visa's U.S. centralization highlights the political and local bias of the network towards the United States; multiple times in its fifty-year history, the network has been a tool for sanctions enforcement for the U.S. Alternatively, Swift's relative global neutrality allows it to navigate global politics and interests with a comparatively impartial role between countries, aligning closer to the UN.

3.1 Visa's Centralized Technological Control

From its founding in 1958, the center of Visa's network has been in California, where its system technology and innovation is continuously reborn, iterated upon, and subsequently distributed across the world. The central node in the Bay Area has not only allowed the company to utilize having one central location for its engineers and products they create, but it is also used as a center of power allowing network and product upgrades to be efficiently pushed to the rest of the world. We now explore three such examples that show the power of the centralized headquarters to both create and implement technological advancements across the network. First, the creation of Dee Hock's BASE II system highlights both the level of technological innovation at the networks center, but also the power that the center wields over its nodes—and how BASE II was adopted very quickly as a result. Second, the network's

implementation of *Verified by Visa* shows the power the company has behind its security measures, and how quickly it can implement new software worldwide. The final example is that of the more recent EMV chip technology that was created and then adopted worldwide—except in the U.S.; Visa then leveraged its power in the U.S. to shift fraud liability to merchants *without* EMV—resulting in a recent rush of adoption nationwide.

In 1973, the BASE II system was designed to automate the clearing and settlement system that at the time was done on paper. After successful rollout of the BASE I authorization system for interbank transactions, Dee Hock and his small team at NBI turned their attention to reducing the 6-8 day clearing timeline that the network was accustomed to. NBI partnered with IBM to create the mainframe system that would provide the computing power and network capabilities, allowing for interbank clearing and settlement to happen every night. The idea to computerize the system was not a new one, nor an impossible task—but the challenge was to first create a universal software that worked for the stakeholders, and then to ensure that it was quickly adapted into the marketplace.

Before implementing the system to its member banks and merchants across the country, the BASE II team at NBI had to overcome the obstacle of stakeholder standardization and market inertia. Paper was the expected standard in 1974 for financial exchange: at the time, the Federal Reserve system was focusing on the "advanced" Magnetic Ink Character Recognition (MICR) technology to automate paper check processing. BASE II bucked the trend of paper reliance in the industry, and pushed forward to remove paper from the entire transaction. The second point of resistance that the NBI team encountered was that consumers were accustomed to receiving the transaction draft from the store—and in a BASE II scenario,

customers would not receive that paper copy. These paper copies were often used by households for expense tracking, and were accepted by the IRS for proof of purchase. These pain points in the implementation—the standard of paper in financial exchange at the time and the customer loyalty to paper drafts—led to a resistance in the BASE II implementation that the central node of the system had to overpower.[53]

Despite the initial concerns about the standardization of paper and the consistent consumer experience, the NBI team raced through the implementation process, creating the entire software system in 18 months at a cost of under $7 million. At NBI's mandate, banks were expected to be BASE II compatible by November 1974, in time for the Christmas rush. The vast majority of the banks made the target, though some received exceptions to upgrade at a later date; by March 1975, the entire system ran BASE II, automating clearing and settlement from 5PM to 5AM every night. And to quell the concern of the paper-trained consumers, the NBI team created facsimile drafts for the customers to receive—and after an initial beachhead test, few customers could even notice the difference.

One new technological change that customers did notice upon implementation was the roll out of *Verified by Visa,* which is a software package to help secure online payments for card-not-present (CNP) transactions.[54] When online ordering became more common in the mid 2000's, Visa combatted the increase in CNP fraud claims by partnering with Arcot Systems, which created a security pop-up window—Verified by Visa (VbV)—that verified the match between the card number and the user. Visa implemented Arcot's solution worldwide, which

[53] Stearns, *Electronic Value Exchange*, Ch. 5.
[54] Miles Brignall, "Verified by Visa scheme confuses thousands of internet shoppers," *The Guardian*, April 20, 2007, accessed May 11, 2017, https://www.theguardian.com/money/2007/apr/21/creditcards.debt; "Verified by Visa – How it Works," Visa Incorporated, last modified 2017, https://usa.visa.com/pay-with-visa/featured-technologies/verified-by-visa.html.

quickly became standard for online purchases; in 2005, the 3D-Secure software behind VbV was expanded to include purchases on mobile devices as well.[55] The VbV roll-out and subsequent expansion provides a strong example of Visa's centralized power as a network by highlighting its ability to recognize a problem in the system—increased CNP fraud—act on it by partnering with a third party, and subsequently install the software worldwide in a relatively efficient and effective manner.

The final example of Visa's centralized ability to efficiently implement technology across the world is the invention and subsequent execution of the EMV chip technology found on most cards today. Before the chip, payment cards used the coded magnetic stripe to convey their payment information to the terminal at the point of sale (POS); the data on the magnetic stripe—the name, number, expiration date, and CVV—is static, making it an attractive and lucrative target for fraud. The EMV chip conveys the same information at the terminal, but includes unique encryption codes for each transaction that only the issuing bank can decrypt—making the payment medium dynamic, and thus an unattractive and challenging target for fraud.[56] The EMV consortium that developed the technology—now called EMVCo and owned by the six major card networks—implemented the technology across the world, which now composes over 97% of card-present transactions in Europe, and 89% in Africa and the Middle East.[57] The chip card is now seen as a standard in the industry, and the increased security has shifted the focus of fraud from card present transactions to online transactions as a result.

---

[55] Kristina J. Yee, "Arcot Systems to Offer 3-D Secure(TM) with Visa...," *BusinessWire*, December 13, 2005, accessed May 12, 2017, http://www.businesswire.com/news/home/20051213005963/en/Arcot-Systems-Offer-3-D-Secure-TM-Visa.
[56] "Visa Chip Technology – Confidence in a Smarter World," Visa Incorporated, last modified 2017, https://www.visa.com/chip/personal/security/chip-technology/chip-cards/index.jsp.
[57] "Worldwide EMV Deployment Statistics," EMVCo, LLC, last modified 2017, https://www.emvco.com/about_emvco.aspx?id=202;

Although the EMV implementation successfully expanded across the world, it failed to quickly gain traction in the world's biggest economy—the United States. By June 2016, only 7.2% of card present transactions in the United States used the chip method (instead of the swipe).[58] Although the U.S. market has been slow to adopt the decades old technology for numerous reasons—including merchant and bank resistance, consumer preference, and payment alternatives (such as ApplePay)—Visa has recently implemented a system of incentives for the network to increase EMV acceptance. One of the most aggressive tactics that the company employed was the merchant liability shift in October 2015, which dictated that fraud liability would be shifted to merchants not using EMV technology. The networks' centralized power allowed it to implement this rule and has resulted in increased EMV use and substantial investment into future EMV compatible POS terminals in the U.S.

Since its founding, Visa's centralized network model has allowed it to take advantage of the technological efficiency of a corporation while still meeting the needs of its global network. Whether implementing the first electronic clearing and settlement system as BASE II, distributing software packages such as *Verified by Visa* across the world, or incentivizing EMV adoption worldwide, the hub-focused nature of the network centralizes technical upgrades and decisions and eases implementation across the network.

3.2 Swift's Network Decentralizes Technical Control

Although the Society for Worldwide Interbank Financial Telecommunication's distributive focus creates benefits such as relative global neutrality, international equity, and localization potential, it comes at a cost: technological innovation and efficiency. This

[58] "Worldwide EMV Deployment Statistics," EMVCo, LLC, last modified 2017, https://www.emvco.com/about_emvco.aspx?id=202;

regionality is a cornerstone of Swift, allowing it to morph and adapt to the needs of banks and companies across the world—but it limits the standardization and upgradability of the network over time. In 1991, while network engineers began upgrading to the Swift II system, the network went completely offline for several hours due to a standardization issue with a messaging protocol.[59] In 2016, thieves leveraged a vulnerability in a Bangladeshi bank connected to Swift and stole $81 million from the New York Federal Reserve through the network.[60] To combat network inertia and promote innovation across the system, Swift has created organizations—such as Swift Lab and Innotribe—to foster community standardization and solution implementation on a global scale.

As Swift's network continued to expand quickly to thousands of banks across the world, network administrators decided to upgrade the network in the 1990s to a more distributed model that could easily ramp up and down to match messaging demand. This new system, called Swift II, leveraged packet switching—the notion of splitting a message into small bits, sending it across multiple lines in the network, and then reassembling it at its destination—which was an ambitious plan for such a regionalized network. The upgrade scheme was delayed over three years, meeting countless hardware and software standardization hurdles that hindered progress—a major example being the decision to build using X.25 messaging protocols instead of the previous Burroughs propriety system, a decision that fractured the network over debates of efficiency, cost, and reliability. During the early years of the upgrade cycle to Swift II, the system went offline twice—for a few hours in June and September of 1991—due to

[59] Scott and Zachariadis, *SWIFT*, Ch. 2.
[60] Michael Corkery, "Hackers' $81 Million Sneak Attack on World Banking," *The New York Times*, April 30, 2016, accessed May 12, 2017, https://www.nytimes.com/2016/05/01/business/dealbook/hackers-81-million-sneak-attack-on-world-banking.html?_r=0.

standardization lags in the new switching conventions and message ordering.[61] Once the Swift II system was online and fully reliable, it became the backbone of the system and allowed for its future exponential growth—but the initial rocky roll out highlighted the lack of standardization inherent in the networks technology.

In February 2016, anonymous hackers leveraged the Swift connection of the National Bangladesh Bank to steal $81 million from The Federal Bank of New York. The Bangladeshi Bank represented a weak point in the Swift network, that could be broken into relatively easily: it used $10 routers and lacked basic firewall protection that is standard at most nodes.[62] The message standardization was simple to copy, alter, and send to the Bank of New York—and since the confirmation in Bangladesh was done by paper print out, the hackers simply disabled the printer software, preventing the confirmation from printing: the money was transferred to anonymous accounts with no trace of the transaction appearing in Bangladesh.[63] The $81 million loss highlighted the lack of technological and security standardization present at each node of Swift, decreasing the safety of the overall network. Swift responded to the theft by investigating the vulnerabilities in the system and with an increased focus on the standardization of safety precautions across the decentralized network.[64]

To combat the lack of technological standardization, management at Swift's headquarters in Belgium has used conferences and events within its global community to foster innovation and further enhance its global secure environment. The solution to the

---

[61] Scott and Zachariadis, *SWIFT*, Ch. 4.
[62] Jim Finkle, "Bangladesh Bank hackers compromised SWIFT software, warning issued," *Reuters*, April 25, 2016, accessed May 12, 2017, http://www.reuters.com/article/us-usa-nyfed-bangladesh-malware-exclusiv-idUSKCN0XM0DR.
[63] "Hackers' $81 Million Sneak Attack on World Banking"
[64] "Joint Statement: Federal Reserve Bank of New York, Bangladesh Bank and SWIFT," SWIFT, last modified 2016, https://www.swift.com/node/34901.

technological uniqueness and inconsistencies across Swift's network has been to organize its community to come together to solve common problems—such as node security and implementation. For example, Swift Labs—located in New York, Hong Kong, and London—was created to provide space for each region to tackle common security challenges and standardize responses across regions.[65] Swift also developed the Innotribe program to combat the monopolistic comfort and inertia that comes from being an industry leader, pushing the community once a year to think together and search for holes and improvements in the network infrastructure.[66] Node diversity is the nature of a global network, and through community events and programs, Swift has attempted to centralize the common problems and solve them as one Swift community—though the localization and regionality has still remained a major challenge for Swift's global security.

3.2.1 Visa as a U.S. Centered Network

Although Visa operates the largest global payment network in the world, its centralized structure favors the United States and thus has at times become entangled in U.S. foreign affairs. For example, in January 2017, the use of Visa's products was restricted in Burma, Iran, Sudan, Syria, and North Korea—not because of technological barriers or consumer choice, but because of U.S. sanctions.[67] High-profile sanctions in the past over Russia's annexation of Crimea and Iran's continued pursuit of nuclear weapons have impacted Visa, which in both cases was required by U.S. law either to restrict the use of products country-wide or to freeze

[65] PlanetSWIFT. "SWIFTLab – Where Ideas Come to Life," YouTube video, posted August 2016. https://www.youtube.com/watch?v=hdePB-SH4Dw.
[66] "Innotribe – About," SWIFT, last modified 2017, https://innotribe.com/about/.
[67] "Credit Card-Sanctioned Countries," Republic Bank Limited, last modified 2017, https://www.republictt.com/duplicate/credit-card-sanctioned-countries.

specific accounts of foreign persons. Finally, due to the U.S.-centered nature of the network, U.S. intelligence agencies have unique access to the data of consumers across the world, and countries across the network have fought for data sovereignty in the post-Snowden era.

Although many other globalized companies headquartered in the United States abide by U.S. sanctions when required to, Visa lies in a uniquely central role as the world's largest financial transaction network. Because of the integral importance that personal financial exchange has, payment sanctions are an effective way to punish foreign actors for acting against the U.S.'s interests. For example, in 2011, the U.S. sanctioned the use of Visa and MasterCard products in Syria because of the regime's human rights violations in Damascus and for the repeated sale of illegal weapons to North Korea.[68] In January 2015, the Obama administration passed regulations finally allowing the use of U.S. Visa and MasterCard in Cuba as relations between the two countries improved.[69] In both Syria and Cuba, the U.S. exploited the power of the centralized networks to its advantage, rescinding and granting business in different parts of the world based on political and policy concerns.

The United States also used Visa's network to issue sanctions in Iran prior to the Iran Deal in 2015. The Joint Comprehensive Plan of Action (JCPOA) was signed in 2015 and formed the agreement that allowed Iran access to U.S. capital markets and U.S. companies in return for concessions in Iran's nuclear weapon program.[70] Visa and MasterCard were finally granted access to the country's 231 million active cardholders who desired to be on the western card

[68] Albert Aji, "Visa, other cards not valid under Syria sanctions," *The Seattle Times*, August 25, 2011, accessed May 12,2017, http://old.seattletimes.com/html/businesstechnology/2016010607_apmlsyriaeconomy.html?syndication=rss
[69] Elizabeth Dexheimer and Indira A.R. Lakshmanan, "MasterCard to Lift Transaction Block on U.S. Cards in Cuba," *Bloomberg*, January 23, 2015, accessed May 12, 2017, https://www.bloomberg.com/news/articles/2015-01-23/mastercard-to-lift-transaction-block-on-u-s-cards-in-cuba-1-.
[70] The US State Department, *The Joint Comprehensive Plan of Action* (Vienna), July 14, 2015.

networks.[71] Visa's U.S. centered network was not just used for sanctions enforcement country-wide, but was also used against specific people who created front-companies on behalf of Iran to funnel funds in and out of the nation—who even sometimes used Visa prepaid cards to make the transfers. Whether used as a massive countrywide network block, or targeted at specific actors acting against the U.S.'s best interest, Visa's *globalized* network in Iran has been used numerous times to *locally* benefit the U.S. and its allies.

The final example of the United States using the centralized power of the Visa network occurred in December 2014, when the U.S. Government issued sanctions on Russia over the annexation of Crimea; all MasterCard and Visa products were suspended in Crimea.[72] In Russia as well, certain banks and specific members of the Russian Government were blocked from the networks, in an effort to "get Mr. Putin to the negation table."[73] Since 90% of the Russian population used either MasterCard or Visa at the time, these sanctions had major impacts on day-to-day commerce.[74] The Russian government responded by requiring the two networks to transfer hundreds of millions of dollars to the Bank of Russia as warranty against the notion of a future network termination. Finally, in order to ensure that these financial network tools are ineffective in the future, the government struck deals with both payment networks to co-brand and co-process their cards with local providers. By doing so, the government not only localizes the payment power in Russia from the U.S. to remove future financial sanctions power, but it

---

[71] Philippe Wojazer, "Iranian banks to issue credit cards for first time," *RT*, September 27, 2016, accessed May 12, 2017, https://www.rt.com/business/360646-iran-bank-first-credit-cards/.
[72] Alexander Winning and Polina Devitt, "Visa, MasterCard stop supporting bank cards in Crimea," *Reuters*, December 26, 2014, accessed May 12, 2017, http://www.reuters.com/article/us-russia-crisis-visa-crimea-idUSKBN0K40TN20141226.
[73] Roger Runningen et al., "Russia Pressed on Ukraine as EU Joins U.S. on Sanctions," Bloomberg, March 21, 2014, accessed May 12, 2017, https://www.bloomberg.com/news/articles/2014-03-21/russia-pressed-on-ukraine-as-eu-joins-u-s-on-sanctions.
[74] Amanda Alix, "How Russia's Tactics With Visa Inc and MasterCard Inc Almost Spelled Disaster for the Country," *The Motley Fool*, May 25, 2014, accessed May 12, 2017, https://www.fool.com/investing/general/2014/05/25/how-russias-tactics-with-visa-and-mastercard-almos.aspx.

also forces the payments to be processed locally, which restricts cross border data transfer. Russia provides yet another example of how Visa has been repeatedly utilized by the United States for foreign policy interests—and in this case, resulted in a globalized nature of the network as it was forced to localize to Russia.

Russia's ideas of localizing transactions within their country was not a new one: this concern of data neutrality within the global network as nearly as old as the network itself. VisaNet, the technical network through which every Visa card transaction runs, has two main nodes: in Colorado, and Virginia. The vast majority of transactions—whether in San Francisco, Singapore, or Spain—run through one of these two nodes in the U.S. Although each node is capable of handling the network traffic itself, they split the load for backup redundancy and upgradeability.[75] Although this centralization is the core of Visa's network and identity as an organization, numerous countries across the world have voiced their concern for their lack of data sovereignty over their own citizen's financial information. Visa's control of citizen data is not just a concern for America's adversaries—such as Russia, who has demanded that their transactions be kept inside the nation—but for its strongest allies, too: Germany and France, for example, have voiced apprehension for the vast amounts of data that American companies have on their citizens.

From its founding, Visa's financial exchange network was U.S. centered, and as it globalized and expanded to become the world's largest consumer focused financial network, its hub remained in the U.S. Over the company's lifetime, the U.S. and its allies have used the

[75] Daniel Fisher, "Visa Moves At The Speed Of Money," *Forbes*, May 25, 2015, accessed May 12, 2017, https://www.forbes.com/sites/danielfisher/2015/05/06/visa-moves-at-the-speed-of-money/#1ead6a5a57c3.

expansiveness of Visa to advance global political agendas—including human rights violations in Syria, nuclear arms control in Iran, and Russia's annexation of Crimea. In all three cases, Visa's international presence was pushed closer to Washington's agenda, jeopardizing its neutrality as a truly global organization. Finally, as data privacy and intelligence overreach concerns entered the world stage, specific countries have begun localizing Visa's network, to quell the natural centralization that the technology company has encouraged.

3.2.2: Swift's Decentralization Stimulates Volume-Neutrality

Swift's initial founding as a decentralized, global organization was designed to foster neutrality as a backbone of the network. The governance of the society is allocated between stakeholders by volume, allowing those who use the system more to govern how it is run. The technological governing products that the network has created—such as the Sanction Screening Service and the Compliance Analytics Service—can thus be used as tools to enforce the rules that the majority stakeholders deem appropriate. The U.S.—a major stakeholder in the network—exploited the Swift network for the Terrorist Financial Tracking Program after 9/11, and in 2017, banks in North Korea were terminated from their connection to the network.[76] Historically the network has been governed by a western majority—but as developing economies continue to grow, the stakeholder control could shift further east. With no clear alternative for large value business-to-business financial exchange, Swift consistently aspires to balance geopolitical necessities with its intended objective to ease capital flow across borders: an equilibrium that has been continually tested as it navigates global demands.

[76] Eric Lichtblau and James Risen, "Bank Data Is Sifted by U.S. in Secret to Block Terror," *New York Times*, June 23, 2006, accessed May 12, 2017, http://www.nytimes.com/2006/06/23/washington/23intel.html; Jeremy Wagstaff Lichtblau and Tom Bergin, "SWIFT messaging system bans North Korean banks blacklisted by U.N.," *Reuters*, March 8, 2017, accessed May 12, 2017, http://www.reuters.com/article/us-northkorea-banks-Swift-idUSKBN16F0NI.

Swift's original governance was designed to match stakeholder power with network use. Its governance structure was designed to reflect message volume and region, giving those that use the system more often more power within the system. The number of directors elected to the society's board and quantity of shares given out to each country is based on the number of transactions that that country sends and receives over the system—which correlates highly with economic output. Since the society's founding, the European Union and the United States have dominated the system both by transaction volume and thus by governance as well. Although the 2016 Swift Chairman Yawar Shar stated that "neutrality is in our DNA," the neutrally defined network is logically biased by its stakeholder majority.[77] This inherent bias—western leaning since its founding—has thus shown influence in the use of the geopolitical and technical tools that the society has employed.

In response to the uptick in sanction requirements and international financial regulations, Swift created a software package to ensure regulatory adherence for banks across the world. The Sanctions Screen Service is an add-on that nodes pay for to receive screening for all inbound and outbound messages on their node. It is a cloud based service that is *centralized*: the sanction lists and regulations are updated centrally and subsequently sent to each regional node across the world.[78] Though the network itself is decentralized and regional, sanction decisions and enforcement is standardized and pushed out to each bank—representing an unusual occurrence that the network houses the power at its center. However, the choice to adhere to the sanctions—or send the "flagged" message anyway—is still the decision of the

[77] Scott and Zachariadis, *SWIFT*, Ch. 5.
[78] "Sanctions Screening," SWIFT, last modified 2017, https://www.swift.com/our-solutions/compliance-and-shared-services/financial-crime-compliance/sanctions-screening.

node, preserving the regional power of each node (however, messages sent to a bank terminated via sanctions may not arrive).[79] Since the majority of sanctions come from western-leaning countries—who dominate the network both through traffic volume and by governance—the neutral focus of the network is undercut, creating friction between aiming for global impartiality while serving the wishes of its stakeholders.

A cornerstone of Swift's neutral focus is on data sovereignty and protection, preserving local data as close to its point of origination as possible. The organization adheres to data privacy regulations upheld by the European Union, which has among the strictest data protection policies in the world. The messages are sent point-to-point, not from spoke-hub-spoke, and are deleted after a certain period of time to decrease database size. However, the network states clearly in its publication materials that "we do not share customers' data (personal or not) with any third party...unless compelled to do so by law...[and] we inform our customers of our compliance...unless this is prohibited by law."[80] However localized and protected the transaction data may appear, it is still controlled by those stakeholders at the center of the network who make the compliance decisions. However close to global neutrality that the organization gets, its centralized decisions stop it short.

A practical example of Swift's volume-based neutrality—the governing structure that grants more voting power in the organization to the nodes with more financial traffic—was in its willingness to work with U.S. on the Terrorist Finance Tracking Program. After the terror attacks in 2001, the U.S. Government approached the network, asking for access to the Swift's

[79] "SWIFT Corporate Brochure," SWIFT, last modified 2016, https://www.swift.com/node/23621; "Swift Compliance Factsheet Sanctions Screening," SWIFT, last modified 2016, https://www.swift.com/node/2311.
[80] "Swift Corporate Brochure"

global transactions.[81] Initially, Swift executives declined, claiming that the network was not responsible for the content sent through it, and that it was out of the jurisdiction of U.S. Law. After being subpoenaed, the network complied, giving the government access to terror related message data across the world. The question remains whether the network would have complied to the request if it had not been from the U.S., a country with a strong stakeholder representation and one of the largest users by transaction volume in the world. The Terrorist Finance Tracking Program continues to operate, though could face more opposition from privacy advocates and stakeholder adversaries in the future.[82]

Although Swift has been the entangled in geopolitical challenges since its founding, its sanctions enforcement on Iran provides an exemplary insight into how the network views its role in international finance, and how it has been used to advance political agendas of its major stakeholders. In an ongoing effort to prevent nuclear advancement by the Iranian military, the U.S. Senate Banking Committee advanced legislation to enact sanctions on Swift itself if it failed to terminate access for Iranian banks. Although Swift's initial response stated that it complies with *global* sanctions enforcement and not those issued by one country (such as the U.S.), after the European Union joined the U.S. request, Swift agreed to terminate the connection of 24 Iranian banks. The CEO of Swift at the time Lazaro Campos was quoted as saying that "disconnecting banks is an extraordinary and unprecedented step for Swift." The Iranian sanctions enforcement marked a turning point for Swift when it was leveraged as a financial tool for geopolitical agendas of its major stakeholders.[83]

---

[81] "Bank Data Is Sifted by U.S. in Secret to Block Terror"
[82] Scott and Zachariadis, *SWIFT*, Ch. 5.
[83] Scott and Zachariadis, *SWIFT*, Ch. 5.

As North Korea has continued to push towards becoming a nuclear power, the UN and U.S. both issued sanctions to penalize the country for not adhering to UN regulations. Delisting numerous banks in the country from Swift were among the sanctions issued, from both UN sanctions and those from the U.S.. Swift, being a society based in the European Union, must comply with United Nation regulations. In March 2017, Swift disconnected three major banks in Pyongyang to comply with a UN blacklist—though an additional four that had been sanctioned by the U.S. remained connected to the network. This was consistent with Swift's practices in the past of complying to with regulations from the United Nations, but not submitting to requests made by individual countries.[84] However, within a week of delisting the initial three banks, Swift announced that it had terminated connection with the remaining four in North Korea due to the "increased ongoing international attention" on North Korea and its disregard for international law.[85] Although the network maintains that it can remove banks from the network that cause harm to the networks "reputation, brand, or goodwill," it removed those banks without direct instructions from the United Nations—showing the networks increased willingness to listen to its major stakeholders (such as the United States) and align closer with specific stakeholder geopolitics.[86]

Swift was founded with the goal to create an international financial exchange network between financial institutions; a cornerstone of this is the focus on neutrality it believed was necessary to stimulate such a global network. As globalization has drastically expanded cross-

[84] Katy Burne, "North Korean Banks Under U.S. Sanctions Remain on Swift Network," *The Wall Street Journal*, March 14, 2017, accessed May 12, 2017, https://www.wsj.com/articles/north-korean-banks-under-u-s-sanctions-remain-on-swift-network-1489483805.
[85] Katy Burne, "4 sanctioned North Korean banks get delisted by Swift," *MarketWatch*, March 16, 2017, accessed May 12, 2017, http://www.marketwatch.com/story/4-sanctioned-north-korean-banks-get-delisted-by-Swift-2017-03-16.
[86] "North Korean Banks Under U.S. Sanctions Remain on Swift Network"

border communication and shrunk the distance between countries, international organizations such as Swift have been faced with inevitable geopolitics that follow. Swift has aimed to practice global neutrality, representing the views and regulations of its major stakeholders and international governing bodies such as the United Nations. Nationalization movements and global geopolitical turmoil have tested the networks neutrality, pushing and prodding it to bend to the needs of special interests and world powers. As the financial sector continues to connect internationally and globalize, Swift faces the timeless balance of remaining the back-end neutral plumbing of the financial industry, and leveraging its monopolistic control to enforce and protect geopolitical interests of its diverse stakeholders across the world.

4. Conclusion

The study of the Visa and Swift network systems has demonstrated the diverse network solutions for efficiently transferring value across the globe. From its founding, Visa's hub-and-spoke, command-and-control, brand-centralized network emphasized system efficiency and security at the expense of local autonomy and localization. Alternatively, the Swift network was born as a distributed, localized, and flexible system of financial institutions that valued regionality and adaptability at the expense of raw efficiency and centralized power. On the global stage, these networks have been pushed and prodded by their stakeholders for geopolitical edge—whether it is Visa's U.S.-centered core being leveraged to cancel accounts and terminate service of those opposing America's global influence, or Swift's transaction-based, neutrality-*aspiring* system that is utilized by the United Nations to advance international relations across the world. The analysis of the structures and controls of the Visa and Swift networks emphasizes the societal role that global networks play in a globalized world, weighing

the efficiency and productivity gains of these systems with the societal obligations of connecting people across the world.

Throughout history of technology, global technological networks have enabled people and products to connect across borders, cultures, and markets. From the Bill of Exchange that enabled the first trade-based check system across Europe, to the dots and dashes of the telegraph that enabled news transfer at the speed of the electron, to the high-speed Internet that enabled unimaginable amounts of data transfer across the corners of the globe, networks have consistently transformed the connectedness of society across the world. Network stakeholders design and evolve technical networks to maximize the system's utility and balance the efficiency of standardization with the adaptability of regional localization. In the case of financial value exchange, Visa and Swift have demonstrated these network-wide tensions and have shown that the design of technical systems—whether hub-and-spoke, point-to-point, or somewhere in between—reflects the needs of a specified stakeholder use, and represents an organizational framework that highlights the role of past, present, and future of technical networks in global societies.

Works Cited

Albert Aji, "Visa, other cards not valid under Syria sanctions," *The Seattle Times*, August 25, 2011, accessed May 12, 2017, http://old.seattletimes.com/html/businesstechnology/2016010607_apmlsyriaeconomy.html?syndication=rs.

Amanda Alix, "How Russia's Tactics With Visa Inc and MasterCard Inc Almost Spelled Disaster for the Country," *The Motley Fool*, May 25, 2014, accessed May 12, 2017, https://www.fool.com/investing/general/2014/05/25/how-russias-tactics-with-visa-and-mastercard-almos.aspx.

"All You Need to Know about Tokenization," Visa Incorporated, last modified 2016, https://usa.visa.com/dam/VCOM/download/security/documents/visa-security-tokenization-infographic.pdf

Wiebe E. BiJker, Thomas P. Hughes, and Trevor Pinch, *Social Construction of Technological* Systems (Cambridge, MA: MIT Press, 1993).

Fracisco Blasques et al., "SWIFT Institute at Sibos 2016 Geneva: a summary of our research so far" (paper presented at the annual SIBOS conference, Geneva, Switzerland, 2016).

Miles Brignall, "Verified by Visa scheme confuses thousands of internet shoppers," *The Guardian*, April 20, 2007, accessed May 11, 2017, https://www.theguardian.com/money/2007/apr/21/creditcards.debt.

Katy Burne, "4 sanctioned North Korean banks get delisted by Swift," *MarketWatch*, March 16, 2017, accessed May 12, 2017, http://www.marketwatch.com/story/4-sanctioned-north-korean-banks-get-delisted-by-Swift-2017-03-16.

Katy Burne, "North Korean Banks Under U.S. Sanctions Remain on Swift Network," *The Wall Street Journal*, March 14, 2017, accessed May 12, 2017, https://www.wsj.com/articles/north-korean-banks-under-u-s-sanctions-remain-on-swift-network-1489483805.

Katherine Burton and Alan Katz, "How crooks are using an international messaging system to rob banks," *Bloomberg Businessweek*, June 2, 2016, accessed May 12, 2017, https://www.bloomberg.com/news/articles/2016-06-02/crooks-are-using-an-international-messaging-system-to-rob-banks.

Barry E. Carter and Ryan M. Farha, "Overview and Operation of the Evolving U.S. Financial Sanctions, Including the Example of Iran," *Proceedings of the Annual Meeting (American Society of International Law),* Vol. 107, International Law in a Multipolar World (2013), pp. 315-322, accessed May 12, 2017, http://www.jstor.org/stable/10.5305/procannmeetasil.107.0315.

Manuel Castells, "The Rise of Network Society," (Cambridge, MA: Wiley-Blackwell, 2009).

Samantha Cook and Kimmo Soramaki, "The Global Network of Payment Flows," *The Swift Institute* No. 2012-006: 2, accessed May 12, 2017, https://www.swiftinstitute.org/news/new-research-paper-the-global-network-of-payment-flows/.

"Company Profile: Society for Worldwide Interbank Financial Telecommunication," SWIFT Marketline, last modified 2015, martketline.com.

Michael Corkery, "Hackers' $81 Million Sneak Attack on World Banking," *The New York Times*, April 30, 2016, accessed May 12, 2017, https://www.nytimes.com/2016/05/01/business/dealbook/hackers-81-million-sneak-attack-on-world-banking.html?_r=0.

"Credit Card-Sanctioned Countries," Republic Bank Limited, last modified 2017, https://www.republictt.com/duplicate/credit-card-sanctioned-countries.

Elizabeth Dexheimer, "Visa Agrees to Buy Visa Europe for as Much as $23.4 Billion," *Bloomberg*, November 2, 2015, accessed May 11, 2017, https://www.bloomberg.com/news/articles/2015-11-02/visa-agrees-to-buy-visa-europe-for-as-much-as-23-4-billion.

Elizabeth Dexheimer and Indira A.R. Lakshmanan, "MasterCard to Lift Transaction Block on U.S. Cards in Cuba," *Bloomberg*, January 23, 2015, accessed May 12, 2017, https://www.bloomberg.com/news/articles/2015-01-23/mastercard-to-lift-transaction-block-on-u-s-cards-in-cuba-1-.

Danielle Douglas, "MasterCard, Visa explain why your credit card isn't safer," *The Washington Post*, February 20, 2014, accessed May 12, 2017, https://www.washingtonpost.com/news/wonk/wp/2014/02/20/mastercard-visa-explain-why-your-credit-card-isnt-safer/?utm_term=.f94bf230e310.

Jim Finkle, "Bangladesh Bank hackers compromised SWIFT software, warning issued," *Reuters*, April 25, 2016, accessed May 12, 2017, http://www.reuters.com/article/us-usa-nyfed-bangladesh-malware-exclusiv-idU.S.KCN0XM0DR.

Daniel Fisher, "Visa Moves At The Speed Of Money," *Forbes*, May 25, 2015, accessed May 12, 2017, https://www.forbes.com/sites/danielfisher/2015/05/06/visa-moves-at-the-speed-of-money/#1ead6a5a57c3.

"Global Payments 2015: A Healthy Industry Confronts Disruption," *McKinsey & Company*, 2015, accessed May 12, 2017, http://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/how%20the%20payments%20industry%20is%20being%20disrupted/global_payments_2015_a_healthy_industry_confronts_disruption.ashx.

Mark S. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology, Vol. 78, Issue 6,* accessed April 24, 2017. http://www.jstor.org.libproxy.mit.edu/stable/2776392.

"History of Visa," Visa Incorporated, last modified 2016, https://usa.visa.com/about-visa/our_business/history-of-visa.html.

Dee Hock, *VISA and the Rise of the Chaordic Organization* (San Francisco: Berrett-Koehler, 2005), Kindle Edition.

"Innotribe – About," SWIFT, last modified 2017, https://innotribe.com/about/.

"Joint Statement: Federal Reserve Bank of New York, Bangladesh Bank and SWIFT," SWIFT, last modified 2016, https://www.swift.com/node/34901.

Alexander Kolyandr, "Visa Reaches Deal with Russia Over Payment System," *The Wall Street Journal*, February 19, 2015, accessed May 12, 2017, https://www.wsj.com/articles/visa-reaches-deal-with-russia-over-payment-system-1424362798.

John V. Langdale, "The Geography of International Business Telecommunications: The Role of Leased Networks," *Annals of the Association of American Geographers*, Vol. 79, No. 4 (Dec., 1989), pp. 501-522, accessed May 12, 2017, http://www.jstor.org/stable/2563645.

Eric Lichtblau and James Risen, "Bank Data Is Sifted by U.S. in Secret to Block Terror," *New York Times*, June 23, 2006, accessed May 12, 2017, http://www.nytimes.com/2006/06/23/washington/23intel.html.

Eric Licthtblau and Sheryl Gay Stolberg, "White House Says Tracking Bank Data Deters Terror," *The New York Times,* June 23, 2006, accessed May 12, 2017, http://www.nytimes.com/2006/06/23/washington/23cnd-react.html.

Tom C.W. Lin, "Financial Weapons of War," *Minnesota Law Review*: 1379, accessed May 12, 2017, http://www.minnesotalawreview.org/wp-content/uploads/2016/04/Lin_ONLINEPDF.pdf.

Heidi Miller, "Asking Tough Questions of Swift," *Global Treasury News*, November 1, 2004, accessed May 11, 2017, https://www.gtnews.com/articles/asking-tough-questions-of-Swift/.

Jon D. Michaels, "All the President's Spies: Private-Public Intelligence Partnerships in the War on Terror," *California Law Review*, Vol. 96, No. 4 (Aug., 2008), pp. 901-966, accessed May 12, 2017, http://www.jstor.org/stable/20441037.

Emanuele Ottolenghi, "Prepaid Cards May Be Iran's Latest Sanctions-Busting Tactic," *Forbes*, June 3, 2014, accessed May 12, 2017, https://www.forbes.com/sites/realspin/2014/06/03/prepaid-cards-may-be-irans-latest-sanctions-busting-tactic/#6dd71f9b92dd.

"Outsmarting Fraudsters with Advanced Analytics," Visa Incorporated, last modified 2016, https://usa.visa.com/visa-everywhere/security/outsmarting-fraudsters-with-advanced-analytics.html

Alanna Petroff, "Visa, masterCard block some Russian cards," *CNN Money*, March 21, 2014, accessed May 12, 2017, http://money.cnn.com/2014/03/21/news/companies/russia-credit-cards/.

PlanetSWIFT. "SWIFTLab – Where Ideas Come to Life," YouTube video, posted August 2016. https://www.youtube.com/watch?v=hdePB-SH4Dw.

Alex Preda, "Socio-Technical Agency in Financial Markets: The Case of the Stock Ticker," *Social Studies of Science, Vol. 36, No. 5,* accessed May 11 2017. http://www.jstor.org/stable/25474473.

Roger Runningen et al., "Russia Pressed on Ukraine as EU Joins U.S. on Sanctions," *Bloomberg*, March 21, 2014, accessed May 12, 2017, https://www.bloomberg.com/news/articles/2014-03-21/russia-pressed-on-ukraine-as-eu-joins-u-s-on-sanctions.

"Sanctions Screening," SWIFT, last modified 2017, https://www.swift.com/our-solutions/compliance-and-shared-services/financial-crime-compliance/sanctions-screening.

Stan Sienkiewicz, "Credit Cards and Payment Efficiency," *Federal Reserve Bank of Philadelphia* (August 2001), accessed May 12 2017, https://www.philadelphiafed.org/-/media/consumer-credit-and-payments/payment-cards-center/publications/discussion-papers/2001/PaymentEfficiency_092001.pdf.

Dave Simmons, "The pros and cons of a SWIFT response," *Forbes*, November 20, 2014, accessed May 12, 2017, http://www.economist.com/news/international/21633830-blocking-rogue-states-access-worlds-financial-messaging-network-potent-measure.

Ryan Singel, "Feds Warrantlessly Tracking Americans' Credit Cards in Real Time," *Wired,* December 2010, accessed May 12, 2017, https://www.wired.com/2010/12/realtime/.

Susan V. Scott and Markos Zachariadis, "Origins and development of SWIFT, 1973–2009," *Business History,* Vol. 54, No. 3, accessed May 11, 2017. http://dx.doi.org/10.1080/00076791.2011.638502.

Susan V. Scott and Markos Zachariadis, *The Society for Worldwide Interbank Financial Telecommunication (SWIFT): Cooperative governance for network innovation, standards, and community (Global Institutions)* (New York: Routledge, 2014).

David L. Stearns, *Electronic Value Exchange Origins of the Visa Electronic Payment System* (London: Springer, 2011), Kindle Edition.

"Swift Compliance Factsheet Sanctions Screening," SWIFT, last modified 2016, https://www.swift.com/node/2311.

"SWIFT Corporate Brochure," SWIFT, last modified 2016, https://www.swift.com/node/23621.

"SWIFT History," Swift, last modified 2017, https://www.swift.com/about-us/history.

"Understanding Swift for Corporates," J.P. Morgan Treasury Services, last modified 2012, https://www.jpmorgan.com/cm/BlobServer/Swift_For_Corporates.pdf?blobkey=id&blobwhere=1320633877670&blobheader=application/pdf&blobheadername1=CacheControl&blobheadervalue1=private&blobcol=urldata&blobtable=MungoBlobs.

The U.S. State Department, *The Joint Comprehensive Plan of Action* (Vienna), July 14, 2015.

"Verified by Visa – How it Works," Visa Incorporated, last modified 2017, https://usa.visa.com/pay-with-visa/featured-technologies/verified-by-visa.html.

"Visa Chip Technology – Confidence in a Smarter World," Visa Incorporated, last modified 2017, https://www.visa.com/chip/personal/security/chip-technology/chip-cards/index.jsp.

"Visa Inc. at a Glance," Visa Incorporated, last modified 2015, https://usa.visa.com/dam/VCOM/download/corporate/media/visa-fact-sheet-Jun2015.pdf

"Visa Inc. Reports Strong Fiscal Fourth Quarter...," Visa Incorporated, last modified November 2, 2015, http://investor.visa.com/news/news-details/2015/Visa-Inc-Reports-Strong-Fiscal-Fourth-Quarter-Adjusted-Earnings-Per-Share-Growth-of-14-and-Full-Year-2015-Adjusted-Earnings-Per-Share-Growth-of-16-and-Announces-a-New-50-Billion-Share-Repurchase-Program/default.aspx.

"Visa International is the Exclusive Payment Card...," International Olympic Committee Digital Properties, last modified 2017, https://www.olympic.org/sponsors/visa.

"Visa U.S.A International Reimbursement Fees," Visa Incorporated, last modified April 16, 2016, https://usa.visa.com/dam/VCOM/download/merchants/visa-usa-interchange-reimbursement-fees-2016-april.pdf

"Visa Speeds Up Checkout Times," Visa Incorporated, last modified April 4, 2016, http://investor.visa.com/news/news-details/2016/Visa-Speeds-Up-Checkout-Times/default.aspx.

William Vlcek, "A Leviathan Rejuvenated: Surveillance, Money Laundering, and the War on Terror," *International Journal of Politics, Culture, and Society,* Vol. 20, No. 1/4, The New Sociological Imagination III (Sep., 2008), pp. 21-40, accessed May 12, 2017, http://www.jstor.org/stable/40206145.

Jeremy Wagstaff Lichtblau and Tom Bergin, "SWIFT messaging system bans North Korean banks blacklisted by U.N.," *Reuters*, March 8, 2017, accessed May 12, 2017, http://www.reuters.com/article/us-northkorea-banks-Swift-idU.S.KBN16F0NI.

Tim Warstall, "How Excellent, The NSA Spies Upon The Visa And SWIFT Networks," *Forbes*, September 15, 2013, accessed May 12, 2017, https://www.forbes.com/sites/timworstall/2013/09/15/how-excellent-the-nsa-spies-upon-the-visa-and-swift-networks/#7de6f9de3d9b.

Alexander Winning and Polina Devitt, "Visa, MasterCard stop supporting bank cards in Crimea," *Reuters*, December 26, 2014, accessed May 12, 2017, http://www.reuters.com/article/us-russia-crisis-visa-crimea-idU.S.KBN0K40TN20141226.

Philippe Wojazer, "Iranian banks to issue credit cards for first time," *RT*, September 27, 2016, accessed May 12, 2017, https://www.rt.com/business/360646-iran-bank-first-credit-cards/.

"Worldwide EMV Deployment Statistics," EMVCo, LLC, last modified 2017, https://www.emvco.com/about_emvco.aspx?id=202.

Kristina J. Yee, "Arcot Systems to Offer 3-D Secure(TM) with Visa...," *BusinessWire*, December 13, 2005, accessed May 12, 2017, http://www.businesswire.com/news/home/20051213005963/en/Arcot-Systems-Offer-3-D-Secure-TM-Visa.

Sam Zuckerman, "Visa shares soar after biggest U.S. IPO ever," *SFGate*, March 20, 2008, accessed May 11, 2017, http://www.sfgate.com/business/article/Visa-shares-soar-after-biggest-U-S-IPO-ever-3290871.php.