Institutions for Cyber Security: International Responses and Global Imperatives

First Submission: 9/1/2010
RUNNING HEAD: INSTITUTIONAL FOUNDATIONS FOR CYBER SECURITY

Revised Jan 3, 2012 –Final Jan 17

Institutional Foundations for Cyber Security: Current Responses and New Challenges

Jeremy Ferwerda

Nazli Choucri

Stuart Madnick

Massachusetts Institute of Technology

Abstract

Almost everyone recognizes the salience of cyberspace as a fact of daily life. Given its ubiquity, scale, and scope, cyberspace has become a fundamental feature of the world we live in and has created a fundamentally new reality for almost everyone in the developed world and increasingly for people in in the developing world. This paper examines an important aspect of this new international reality, namely the *network of institutions responsible for addressing threats to the security of cyberspace and international relations transmitted via cyber venues*. In this context, institutions are located at the intersection of two important lines of inquiry in political science, namely in the long tradition of institutional analysis in international relations and the nascent area of theorizing about cyberpolitics in international relations. Our purpose is to provide a mapping, an initial base line, for representing, and tracking, what is likely to be a rapidly-evolving feature in the international landscape, real as well as virtual. Accordingly, we shall highlight emerging responses and challenges, while simultaneously identifying the strengths and weaknesses of the current institutional framework. A secondary goal is to investigate the feasibility of using quantitative data to evaluate cyber security performance.

Keywords: cyber security, cyber governance, cyber institutions, international security

Introduction

The expansion of cyberspace has occurred at a dramatic pace over the past two decades. Almost every location on the globe now has some degree of cyber access, outpacing even the most optimistic expectations of the early architects of the Internet. Less anticipated, however, by the initial innovators or anyone else, was the subsequent introduction of cyber threats and the accompanying innovations in the disruption and distortion of cyber venues. This evolution of security concerns has created two broad sets of uncertainties. First, there are ambiguities and challenges surrounding the empirical assessment of threats, actions, and events. Second, and more critically, there is a marked absence of integrated global institutional mechanisms designed to track, record, and respond to cyber incidents. [1]

The purpose of this paper is to take stock of current *institutional responses* to cyber threats at the international level and, to the extent possible, at the national level as well. We do not seek to address all policy responses to cyber security threats broadly defined, or to review research on policy developments, or to consider various forms of deviant cyber behavior or to consider new approaches to theory and methods. Our goal is to 'base-line' the international organizational responses to a rapidly changing cyber security landscape. We ask: Who are the major institutional actors? What are their missions and responsibilities? Can we begin to discern the emergence of a fabric of global governance for cyberspace?

[1] We recognize the relevance and contributions of Charney (2009), Denning (1998), Diebert, et al (2008, 2010, 2011), Diebert and Rohozinski (2010a, 2010b), Dunn-Cavelty (2011), Hansen et al (2011) and Hundley and Anderson (1995/1996) and Libicki (2009). We take these into account as they bear on the international institutional issue addressed in this paper.

Institutions in International Relations

There is a long and respected distinguished tradition of institution-centric scholarship in modern international relations. The classical literature in this field focused on the United Nations and its institutions against a background of the failures of the League of Nations; [2] this literature was largely descriptive, highlighting structure and function.[3] With the evolution of European integration, institutionalism took a new turn, seeking to connect domestic and international politics, and to signal potentials for diffusion of institutional development.[4] Subsequently, the conceptual frame of reference shifted to focus on the "demand" and the "supply" driving the development of international institutions.[5]

Subsequently, the concept of regime emerged as an important anchor in the field. In this paper, however, we focus on the formal aspects of regimes, namely the institutional manifestations, rather than on underlying norms and principles. While the literature tends to argue that consensus on norms precedes the formation of institution, we suspect that in the cyber domain the reverse dynamics hold, namely that institutions may well be the precursors for formalizing norms and principles that, in turn, might consolidate and strengthen the institutions themselves.

At this writing, yet another shift has taken place, namely from institution-centered issues to matters of broadly defined governance. Based on the evidence presented in this paper, we shall argue that the current institutional landscape managing security issues in the cyber domain is not sufficiently resilient to address existing and future challenges effectively. At the same time,

[2] See for example, Goodrich, (1947), Claude (1967) , and Hoffmann (1987).
[3] See Mitrany (1948). For example.
[4] Haas (1961) is a good example.
[5] See Keohane (1983) as an example. The concept of regime emerged as an important anchor in the field.

however, there is sufficient evidence to argue that we are observing a process of institutionalization, and that the overall architecture is still "under construction."

Advances in the theory and development of international relations have, by necessity, been anchored in the state-centric logic of world politics. Among the dominant assumptions of conventional institutional analysis is that states are the major actors, pursuing their own self-interest by means that follow a rational calculus.[6] Missing from this mindset is the relevance of non-state actors (for profit and not for profit), as well as attention to motives other than self-interest in the purely geopolitical sense. Under "normal" conditions, this omission can be readily accounted for or corrected by assumption or via targeted research; however, the cyber domain is not yet routinely considered a "normal" and integrated aspect of international relations. Thus, traditional institutional inquiry does not "fit" very well into the cyber realities. At least three features of cyberspace are seriously at odds with core assumptions in international relations, thus potentially seriously limiting the portability of theory from the traditional into the cyber domain.

First is the fact that cyberspace is managed by the private sector – albeit with the support and direction of the dominant power in world politics, the United States. The involvement of the state-system in the management of cyberspace is a relatively recent development; the entire cyber domain is managed by non-state entities, an important aspect of scale and scope in international relations.

Second, the usual mechanisms for tracking activities in the physical world – statistics, standards, are not readily portable to the cyber domain. An international consensus on the differences and similarities is yet to be fully established.

[6] Keohane (2002) reprinted in Brecher and Harvey eds (2002).

Third, the very nature of the "virtual" is distinct from that which is physical. Threats in the "virtual" domain are often identified after the fact, rather than tracked "in process." In the cyber domain, there is not only no early warning system, there are as yet few early signals of a cyber threat, if any.

These and other characteristics of cyberspace impede effective understanding and management of cyber security at the international level. When we consider responses at the national level, we shall signal theoretical imperatives and situational realities that shape and are shaped by politics within the boundaries of the sovereign state.

Framing the New Context

Throughout the early years of Internet development, security was not established or maintained via a formal or planned institutional framework; instead, the critical roles of threat detection and mitigation were largely left to the private sector. Companies were expected to handle security for their own products, and users accepted some inherent risk or liability. However, this approach was never suited to handle significant growth in vulnerabilities. Individual corporations lacked incentives to share information, and more importantly, lacked the legal authority to deal with emerging national threats or to prosecute criminal networks. As a result, response to cyber incidents remained closeted and uncoordinated, with private entities adopting a largely reactive approach.

Observing this situation, several non-profit organizations attempted to fill the organizational gap by providing volunteer response teams, information sharing networks, and security guidelines. By focusing on issues that spanned the corporate barrier, these non-profit organizations established a foundation for coordinated community response to emerging cyber threats. Although they were

often successful at mitigating localized security issues, non-profit organizations lacked the requisite authority and resources to effectively respond to crises of global or national scope.

Over the better part of a decade, the convergence of four distinct but interconnected trends created demands for formal interventions involving governments and international coordination. First, Internet usage continued to rise, coupled with an expansion in forms of use. Second, many governments recognized that cyber vulnerabilities continued to threaten not only the security of their own networks but also those of their citizens involved in routine activities on a daily basis. Third, there was a noted absence of coordinated industry response or of efforts to develop cooperative threat reduction strategies, thereby reinforcing an unambiguous gap-in-governance. Finally, a growing set of cyber incidents, large and small, signaled to governments the potential impact of their failure to address the emerging threat. In response to these trends, governments, in various ways, mobilized significant national and international resources towards the creation of a broad cyber security framework; an overview of the resulting institutional responses serves as the focus of this paper.

The Institutional 'Eco-System'—A Baseline

As a point of departure, we have developed Table 1 to identify and define organizations and entities referred to in this paper, as well as to provide a baseline for the specific inquiry we have undertaken. Even at point of departure, a cursory look at this table indicates that the cyber security 'institutional eco-system' is a complex assortment of national, international, and private organizations. Parallel to the organic fashion in which cyberspace itself developed, these organizations often have unclear mandates or possess overlapping spheres of influence. At this

stage, our goal is only to highlight these major entities and, to the extent possible, to signal their relationships and interconnections, compiling something of a census of institutions. A secondary, but also important, objective is to explore data quality and the extent to which we may infer organizational performance from public metrics, creating a performance assessment of sorts.

Throughout this analysis, we will focus on to two separate categories of malfeasance: *cyber threats* and *cyber crime*. The former involves the exploitation of infrastructural weaknesses and security vulnerabilities. Responses to these threats often involve technical rather than legal measures; as such, a variety of organizations ranging from non-profit entities to intergovernmental bodies are actively involved in cyber defense. In contrast, cyber crime refers exclusively to attacks on private entities with the intent of gaining profit or inflicting damage. Although the potential for cyber crime can be mitigated by enhancing the security of Internet networks, only national governments possess the proper legal tools and jurisdiction to prosecute attackers. As a result, effective response to cyber crime is largely restricted to sovereign entities.

While we catalogue many of the major institutional players in this aspect of cyber security, we do not claim to provide an exhaustive "census." Two criteria were used to select organizations for this study. First, we focused on entities that provide public qualitative or quantitative data. Second, within each of our areas of focus (International, Intergovernmental, National, Non-Profit, and Private Sector), we selected institutions with coordinating responsibility or formal mandates issued by recognized international or national bodies. For the national sphere, we focused on the United States as a representative model but also included several examples of non-U.S. national entities; detailed analysis of other national efforts is beyond the scope of this paper.

[Table 1 here]

International Institutional Response

We focus first on the new institutions created specifically in response to cyber threats international but not intergovernmental in scope. In so doing, we begin with a brief overview of *Computer Emergency Response Teams* (CERTS),[7] and then examine a subset of collaborative organizations that coordinate CERT policy.

CERTS

An important addition to the dense network of international entities in the 'real' or physical arena, CERTs occupy a salient role in the cyber security landscape. As defined by the CERT Coordination Center (CERT/CC), these teams organize responses to security emergencies, promote the use of valid security technology, and ensure network continuity (CERT Program, 2009a). In principle, this means that CERTs focus on identifying vulnerabilities and fostering communication between security vendors, users, and private organizations. Although the majority of CERTs were founded as non-profit organizations, many have transitioned towards public-private partnerships in recent years. This increasing level of integration with national governments represents an attempt to build upon the successes of non-profit CERTs by providing a level of structure and resources hitherto unavailable. However, it is important to note that while the CERT network is becoming increasingly organized, individual CERTs may differ considerably in their ability to effectively perform their mandates. At present, there are over 200 recognized CERTs, with widely different levels of organization, funding, and expertise (Forum of Incident Response and Security Teams, 2009a).

[7] These organizations are also referred to as Computer Security Incident Response Teams (CSIRTs).

At least three products are expected to result from CERT activities and interactions: a reduction in unaddressed security vulnerabilities, improved understanding of the nature and frequency of cyber threats, and improved methods of communicating and reporting these threats to other security teams and the general public. From a data perspective, it is important to recognize that although CERTS are not established to serve as information gathering institutions *per se,* their activities involve active threat monitoring and information exchange. As a result, many CERTs attempt to provide quantitative data for the cyber security community. To date, however, there is little effort to align or coordinate methods of data collection, and availability and reliability of reported information thus varies widely across the CERT landscape. This means that the focus on organization has not yet extended to matters of performance and coordination.

Organizational Structure

In general, CERTs share a common structure and backbone. In principle this should help coordination. The majority of CERT teams are defined according to guidelines originally published by CERT/CC, and many use common toolkits to establish their organizations (Killcrece, 2004). As a result, CERTs tend to differ from each other mainly in their area of focus (academic, private, national, regional), or their respective area of expertise (phishing, viruses, information security). These roles are largely self-defined according to each team's level of funding (which can vary widely), technical expertise, and the presence of perceived gaps within the CERT collaborative network. This means that the principle of autonomy supersedes that of collaboration. One expected advantage of this underlying flexibility is that it greatly improves the possibility of coordination between CERTs. However, this loose network also reduces the locus of responsibility or accountability for individual performance. In traditional institutional theory, the underlying generic

objective is to facilitate collective action, reduce transaction costs, and enable the performance of functions or the provision of services. To illustrate the complexity of arrangements, Figure 1 presents a subset of these structured relationships at different levels of analysis of organization. It is not clear that this complexity effectively supports any of these requisites.

[Figure 1 here]

Coordinating Organizations

A distinguishing feature of the CERT system is its coordinating mechanism. Established at Carnegie Mellon University in 1998 in response to a major internet worm, CERT/CC was the first operational CERT, and defined many of the parameters of the role. The Defense Advanced Research Projects Agency (DARPA) originally provided federal funding for the organization with the assumption that CERT/CC would serve as a center for direct threat assessment and response. However, as cyberspace expanded, a single organization proved insufficient to handle the increasing volume of security incidents, and CERT/CC was forced to reframe its activities and priorities. Rather than responding directly to emerging incidents, CERT/CC's renewed mission utilized the lessons learned to provide guidelines, coordination, and standards for other CERTs. By relinquishing operational control in favor of a collaborative structure, CERT/CC laid the foundation for the establishment of regional, focused organizations. Today, the CERT network has expanded beyond the scope and control of CERT/CC, although the organization continues to play an influential role in establishing national CERTs in developing countries and fostering inter-CERT communication.

In addition to CERT/CC, many CERTS also interact with parallel coordination networks, such as the *Forum of Incident Response and Security Teams* (FIRST). This body was established to enhance information sharing between disparate security groups (FIRST, 2009b). Now composed of more than 200 organizations, FIRST is notable for its influential annual conferences and its extensive integration of national, academic, and private CERT teams (FIRST, 2009a). The establishment of these conferences in itself provides a basis for reinforcing communication and, as theory would suggest, enhances potentials for coordination.

National CERTs

The collaborative structure maintained by coordinating agencies such as FIRST and CERT/CC clearly aids in enhancing information flow among security teams. However, if CERTs were only organized in this fashion, it would be unclear which organizations possessed regional authority to coordinate the actions of other CERTs; for instance, in the event of a national attack on civilian networks. This problem was addressed by transitioning the CERT structure to the national level. One valuable side effect of this shift to national-level jurisdiction was the creation of public-private partnerships between national CERTs and existing national agencies.

However, a solution to one problem can often give rise to additional complications. Given the diversity of national political systems and bureaucratic practices, the transition to national CERTs exacerbated the realities of legal and jurisdictional diversity. For example, while some national CERTs, such as US-CERT, were specifically tasked by federal governments to defend civilian networks, other organizations operate in a legal vacuum, and assume national responsibility via general consensus. Often, this legitimacy is granted by regional organizations such as AP-CERT in Asia and TF-CERT in Europe (see Figure 1) that steer regional CERT policy. While this diversity

is not necessarily a problem, it may impede information sharing, and suggests that national CERTs may or may not be held to international operating standards.

We must note that although national CERTs are endowed with regional authority, they remain restricted in their capacity to respond to cyber criminals. National CERTs occupy a first-line responder role in the event of attacks on national civilian networks, but lack the jurisdictional authority to shut down criminal networks and prosecute perpetrators. As a result, national CERTs focus primarily on responding to and preventing *technical* cyber threats – a necessary requisite for coordination but not a sufficient one. In order to effectively deal with legal issues, clear lines of communication between national CERTs and government agencies are essential. Although this link has been formalized in some countries such as the United States, other nations are still developing the requisite connections between national CERTs and legal authority. At the same time, however, current CERT structure also includes vertical linkages – national, regional, and international connections – that are always difficult to forge but facilitate resilience and robustness of institutional performance over time.

CERT Data Provision

It is unfortunate that the high level of CERT cooperation and standardization does not extend to the collection of quantitative data. As suggested earlier, data availability varies widely among CERTs, and organizations that publish statistics do not necessarily use similar reporting methods. Moreover, there are no efforts underway to formally align and standardize metrics. In general, the lack of robust data can be traced to three underlying factors. First, it is inherently difficult to quantify cyber data due to uncertainties surrounding the nature, geographical location, and target of attacks. The rapid pace of technological development, coupled with a lack of

standards-providing organizations has thus led to significant disparities in the diagnosis and classification of cyber events. Second, many CERTs lack a compelling business reason to gather or verify the accuracy of their quantitative data. CERTs typically possess limited funding capacity and many organizations choose to allocate their resources to cyber response in lieu of robust data collection. Lastly, there is no central authority or volunteer organization tasked with disseminating, collecting, or verifying CERT data. If there is an impediment to effective data use it is to be found in the domain of motivation – the foundations and the data are in place, but there appears to be little incentive in taking the next steps to disseminate gathered data.

Although quantitative data is fragmented, the collaborative nature of the CERT network means that a significant amount of information remains available on CERT activities. From a research standpoint, CERT/CC and FIRST provide a means to analyze global CERT policy. In addition, CERT/CC provides a variety of data sources that can be used to evaluate historical CERT activity. These statistics include the number of security alerts, vulnerability notes, and advisories published per year. Although these figures are self-reported and the threshold necessary to publish an alert may vary from year to year, they provide a baseline for estimating global CERT activity. This analysis can be complemented by CERT/CC statistics on the number of incident reports and hotline calls received from member organizations and national CERTs.[8]

Useful information can also be gleaned by viewing aggregate data at the regional level. In particular, AP-CERT and several other regional bodies publish statistics that cover the number of incidents handled and reported, attack vectors, counts of defaced websites, and other Web vulnerabilities. While these statistics are not as robust as those provided by the private sector, they

[8] Unfortunately, CERT/CC has announced that no statistics will be published after Q3 2008. As a result, analysis is limited to historical applications (1988-2008).

are partitioned along national lines and provide country-specific statistics that are valuable for analyzing divergent responses to cyber threats. By coupling this information with widely available metrics such as internet connectivity or arrest rates, and controlling for data quality, it may be possible to develop a statistical model to analyze the overall effectiveness of cyber defense across nations.

Inter-Governmental Organizations

Although CERTs occupy an important role in the international security ecosystem, their core competencies or self-defined responsibilities do not extend to consensus building, legislation, or awareness-raising. While this set of functions remained largely unclaimed in the nascent years of Internet development, they have recently been embraced by a variety of intergovernmental organizations.

By definition, international organizations consist of sovereign states. All of the major international organizations and many minor ones were established long before the creation of cyberspace. They are major users of cyber venues and often significant data providers as well. Unlike the CERTS, which are based on collaborative and hierarchical principles, intergovernmental organizations are composed of equal actors defined by their status as sovereign entities. All of these organizations are expected to be driven first and foremost by their own formal mandates and priorities. Thus, to the extent that any large international organization considers security in cyber venues as relevant to their concerns, it is mostly as a secondary priority. Given the pervasiveness of cyber venues, however, we expect that these organizations will devote increasing attention to cyber issues in the years to come.

If we focus on organizations that, in principle, have some clear interest or focus on cyberspace, we can identify the major actors and their zones of activity or interest. Unsurprisingly, this leads to a diffuse network of organizations and a wide array of cross-cutting linkages. By way of orientation, we show in Figure 2 several well known international organizations (such as the UN) and new cyber-focused entities that do not have the status of 'organization' but are likely to retain a long standing institutional presence on the international arena (such as the World Summit on the Information Society).

[Figure 2 here]

Emergent Responsibilities

The involvement of international organizations in cyber security issues can be traced to early meetings of the G8 Subgroup on Hi-Tech Crime. In 1997, the G8, comprised of the world's most developed economies established in cooperation with the International Criminal Police Organization (INTERPOL) a 24/7 'Network of Contacts' in order to help national governments "identify the source of terrorist communications, investigate threats and prevent future attacks" ("G8 24/7 High Tech Contact Points," 2009). As part of the program, countries were asked to cooperate with INTERPOL in international investigations by sharing information on electronic crimes and by designating an official cybercrime point of contact. While the success rate of the program remains classified, a similar referral model was later mirrored by the FBI in the form of Internet Crime Complaint Center (IC3), which speaks to its relative success. As of 2007, 47 countries were actively involved within the network (Verdelho, 2008).

The 24/7 Network of Contacts, empowered by Article 35 of the Convention on Cyber Crime, is a rare example of direct international intervention and collaboration. It calls for the

provision of advice, the preservation of specified data, and the collection of evidence in the pursuit of suspect cases. In most cases, international organizations cede direct action to national governments, and instead focus on organizing conferences that bring together security professionals, academics, law enforcement agencies, and government representatives. These conferences can be seen as part of an evolving trial and error process through which international organizations explore the unchartered terrain of cyber security. In addition, the white papers published by these groups serve a key role in building international consensus and developing standard practices and guidelines. In many ways, this process is an important step in the emerging response to cyber threats and the quest for cyber security; at the very minimum, it provides a framework for consolidating the constituency required for any effective action.

Inter-Governmental Conferences

A closer look at two such conferences, the Organisation for Economic Co-operation and Development (OECD)-sponsored meetings – longstanding institutional initiatives) – and the World Summit on the Information Society (WSIS) – a new feature in the global landscape – helps to clarify the nature of the intergovernmental eco-system by illustrating the broad differences in institutional and statutory status that characterize increasingly complex inter-governmental initiatives.

OECD-sponsored Conferences.

The OECD has been actively involved in the cyber security domain since 2002 (OECD, 2009a). Meeting twice a year in Paris, the *Working Party on Information Security and Privacy* (WPISP) has published several influential white papers, including "Guidelines for the Security of

Information Systems and Networks" (2002) and "Promotion of a Culture of Security for Information Systems and Networks" (2005). These guidelines have been accompanied by stock-taking efforts that track the implementation of policy in member countries (OECD, 2009b). The WPISP has also released several surveys on information security policies in member countries, and has created a 'Culture of Security' Web portal for member states. Since the WPISP is contained within the OECD framework, it represents a formalized extension of OECD's core mission and provides a common approach for all member states.

WSIS.

The World Summit on the Information Society (WSIS) represents a new process located the opposite end of the evolving cyber security spectrum. Convened under the auspices of the United Nations, the summit served as the first comprehensive response to the emergent 'virtual' global society in a world increasingly concerned with the dilemmas of sustainable development. Although it was not conceived as a security-centric activity, the WSIS objectives that dealt with cyber security were broadly consistent with the goals and orientation of the WPSIP. Given differences in impetus, legal status, and participation, this alignment of concerns can be seen as another instance of consensus building within the international community.

Operationally, the WSIS was organized into two phases, each standing as a global conference in its own right. The first phase, held in Geneva in 2003, had representatives from over 175 countries committed to a wide-ranging action plan. Action Line C5 focused on "building confidence and security," and committed member countries to increasing security awareness, enacting legislation, and cooperating more extensively with the private sector (WSIS, 2003). These goals were expanded upon in 2005 at the second phase in Tunis, when member organizations

reaffirmed their Geneva commitments and agreed upon a collective stock-taking method to track action line implementation. The efforts by member states to implement Action Line C5 are viewable in a public database, and are also published in annual reports (WSIS, 2009a).

As an UN-based initiative, WSIS decisions were made at the state-level, and only sovereign states served as 'decision-makers.' At the same time, all stakeholders wishing to participate in the overall process – from agenda setting to various forms and forums of deliberations – were encouraged to do so. This practice dated back to the United Nations Conference on Environment and Development (UNCED) in 1990, a major landmark in the history of international collaboration. The WSIS inter-governmental initiative is a milestone in its own right in that it sought to combine several distinct aspects of the UN's 20th century development agenda with emergent implications of information technology.

Specific Institutional Mandates

For the most part, the foregoing efforts can be seen as 'self-initiated,' whereby private or public entities voluntarily take on a particular function in the emergent cyber security domain. However, more recently the international community has issued operational mandates to specific organizations. Here we note the most dominant initiatives.

ITU.

One of ITU's core missions is to standardize telecommunication technology and release statistics that can be used to track the Internet connectivity of nations (ITU, 2009b). Utilizing a group of high-level experts, ITU provides a variety of resources and toolkits addressing legislation,

awareness, self-assessment, botnets, and CERTs (ITU, 2009a). Additionally, ITU publishes guides that educate developing nations on cybercrime and promote best practices and approaches. Although the International Telecommunications Union (ITU) core competencies are mission-specific, they have recently acted in a direct fashion by establishing an arm that will provide international threat response. The ITU was given the primary responsibility for coordinating the implementation of WSIS' Action Plan C5 (WSIS, 2009b). In response, the organization launched the 'Global Cybersecurity Agenda' in 2007, working with the International Multilateral Partnership Against Cyber Threats (IMPACT), headquartered in Malaysia.

Envisioned as a global response center focused on combating cyber terrorism and protecting critical infrastructure networks, the *International Multilateral Partnership against Cyber Threats* (IMPACT) is a public-private venture headquartered in Malaysia (UNESCO, 2009). Among other services, IMPACT facilitates a real-time warning network to 191 member countries, 24/7 response centers, and the development of software that allows security organizations across the globe to pool resources and coordinate their defence efforts (IMPACT, 2009). Additionally, IMPACT maintains a research division, hosts educational workshops, and conducts high-level security briefings with representatives of member states. These efforts are intended to make IMPACT the "the foremost cyber threat resource centre in the world" (ITU, 2009c).

Although IMPACT has only been operational since March 2009, it is likely that the organization will become a significant provider of technical security data in the near future. If this initiative is successful, an important precedent would be set for the proposition that an international organization can effectively perform a mission that lies beyond its initial cyber mandate, build upon its core competencies, and extend its regulatory domain in response to technological innovations. Its

efforts to promote cyber security arose as a function of the increasing threat rather than as part of its original mission; thus, the international community chose to build upon existing organizational strengths rather than establishing a new institution.

Parenthetically, the apparently enhanced role of the ITU is resisted by those institutions that were created specifically for the management of cyberspace. This resistance is not driven by security-concerns as much as by the perception that the ITU is increasingly seeking to encroach on the cyber governance responsibilities of private-sector institutions such as the Internet Corporation for Assigned Names and Numbers (ICANN), the Internet Engineering Task Force (IETF), and others, which were created to establish and norms and rules for the manage cyberspace and its complexities.

NATO.

A second major adaptive initiative has been demonstrated by NATO in a way roughly similar to IMPACT. Given the dramatic demonstration of cyber attacks against Estonia (a NATO member), this intergovernmental organization established a technical response arm in the aftermath of the coordinated attacks on Estonia in 2007. Designated the Cooperative Cyber Defense Centre of Excellence (CCDCOE), this entity is responsible for training NATO member states, conducting attack exercises, and supporting NATO in the event of an international cyber attack (Cooperative Cyber Defence Centre of Excellence, 2009). Interestingly, not all NATO states have joined the CCDCOE program, with many countries opting to rely on their own traditional military cyber defense networks. There is no strong evidence that all members of NATO are willing to engage in a common approach to a shared problem, presumably because many states are developing their own

strategies for cyber warfare. At the same time, however, the CCDCOE fills an important void for several European states, notably those whose own cyber security capabilities are yet to be developed.

ENISA.

All things considered, it is fair to conclude that the overall European technical response to cyber threats and cyber security has been somewhat limited in scope. Although the European Union has published numerous resolutions on cybercrime, and the European Police Office (EUROPOL) is actively engaged in investigation, the European Union's only substantive action thus far has been the creation of the European Network and Information Security Agency (ENISA). Tasked with a broad mandate "to enhance the capability of the European Union… to prevent, address and respond to network and information security problems," ENISA largely focuses on awareness building, promoting internet safety practices, and working with regional CERTs, and does not provide a comprehensive defense against regional cyber incidents (Europa, 2009).

Convention on Cybercrime.

One area in which European organizations have taken the lead is within the legislative realm. In partnership with the United States, Japan, and others, the Council of Europe ratified the *Convention on Cybercrime* in 2004, which remains the only binding international legislation dealing with the cybercrime issue (Council of Europe, 2009a). As of September 2009, 26 countries have ratified the treaty, and an additional 20 countries have signed but not yet ratified (Council of Europe, 2009b). The convention defines the criminality of cyber crime, enables law enforcement

agencies to effectively investigate electronic crimes, and fosters international cooperation and data sharing (Council of Europe, 2001).

In support of the Convention, the Council of Europe implemented two distinct action plans aimed at training law enforcement agencies and improving national legislation; it has hosted global conferences on cybercrime issues annually for the past three years (Council of Europe, 2009c). Additionally, the Council of Europe maintains an extensive database on the progress of national cybercrime legislation (Council of Europe, 2009d). This growth in function is important as it provides evidence of institutionalized response and a broad framework necessary to effectively combat international cyber crime. However, it remains unclear whether the provisions of the Convention will be able to keep pace with the rapid development of the domain; international legislation must necessarily be reactive and will lag behind technological efforts. The true value of the Convention may thus lie in its capacity to 'jump-start' national cyber crime legislation via its provision of an adaptive legal framework.

Data Provision

Although the international security sphere has been growing exponentially over the last half decade, international consensus on the nature and definition of cybercrime issues remains in a formative phase. International institutions are focused on building global and local awareness and tend to adopt an advisory or academic role. In this vein, many organizations provide valuable qualitative data, but few provide the quantitative statistics required for robust analysis. As a result, it is difficult to objectively determine the overall performance of these organizations.

This analytical gap may gradually be mitigated as organizations move from a passive posture to an active and fully engaged role within the security landscape, as is evident with the

establishment of IMPACT and CCDCOE. Until then, the data provided by inter-governmental organizations can be most effectively used to trace the enactment of legislation, standards, and policies across member states. Utilizing stock-taking databases and ratification systems, it should be possible to determine which countries or regions are on the leading edge of enacting the necessary institutional frameworks to properly combat cyber crime.

Finally, it is important to stress that institutionalized data collection activities are always undertaken within a mission-framework. In other words, collection of data is driven by the overall self-defined objectives and priorities of each organization. This is one of the major sources of non-comparability across data sets. So far, at least, we have not yet seen efforts to standardize definitions, collection procedures, or reporting mechanisms. In one sense, this is not an unexpected development, as information standardization usually takes place only after widespread data provision and demand.

National Response to Security Threats and Cyber Crime

It is fair to say that theoretical approaches to institutions at the international level (generally addressed by scholars in the field of international relations) are based on historical and conceptual foundations different from those of institutional analysis at the national level (generally addressed by scholars in the field of comparative politics). While there are some common concerns and shared presumptions, the overall motivations, assumptions, and perspectives on the underlying problems differ considerably. Here we do not need to explore the difference epistemologies in any detail, suffice to note that in the most general terms, institutions in all contexts and at all levels of analysis are considered fundamental mechanisms of collective actions and that, at the very

minimum, they reduce transaction costs, facilitate the provision of pubic goods, and enable the pursuit of social goals. While these core theoretical features are relevant to all institutional activities in response to cyber threats and cyber attacks, the theoretical foundations for understanding institutional responses at the national level are based on domestic imperatives with little attention, if any, to international considerations (we shall return to this issue later on).

In a review of institutionalism theory, Hall and Taylor (1996) argue that contemporary institutionalism, known as "new institutionalism," is actually an amalgam of three types of theoretical considerations rather than one single theory—namely historical institutionalism, rational choice institutionalism, and sociological institutionalism. The first focuses largely on constitutional issues, bureaucratic arrangements, and operating procedures of interaction. The second, rational choice institutionalism, focuses on the value of reduced transaction costs, the relationship between principals and agents, and strategic interaction – all based on the underlying logic of rational choice. Sociological institutionalism, the third variant, concentrates largely on why organizations adopt particular sets of institutional forms, including procedures and symbols. A somewhat different perspective on institutional issues within the bounds of the sovereign state put forth by Reich (2000) argues that the relevant institutional features or theoretical perspectives should be viewed in the context of the specific case in question. This view is based on Lowi (1964), who argued that the policy domains, or subject matter, dictate the "best" institutional forms— thus placing the empirical context in the forefront, and matters of theory in a derivative position. This pragmatic perspective fits well with the policy imperatives created by the cyber domain.

Leading Role

The United States has been at the forefront of institutional response to the new realities formed by cyberspace. It is the leading world power, the state that originally encouraged and supported the creation of cyberspace, and the country that remains renowned for its innovative spirit. By default, the United States has been thrust in a leadership position and has acted as a model for other governmental response to cyber issues, notably in Europe and Asia. But while the United States possesses arguably the strongest known national safeguards against various cyber threats, these programs appear to be far from sufficient. Indeed, according to a recent policy review, "it is doubtful that the United States can protect itself from the growing threat" by maintaining its current security structure (White House, 2009a). The review continues:

> The Federal government is not organized to address this growing problem effectively now or in the future. Responsibilities for cybersecurity are distributed across a wide array of Federal departments and agencies, many with overlapping authorities, and none with sufficient decision authority to direct actions.

In order to trace the foundations of this institutional condition, we must turn to the early federal efforts to combat cyber vulnerabilities. The government initially delegated civilian network defense to the private sector or federally funded organizations such as CERT/CC. In parallel, the intelligence and military communities developed and maintained closeted defense systems. Although the relative technological advantage that these organizations possessed initially allowed them to maintain superiority over external threats, the lack of data sharing and cooperation among agencies, coupled with a rise in global technical competence, led to a growing security dilemma.

After the events of 2001, the United States began a substantial revision of its Internet security policy. Through a series of Presidential Directives, the nascent Department of Homeland

Security was granted responsibility for cyber Internet security efforts. These aims were codified in *The National Strategy to Secure Cyberspace* (2003), which led to a dual approach to cyber defense. With the cooperation of CERT/CC, a national CERT (US-CERT) was established within the National Cyber Security Division of the Department of Homeland Security (DHS) and was tasked with defending federal civil networks (.gov domains). In order to coordinate the actions of various federal agencies, DHS was asked to develop contingency plans and warning systems, and was granted the ability to coordinate the efforts of 19 federal agencies in the event of a cyber attack of national significance (White House, 2003). Notably, however, the document stressed that "the private sector is best equipped and structured to respond to an evolving cyber threat," and clearly delineated a separate approach for the "national security community" (White House, 2003).

As a result, although DHS assumed responsibility for a previously neglected area of defense (federal civil networks), the compartmentalization of internet defense strategies continued unchecked. However, it is important to note that this compartmentalization may be a normal byproduct of organizational and bureaucratic politics. As any legal scholar would be quick to point out, this segmentation is not an arbitrary development, rather, it is supported by a legal framework delineated the discrete assignment of responsibilities.

The critical issue here is not that we must move toward a uniform or centralized response to cyber threats. Rather it is that barriers to communication and information sharing – resulting from legal segmentation – create added constraints on rapid response to cyber threats. This situation is well-appreciated by most, if not all, parts of the bureaucracy. Although periodic restructuring initiatives have consolidated the security arena, it is recognized that these changes remain marginal given the scale and scope of cyberspace and the associated threat potential. Nevertheless, the

government appears committed to discovering valid alternatives, and there are several efforts underway that may result in an effective response structure.

Emergent Efforts

US cyber policy was further refined in 2008, when President Bush signed a presidential directive establishing the CNCI, or the *Comprehensive National Cybersecurity Initiative*. The initiative reportedly includes several major policy revisions. First, in conjunction with the Office of Management and Budget (OMB), the DHS was tasked with reducing the number of network connections between federal agencies and external providers from 4,000 to 50 within four months (Samson, 2008). Second, an optional DHS program that monitored traffic to and from federal websites, codenamed EINSTEIN, was transferred to the authority of the National Security Agency. The new version of the program will purportedly capture content as well as traffic, and will proactively monitor federal, and possibly private, networks (Samson, 2008). Lastly, the CNCI includes several provisions that are aimed at increasing R&D, coordinating cyber counterintelligence, and promoting information sharing among government organizations (White House, 2009b).

Upon assuming office, President Obama endorsed the CNCI plan, albeit under conditions of increased transparency. Additionally, the White House authorized a sweeping review of cyber policy. Recognizing the increasing compartmentalization of national cyber defense, the final report recommended establishing a cyber security office within the White House. Leading this office, an official (referred to as the Cyber Czar by the press) would be a member of the National Security

Council and would have frequent access to the President.[9] Although the office would not possess the "authority to make policy unilaterally," it would coordinate the responses of federal departments and attempt to bridge communication and policy gaps by "recommend[ing] coherent unified policy guidance… in order to clarify authorities, roles, and responsibilities for cyber security-related activities across the Federal government." Recognizing that "federal responses to cyber incidents have not been unified," the review recommends eliminating overlapping responsibilities between agencies and defining specific roles for cyber defense across government networks (White House, 2009b).

These recommendations are still in the process of being implemented. But considerable strides have been made in providing a coherent logic and rationale for the overall organizational response system. The proposed structure is presented in the figure below.

[Figure 3 here]

The transition from an organic, overlapping defense network to organized hierarchies can best be observed as a recurring pattern within the cyber security landscape. However, while centralization and coordination is necessary in order to effectively respond to rapidly evolving threats, inefficient organizational structures may confound the problem by reinforcing barriers to bureaucratic adaptation. While few governments are as large and complex as that of the United States, the fact remains that US cyber policies and the mechanisms for their implementation provide important signals to other governments. Even if the US response does not serve as a formal model, its institutional responses will be closely scrutinized by others.

[9] Note that the position has been established, and is currently filled by Howard Schmidt.

Concurrently, we must appreciate that the governance of cyberspace is a complex process whose full dimensions are yet to be determined and whose crafting is at an early stage of development. In this connection, we can expect that, over time, we will see more and more forms of lateral intergovernmental cooperation with the requisite institutional cross-border institutional collaboration. The theoretical foundations for such developments are accommodated by the structure of the process of transnational activities as farmed by Nye and Koehane (1977) and the extensions in transnational governance outlined by Slaughter (2004) in the context of globalization processes.

Cyber Crime

The US is a signatory to the Convention on Cyber Crime, with reservations. An important case of organizational restructuring in response to cyber threats is illustrated by its own responses to the threats of 2001, when the Federal Bureau of Investigation (FBI) collaborated with the National White Collar Crime Center to form the Internet Crime Complaint Center (IC3). Sharing some structural similarities with INTERPOL's 24/7 network, IC3 was created to provide a central contact point for reporting Internet crimes. The program is still active today, and by most accounts, has been a success. In 2008 alone, the IC3 processed over 275,000 complaints, 26% of which were deemed valid and referred to law enforcement agencies (National White Collar Crime Center, 2008). However, while the organization serves as a successful model for a national reporting system, this model has been unable to constrain the growth of cyber crime. FBI surveys have shown that most Internet crime remains unreported, and only a fraction of total cyber incidents are processed by the IC3. Furthermore, although the estimated dollar loss of cybercrime has increased

every year since 2005, referrals have decreased substantially during the same period (National White Collar Crime Center, 2008).

In some sense, the lack of dramatic success thus far is unsurprising. Efforts to halt the spread of cyber crime suffer from a number of inherent challenges. First, in contrast with traditional crime, the criminality of cyber activities remains ill-defined. Many individuals are not accustomed to reporting cyber crime to law enforcement organizations because issues may be deemed 'minor' or purely technical in nature, or because events on the Internet are deemed outside the jurisdiction of a local police agency. This issue is present in the corporate sphere as well, as many companies view the public acknowledgement of security vulnerabilities as a corporate liability. Second, even when crimes are reported, investigation and prosecution remains difficult. Evidence is often ephemeral and transitory, and the global nature of cyber crime presents serious difficulties in pinpointing the location and identity of criminals. Lastly, it often proves difficult to assess the true monetary damage of cyber crime; for instance, in the case of information theft or security breach. Given that law enforcement agencies possess limited resources, this ambiguity surrounding the true impact of cyber crime creates difficulties in setting investigative priorities.

Although many of the efforts of the FBI and the Department of Justice have focused on combating cyber crime at the national level, recent initiatives have attempted to ameliorate some of the aforementioned problems by embedding cyber crime experts in local institutions. For instance, since 2003 the FBI has established collaborative Computer Crime Task Forces, which assist police agencies in investigating local cyber crimes. As of 2006, there are over 92 task forces spread throughout the United States (Federal Bureau of Investigation, 2006). In a similar vein, the DOJ has

established Computer Hacking & Intellectual Property units in local federal courts, which provide lawyers with the training to effectively understand and prosecute cyber crime.

In recent years, the Federal Trade Commission (FTC) has also played an active role in preventing the spread of cyber crime. This new area of focus was not specifically mandated, but rather arose as a byproduct of efforts to expand the FTC's role in consumer protection. Although the FTC is not tasked with prosecuting or investigating criminal networks, the commission acts by issuing formal complaints and restraining orders against ISPs that are suspected of hosting or promoting illegal activity. These actions prevent ongoing cyber crime activities while prosecution efforts are underway. The FTC thus occupies a critical role in cross-sector collaboration, as the organization possesses the legal authority to rapidly respond to time-sensitive security alerts from NGOs, CERTs, and local government agencies.[10]

In many ways, the United States is simultaneously pursuing centralized and decentralized approaches to combating cyber crime (Figure 3). Critical to the success of either approach is the establishment of a national culture that understands, recognizes, and reports cyber crime. Although statistics on the success of local efforts remain limited, it is important to recognize that initial investments in the sector may not display immediate dividends, due to the necessities of preliminary education and training.

[Figure 4 here]

In 2005, the ITU released a comparative analysis of cyber security initiatives worldwide (ITU 2005). This report revealed a wide range of approaches with different degrees of development.

[10] These are all examples of institutional developments in response to cyber security threats.

While the process of institutionalizing responses to cyber threats is at an early stage, it is possible to discern possible emergent trajectories via the use of (highly incomplete) quantitative data provided by national governments. Although it is unlikely that governments will publically release data related to national security intrusions, data relating to civilian criminal activities is available for a select few countries.

For example, in the United States, the Department of Justice maintains a partial database of high-profile cases and convictions, while the FBI regularly publishes IC3 and survey data on cyber crime trends.[11] Similarly, national governments in Korea, Japan, and Taiwan release comprehensive yearly statistics on cyber crime investigations, prosecutions, arrests, and demographic data. Although less directly available, statistics are also provided by countries such as the United Kingdom, Germany, and France.

Unfortunately, however, many countries lack robust legislation dealing with cyber crime; as a result, cyber crime is rarely reported as a distinct category within national police reports. Until such time that additional countries ratify the Convention on Cybercrime – and governments actively pursue its implementation – it is probable that cybercrime data will not become more widely available.

Conclusions to Date

As presented above, the institutional cyber security landscape consists of a complex array of organizations that exhibit significant diversity with regard to missions, mandates, interests, opportunities and constraints.

Characteristic Features

[11] Note, however, that the United States does not currently provide any comprehensive statistics on arrests or prosecutions.

On these bases, we put forth the following observations:

a) The current institutional landscape resembles a security patchwork that covers critical areas rather than an umbrella that spans all of the known modes and sources of cyber threat.

b) Given the multiple contexts and diverse institutional motivations, we expect that responses will be driven more by institutional imperatives and reactions to crisis than by coordinated assessment and proactive response.

c) Due to the complex global agenda at all levels of development, states may not be willing to proceed until international norms are developed, rather they will 'take matters in their own hands' and develop first order responses.

d) Cross-sector collaboration among public, private, and volunteer organizations may serve as a temporary measure to cover holes in the current defense network. However, at some point effective institutions will be necessary; they may develop in parallel with rising public awareness.

e) So far, we have not yet seen large terrorist groups engaged in cyber malfeasance. This pattern cannot be expected to continue. Recent efforts to infiltrate critical US infrastructure and the devastating attacks on Estonia and Georgia in 2007 and 2008 underline the dangers of being lulled into a false sense of security. As the Internet becomes increasingly central to modern society, it is likely that criminals, terrorist groups, and other opponents to state authority will target this sector in the hopes of disrupting critical national functions. So far, the potential for significant threats is far greater than institutional capabilities to contain these

threats. In other words, the 'demand' for security far exceeds the provision of effective 'supply.'

Institutional Anchors for Cyber Security

Such features notwithstanding, based on the evidence to date, we suggest that considerable strides have been made to establish foundations for collaborative responses. In the best of all possible worlds we would expect to see the emergence of a collaborative framework – a large umbrella network – allowing autonomous organizations to flexibly adapt to emerging threats in a coordinated manner and increases the impetus for information sharing in the realm of cyber security. While the potential for such an umbrella network has yet to be realized, we can now point to some institutional anchors that could support, or even consolidate, such a development:

a) The establishment of Not-for-Profit institutions designed to focus on cyber threats (CERT/CC, FIRST, and private CERTs), however "disorganized," is a growing trend on the international landscape. In some instances, these institutions have transitioned to private-public partnerships.
b) A number of International institutions established to manage interactions among advanced states (notably supported by the OECD) reinforce rather than undermine this development.
c) International conferences designed to communicate the potential for information technology to facilitate transitions towards sustainable development (WSIS), while not centered on security issues, nonetheless have the advantage of large-scale private and public participation, thus raising the political profile of cyber issues globally.

d) The functional international organizations with core missions and competencies (notably the ITU) have adopted security as part of their missions.

e) Despite these seemingly complex and uncoordinated responses at the national level, specific agencies are more and more tasked with responding to cyber crime (notably the FBI in the United States).

f) The development of binding international legislation (i.e. the Convention on Cybercrime) elevates the sense of vulnerability as well as the need to coordinate responses to a higher level of awareness than ever before.

g) In the field of military security framed more formally, we observe the salience of organizations and strategies focused on the defense of military and intelligence networks (i.e. CCDOE, CNCI).

Each of these institutional responses reflects mandates, rules and responsibilities. None are accorded complete regulatory power. Indeed, there is little evidence of overarching institutional coordination or routinization. On one hand, this pattern represents a certain degree of disconnect. On the other, it can be seen as a dynamic and shifting response to dynamic set of cyber threats. In the latter context, one could argue that the increasingly dense landscape of institutional responses is an excellent indication that the international community is taking serious steps to control a cyber threat of epidemic proportions.

Critical Missing Piece

Although the current system of institutional arrangements shows signs of weakness, it is also true that the level of organization and cooperation has been steadily increasing. Missing from the these

international institutional developments (and thus from the above analysis) is a critical piece of institutional architecture to support a fundamental function, namely systematic consideration for data issues and matters of data provision and alignment. To some degree, the effectiveness of this effort can be quantified through the use of statistics. While a relatively small number of organizations produce reliable data, sufficient information exists to develop a model that maps degree of vulnerability versus the effectiveness of organizational response. For instance, international data on cyber crime legislation and awareness can be correlated with arrest rates in individual countries. When combined with stocktaking databases, this method allows one to determine the rate of progress in individual nations versus cybercrime issues. Similarly, quantitative data provided by national CERTs can be used to obtain insights about their performance in their respective national contexts and constituencies. An example of these kinds of analysis, along with a Data Dashboard tool, can be found in the report "Experiences and Challenges with using CERT Data to Analyze International Cyber Security" (Madnick et al, 2009).

Over time, we anticipate the possibility of pairing international and national statistics with information from the private sector. Security and monitoring companies such as Symantec, Arbor Networks, Microsoft, and McAfee provide quantitative data that address the global spread of Internet vulnerabilities. In many cases, the volume and quality of data released by these organizations far outpaces the information released by international and national organizations; however, the true value of this information lies not in an isolated analysis, but in the intersection of private data with the national and international sphere. For instance, statistics concerning the originating country of cyber attacks or the absolute volume of attacks can potentially be paired with

national CERT data to determine the degree of national vulnerabilities and traffic that each CERT is capable of handling.

These metrics, and others that can potentially be derived, may provide a powerful method of simultaneously evaluating data quality and organizational performance. An important next step in our inquiry is to examine additional data providers and explore ways of pairing this data with national and international organizations to form evaluative statistical models. While doing so, it is important to remain cognizant of the institutional context that that enables or constrains the provision of information.

Select References

CERT Program. (2009a). *About CERT*. Retrieved on September 17, 2009, from http://www.cert.org/meet_cert/

CERT Program. (2009b). *CERT statistics (historical).* Retrieved on September 26, 2009, from http://www.cert.org/stats/cert_stats.html

Charney, Scott. (2009). *Rethinking the Cyber Threat: A Framework and Path Forward*. Retrieved from http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=747

Claude, Inis L., Jr. (1967). "Collective Legitimization as a Political Function of the United Nations," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

Cooperative Cyber Defence Centre of Excellence. Retrieved on January 11, 2009, from http://www.ccdcoe.org/11.html

Council of Europe. (2001). *ETS No. 185 - Convention on cybercrime*. Retrieved on September 19, 2009, from http://conventions.coe.int/Treaty/en/Treaties/Html/185.htm

Council of Europe. (2009a). *Council of Europe action against economic crime*. Retrieved on September 28, 2009, from http://www.coe.int/t/dghl/cooperation/economiccrime/cybercrime/Default_en.asp

Council of Europe. (2009b). *Convention on cybercrime*. Retrieved on September 27, 2009, from http://conventions.coe.int/Treaty/Commun/ChercheSig.asp?NT=185&CM=1&DF=09/09/2009&CL=ENG

Council of Europe. (2009c). *Project on cybercrime (phase 1).* Retrieved on September 26, 2009, from http://www.coe.int/t/dghl/cooperation/economiccrime/cybercrime%5Ccy%20Project/projectcyber_en.asp

Council of Europe. (2009d). *Cybercrime legislation - country profile*s. Retrieved on September 28, 2009, from http://www.coe.int/t/dg1/legalcooperation/economiccrime/cybercrime/Documents/CountryProfiles/default_en.asp

Denning, Dorothy E. (1998). *Information Warfare and Security*. Reading, MA: Addison-Wesley.

Diebert, Ronald J., John G. Palfrey, Rafal Rohozinsky and Jonathan Zittrain (eds.). (2008). *Access Denied: The Practice and Policy of Global Internet Filtering*. Cambridge, MA: The MIT Press.

Diebert, Ronald J., John G. Palfrey, Rafal Rohozinski and Jonathan Zittrain (eds.). (2010). *Access Controlled: The Shaping of Power, Rights, and Rule in Cyberspace*. Cambridge, MA: The MIT Press.

Diebert, Ronald J., John G. Palfrey, Rafal Rohozinski and Jonathan Zittrain (eds.). (2011). *Access Contested: Security, Identity, and Resistance in Asian Cyberspace*. Cambridge, MA: The MIT Press.

Diebert, Ronald J. and Rohozinsky, Rafal. (2010a). "Risking Security: The policies and paradoxes of cyberpace security," in *International Political Sociology*, 4 (1), pp. 15-32.

Diebert, Robert J., and Rohozinsky, Rafal. (2010b). "Undercover of the Net." in Anne Clunan and Harold Trinkunas, (eds.), *Ungoverned Spaces? Alternatives to State Authority in an Era of Softened Sovereignty* (pp. 255-274). Stanford, CA: Stanford University Press.

Dunn-Cavelty, Myriam. (April 2011). "Cyber-Allies: Strengths and weaknesses of NATO's cyberdefense posture." *IP Global Edition*, 12 (3), pp. 11-15.

Europa. (2009). *European Network and Information Security Agency (ENISA)*. Retrieved on September 21, 2009, from http://europa.eu/legislation_summaries/justice_freedom_security/fight_against_organised_crime/l24153_en.htm

Federal Bureau of Investigation. (2006). *Netting cyber criminals*. Retrieved on February 20, 2010, from http://www.fbi.gov/page2/jan06/ccctf012506.htm

Forum of Incident Response and Security Teams. (2009a). *Alphabetical list of FIRST members.* Retrieved on September 20, 2009, from http://www.first.org/members/teams/

Forum of Incident Response and Security Teams. (2009b). *FIRST history*. Retrieved on September 29, 2009, from http://www.first.org/about/history/

Goodrich, Leland M. (1947). "From League of Nations to United Nations," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

G8 24/7 High Tech Contact Points. *Cyber Security Co-Operation.* Retrieved on October 28, 2009, from http://www.cybersecuritycooperation.org/moredocuments/24%20Hour%20Network/24%207%20invitation.pdf

Haas, Ernest B. (1961). "International Integration: The European and the Universal Process," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

Hall, Peter A., and Rosemary C.R. Taylor. (1996). "Political Science and the Three New Institutionalisms." *Political Studies*, 44 (5), pp. 936-957.

Hansen, Derek L., John Carlo Bertot, Paul T. Jaeger. (2011). "Government Policies of the Use of Social Media: Legislating for Change." In *Proceedings of the 12th Annual International Conference on Digital Government*. pp. 131-140.

Hoffmann, Stanley. (1987). "International Organization and the International System," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

Hundley, Richard O., Robert H. Anderson. (Winter 1995/1996). "Emerging Challenge: Security and Safety in Cyberspace."*IEEE Technology and Society Magazine*. 14(4). Pp. 19-28.

IMPACT. (2009). *Welcome to the coalition*. Retrieved on October 23, 2009, from http://www.impact-alliance.org/

International Telecommunication Union. (2005). *A Comparative Analysis of Cybersecurity Initiatives Worldwide.* Retrieved on December 16, 2011, from http://www.itu.int/osg/spu/cybersecurity/docs/Background_Paper_Comparative_Analysis_Cybersecurity_Initiatives_Worldwide.pdf

International Telecommunication Union. (2009a). *Global Cybersecurity Agenda (GCA)*. Retrieved on September 25, 2009, from http://www.itu.int/osg/csd/cybersecurity/gca/

International Telecommunication Union. (2009b). *Information and communication technology (ICT) statistics*. Retrieved on September 25, 2009, from http://www.itu.int/ITU-D/ict/

International Telecommunication Union. (2009c). *Global Cybersecurity Agenda (GCA): Technical and security measures*. Retrieved on September 25, 2009, from http://www.itu.int/osg/csd/cybersecurity/gca/tech-proced.html

Keohane, Robert O. (1983). "The Demand for International Regimes," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

Keohane, Robert O. (2002). "Institutional Theory in International Relations," in Michale Brecher and Frank P. Harvey (eds.), *Millennial Reflections on International Studies* (pp. 160-164). Ann Arbor, MI: The University of Michigan Press.

Killcrece, Georgia. (2004). *Steps for creating national CERTs*. Carnegie Mellon Software Engineering Institute. Retrieved on September 13, 2009, from http://www.cert.org/archive/pdf/NationalCSIRTs.pdf

Krebs, Bryan. (2008, May 15). Government secrecy and the mysterious cyber initiative. *The Washington Post*. Retrieved on September 25, 2009, from http://voices.washingtonpost.com/securityfix/2008/05/government_secrecy_and_the_mys.html

Libicki, Martin C. (2009). *Cyberdeterrence and Cyberwar*. Santa Monica, CA: RAND Corporation.

Lowi, Theodore J. (1964). "American Business, Public Policy, Case Studies, and Political Theory." *World Politics*, 16 (4) pp. 677-715.

Madnick, Stuart, Li Xitong, & Choucri, Nazli. (2009). *Experiences and challenges with using CERT data to analyze international cyber security*. Proceedings of the AIS SIGSEC Workshop on Information Security & Privacy (WISP 2009), Phoenix, Arizona, December 2009, pp. 6-16.

Mitrany, David. (1948). "The Functional Approach to World Organization," in Oran R. Young (ed.), *The International Political Economy and International Institutions, Volume 1* (pp. 22-52). Cheltenham, UK: Edward Elgar Publishing Limited.

Nakashima, Ellen (2008, January 26). Bush order expands network monitoring. *The Washington Post*. Retrieved on September 26, 2009, from http://www.washingtonpost.com/wp-dyn/content/article/2008/01/25/AR2008012503261.html

National White Collar Crime Center. (2008). *IC3 annual report*. Retrieved on September 23, 2009, from http://www.ic3.gov/media/annualreport/2008_IC3Report.pdf

Nye, Joseph S., and Robert O. Keohane. (1977). *Power and Interdependence: World Politics in Transition*. Boston, MA: Little, Brown and Company, 23.

OECD. (2009a). *What is the Working Party on Information Security and Privacy (WPISP)?* Retrieved on October 23, 2009, from http://www.oecd.org/document/46/0,3343,en_2649_34255_36862382_1_1_1_1,00.html

OECD. (2009b). *Initiatives by country.* Retrieved on September 27, 2009, from http://www.oecd.org/document/63/0,3343,en_21571361_36139259_36306559_1_1_1_1,00.html

Reich, Simon. (2000). "The Four Faces of Institutionalism: Public Policy and a Pluralistic Perspective." *Governance*, 13 (4), 501-522.

UNESCO. (2009, March 23). *UN-backed anti-cyber-threat coalition launches headquarters in Malaysia*. Retrieved on March 24, 2009, from http://portal.unesco.org/ci/en/ev.php-URL_ID=28464&URL_DO=DO_TOPIC&URL_SECTION=201.html

Verdelho, Pedro. (2008). *The effectiveness of international co-operation against cybercrime*. Council of Europe. Retrieved on September 27, 2009, from http://www.coe.int/t/dghl/cooperation/economiccrime/cybercrime/T-CY/DOC-567study4-Version7_en.PDF/

Samson, Victoria. (2008, July 23). The murky waters of the White House's cybersecurity plan. *Center for Defense Information*. Retrieved on September 26, 2009, from http://www.cdi.org/program/document.cfm?DocumentID=4345&from_page=../index.cfm

Slaughter, Anne-Marie. (2004). "Disaggregated Sovereignty: Towards the Public Accountability of Global Government Networks." *Government and Opposition.* 39 (2) pp. 159-190.

The White House. (2003). *The National Strategy to Secure Cyberspace*. Retrieved on September 20, 2009, from http://www.dhs.gov/xlibrary/assets/National_Cyberspace_Strategy.pdf

The White House. (2009a). *Cyberspace policy review: assuring a trusted and resilient information and communications infrastructure.* Retrieved on September 23, 2009, from http://www.whitehouse.gov/assets/documents/Cyberspace_Policy_Review_final.pdf

The White House. (2009b). *The Comprehensive National Cybersecurity Initiative.* Retrieved on March 20, 2010, from http://www.whitehouse.gov/cybersecurity/comprehensive-national-cybersecurity-initiative

WPISP. (2002). *OECD Guidelines for the Security of Information Systems and Networks: Towards a Culture of Security*. Paris, France: OECD.

WPISP. (2005). *The Promotion of a Culture of Security for Information Systems and Networks in OECD Countries*. Paris, France: OECD.

WSIS. (2003). *Plan of action.* Retrieved on October 17, 2009, from http://www.itu.int/wsis/docs/geneva/official/poa.html

WSIS. (2009a). *Stocktaking*. Retrieved on October 17, 2009, from http://www.itu.int/wsis/stocktaking/index.html

WSIS. (2009b). *WSIS C5*. Retrieved on October 17, 2009, from http://www.itu.int/osg/csd/cybersecurity/WSIS/

Author Note

Jeremy Ferwerda

PhD Student
Department of Political Science
Massachusetts Institute of Technology
E53-470, Cambridge, MA 02142
ferwerda@mit.edu

Nazli Choucri

Professor of Political Science
Department of Political Science
Massachusetts Institute of Technology
E53-493, Cambridge, MA 02142
nchoucri@mit.edu

Stuart Madnick

John Norris Maguire Professor of Information Technology, Sloan School of Management
Professor of Engineering Systems, School of Engineering
Massachusetts Institute of Technology
E53-321, Cambridge, MA 02142
smadnick@mit.edu

This work is funded by the Office of Naval Research under award number N00014-09-1-0597. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the Office of Naval Research.

This work has not been simultaneously submitted to any other journal.

Correspondence concerning this article should be addressed to Stuart Madnick.

THIS TABLE HAS BEEN UPDATED: SEE TABLE 1 FILE

Note: If this table is deemed oversized for publication, it can be removed or shortened.

Table 1
International Institutional Eco-System

Captions

Figure 1. International CERTs

Figure 2. Key Intergovernmental Institutions

Figure 3. Proposed US structure

Figure 4. US Investigation/Prosecution Organizations

Institution	Role	Data Availability	Example Variables (if applicable)
Computer Emergency Response Teams (CERTs)			
AP-CERT: Asia Pacific Computer Emergency Response Team	Asian Regional coordination	High	Collation of security metrics from member CERTS in Asia
CERT-CC: Computer Emergency Response Team - Coordination Center	Coordination of global CERTs, especially national CERTs.	Moderate	Vulnerabilities catalogued, Hotline calls received, Advisories & alerts published, Incidents handled
FIRST: Forum for Incident Response and Security Teams	Forum and information sharing for CERTs	Low	Secondary data from conferences and presented papers
National CERTS (e.g. US-CERT)	National coordination; national defense and response	High	Varies- Volume of malicious code and viruses, Vulnerability alerts, Botnets, Incident reports
TF-CSIRT: Collaboration of	European regional	N/A	N/A

Security Incident Response Teams	coordination		
International Entities			
CCDCOE: Cooperative Cyber Defence Centre of Excellence	Enhancing NATO's cyber defense capability	N/A	N/A
Council of Europe	International Legislation	Moderate	Legislation & ratification statistics; Secondary data from conferences and presented papers.
EU: European Union	Sponsors working parties, action plans, guidelines	N/A	N/A
ENISA: European Network and Information Security Agency	Awareness raising, cooperation between the public and private sectors, advising the EU on cyber security issues, data collection	Low	Awareness raising stats, spam surveys, Regional surveys, Country reports. Qualitative data assessing the EU cyber security sphere.
G8: Subgroup on High Tech Crime	Sponsored 24/7 INTERPOL hotline, various policy guidelines	N/A	N/A

IMPACT: International Multilateral Partnership Against Cyber Threats	Global threat response center, data analysis, real-time early warning system	N/A	N/A
INTERPOL: International Criminal Police Organization	Manages 24/7 hotline, trains law enforcement agencies, participates in investigations.	N/A	N/A
ITU: International Telecommunications Union	Sponsors IMPACT. Organizes conferences, releases guidelines and toolkits, facilitates information exchange and cooperation.	Moderate	Internet usage and penetration statistics; Secondary data from conferences & presented papers
NATO: North Atlantic Treaty Organization	Responding to military attacks on NATO member states	N/A	N/A: classified
OECD: Organisation for Economic Co-operation and Development	Develops policy options, organizes conferences, publishes guidelines and best-practices.	Low	Secondary data from conferences and presented papers
UNODC: United Nations Office on Drugs & Crime	Promotion of legislation, training	N/A	N/A

	programs, awareness, enforcement		
WSIS: World Summit on the Information Society	Global summit on information security; publishes resolutions and monitors implementation through stocktaking efforts.	Low	Stocktaking database & Secondary data from conferences and presented papers
U.S. National Entities			
NSA: National Security Agency	Shares Director, General Keith Alexander, with US CYBERCOM; specializes in cryptology services and research	N/A	N/A
CIA: Central Intelligence Agency	Defense of intelligence networks, information gathering.	N/A	N/A: Classified
DHS: Department of Homeland Security	Protection of federal civil networks & critical infrastructure; information sharing and awareness; coordinating federal response and	N/A	N/A: Unclassified data released through US-CERT

	alerts.		
DoD: Department of Defense	Defense of military networks, counterattack capability.	N/A	N/A: Classified
DOJ: U.S. Department of Justice	Federal Prosecution	Moderate	Non aggregated data: Prosecuted Cases, Crime by industry
FBI: Federal Bureau of Investigation	Federal Investigation	Low	Total reported incidents, Number of referrals to law enforcement agencies. Annual surveys on corporate computer crime including: Type and frequency of attacks, Dollar loss, Attack source
FTC: Federal Trade Commission	Consumer Protection	N/A	N/A
IC3: Internet Crime Complaint Center	Cybercrime Reporting & Referral Center	High	Total complaints, Referred complaints, Estimated dollar loss, Complaints by

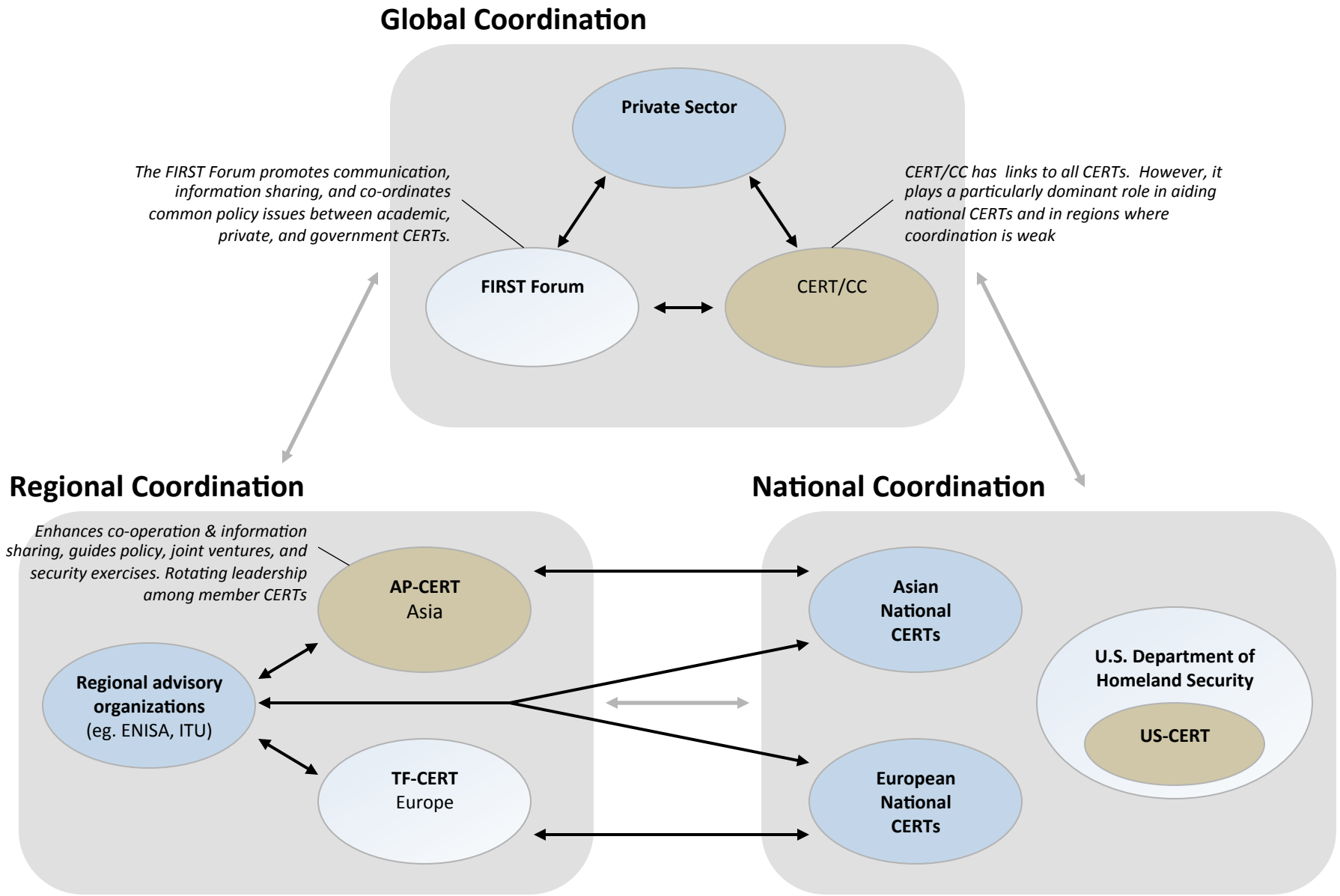
			industrial sector
NW3C: National White Collar Crime Center	Provides training and support to law enforcement agencies, helps administer the IC3 with the FBI.	N/A	N/A: statistics released through IC3
FSSCC: Financial Services Sector Coordinating Council	By DHS mandate, identifies threats and promotes protection to protect Financial Sector critical infrastructure assets	N/A	N/A
Secret Service	Investigation of economic cyber crimes.	N/A	N/A
US-CERT: United States Computer Emergency Response Team	Defense of federal civil networks (.gov), information sharing and collaboration with private sector.	Moderate	Incidents and events by category, Vulnerability reports
Non-U.S. National Entities (frequent collaborative partners)			
GCHQ: Government Communications Headquarters (U.K.)	One of three of Britain's intelligence agencies	N/A	N/A

	responsible for information assurance and cryptology; Britain's leading authority on cybersecurity		
National Cyberdefence Centre (Germany)	Recently opened (June 16th) agency for cybersecurity in Germany; responds to reports of cyberattacks on critical infrastructure	N/A	N/A
National Police Bureaus (For example: Taiwan, South Korea, Japan, France)	Investigation, enforcement	Varies	Cases, arrests, prosecutions, demographics
Non-profits			
GICSR: Global Institute for Security and Research	Conducts R&D with industry leaders, public-private sector, and academia to develop policy and strategy for cyberspace	N/A	N/A
Internet Society	Non-technical branch of Internet Engineering	N/A	N/A

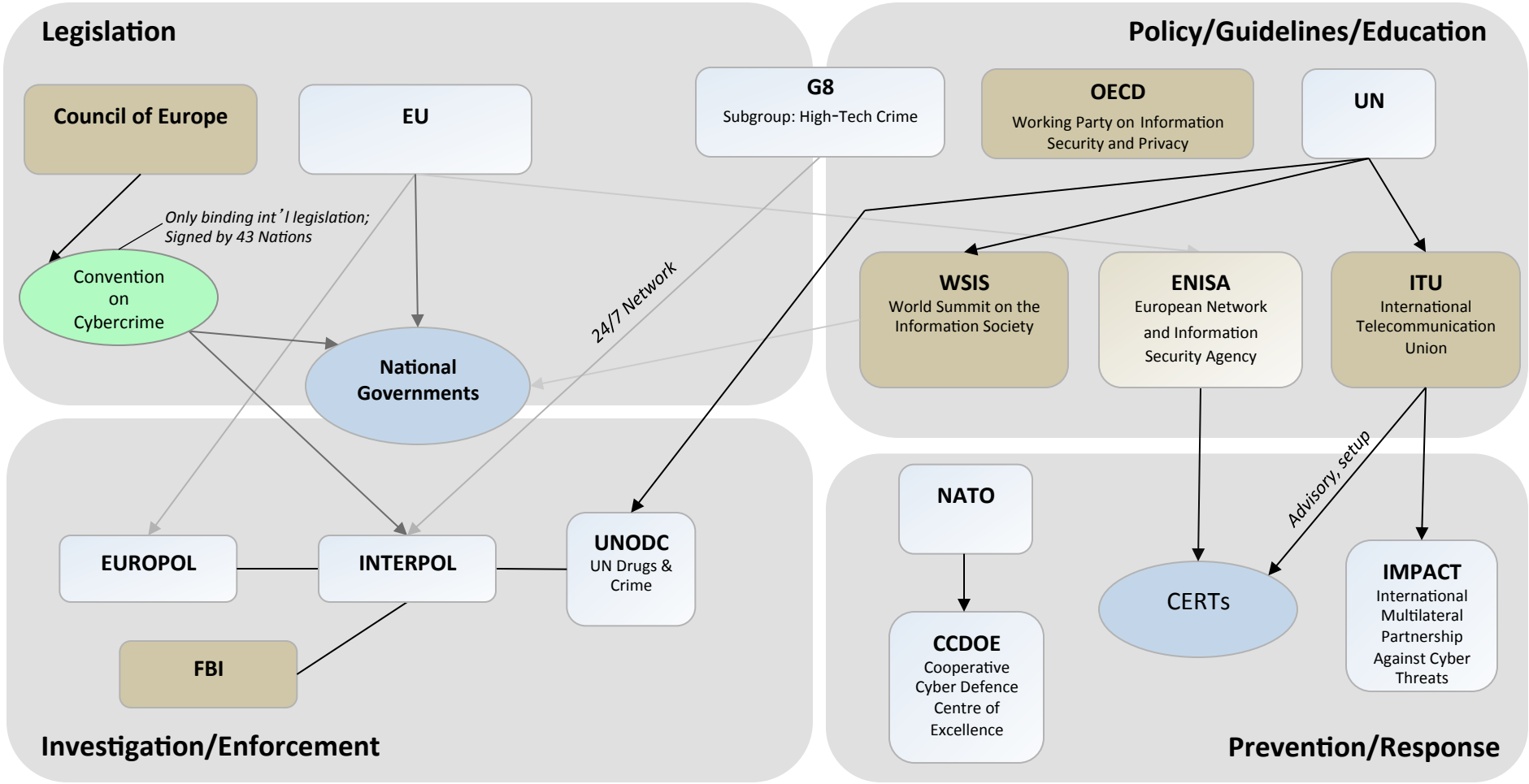
	Task Force (IETF); provides leadership in addressing policy issues that confront the future of the Internet		
CyberWatch	Develops educational programs and curriculum to train next generation of cybersecurity experts	N/A	N/A
CAIDA: Cooperative Association for Internet Data Analysis	Gathers data that will increase situational awareness of Internet topology structure, behavior, and vulnerabilities.	High	Graphs and visuals of Internet traffic patterns
Private Sector			
MacAfee	Industry leader in antivirus software; computer security services	Moderate	White papers
PROINFO	Products analyze vulnerability	N/A	N/A

	dependencies and shows all possible attack paths into a network.		
Raytheon Co.	Cybersecurity Solutions division offers wide arrange of information assurance services	N/A	N/A
Lockheed Martin	Defense contractor that supplies many governmental cybersecurity G&S	N/A	N/A
Red Tiger Security	Investigates cyberattacks	N/A	N/A
HB Gary	Investigates cyberattacks	N/A	N/A
Versigen iDefense	Investigates cyberattacks	N/A	N/A
International Computer Security Association	Specializes in anti virus, anti spam, and firewall services among a wide array of other cybersecurity services	Moderate	Graphs of which countries sent the most spam per week

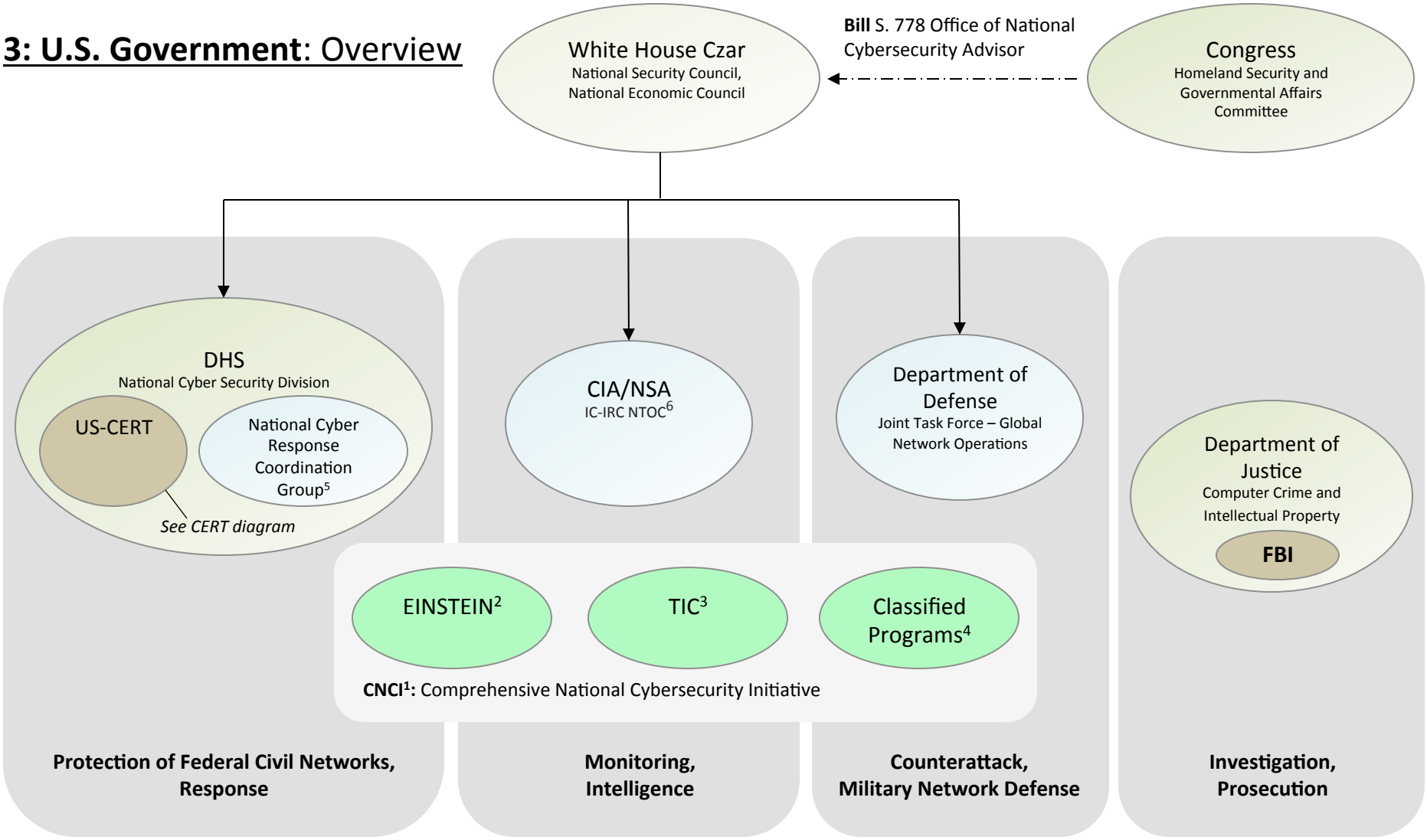
1: International CERTs Note: Asia, Europe & USA used as representative examples



2: International Institutions

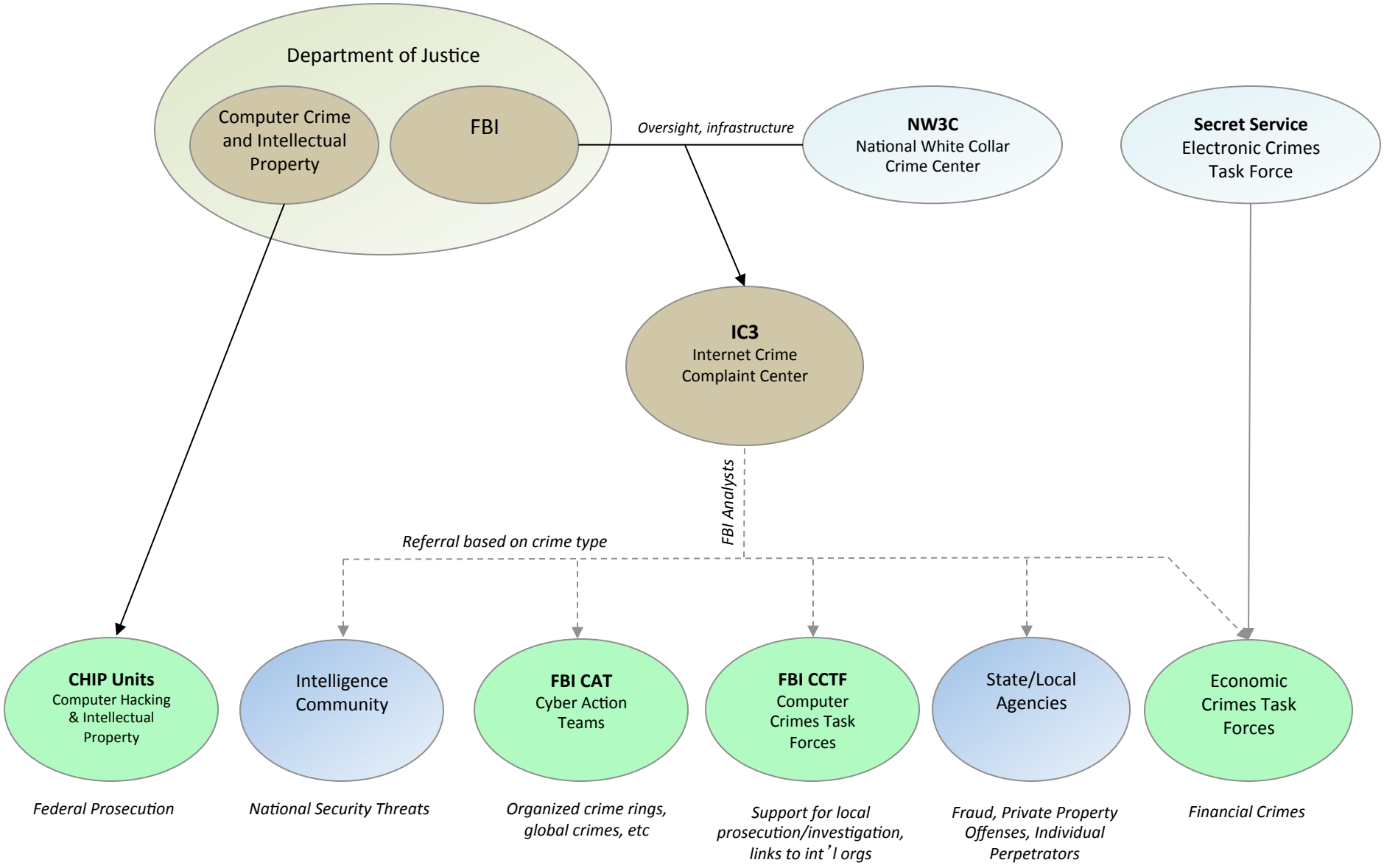


3: U.S. Government: Overview



1. CNCI: Authorized by President Bush via *Presidential Directive HSPD-23*. CNCI is a classified $17 billion program devoted to improving internet security throughout federal and military networks.
2. EINSTEIN: Originally an optional program developed by DHS/US-CERT to monitor federal network intrusion, EINSTEIN is now a classified NSA program devoted to monitoring various internet networks, including the private sector.
3. Trusted Internet Connections Program: Devoted to reducing the number of connections to Federal networks from 3000 to 50. Co-sponsored by the OMB.
4. The Department of Defense components of the CNCI program remain classified. It is speculated that they include counteroffensive capability.
5. NCRG: The National Cyber Response Coordination Group coordinates the efforts of 19+ Federal agencies in the event of an attack of national significance.
6. IC-IRC: Intelligence Community—Incident Response Center, **NTOC:** NSA/CSS Threat Operations Center

4: U.S. Government: Investigation/Prosecution



Key for Figures: