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#1 *Politics after Networks*

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AGAINST NETWORKS

This is an excerpt of an article written in 2004. The long version can be found here.

What were networks? The idea that we live inside networks has become so familiar as to seem unremarkable. If we don't already perceive ourselves to be fundamentally networked creatures, we are at least comfortable with living in a "network society" or seeing a network from the "inside out" or running up against one of a thousand buddy lists, circles and networks of highly heterogeneous and diverse kinds.[1] As Knox et. al. point out, there is a remarkable lack of consistency to the various theoretical and methodological approaches to understanding "networks".[2] Different disciplines from sociology and anthropology to graph theory in mathematics all claim networks as their province without any real agreement that they are talking about the same thing. But what were networks? Are the Internet and a kinship network at all the same thing? Is the Internet a network? It seems silly to ask: but by what theory and definition should we make sense of that statement? What would it have meant for the Internet to be a network now, as opposed to 20 years ago?

Part of the confusion stems from there being (at least) two distinct theoretical modes of approaching networks, which coexist very uneasily. The first is classically structuralist: those approaches to networks that treat them not so much as ontological existents, but as structures of relations that obtain between parts. For example, social network analysis of the kind associated with early "six degrees of separation" (the pioneering work of Stanley Milgram and Manfred Kochen), 1970s anthropology, or with the graph theoretical sociology of Duncan Watts, where networks appear not just among people, but as abstract structures that describe the brains of worms, the western

1 Manuel Castells, *The Network Society*, Malden MA, Blackwell, 1996; Annelise Riles, *The Network Inside Out*, Ann Arbor MI, Michigan University Press, 2002.

2 Hannah Knox, Mike Savage and Penny Harvey, "Social Networks and the Study of Relations: Networks as Methods, Metaphor and Form", *Economy and Society*, 35(1), 2006, pp. 113–140.

electrical grid of the US, or the parlor game "six degrees of Kevin Bacon". The second might be called poststructuralist, if that term were not too distracting: those approaches that treat networks as having both an ontological character (relations among parts) and an epistemological one (a way of knowing those relations), and attempt to resolve the complexity of their interaction. In this category one might include the work of Harrison White and his students, Marilyn Strathern and her students and the broad field of Actor-Network Theory (ANT).

What the second approach reveals that the first deliberately brackets is that our theories are sometimes also objects and actors in the world – and the concept of a "network" has become just such a problematic theory. In the first approach, the proliferation of wires, waves, buddy lists, links and 'friends' is just more fodder for the analytical cannons; but in the second approach, the same proliferation became a problem as soon as there were more networks (like the Internet) than networks (like those that bind Melanesians or scientists together). As Riles demonstrated, as soon as the network becomes a common cultural resource, it can become a kind of cosmological operator: a concept that not only describes structure, but gives actors a way to extend that structure, and make sense of it in new ways. As the world is filled with new ways of networking, so changes the meaning of those connections, "imperatives to connect" and failures to connect.[3] As we saturate ourselves with tools for network making and breaking – we saturate our consciousness as well: we leave society (that 19th century network) behind and live in networks instead.

Precisely this problem of the mix-up, between a theory of networks and the proliferation of networks in life, has bedeviled the field of ANT, which emerged more or less alongside the successful proliferation of the Internet. As the tools of analysis of ANT improved, so too the Internet provided diverse new tools for thinking like a network, until by 1999, the confusion between networks and networks was so thorough that Bruno Latour suggested we should stop using the word altogether.[4]

This article proposes the opposite: the solution to the confusing proliferation of networks is not to ignore them but to use the tools of ANT to do something that, ironically, they have never been used to do: *understand the Internet itself*. The approach of ANT remains a powerful one, but one broadsided by a changing world. Understanding the

3 Sarah Green, Penny Harvey and Hannah Knox, "Scales of Place and Networks", *Current Anthropology*, 46, 2005, pp. 805–826.

4 Bruno Latour, "On Recalling ANT", in: John Law and John Hassard (eds.), *Actor Network Theory and after*, Oxford UK and Malden MA, Blackwell, 1999, pp. 15–25. He has since repudiated the repudiation: cp. *Reassembling the Social. An Introduction into Actor-Network-Theory*, Oxford UK and New York NY, Oxford University Press, 2005.

Internet the way ANT does, would mean exploring it as a contest to create a particular kind of universal that allows knowledge and control to be fixed, circulated and extending throughout the planet. But the production of global networks can happen in many different ways and *the Internet is not the only kind of network, but it is currently the only one of its kind*. Or to put it differently, ANT and other approaches have been content to think of networks as having one form: *anynetworkwhatsoever*. But to explore networks using ANT reveals that networks are fragile achievements of diverse kinds: *this network here*. The Internet, in its mammoth and sudden success as the *de facto* network everyone must encounter, is not any network whatsoever, but a specific kind of achievement – one that can be understood as a particular kind of universal.

ANT might urge us to treat the Internet as a "black box" – a settled and sealed fact that stands in as nature and only emerges from the box when a controversy appears. But this would be a red herring of sorts: the Internet is far from settled the way scientific facts are – and this is part of its power. Instead, I propose treating it as a *brown box* – the metaphor of the humble cardboard box, replete with packing slips, bar codes and tracking systems, is more appropriate to understanding the difference that the Internet makes. The Internet is a specific kind of accomplishment that produces a specific kind of universality (often heralded in its claims to openness, extensibility, the "end to end" principle, net neutrality, etc.). What's more, it is the only one of its kind – it is singular and its singularity is dominant over all kinds of other networks. It is the brown box in which all our black boxes are delivered.

SCIENCE STUDIES' NETWORKS REVISITED

For almost 20 years, ANT and Science and Technology Studies (STS) have been using the word "network" to help explain how the embodied material, active work of scientists and engineers could be related to the knowledge produced without relying on a language of logical structure or conceding to the philosophers of science the proper description of the growth of knowledge. Although the approach is often referred to as theoretical, it is really more of a method than a theory of anything. Perhaps the most detailed expression of this method is the book *Science in Action* by Bruno Latour. It is a "how to" book: "how to follow scientists and engineers through society". Critically and philosophically speaking, the book has clearly been important – love it or hate it, it has challenged the standard practices for studying science and engineering

(along with a host of other works and approaches in sympathy with it).[5] The approach consists primarily of a series of questions and tactics ("rules of method") for following scientists, engineers, the machines they employ, the inscriptions they produce and the statements they deliver as they "discover" (come to know an/or assert) facts over time.

Latour suggests that the work of making people *know* the truth is a massive, expensive, complicated endeavor that involves much writing, testing, experimenting, arguing and demonstrating – and one that is coeval with the very investigation of nature or society itself. It is an endeavor that proceeds bit by bit, standardizing the ways in which the world is measured, represented, and discussed. As it proceeds and expands, more and more people are convinced and come to know the truth – because they can no longer make their own beliefs (magic, crystals or folklife) stand up to the arguments and tools of science and technology. For Latour, the word that captures this power is *network*.

The word network indicates that resources are concentrated in a few places – the knots and the nodes – which are connected with one another – the links and the mesh: these connections transform scattered resources into a net that may seem to extend everywhere.[6] Those considered irrational, or trapped in misrecognition are so for no other reason than that they are not yet in the network – they fall through the mesh, at least until the so-called digital divide (the network) is sutured up in order to include them. But those outside the network of science and technology do not exist in some kind of pre-network homogeneity – they too have their own networks – all the world is but networks! And to extend the network of science and technology, those in it must struggle against and overcome other more or less powerful networks. Thus can the entirety of science (and many other endeavors) be described in this fashion – theories are built of facts, machines and ideas that are in turn made of other theories and facts and so on which are standardized and made to be mobile throughout the network – and as this network expands, more and more of the world seems to belong to it.

In the same way that the concept of the black box is meant to displace the terms theory, fact, data, experiment, even science (as *a priori* theories of what science consists of), the concept of the network in science studies has been employed to displace the classical terms of society and social theory: agency, structure, kinship, roles, individual, social group, class, relation, etc. That is, rather than beginning an analysis with these terms as the defining groupings, Latour urges us to

5 Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society*, Cambridge MA, Harvard University Press, 1987.

6 Latour, *Science in Action*, p. 180.

dive into the mess of the world, with only the network tool in hand, and explore what people are doing, including what they are doing with terms like kinship, social relation or agency. In some ways it is simply an urge to be more scientific – but not by mimicking scientists.

The "network" of science studies is distinctive for two reasons: first, the networks of science studies consist *only* of relations, nodes emerge based only on the links formed – it was not intended to be a classification, or an arrangement of ontologically stable objects – as a result, the claim goes, they therefore come with no predetermined categorical associations that would determine the structure of scientific action or knowledge; they do not privilege humans at the nodes over machines, animals, statements, documents, formulas or organizations. Networks are material, traceable, and phenomenal – but they are not to be mistaken for the world, they are the tool that the analyst uses to make sense of the world. "Network" is the word that will stand for the analysis of pure relation, pure becoming, in a complex, technical world.

The second reason this version of "network" is distinctive is that it emphasizes the role of translations. Actors or machines or statements which emerge as a node can be transformed (translated or transduced) by having old links severed and new ones created, thus both changing the nature of the thing at that node, and translating the meaning, power, or interests of the other nearby nodes in the network. Because the "network" is pure relation, it is not the sink, but the source of meaning – for both actors and analysts. Michel Serres' notion of "northwest passages" that exist between ideas, disciplines or people or of "irreductions" or later of "transductions" give analysts a way to follow the development, transformation, borrowing and growth of knowledge through these empirical pathways, rather than strictly through the cognitive claims for either a logical structure of scientific knowledge or a scientific method unfolding irrevocably, independent of place, tools, times, or people.[7] It is a process-oriented social analysis, but at least in its most abstract form, one that relies heavily on a set of very common-sense terms: network, actor, translation and relation.

INTERNET KILLED THE NETWORK

Fast forward twenty years. If "network" was not confusing to begin with, then it should be by now. Today, network means the Internet – or a handful of other information and communication technologies we live in. The kinds of relations that can exist on a network (we now say

7 Latour's ontological forays are set out in the second part of *The Pasteurization of France*, Cambridge MA, Harvard University Press, 1988, which builds on the work of Michel Serres (especially, the five volume *Hermès* series) and more generally on Saussurian and Greimasian linguistics), cp. Roar Høstaker, "Latour – Semiotics and Science Studies".

"on" more often than "in") consist only of communicative ones, and any classic metaphysical notions of knowledge, ideas or concepts have been neatly replaced by that of "information". Even the more tangible, logistical networks such as those of shipping companies have been subject to a creeping redefinition, as for instance, UPS, which now does as much business consulting in the creation of logistics and tracking software systems as it does in shipping real objects. This fact has not escaped the attention of the wise and humble Latour:

> "This is the great danger of using a technical metaphor slightly ahead of everyone's common use. Now that the World Wide Web exists, everyone believes they understand what a network is. While twenty years ago there was still some freshness in the term as a critical tool against notions as diverse as institution, society, nation-state, and more generally, any flat surface, it has lost any cutting edge and is now the pet notion of all those who want to modernize modernization. 'Down with rigid institutions', they all say, 'long live flexible networks'.
>
> What is the difference between the older and the newer usage? At the time, the word network, like Deleuze and Guattari's term rhizome, clearly meant a series of *transformations* – translations, transductions – which could not be captured by any of the traditional terms of social theory. With the new popularization of the network it now means transport without deformation, an instantaneous, unmediated access to every piece of information. That is exactly the opposite of what we meant. What I would like to call 'double click information' has killed the last bit of critical cutting edge left in the notion of network. I don't think we should use it anymore."[8]

So, what were all these sociologists and historians saying? Lovestruck with the anti-essentialist methods of the late 20th century, besotted with anti-flat topologies, smitten by gauzy seductive images of transduction… were they actually talking about networks, or were they talking about something different… perhaps *networks*? Twenty years earlier, the concept of "network" had rhetorical force as a replacement, perhaps, for any broad *a priori* concept of "social relations". The sexy new "network" of 1985 did not come with any of the monkey histories of structure, agency, nationalism, society, gender, race, or class on its theoretical back. Twenty years earlier, the network was an obscure object of engineering desire – something normal people around the world did not touch, depend on, interact with, fall in love on, get downsized by, or become addicted to.

8 Latour, "On Recalling ANT", pp. 15–16.

In the good old days of science studies, digital software and computer networks were one or two technoscientific objects among many. But by now, it has become clear that the digital computer was never just one technical object among many. No self-respecting laboratory, no serious engineer, no ambitious graduate student would be caught dead conducting experiments or building bridges or learning calculus without one. It is the ultimate "black box" hooked up to a comprehensive, complex and dynamically interconnected collection of humans and machines that, as Latour laments, is exactly the opposite of what we theorists meant by the term network; now it means the circulation of information without deformation.

But is this repudiation disingenuous? If "network" was cribbed from the emerging technical fields whose objects were lines and nodes and cables and routers and protocols and software and clicks and keyboards, how in the world did the *real* network of the World Wide Web turn out to be the opposite of what science studies saw in this metaphor? From where did this other, debased meaning come – and why is it being applied to the *real* World Wide Web rather than the analytic "network" of Actor-Network Theory? Furthermore, can we honestly simply dismiss it and insist that people understand network differently – or stop using the word? Historically speaking, technical networks were *never* about translation, transduction or transformation – from Claude Shannon onwards they have always been positively obsessed with the minimization of noise, the absolute replication of the message, and about the full exploration of the metaphysics of information as a replacement for any notion vaguely reeking of "spirit" or "idea". Just because Bruno Latour and friends *want* it to mean something else, does not mean that, Humpty Dumpty style, it could have.

Part of the confusion here stems from the distinction between those networks that are obviously tangible (cables and roads and railways) and the ideas, concepts, knowledge, laws or information that occupy a central, but intangible, role in modern society. Latour suggests that we find it easy to understand the concept "network" when one thinks about trains or telephones, but somehow harder when we think of ideas, facts or knowledge. But, he suggests, there should be no difference for these things:

> "The itinerary of ideas, knowledge or facts would have been understood with no trouble if we had treated them like technological networks… The itinerary of facts becomes as easy to follow as that of railways or telephones, thanks to the

> *materialization of the spirit that thinking machines and computers allow*."[9]

In this passage, "network" is both the real network and the Actor-Network network; indeed, the very reference to "materialization of spirit" puts Latour squarely in the same camp as those earlier theorists of networks: the cyberneticians. For Norbert Wiener or Claude Shannon or even Gregory Bateson, communication and control are not achieved through ideas and knowledge, but are strictly material phenomena. Ideas, knowledge, information and communication can be – indeed must be – tracked, traced, circulated, and circulated again through physical media (whether this means voice or print or electrical charge) in order for it to have any meaning at all. For the cyberneticians, there is in fact no other network than that of the telephone (understood as the model medium of all human communication and control) – all else is metaphysics.

Latour's rash decision to abandon the word (which he has since repudiated) may have come about because of the proliferation of different kinds of networks – and in particular, because of the very distinctiveness of the Internet (on which the World Wide Web depends): ANT's networks were *general* – they allowed us to follow *any network whatsoever* – whether that means a specific technical system, or a "network" of face-to-face interactions, or a network of citations in an article or handshakes at a conference. The approach is totally agnostic about the particular kinds of connections that might be followed. It gives us a rich philosophical approach – an ontological politics, or an ontological choreography – for understanding contemporary society.[10] The Internet, by contrast, the "materialization of spirit", does not belong to ANT. Rather it is a common feature of the modern world, and one that exists in specific, particular ways: *this network here*.

The reason the confusion persists, I would suggest, is that "network" remains the right word. "Network" not only allows analysts of science and technology to get around concepts like agency and structure, or social relations, or institutions, as Latour suggests, but it also provides a way to capture how science and technology can be local and global at the same time. It presents a way to tackle the tricky issues of *scale*. But the crucial difference is that the Internet is not the ANT network, but one crucial component of that ANT network. Instead of abandoning the word, however, perhaps we should be bravely asking

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9 Latour, *We Have Never Been Modern,* Cambridge MA, Harvard University Press, 1993, p. 119, emphasis added.

10 On ontological politics, cp. John Law, *Aircraft Stories: Decentering the Object in Technoscience*, Durham, Duke University Press, 2002; Anne Marie Mol, *The Body Multiple: Ontology in Medical Practice*, Durham, Duke University Press, 2002; Charis Cussins, "Ontological Choreography: Agency Through Objectification in Infertility Clinics", *Social Studies of Science*, 26, 1996, pp. 575–610.

which networks for what goals? We should be investigating not only the particular configurations that rely on networks, but the networks themselves. One powerful reason for exploring the *this network here* as an ANT network is that some people might prefer *that network there* instead. And if networks can resist as well as enable, and if people must choose between them, then we are confronted anew with questions of ethical and political weight: how shall we network?

These are issues that have all been raised as the Internet has proliferated through almost every realm of life and practice in the world. The emergence of open source and free software, debates about Internet names and numbers, questions of open access, digital rights management technologies, identity theft, security technologies, viruses and worms, and a host of other issues should all be understood as debates about this particular network – the Internet – and the way in which it should be configured to enable or disable the activities that we are all so familiar with thanks to the extensive work in science studies. If *facts* needed to be explained by getting empirical and jettisoning presuppositions about the cognitive structure of science, then perhaps it is time to get empirical with *networks* and to jettison presuppositions about their connections and seams, their fluidity or stability, their matter or form, or their structure, history, and evolution. Perhaps it is time to open the *brown box* instead.

BROWN IS THE NEW BLACK

Instead of the canonical black box of scientists and engineers and economists and STS, consider the humble but ubiquitous brown box – the paradigmatic object of trade. Brown boxes come in all sizes, from jewelry box to shipping crate. Brown boxes do not have slots labeled in and out, nor do they remain closed until a controversy rends them; in fact, someone is *meant* to open a brown box. Unopened and abandoned brown boxes are cause for alarm and should be reported to the authorities immediately. Whereas the contents of black boxes are stable, standard, replicable and reliable and no one asks about them anymore. A brown box can contain nearly anything, singular or mass produced, irreplaceable or not. In fact, it is not the contents of a brown box that are reliable – it is the box itself. What is in the box is generally not the responsibility of those who transport it, but the concern of customs agents, police, departments of homeland security, and above all, consumers.

Brown boxes, furthermore, are not all the same. They come with specific data, usually encoded on the box somehow: sender, addressee, postage, cancellation, barcode, tracking number, bill of lading, notice of receipt, a customs form often bearing the cryptic, but portentous, word

"gift" (a brown box can be a gift, whereas a black box is never a given). Brown boxes themselves do not malfunction, despite being labeled "fragile" – though they do occasionally disappear or "die" (dead letter office), or get "repaired" by the postal service. Depending on what is written or encoded on it, where it is, and where it has been, the brown box represents a real instance of an extensive, specific, labeled, owned and operating network. Further, it is not only tangible brown boxes that are included here, but the figure or template as well: the "packet" of information, encapsulated in headers that determine its route, its lifetime, its size and importance.

Brown boxes are not combined in the ways black boxes are, they are usually singular and enumerable and non-fungible. Even if one box contains 25 copies of *Science in Action*, another box that contains 25 more copies is still a *second* box, and this makes all the difference to bookstores, students and professors of science studies, and most of all, Harvard University Press. "Brown box" (as a conceptual tool) suggests that we ask questions similar to those that the black box allowed us to ask – but to be specific about the *particular networks* through which objects, humans, facts, knowledge, data etc. travel. Look not for the generic network, but for the postal systems, freight routes, trucking routes, CB, radio, telephone, telegraph, logistics, supply chains, USPS, UPS and Thurn and Taxis, Visa, MasterCard, American Express, Federal Express, Pony Express, SeaLand, underwater cables, low earth orbit satellites, shipping lanes, spice trades, merchant marines, routers, hubs, service providers, accounts and passwords and so on. Furthermore, do not look for what is invariant about all networks – lines and nodes and relations and graph structures – look for the differences, because these are what need explication.

Looking at brown boxes, looking at *this network here,* provides the researcher with a way to understand the particular *systems of representation* in use in that network. The very simple technology of a packing slip is such a system: contents, price, weight, seller, buyer, shipper and insurer. These systems of representation are little shared languages, *programmed languages*, structured means of representing particular activities, particular networks of action with limited function and extension – whether trade or communication or diplomacy or science. They are intermediary languages – languages in which two people (or machines) who may be unknown to each other can communicate precisely and efficiently; the more correspondents who learn this little language, and who agree to use it, the bigger the network gets. Brown boxes are thus preceded by and leave in their wake documents and inscriptions of specific kinds: codes and data, tracking numbers, zip codes, packing slips, bills of lading, customs forms, control and messaging data, "pings" and "pongs", logs, styles of address, rules of creation, packing,

labeling, handling, insuring, financing, shipping etc. The Internet is a flexible meta-system of representation, in this sense, capable of managing each and every one of these heterogeneous systems, if only they submit to a modicum of *standardization.*

As opposed to this, in laboratory science, and specifically in a Latourian light, there can be only *one* successful standard – someone has to win. Either black box A, which works reliably with all the others, is the right way to do it, or black box B is, and as *Science in Action* demonstrates, a great deal of struggle goes into producing a winner.[11]

From the perspective of the early 21st century, however, a winner in a standards contest is not always necessary. There can be UPS *and* FedEx – two networks with two different systems of representation, which are not to be confused (if you want your package delivered). Apple *and* Microsoft. TimeWarner *and* Comcast. More and more, there are multiple possible systems of representation and multiple networks for the same purposes (shipping, communicating, transferring money, keeping track of inventory etc.). The differences between these networks are important to understand, if there is any hope of capturing the political and economic meaning of these multiple networks.

In fact, if we broaden the view of STS beyond questions of socio-technical difference to political and legal difference, it becomes clear that there are different demands on networks. Regulation, and in particular, antitrust policing, are an essential component of modern networks: there *must be* more than one network in order to have competition at all. If a single corporation controls the extent and spread of a network – think AT&T pre-1984 – then they are a monopoly. Where competition between facts (between black boxes) in science is expected to result in a winner, competition between networks (between brown boxes) is not – or at least not in the same sense (a "market leader" perhaps, but never one who monopolizes a product, a service, a system of representation).

The brown box is thus a good analytic device for connecting questions about the relationship of extensive networks (whether in science or other realms) to questions of the political and legal organization of governance. Infrastructures like national electrical grids or local water systems were historically not "brown boxes": they lacked systems of representation. But today, the ability to track and monitor older infrastructures, to standardize them in new ways and to essentially "invert" them into information infrastructures, or meta-infrastructures, is increasingly subject to both investigation and contest. Paul Edwards

11 The Latourian ontology is built on "trials of strength", as in *Pasteurization of France*, an approach much critiqued – cp. Donna Haraway, *Modest_Witness@Second_Millenium*, New York NY, Routledge, 1997.

has captured it succinctly by suggesting that the Internet has become the "infrastructure of infrastructures" – that one information system through which it is possible to monitor and track, standardize and control the others. While there is truth to this assertion, it begs the question of what exactly it is that gives the Internet this power, what makes it a system appropriate for such monitoring and control, and not any other? In short, what makes it so *singular?*

TCP/IP, OSI AND THE SINGULARITY OF THE INTERNET

One important reason that there is currently only one Internet is that, ironically, it has emerged from a remarkably plural mixture of state, corporate, military, university and amateur innovation and participation as a kind of experiment from which no one, for any reason, was explicitly excluded. The result is that it has to date belonged to no one (or no one for long), and therefore raises new and unfamiliar questions about who built it and why, and about the relationship of organization to coordination.[12] It is not self-evidently a nation, a government, an agency, a corporation, an organization, an institution, or a technology. Yet over the last thirty years, the Internet has increasingly become the *de facto* tool for *interconnecting* multiple, diverse, real networks, nations, corporations etc. It lets humans engaged in particular activities achieve coordination through standard systems of communication, designation, and specific, highly circumscribed systems of representation and translation. In fact, it is better understood not as a network, but as the name suggests, an "internetwork".

As an "internetwork" it brings different objects (with different functions) and different groups of people (with different goals) into a common space of communication and control. To join, these heterogeneous groups must make a sacrifice to homogeneity and coordination, but in return they are connected to everyone else willing to make this same sacrifice. This interconnection is both technical and social – different groups understand the value of being connected to the same resources in different ways, but find the necessity of agreeing on the form of connection to be (almost) universally valid.[13]

But the Internet also *disintegrates* in new ways. The same Internet that allows for coordination also allows for more dynamic *separation*

12 The Internet was never simply a military technology, but a complex undertaking among diverse actors. Far too much is made of the Internet being a military network, as if this were an obvious indictment, implying that it therefore contains all sorts of insidious, bellicose or imperial characteristics that the world of happy WWW uses surf over in ignorance.

13 The design of the Internet, in particular, of the protocols which are meant to govern how implementations of pieces of the Internet should be built and operate (TCP/IP) were first laid out in Vinton G. Cerf and Robert Kahn, "A Protocol for Packet Network Interconnection", *IEEE Transactions on Communications*, 22(5), May 1974.

(intranets, firewalls, encrypted channels, corporate-only VPNs). Rather than building such separate networks from the ground up, however, the Internet provides the platform by which a potentially common space can be carved up through the instantiation of particular software or network configurations – so long as those universal forms of connection at the core remain stable enough. Likewise, different groups find the ability of the Internet to achieve flexible disintegration to be extremely powerful when it comes to issues of privacy, security and property. In the terms of the earliest design documents of the Internetworking protocols, the principal goal is to maintain administrative boundaries while allowing maximum resource sharing.

The flexibility of the Internet to both integrate and disintegrate – to *interconnect networks* – and to do so relatively dynamically through the creation of software and networking protocols, rather than through massive investment in capital goods or the creation of new organizations, is what makes it distinctive, what makes it a very special kind of brown box, with its own system of representation. At the heart of this technical and social object is a series of contested and changing protocols – protocols whose peculiar history has rendered them standard and nearly ubiquitous – a network (in the technical sense) rendered universal as a Network (in the sense of ANT).

The history of the Internet and its protocols is the history of a *process* of making networks universal – the history of a standards process bootstrapped out of social practices common among the early creators of the system, chief among them the TCP/IP Protocol of Cerf and Kahn and the system for creating and distributing "Requests for Comments" (RFCs) which allowed distributed users to work on rapidly evolving *implementations* which would eventually become *standards*. This model was opposed to a process of standardization recognized as nationally and internationally legitimate, consensus-driven, expensive, and complete – overseen by the Geneva-based International Standardization Organization (ISO) – and its resulting protocol the Open Systems Interconnection Reference Model (OSI). While ISO and its OSI standard represented the legitimate, international, and largely successful model of creating technical standards for use across industry and government, TCP/IP was developed in a much looser, ad hoc manner that privileged the work of private actors (both corporations and individuals) over state actors. The result is a radically different style of planning – by developing a loose collection of goals, which might be ordered differently in different contexts (TCP/IP) as opposed to the rational planning goal of completeness and consensus.[14]

14 The story and significance of the TCP/IP protocols has been told in several places: Janet Abbate, *Inventing the Internet*, Cambridge MA, MIT Press, 1999; Peter H. Salus,

The TCP/IP protocols are often referred to as enabling "packet-switched" networks, but this is only partially correct; the real innovation of this set of protocols was a design for an "internetwork" – a system that would interconnect several diverse and autonomous packet switched (or even circuit-switched) networks together, without requiring them to be transformed, redesigned or standardized. The explicit goal of TCP/IP was to share computer resources – not necessarily to connect two individuals or firms together, or to create a competitive market in networks or networking software. "Resources" meant specifically memory and computational power, though access to data and programs was clearly also crucial. Sharing between different kinds of networks implied allowing the different networks to develop autonomously (as their creators and maintainers saw best), but without sacrificing the ability to continue sharing. The "ground rules" for such a system therefore included that 1) no changes would be required of each network internally in order to connect to the Internet; 2) communication was "best effort", meaning that packets which were dropped or disappeared would simply be retransmitted (rather than requiring a permanent connection between two machines); 3) a special "black box" computer, called a gateway, would form the connection points between networks, and it would retain no information – simply route the information back and forth between networks; and 4) there should be no global control at the top level.[15]

Years later, David Clark, Chief Internet Engineer for several years in the 1980s, gave a much more explicit explanation of the goals that led to the TCP/IP protocols. In particular he suggests that the main overarching goal was not just sharing of resources, but "to develop an effective technique for multiplexed utilization of existing interconnected networks" and more explicitly stated the issue of control that faced the designers: "Networks represent administrative boundaries of control, and it was an ambition of this project to come to grips with the problem of integrating a number of separately administrated entities into a common utility." The need for a system that maintained autonomy of control while at the same time allowing for resource-sharing and communication, determined not only the design of the system, but the *order* in which the various goals would be prioritized. Clark lists seven goals for TCP/IP:

Casting the Net: From ARPANET to INTERNET and Beyond, Halbergmoos, Addison-Addison-Wesley, 1995; Alexander Galloway, *Protocol, or How Control Exists after Decentralization,* Cambridge MA, MIT Press, 2004; Gerald W. Brock, *The Second Information Revolution*, Cambridge MA, Harvard University Press, 2003; Robert Kahn et. al., "The Evolution of the Internet as a Global Information System", *International Information and Libraries Review*, 29, 1997, pp. 129–151; and David Clark, "The Design Philosophy of the DARPA Internet Protocols", *SIGCOMM '88 Symposium on Communications Architectures and Protocols*, August 1988, pp. 106–114.

15 Adapted from Kahn et al., pp. 134–135.

> "1.Internet communication must continue despite loss of networks or gateways.
> 2. The Internet must support multiple types of communications service.
> 3. The Internet architecture must accommodate a variety of networks.
> 4. The Internet architecture must permit distributed management of its resources.
> 5. The Internet architecture must be cost-effective.
> 6. The Internet architecture must permit host attachment with a low level of effort.
> 7. The resources used in the Internet must be accountable.
> This set of goals might seem to be nothing more than a checklist of all the desirable features. It is important to understand that these goals are in order of importance, and an entirely different network architecture would result if the order were changed."[16]

Clark's focus on the ordering of goals is important for understanding why the Internet ended up looking so different to other networks that existed throughout the 1970s and 1980s – but it does not quite explain the reason why TCP/IP eventually triumphed and became the *de facto* standard for Internetworking around the globe. It also helps orient an understanding of why "openness" can be understood as a goal, since 2 and 3 above are both explicitly concerned with diversity and interconnection at the expense of either accountability or cost-effectiveness (5 and 7). Clark's expression of this ordered set of goals helps make sense of the struggle with OSI, which might be said to represent a different ordering of these goals and others (such as "comprehensiveness" or "completeness").

CONCLUSION

The struggle between OSI and TCP/IP would be a classic case of controversy in STS, like that between NTSC and PAL or AC and DC, except that the TCP/IP is not a national standard of any kind: it is a *de facto* standard that has leapt over the hurdles in place to make a network universal in the classic terms of ANT. The open and extensible process of improving the Internet, and the political and economic background of regulation, antitrust and the process of international consensus standardization has meant that the Internet is a qualitatively different kind of network – in both the ANT sense and the more colloquial sense. As the example of Clark's ordered set of goals makes clear, at

16 David D. Clark, "The Design Philosophy of the DARPA Internet Protocols," in: William Stallings (ed.), *Computer Communications: Architectures, Protocols, and Standards, 3rd ed.*, Los Alamitos, IEEE Computer Society Press, 1992. Originally in: *SIGCOMM '88 Symposium on Communications Architectures and Protocols*, August 1988, pp. 106–114.

stake in this struggle are fairly clear orderings of values – a clear recognition in fact, that technologies represent the instantiation of values (rather than their absence) and that one ought to get clear as soon as possible which values are most important. In the case of TCP/IP those values were interconnectivity, extensibility, robustness, and respect for administrative boundaries, and in many ways the implications of these values are visible in the world we live in today: Web 2.0, blogs and wikis, Free Software and Open Access etc. The fact that other goals – security, accountability and cost – were not at the top of the list also has implications: spam, identity theft, and net neutrality for instance.

Perhaps the most important implication, from the perspective of ANT, however, is that what this new world of networks reveals is the possibility – indeed the necessity – of choosing one kind of network over another. ANT's studies of science and technology were very effective at showing how the "materialization of spirit" rendered possible by software and networks allows us to chart and track the spread of a network – the way facts are forced around the world through hard work rather than raining down from a Platonic sky. Similarly, the Internet's success should demonstrate to ANT that not just any network can achieve this success, and that the factors – political, economic and metro logical – contributing to the success of a network, are what need to be made visible so that the values that undergird one kind of network can be clearly displayed next to those of another.

Opening the "brown box", therefore, implies more than simply showing that networks are "socially constructed" – or even that they are "constructed" since such an assertion would border on the absurdly obvious. Opening the "brown box" implies demonstrating how the goals and interests of the builders of networks are intertwined with the functions and goals of those networks themselves (if they can even be said to have functions and goals). It is to ask how the political and ethical ideals of the past (how shall we live) are transformed within and through these complex technological systems (how shall we network, what shall our infrastructure be? How shall it control, or be controlled?). It is therefore also a question of the nature of political community after the Internet.