Situating Information Infrastructure Builders as International Organizations

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This paper analyzes three, non-state information infrastructure-building (IB) organizations relative to the international system. It reports on ethnographic content analysis of the organizations' work and deliberative archives to operationally distinguish their structures, scopes, and influences from those of conventional international actors. It finds IBs enable interested stakeholders distributed on a global scale to organize around public infrastructure needs not addressed by (nor derived from) sovereign mandates of states, and IBs' operational and conceptual distances from the current roles of states and state organizations impedes cooperation on policy of mutual concern. It concludes by arguing for more theoretical and operational recognition of the role of non-state infrastructure builders in the international system and proposes some approaches to do so.

Introduction

International organizations (IOs) generally refer to "associations established by governments or their representatives that are sufficiently institutionalized to require regular meetings, rules governing decision-making, a permanent staff, and a headquarters" (Shanks, Jacobson, and Kaplan, 1996). Categories of IOs (sometimes disputed) include: nongovernmental organizations (NGOs); multinational corporations (MNCs); organizations consisting of nations as their members, such as the EU, the World Trade Organization, the UN, or Organization of American States; and global public policy networks of state, corporate, NGO, and individual representatives. Such categorization implicitly assumes the relevant unit of demarcation for global issues is the nation state and that states are the primary locus policy-making of global scope. Inspired by market and intergovernmental failures to address global social and economic challenges, the locus of innovation has recently shifted from Westphalian state-based institutions to non-state groupings of immediate stakeholders (Reinicke, 1999). Such global public policy networks "complement national policy-making and international cooperation" (Benner, Reinicke, and Witte, 2004) thus remain rooted in the state concept. "Public policy has been a prisoner of the word 'state'" (Detomasi, 2007) and so has theory. Associative governance theorizes policy and infrastructure-building at the sub-national level (e.g., Bradford, 1998; Leibovitz, 2003) but retain the state and non-state divide.

Some scholarship examines how global public policy-making is or is not democratic, accountable, or legitimate (e.g., Stone, 2008). But state-oriented organizations' practical effectiveness converting public inputs into policies satisfying an increasingly state-spanning public has frustrated theories of political science. For example, widespread social discontent with international intellectual property regimes (e.g., Boldrin and Levine, 2008, pp. 1–14; Bessen and Meurer, 2008 pp. 1–28), lack of environmental coordination (e.g., Mowery et

al., 2009), and human rights abuses (e.g., Hafner-Burton and Tsutsui, 2007) highlight gaps in understanding. Globalization approaches (e.g., Hall and Biersteker, 2002a) lead to market or moral perspectives of emergent "private authorities" as "residual[s] of the nation state" (e.g., Hall and Biersteker, 2002) that have few endogenous traits. Globalization explains that states embrace information *technology* for social and economic goals but fails to explain states' ineffectiveness governing information *infrastructure* despite public interest to do so.

This paper appeals from common assumptions about international system participants to better understand the international roles of information infrastructure builders. Specifically, it compares mandates, structures, inputs, and outcomes of three non-state information infrastructure builders (IBs) having global scope to those of international organizations to attempt to situate the IBs in or around the international model. The IBs' unique position as non-state yet not private, influential, autonomous, and global actors blends characteristics of state-sanctioned IOs. Thus, they inspire reconsideration of the category and role of international organizations.

This paper draws from examples in which IBs make and impose policies having global reach to interrogate whether the inter-*nation*-al perspective sufficiently explains IBs' operational effects on hundreds of millions of individuals worldwide. Overall, this paper posits that IBs represent a new form of non-state-derived organization operating in global policy areas previously thought to be exclusively state mandates.

The remainder of this paper proceeds as follows. First, it compares the mandates, structures, inputs, and policy outcomes at several kinds of international organizations, with those at the three IBs studied. Second, it argues that IBs do not belong to the current categories of IOs and explores some implications of the emergence, study, and accommodation of IBs among state-derived international actors.

Characteristics of Infrastructure Builders

This section briefly introduces the IBs studied and the method of their examination for the present paper. It examines the mandates, structures, inputs, and outcomes of IOs and IBs to argue IBs share many characteristics with other entities operating internationally but not their assumptions about the central role of states in global policy.

Introduction to Infrastructure Builders

This paper is stimulated by ethnographic research into innovation processes at three international open online infrastructure-building organizations relying on computer-mediated communications (CMCs) (Li, 2010b). They were the Apache Software Foundation (ASF) for its HTTP Server (hyper-text transfer protocol server, i.e., web server) project, the Mozilla Foundation for its Firefox web browser project, and the American Registry of Internet Numbers (ARIN) for its Policy Development Process.[1] The three organizations and projects are key components of a common online technological and social infrastructure; over 400 million individuals use the

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1. The three IBs each have diverse roots including publicly funded research, but several steps and many years removed. Apache and Mozilla descend separately from University of Illinois work. Formally ARIN and the four other regional Internet registries (RIRs) are subordinate to the Internet Corporation for Assigned Names and Numbers (ICANN), a U.S. non-profit corporation having a historic mandate from the U.S. Department of Commerce (DOC) as the Internet Assigned Numbers Authority (IANA). Operationally, the DOC has no role in ARIN; ICANN's primary responsibilities for domain names does not involve RIRs' IP address allocation work; and RIR policy decisions concerning ICANN are infrequent and predictable.

Firefox web browser to retrieve and display web pages from seventy million web servers running instances of Apache HTTP Server. Apache HTTP Server also underpins web sites and communities such as YouTube, Wikipedia, Twitter, the BBC, Digg, LiveJournal, the U.S. Senate online (Netcraft, 2009), and uncountable other blogs, forums, and communities. The web browsers and web servers are connected to each other via the public Internet, which serves 1.7 billion users, and uses an addressing system managed through ARIN in North America. The three organizations, and seven of their satellite organizations studied, use similar public processes to solicit and collect stakeholder input to iteratively enhance the information infrastructures they develop.

ARIN, Mozilla, and ASF command substantial market share (approximately 30–100 percent in North America, 20–40 percent, and 70 percent respectively) over locked-in deeply embedded infrastructures deployed by end-users, organizations, and governments. In that way, IBs impose their policies on such stakeholders. Any user of an IB's infrastructure may refuse the IB's imposition of new policies, features, and defaults by implementing a (costly) parallel infrastructure. The vast majority of users adapt imposed policies to local settings, rather than "fork" a copy of the infrastructure despite the availability of all the materials, specifications, and tools required to do so at no monetary cost.

Methods

Ethnographic content analysis was used to examine detailed public records concerning work, deliberation, and organization from the three IBs. This method was chosen because it allows IB stakeholders' orientations and categories to emerge from what they say and do in practice rather than being imposed externally. The only channels of communication among IB stakeholders, participants, and policy-makers were CMCs, including online discussion lists, forums, and workflow management systems ("Bugzillas"). Communications through such CMCs are comprehensively archived in searchable databases by the IBs as required practice.

From approximately thirty candidate cases, eight cases were selected of policy deliberation and implementation concerning internal and external stakeholders. They were examined for patterns about how IB participants planned, conducted, and narrated their work. Chosen were cases that followed the IB's own theoretical practices to use stakeholder input to generate policy outputs and cases that variously deviated from the IBs' ideals. Together, these eight cases encompassed approximately one thousand pieces of communication organized by the entire (formal and informal) public discussion at each IB about the policies in each case. (Details are given in Appendix 1 and Li, 2010b).

Previous work found the three IBs not to be democratic in their decision-making by criteria commonly used to judge states' democratic tendencies (Li, 2010a), as expected since their charters were meritocratic rather than democratic (Li, 2010b), and technical standards-setting organizations lack some democratic legitimacy features (Warning, 2009:203–204). Participants' motives for engagement with each other were based on common social goals, not on seeking geographical or financial exclusivity. Seven of the many satellite projects of the three IBs (they made modules or plug-ins to extend the functionality of the IBs' technical outputs) were found to exhibit the same overall patterns of communication, workflow management, inputs, and outcomes but at smaller scales than the three IBs studied.

The present work sought evidence relating the IBs' internal structures and policy processes to their effective global reach on policies of state sovereign concern. It examines IBs' positions relative to states and international organizations to explore the question of (how) do IBs participate in the international system? The following sections compare and contrast characteristics of IBs and current categories of IOs.

Characteristics of Organizations

Barnard (1938: 78) broadly defines an organization as "a system of consciously coordinated activities or forces of two or more persons." The mandate of an organization defines its purposeful coordination. "International organization" embeds the concept that an IO's mandate concerns affairs of persons in more than one nation state. The membership, source of legitimacy, and scope of influence of an organization contribute to the operational definition of an organization's mandate. An organization's system of activities is manifest in its structure for operating itself and managing resources. Comparing IBs' and IOs' inputs and the social, economic, political, technical other outcomes of their *activities* enables using mandates, structures, inputs, and outcomes to broadly differentiate organizations.

Several current categories of global scope organizations are examined: nation states, state ministries, transnational bureaucracies, corporations, transnational enterprises, nongovernmental organizations, technical standards organizations, international organizations, policy networks, and individual natural persons.

If IBs are a kind of current category of IO, IBs would share characteristics with that type of IO. If IBs do not share most characteristics with any current category of IO but some characteristics with several categories of IO, then IBs must be a different kind of IO, or they are not a kind of IO at all.

Nation States

Sovereign nation states have "supremacy in respect of power, domination, or rank; supreme dominion, authority, or rule" (OED, 1989). Operationally, nation states have the broad mandate to be responsible for, or to delegate responsibility for, all economic, social, and political activities of all individuals inside their sovereign geographic borders as recognized by their peers, although the nation itself is conceptually troubled (Tishkov, 2000). States may be accountable to themselves, to their citizens, to the international community, or to no one. State governments and bureaucracies fulfill legislative, executive, and judicial functions; sanction legal entities to operate inside their borders; and may participate in transnational organizations, IOs, and technical bodies. States take policy inputs from many sources, including leaders and domestic and international lobbyists and stakeholders; and draw capital resources through taxation, natural resources, commerce, monopolies, etc. States have the ability to enforce policy via coercion (police, military, etc.) to achieve domestic and sometimes international objectives in social, economic, political, or other areas.

By contrast, IBs' are responsible for narrow or broad technical and social activities among voluntary communities of interest. IBs are accountable to their stakeholders and contributors. They have no sovereignty over geography but can be globally authoritative in particular

technical areas of practice. IB exercise legislative, executive, and judicial functions through infrastructures superficially resembling branches of government but which integrate government, commercial, and social functions and responsibilities (Li, 2009). IBs take a majority of policy inputs from directly affected users, have no or limited taxation powers, and may act exclusively on some areas of policy. IBs enforce policy through widely and deeply adopted *de facto* standards (reference implementations, application programming interfaces [APIs], resource allocation procedures) to achieve social and technical objectives internally and among their stakeholders. The IBs studied have no status at the UN General Assembly, nor on most other international forums recognizing states. While ARIN and other Internet stakeholders have standing at the UN's newly formalized Internet Governance Forum in recognition that Internet organizations are important to the international system, the large distance between an IB's board-level formal representatives and the IB's technical and operational decision-making impairs information flows. Even at ARIN, which has the fewest administrative layers between stakeholders and governing board members, such members did not mention the IGF on policies concerning global Internet governance. They did, however, refer to authorities at ICANN and other RIRs.

State Bureaucracies or Departments

State bureaucracies have mandates to carry out policies of state governments and are accountable to their governments. Their typically hierarchical structure delegates responsibilities from cabinet secretaries down to individuals who interact with citizens and capital assets. Their inputs include legislation, regulation, and funding from the government for specific purposes. Their outcomes include enabling or disabling citizens from doing things or accessing resources according to formal or informal policy.

IB bureaucracies' mandates arise from internal project managers and members and are operationally accountable to project managers and members, not to the IBs' boards of directors. Their structure typically integrates low- and high-level social and technical decision-making with implementation, and membership attaches to individuals rather than representatives of states or corporations. States provide no monetary or policy inputs. IBs' inputs include ideas from stakeholders and resources gathered from stakeholders to implement specific capabilities. Their outcomes include technical implementations having narrow or profound social impact, but in all cases they affect the ability of citizens in multiple states to conduct economic or social activities.

The IBs studied were not directly compelled by states to act on the impending exhaustion of unassigned Internet Protocol addresses required to identify each computer on the public Internet (NRO, 2010) but did so anyway through ARIN's several policies and policy proposals about IP address allocation. Apache and Mozilla's independent work on implementing protocols for Server Name Indication (SNI), which allows multiple web sites to securely share single IP addresses and also critically enables more computers to be online using the remaining unassigned IP addresses.

IBs sometimes must interact with states to enforce policies binding on legal entities (e.g., ARIN's attempts to secure legal agreements with so-called "legacy resource" holders, after

offline concerns prevented ARIN from enforcing its new policy by requiring stakeholders to update its contact database). Experts (lawyers, computer professionals) are hired to address immediate problems, not to engage the problem at the structural policy level. Although ARIN arises from the U.S. Department of Defense, the U.S. explicitly disclaimed interest in computer data infrastructures in the *U.S. v. AT&T* (552 F. Supp. 131 (DDC 1982)) settlement by agreeing to unregulated access to computer data and software markets.

State governments including China (AFP, 2011; Buckley, 2011) and the U.S. (U.S. Strategic Command, 2010) recently established standing cyber-military organizations rather than engage IBs about information infrastructure security at the policy level. Militaries are not generally raised against domestic concerns under states' own effective jurisdiction but against threats. This implies IBs are also not functionally some other kind of sub-state organization nor are their infrastructures under effective state control.

Interstate or Transnational Bureaucracies

Transnational bureaucracies (TNBs) comprise elements and resources from bureaucracies of multiple nations working toward a common purpose (Warning, 2009) such as the Financial Action Task Force on Money Laundering. Their policy inputs and resources come from states, while their policy outputs return to states and commercial interests for adoption.

Unlike TNBs, IBs have substantial public participation, do not acknowledge states or state representatives, and do not rely on non-state funding sources (Mozilla, n.d.; Apache, 2010; ARIN, 2010). IBs are accountable to their contributors and stakeholder communities rather than state ministries or industrial corporations.

Corporations

Corporations are given legal existence by states to fulfill some ongoing financial or social gains set out in corporate charters. Directors collectively make decisions and bear legal responsibilities for corporation's actions. Executives direct employees to carry out operations in specialized areas of responsibility. Corporations' policy inputs come from management, shareholders, and clients, while their financial inputs come from commercial activities, government grants, private investments, or donations. Shareholders and management may coerce employees to follow particular policies. Policy may also be enforced on outsiders by locking in clients to product or program offerings. Primary outcomes may include economic, social, political, or technical changes or gains that help fulfill their charter, achieved through providing proprietary knowledge, processes, or expertise. Historically, corporations that gain monopolies over critical infrastructures (e.g., Standard Oil, AT&T, IBM, Microsoft) became subjects of state investigation and regulation.

All three IBs studied, and many others, are legal corporations for the purposes of interacting with physical infrastructures such as computer servers, holding conferences, receiving donations, or employing administrative bureaucracies. However, their predominantly volunteer staffs serve contributor and broad user stakeholders, rather than shareholders. IBs' policy inputs also come from internal leaders and external clients, while their (limited) funding, can come from cost recovery for services, private investments or donations, or commercial activi-

ties. Directors are elected from active stakeholders—most of whom are not shareholders in any financial sense—and derive specialized coercive powers over stakeholders from monopoly or lock-in. Volunteer contributors make most substantial and operational decisions. Like corporations, IBs' primary outcomes may include economic, social, political, or technical changes or gains fulfilling their charter. Unlike corporations, IBs do not generally seek exclusivity over the ability to provide a product or service, but openly invite inspection and actively share new knowledge. IBs' goals are unrelated to profit, and only vaguely related to the public science and education purposes specified for organizations falling under Section 501 (c) (3) of the U.S. Internal Revenue Code. Of note, Mozilla is substantially financially dependent on Google via a business arrangement to make Google the default search engine in Firefox.

The IBs studied have not been regulated or investigated by states despite having (in some cases) near monopolies on critical infrastructures. They also have not sought legitimization through regulation (as in the natural resource extraction or professional practices industries, among others) nor have they sought trade or competitive protections. Some international information infrastructure participants such as PayPal, Kazaa, and BitCoin have drawn government interest. Other like the Pirate Party have attempted to broker relationships between national governments and concerned Internet stakeholders.

Unlike micro-multinationals, IBs do not operate in multiple countries to obtain tax or legal benefits, and their "presence" in host nations may be limited to cooperative individual contributors or users with no legal relationship to IBs. Such contributors may also separately advocate for changes in local policies (e.g., for the use of Open Source software in government information technology projects) but not as an activity directed by IBs. Mozilla engages local independent organizations to localize its software releases for international (non-U.S.) markets through its Mozilla localization process (Mozilla, 2010).

Transnational Enterprises

Transnational enterprises (TNEs) attempt to increase profit for member organizations across international borders. As legal entities under national laws they draw policy inputs and powers of coercion from members and from other transnational organizations (Warning, 2009:27). Their outcomes include infrastructures and rules that further interests of international commercial members.

IBs may barely have formal legal existence in only one sub-national jurisdiction. IBs may be "non-national" organizations since inputs and outputs are not specific to any particular state, nor are conceptual or tangible value-added transformations applied by humans working in any particular jurisdiction. Unlike TNEs, IBs do not generally care to participate in the international system and do not seek legal recognition in international affairs. They also are not aggregates of commercial members seeking profits. In ARIN Policy Proposal 2008-4, ARIN declined to independently define what was, or was not, in the Caribbean region. The question concerned which geographies would or would not be subject to a new policy about resource allocation to spur local competition against established commercial and state-owned telecommunication companies.

Nongovernmental Organizations

NGOs are a type of voluntary incorporated permanent entity organized for nonprofit, non-governmental social purposes (reviewed in Kilby, 2004). From the UN's perspective, NGOs exclude government participants, do not seek to overthrow UN member states, and may draw on a mixture of staff and volunteers for local or international nonprofit legal operations. Operationally, their policy and financial inputs come from individual, corporate, and government sources and their outcomes may include implementing particular values in the international system through political criticism or programs.

IBs do not generally lobby states but some criticize governments and corporations to garner support (e.g., the Mozilla Foundation's support of Open Source software to help Firefox compete for mind- and market-share with Microsoft's Internet Explorer). IBs may accept technical or financial contributions from individuals who are also government bureaucrats, but individual participants' government affiliation provides no special consideration. Their outcomes include implementing particular technologies for use by individuals, corporations, and governments worldwide, without considering the explicit international system. For example, in Firefox bug 327181—which sought to warn users against using insecure connections to web sites—Firefox contributors conceived of users in regions of Europe and North America as employing different mental paradigms about trust and security in online transactions. Participants realized their work on a fraud-related problem crossed international borders, but did not consider security of online consumer financial transactions—or online communications in general—to be issues concerning states.

(Technical) Standards Organizations

Standards or accreditation organizations develop, promulgate, interpret, and maintain standards applying to many external users to ensure quality and interoperability of goods or services. Their members may include nongovernmental organizations; governmental agencies; organizational, corporate, and individual technical expert members from any state; and academics. Social, technical, financial and policy inputs come from states, the public, industry, and stakeholders. Standards organizations must work through states to seek approval from stakeholders and states to enact standards but may not clearly be responsible to their stakeholders, the public, or governments (Gulbrandsen, 2008). They assist regulatory adoption of standards by states but do not usually implement products or services based on those standards.

IBs are not sanctioned by an IO like the International Telecommunication Union. IBs' actions are not legally binding outside their own organizations, and their standards are not directly adopted at the state level. Their actions are implicitly binding on members of the public through use. Like standards organizations, IBs may have monopolies (but only on reference implementations) and they both create and implement standards to advance public good, safety, and economic interests through interoperability. Some IBs also specify and implement standard interfaces such as APIs enabling third parties to develop "plug-in" modules to extend the core IB functionality. IB participants' discussions about when and how to alter interfaces often concern the sustainability of plug-in ecosystems.

In Apache bug 34607, one outsider was trusted to implement basic Server Name Indication (SNI) protocols that would be used by the international community for secure online transactions and identity verification but was improperly, procedurally blocked as a project leader in the open. A consensus of IBs had agreed that SNI was a good idea (Mozilla implemented support via bug 327181; the independent OpenSSL project developed a standard set of cryptographic libraries to support SNI for Apache HTTP Server, the Firefox browser and many programs and platforms), but few individual participants drove development internally or coordinated development across multiple IBs. One previously unknown stakeholder who needed SNI implemented SNI with inadequate supervision (according to both the stakeholder and project leaders) when project leaders knew SNI would benefit a majority of the world's secure web-based transactions.

Since IBs generally conduct policy development and implementation completely in the open, leaders' decisions and accountability may be challenged by a consensus of stakeholders, resolving the deficiency without personal or political prejudice. The voluntary and pseudo-anonymous nature of individual association with IBs, and the priority of the common technical ground over personal, cultural, corporate, or state-political differences, reduce abstraction between policies and practical needs.

International Organizations

IOs are endowed with competencies and authorities of states that create for them inter-state cooperation that exceeds capabilities of individual states. As neutral and relatively autonomous entities, they adopt various structures that inspire trust and confidence of reputation independent of their sponsoring states. They convert policy ideas and concepts shared among member states into potential policy options. They derive funds form membership dues and have only very abstract accountability to citizens. IOs have various specific functions but may not expand their authority (as reviewed in Warning, 2009:32–43).

In contrast, IBs are not composed of state participants, organizations, or power sources. IBs have direct accountability to stakeholders (but not necessarily to each of hundreds of millions of stakeholders). IBs do not draw goals from multiple agreeing states. And IBs may expand their authorities at will within broad information infrastructure domains. Apache and Mozilla have established research labs explicitly to expand their reaches in the networked environment, and they both support large ecosystems of third-party modules (over 500 at Apache, and over 10,000 at Mozilla) expanding their influences. The Apache Incubator is an "entry path into The Apache Software Foundation (ASF) for projects and codebases wishing to become part of the Foundation's efforts" (ASF, 2009), which has assimilated dozens of projects—including e-commerce, e-mail, database, and application server infrastructures—serving hundreds of millions of users.

ARIN, which has a geographic mandate, employed different expansion tactics to establish two of the four other Regional Internet Registrars responsible for distributing IP addresses to users. ARIN spun out Latin the America and Caribbean Network Information Centre (LAC-NIC, and the African Network Information Center (AfriNIC). (The other two RIRs are Réseaux IP Européens Network Coordination Centre [RIPE NCC], responsible for Europe; and

Asia-Pacific Network Information Centre [APNIC].) The five RIRs have in turn created the unincorporated Number Resource Organization, "a coordinating body for the five Regional Internet Registries (RIRs) that manage the distribution of Internet number resources including IP" (NRO, n.d.) consisting of an executive council, the NRO Number Council, policy development processes, and various technical coordination functions. ARIN is not a state, but its role housing the technical infrastructure for the NRO secretariat give it more hegemonic overtones than do Apache or Mozilla's expansions. ARIN considered issues of local, national, and international economic competition in data services and Internet access (concerning state jurisdictions of commerce, trade, regulation, and education) without direct representation by affected states in Policy Proposal 2008-4. It has threatened to reclaim or restrict the mobility of Internet number resources held by state and private entities allocated before ARIN's existence (Policy Proposal 2008-7).

(Global) (Public) Policy Networks

Policy networks have the mandate to gather individuals and representatives from a variety of state and non-state contexts to research and consider new approaches and solutions to global problems faced by democracies. They may or may not be legally incorporated entities with a variety of funding sources supporting mobilization of political and intellectual capital of wide-reaching "progressive" communities toward a common agenda. As non-state actors, global policy networks may engage in state policy-making in addition to bringing attention to shared problems and potential solutions (Benner, Reinicke, and Witte, 2004). Leaders are responsible to their intellectual, social, and financial contributors.

By contrast, IBs' mandates are not limited to democracies and their memberships are generally only available to natural humans. They draw their intellectual and technical capital from respected individuals within their own, with limited translation of reputations (or regular contact) among non-directly related IBs. Information from IBs can informally reach lobbyists for online issues via individuals who have both technical and state policy interests.

Individuals

Natural individuals have no mandates or legal standing in the international system but may come to represent entities that do have standing.

Individual leaders of some information infrastructure projects can exercise a great deal of personal control (e.g., Hans Reiser of the ReiserFS computer file system), without whom projects become unsustainable. Some builders of information infrastructures may be defined by or through particular individual participants. Linus Torvalds is the custodian of the Linux kernel, a personal student project on which many computer servers have come to be based. The late John Postel was the editor of the Request for Comments, an authoritative set of technical specifications and communications for Internet infrastructure, and later an Internet Assigned Numbers Authority leader. Richard M. Stallman's personal belief in computer software freedom yielded the Free Software Foundation which produces a standard set of software licenses and system tools used by computer professionals worldwide. Space tourist Mark Shuttleworth financially, intellectually, and publically supports the Ubuntu Linux desktop operating sys-

tem at no charge to schools and governments worldwide. Their freedom to act on personal authority varies from absolute to strongly socially circumscribed. Small-scale projects with international collaborators may count millions of dependent users and stakeholders and are not merely extensions of the (non-removable yet still accountable) individual leader in the sense of the sovereign ruler. In many examples of plug-ins, smaller-scale projects are explicit extensions by capabilities granted by large projects.

Exceptions

The above categories of organization (excluding individuals) will be collectively referred to as state-derived organizations (SDOs). Considering some possible specific analogues in the international system may better inform how to situate IBs.

Two exceptions within the international system come to mind. The International Committee of the Red Cross—a Swiss not-for-profit corporation with a unique authority deriving from the Geneva Conventions among states—operates with certain immunities from state laws. The Sovereign Military Order of Malta—pre-dating the modern international system and having its own air force—is considered a sovereign subject of international law. Both have at least de facto sovereign qualities but are not themselves states nor operational entities of any state. Their broad mandates, structures, inputs, and outcomes are clearly global, providing widespread social benefit, but defy categorization in the international system and are only patched in by states for interoperability.

IBs also resemble former concerns such as the Dutch East India Company or the Hudson's Bay Company, having power to: direct internal and local economies by rewarding valuable contributions; expand their mandates and influence; and negotiate and enforce standards with third parties. IBs may be exploring, developing, colonizing new cyber-territories, but IBs do not generally do so on behalf of particular states or for private financial gain.

The key difference between IBs and these few historically unique exceptions is that IBs have far fewer resources, broader operational relevance, and far lower barriers to entry than other entities in the international system. And as has been suggested, the three IBs studied are probably not unique as IBs. ASF also supports enterprise, e-mail, and database platforms used by hundreds of millions of individuals. Linux powers almost majorities of smart phones, embedded software systems, data warehouses, and institutional computer workstations. And the suite of utilities provided by the Free Software Foundation underpins application development and computer system administration for much of the above.

However, the number and diversity of potential IBs having influence in the international system must not be over-stated. Familiar SD measures of size or scale are not necessarily good indicators of a sustainable IB. Facebook employs a nonconvertible internal currency for an ecosystem of merchants, service providers, and 500 million users; claims a community governance process; and operates a critical social and industrial infrastructure for real-world networking. Facebook has no geographic territory but is reluctantly engaged by regulators on issues of privacy, censorship, and human rights in states worldwide, and operationally weakens regulation around use of personal information. By contrast, the Second Life community has 21 million residents (Linden Labs, 2010), a convertible currency (the Linden dollar), federated

and delegated separation of powers in the familiar branches, a reserve banking system, economy, titles to virtual lands, and foreign correspondents embedded by major news agencies. Independent organizations owning title to virtual lands in Second Life employ an industrial workforce to produce virtual goods, offer education through universities, host international conferences, etc., collectively imputing many of the tangible features of statehood. But Second Life avoids engaging in policy-making with states (other than submission to their regulation with respect to finances in in-game casinos, income taxes earned by real-world citizens, etc.).

Concurrently, 4chan, Cryptome, and other communities—whose members bridge underground and mainstream information infrastructure communities—sometimes aspire to influence state and corporate policy. The IBs studied have, but do not seek, operational policy-making effectiveness. Additionally, none of these other efforts are essential for international social or economic relations.

Famously, peer to peer file-sharing platforms such as Napster, then Kazaa, and Limewire claimed dozens of millions of users and strong network effects, but their practical terminations at the hands of U.S. courts over copyright issues did little to stop copyright infringement. Conversely, IBs' open and distributed natures make them difficult to eliminate through a single point of failure. But that also removes their exclusive ability to withhold their services or resources from state and corporate users of IBs' infrastructures. Apache has no technical means to order all instances of its software installed on government computers to stop running in protest.

Common Mandates, Structures, Outputs, and Outcomes of IBs

To summarize, the common mandates of IBs are to form international communities of personal expert and nonexpert stakeholders to sustainably develop and maintain particular unregulated technical and social infrastructures. Their policies meet needs of interested stakeholders for broad benefit, achieving compliance through consensus rather than enforcement.

IBs are structured to be meritocratic and agnostic to stakeholders' affiliations, relying on open, transparent, and reproducible methods documented via public proceedings. Stakeholders, rather than bureaucrats, supply the majority of viable ideas and hold the casting vote. Their work, legitimized through use, yielded policy in several domains that would reasonably fall under state jurisdiction, without explicit state permission to oversee such areas. IBs redistribute responsibility for localization and customization (local regulation) via plug-ins having real-world implications for state economies (e.g., blocking spam supporting organized crime, enabling schools to be online, evading government censorship).

Policy-making among IBs rely on much fewer points of central control than do SDOs, enabling informed and timely decisions about policy to be explicitly and clearly made with fewer resources than SDOs. IBs emulate interfaces to the international system when they must interact with that system, without being bound to the international system's rule structure or relationships. All three IBs arose independently from SDOs, but converged on a common operational pattern and distance from state interests.

If IBs' states manifest IBs purposefully, why do states not effectively regulate or control IBs? IBs' policies permit interference with intra- and inter-state commerce, aiding organized

crime, supporting national uprisings, and controlling access to state or hostile information. Under the liberal interpretation of the international system, states choose not to engage Internet policy, because that is the expressed preference of the interests of domestic society. However, to conclude "domestic society" has knowledgably expressed many substantial preferences about the Internet—based on citizens' protests against expanding online copyright legislation, or their tacit use of IBs' work—would require exaggerated interpretation. Citizens also complain about online fraud.

Any "permission" and oversight IBs sometimes obtain from states—incorporations as non-profits or small businesses in one sub-national jurisdiction—is completely mismatched to IBs' social and economic importance relative to national and international social and commercial affairs. States simply have no entity category for "incorporated volunteer stewards of global information infrastructures." This gap matters practically because states and IBs lack a mutual model through which to communicate with the other, and the gap matters theoretically, because it reveals the limits to our current concepts of IOs and their role as vehicles and subjects of policy.

However, it would be a mistake to view IBs as independent of sovereign states or the physical and social infrastructures they manifest. IBs are linked to state-derived forms by ties to physical infrastructures and to people living in states. The following sections explore a possible construction of IBs alongside the international system.

Infrastructure Builders' Potential Roles in the International System

The above empirical exploration of highly impactful policy-making information infrastructure builders provides three main foci about the nature of the international system and the role of IOs:

a. IBs share characteristics of several kinds international organizations, but do not share many characteristics of any one kind of international organization. IBs' global impact in traditional areas of state and IO concern requires careful thought about how to theorize and categorize their ongoing activities and relations.

b. IBs continue to design information infrastructures that deeply embed policy outside state involvement. By not communicating with each other, both IBs and states lose policy influence on information infrastructures on which all stakeholders rely to receive benefits of policy.

c. Citizens worldwide increasingly depend on policies set forth by the IBs' information infrastructures, and on complementary policies set forth by states' IO activities. Both kinds of organization must agree on a theory of information infrastructure to sufficiently make and evaluate policy for sustainable information infrastructures.

Revising Definitions and Categories

The idea of geographic states requires IOs' policies to act primarily via states' policies and legislation to exert influence at a distance. "International" not only requires "organization" but also implies large-scale design and planning. However, IBs and many specialist and generalist organizations operating worldwide through modern global information infrastructures break with that assumption in a scale-free way. The term "micro-multinational corporation" explicitly disclaims the depth requirement to horizontal worldwide scale.

Lessons from IOs can powerfully explain IBs' overall organization and functions. Section 2 illustrated that core IO concepts and problems of legitimacy, accountability, power relations, consensus, motives, and opportunities in policy-making and expansion all have direct analogs among IBs. From the inter-nation-al organization perspective, the leap is small to the inter-infrastructural organization perspective. We might extrapolate dynamics of the inter-infrastructural system of IBs from knowledge about the international system of states.

Well, not quite. IBs may constitute a system by virtue of interoperating on the common global infrastructure of the Internet, but states interoperating on the common global earth nonetheless require instantiating and sustaining functional institutions of cooperation. Several IBs collaborated on server name indication to solve a particular problem but did not leave behind a system facilitating sustained cooperation. Yet, the Bugzilla workflow platform developed by Mozilla is used by Apache, the Git distributed revision control tool was developed by Linus Torvalds, and several organizations now extend Jon Postel's administrative patterns as a key Internet custodian. Like authoritative RFCs, IBs' modern patchwork of collaboration and external relations systems works. However, standards to recognize key informal communications or forums remain more ambiguous than diplomatic protocols. This variability presents an opportunity to study if and how consensus emerges.

Innovation tells us how to examine entities instigating changes in practice and competition (e.g., Henderson and Clark, 1990), arising from new ideas and connections (Rogers, 1962) that diffuse new ideas to adopters (Abernathy and Utterback, 1978). IBs as outsiders introduce an innovation radical to the current configuration of international organizations by changing both components and connections. IBs exhibit the same kinds of outcomes as IOs but move more quickly, on a far lower cost basis, more transparently, with far more pervasive reach, and potentially far greater effect. From the innovation perspective, established IOs should view IBs as a threat and will defend themselves accordingly by erecting structural barriers (like seats at forums) or attempting to leverage past competencies (such as militarizing cyberspace).

International organization theory could draw upon the extensive knowledge about the *kinds* of components and connections possible in a scale-free system of international actors to identify IBs, while still searching for current alternative meanings of those components and connections to the whole. This would improve the current ontology by explicitly considering a broader and more reflective range of policy sources and influences.

From the IBs studied, a small highlight to the body of theory about international organization might claim both variety and depth of policy influence are scale-free with respect to size or complexity of organizational structures. This emphasizes the need to pay attention to small and capable organizations other than the kind that set international agendas through terror. More importantly, regardless of how IBs are classified, there is the practical need to help IBs develop competencies to constructively interact with IOs and other state-derived organizations (as well as the reverse relations).

Design for Inclusion

We conceive states jealously guarding their sovereignty—building elaborate structures to manage the outflow of sovereignty to international organizations to achieve policy goals.

Sovereignty is a means for exclusive control, but sovereignty is not the only means. IBs begin by giving away all unused exclusivity and control, and then deploy infrastructures to manage parts of their processes that emerge as critical to their value-adding activities. Both states and information infrastructure builders find an operational middle ground bearing little resemblance to their theoretical ideals. And in both kinds of cases, effective control comes to rest in the hands of a small number of individuals who are not practically obliged to act transparently or faithfully.

Modern life is increasingly shaped by non-state intangible information infrastructures rather tangible state capital and services. Value is generated nonlinearly. Each piece of information adds more than its own inherent weight as it is combined and related to other information. Control of information enhances control of influence. Previous institutional attempts, even by organizations familiar to IBs, to create controlling systems were limited in membership, scope, and legitimacy. For example, the Internet Engineering Task Force's attempts to retroactively standardize HTTP cookies on which all web-based transactions rely have been criticized as failures by IB participants (Zalewski, 2010). More recently, the World Wide Web Consortium's (W3C) work on a standard for the fifth version of the HyperText Markup Language (HTML5) has generated criticism of the process by participants, some of whom have implemented and deployed pre-standard versions of the technology despite W3C's (nonlegally binding) injunctions against doing so (Krill, 2010).

Since states cannot retroactively discard IBs, nor strongly regulate IBs or their infrastructures now as an outsider (the infrastructure is designed to prevent this), states could try to influence IBs through providing good information as partners to co-design sustainable information infrastructures. Conversely, IBs contributors and platforms must physically operate in the context of states for the foreseeable future.

The realization of the Internet Governance Forum puts the Internet in a strange place. Why, of all the recognized IOs around transport and communications infrastructures (mail, ships, planes, phones, goods, etc.) must the Internet be "governed" as though operated with some overall positive plan? Why is the venue for discussing a globally important topic an ephemeral forum having a secretariat of almost three full-time equivalent staff rather than a durable organization? Perhaps the name recognizes the Internet's state-like external nature underpinned by a very dynamic core and volunteers.

International organization theory could draw upon the infrastructure development literature (e.g., Bietz et al., 2010; Turner et al., 2006; Atkins et al., 2003) to better understand not only how and why existing systems include and exclude particular stakeholders but to also design and implement systems that better include (or exclude) stakeholders in future.

In the case of the IGF, the UN instantiated a weak member of the class of international organizations with which it is familiar. One could replace the word "Internet" with "aviation" or "vaccination" or "potable water" in the IGF mandate (Paragraph 72 of the Tunis Agenda) and arrive at accurate mandates of other international organizations. The IGF would appear to be designed around an uncharted phenomenon, not for the Internet, without considering users of the designed forum, nor long-term sustainability. Interpreting the IGF design as an enclosure bringing (some) institutional stakeholders "into the tent" (to prevent the masses from overrun-

ning the compound), we see the IGF has achieved little operational effect in several generations in Internet time since 2006. (The elite conference format is not a preferred communication option among IB participants.) Under-represented on IGF's lists of contributors (IGF, 2010, 2011) are noninstitutional members, as well as low- to mid-level contributors whose very locally oriented volunteer work sustains IBs. IGF also provides only weak accountability mechanisms to the community. Unlike the other transport and communications IOs, the IGF provides no room for legislation-backed protocols for the international transmission of data. This may be a benevolent design choice to prevent states from regulating the Internet, but it also does not meaningfully support efforts to address global Internet issues such as Internet Protocol Version 4 (IPv4) address exhaustion that will hamper every (national or otherwise) Internet penetration agenda.

Converging Concepts of Information Infrastructure

Third-party use of IB's technological outputs to affect the international system should concern both international and IB systems. Humans inject values through design and use of information infrastructures, with the consequence that IBs' outputs may be employed both for "good" and "bad" purposes at the intersections between states and IB systems. This is a concern to states and IOs, because the way to enact international policy will increasingly be through information infrastructure built by IBs: e-science, e-government, e-commerce, etc. Topics to be regulated will also increasingly arise from information infrastructures: privacy, international espionage, education, health, etc.

States have attempted to address Internet fraud, intellectual property protection, organized crime, personal identity protection, spam, security, and commercial issues through piecemeal legislation (according to their geography based theory of infrastructures) but have not gained widespread compliance (e.g., Russell, 2010) or public support (e.g., Marshall, 2010). The few notable crossovers have generally been hostile and ineffective (e.g., oppressive regimes against social media; open content authors against intellectual property holders; politicians against digital secrecy to encrypt personal files; politicians supporting digital secrecy to prevent online access to public information). Neither reacts well to innovations in the other (e.g., ACTA, DMCA, encryption and digital surveillance). These are familiar problems for IOs.

The lowest common infrastructure denominator among states was markets for goods. The lowest common denominator within and among IBs could still be the interconnectedness among suppliers and consumers but in an economy transacting information and social capital, rather than material wealth. The international paradigm fails to understand such recently recognized (although probably not new) social, cultural, and economic policy-makers and actors with goals more or differently abstract than those of the state system.

Today, both IBs and IOs rely on a common technical apparatus conceived in opposition. Yet, it works. The overlap between the two views could contain an *operational* theory of information infrastructure, but how do we tease that out? First, both IBs and IOs need to know something about information infrastructures to evaluate (potential) changes to it. Second, while IOs have tacit knowledge about how to build information infrastructures that are selectively permeable to particular information and outcomes, IBs know how to build completely permissive infrastructures.

Uniquely, IBs and IOs (taken broadly) are positioned to triangulate a theory about both large and small information infrastructures, and as important, about how to contemplate the resulting implications for stakeholders. The explicit formulation of such a theory would enhance scholarly and practical policy development and implementation pertaining to the Internet and other information infrastructures. Unfortunately, the most advanced work in information infrastructure theory, while international in content, tracks primarily the institutional use context (e.g., Atkins et al., 2003; Tilson et al., 2010).

Conclusions

This paper has argued for examining information infrastructure builders' roles in the international system. It has shown IBs share characteristics with several types of international organizations, that it conducts policy activities in areas comparable to those under IO and state mandate, and that IBs' and IOs' failure of mutual recognition threatens public policy regarding information infrastructures. Finally, it has proposed examining IBs' roles among IOs from two additional perspectives to call attention to the need to find agreement between IOs and IBs about the nature information infrastructures.

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Appendix—Summary of Cases Reviewed

Apache HTTP Server log rotation trigger (Bug 44427)

Apache HTTP server may need to record log entries at any time, but only one action may be performed on a log file at once. Externally archiving a log file requires either that the server stops to release the log files for an operation and then restart, or risk losing log entries. A trusted ASF committer proposed a policy to allow the server processes to temporarily yield control of the log file to allow copies of the records to be made. The committer worked with stakeholders to enhance the infrastructure. His proposals were accepted after an unremarkable review process. This base case followed the IBs' general patterns of proposals, work, review, and approval.

Apache HTTP Server policy to support SNI (Bug 34607)

Server name indication allows a web server to host multiple web sites on a single IP address. IP addresses are in limited supply and their use incurs fixed and reoccurring costs. For security, web site providers and users increasingly demand to encrypt their transactions. Enabling web site providers to offer secure SNI required coordinating infrastructure building efforts with several internal and external stakeholders. After the process was repeatedly stalled, the stakeholder who sought to implement SNI publically held project leaders to account, moving the process to completion.

Firefox secure connection warning (Bug 327181)

Web servers may have policies to securely encrypt traffic with users' web. Web browsers behave unobtrusively when security standards are followed, but may handle exceptions differently. A proposed policy would make security warnings more difficult for users to ignore or bypass. Predominantly U.S. contributors consulted with external authorities, as well as with European

stakeholders to understand their needs. After several iterations, a new policy was implemented that protected users as intended, but also impaired users' access to insecure web sites.

Firefox "Home" button relocation (Bug 404109)

On almost all graphical web browsers, the "home" button is conceived and used like a book-marked item in that way, but also as a standard navigation element. In the months prior to the home button being moved to enable technical advance, this policy change was not discussed in any sanctioned discussion forums but was implemented through a project leader's personal authority. The decision was reversed after much internal and public criticism from third parties whose add-ons would not work with the new layout.

Threaded Firefox windows (Bug 40848)

Modern desktop computer applications allow the user to interact with several documents at once. Competing approaches to technical implementation have different costs and benefits. Despite objective evidence from both internal and external sources of an alternative ap-proach, and strong stakeholder demand, one junior bureaucrat's personal disagreement with the alternative prevented it from being explored for several years. Senior project leaders formed a sub-project to implement the alternative under a different name, without the junior bureaucrat's involvement.

ARIN Minimum Allocation in the Caribbean Region (2008-4)

ARIN's policy is to allocate Internet protocol addresses in contiguous blocks of 4,096 ad-dresses or larger multiples to Internet Service Providers. An ISP may ask for allocations of addresses by showing efficient current or potential utilization of addresses. It is desirable to maximize the number of addresses in each allocation in order to minimize the total number of allocations since each allocation must be stored in finite memory on Internet routing hard-ware. On behalf of a bureaucrat from a Caribbean state, a stakeholder proposed to reduce the minimum allocation size to enable smaller ISPs to be established. Despite the potential to open state-run telecoms to competition from new voice over IP entrants, stakeholders did not consult any Caribbean governments before strongly approving the policy change.

ARIN WHOIS integrity policy proposal (2008-7)

Internet resource authorities assign IP addresses to individuals and corporations for use on the public Internet. Under policies pre-dating ARIN, IP addresses were allocated to many indi-viduals and organizations without legal agreements. The legal status of IP address ownership has not been strongly established. ARIN requires accurate contact information to authorize changes to technical allocation records as allocation holders legally merge, relocate, dises-tablish, reconfigure, etc. their networks. Some stakeholders proposed to require all resource holders to sign updated legal agreements in order to update technical allocation records. The policy was defeated after being rushed to a scheduled vote since the broader membership was divided about convoluted policy purposes and instruments, and out of concern for allocation holders who could not sign legal agreements on behalf of their employers.

ARIN Identify invalid WHOIS POCs (2008-7, second round)

A more complicated but more deliberated and explicit version of the above policy proposal that fully addressed stakeholder concerns was debated and approved at the subsequent scheduled vote.