Against Networks[1]

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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 a t 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 heterogenous and diverse kinds.[2] Networks have their own art forms (Martin Dodge, Mark Lombardi) and their own hidden histories, but as Knox et.al point out, there is a remarkable lack of consistency to the various theoretical and methodological approaches to understanding "networks."[3] Different disciplines from sociology and anthropology to graph theory in mathematics all claim networks as their province without any real agreement that

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[2] Manuel Castells *The Network Society*, Blackewll, 1996; Annelise Riles *The Network Inside Out*, Michigan University Press, 2002.

[3] Penny Harvey, Mike Savage and Hannah Knox, "Social Networks and the Study of Relations" *Economy and Society* 35(1) 2006:113-40.

they are talking about the same thing.[4] 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

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[4]This paper deals primarily with work in Actor-Network theory, which has become a popular locus of
attention for anyone studying "networks"--but which is often (willfully, perhaps) ignorant of other
approaches. Any map of network approaches should include the work of Barry Wellman or Stanley
Wasserman in sociology, see *Social Structures: A Network Approach* (Cambridge, UK: Cambridge
University Press, 1988); Stanley Wasserman, Peter Monge and Noshir Contractor *Theories of
Communication Networks*, Oxford University Press, 2003; Stanley Wasserman and Katherine Faust, *Social
Network Analysis: Methods and Applications*, Cambridge University Press 1994. Similar trends towards
using networks as analytical tools seem to have prominent genealogies in many disciplines stretching
back to the oddly compelling studies by J. Moreno on social networks, "sociometry" and "psychodrama",
see especially *Who Shall Survive? A new approach to the problem of human interrelations,* (Washington D.C. :
Nervous and Mental Disease Publications, 1934). Network analysis caught fire in the 1970s after a
prominent study by the social psychologist Stanley Milgram (the "small world" experiment) and its
extension and exploration by Ithiel de Sola Pool and Manfred Kochen at MIT, see especially *The Small
World*, ed. Manfred Kochen, (Norwood, NJ.: Ablex Publishing, 1989). The concept of a network was
drawn less from engineering than from an even more rarified mathematics: graph theory, which helped,
or hurt, depending on your view, social theorists to calculate complex structures of relations by using
nodes, ties and block diagrams. Since about 2000, there has been a huge and very sudden revival of
interest in "network theory" as evidenced by a maxi-spate of popular books such as Albert-Laszló
Barabási, *Linked: The New Science of Networks* (Cambridge, MA.: Perseus Pub., 2002), Duncan J. Watts, *Six
Degrees: TheScience of a ConnectedAge,* (New York: Norton, 2003), Mark Buchanan, *Nexus: Small Worlds and
the Groundbreaking Science of Networks (*New York: Norton, 2002) or Steven Strogatz *Sync: The Emerging
Science of Spontaneous Order*, (New York: Theia, 2003). Predictably for popular science books, none of
these books make any mention of previous work done in social science (especially not Actor Network
Theory) beyond the canonical studies by Stanley Milgram, Ithiel de Sola Pool, and Manfred Kochen.

approaching networks which co-exist 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. Hence, 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 electrical grid of the US, or the parlor game "six degrees of Kevin Bacon." The second might be called post-structuralist, if that term weren't 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. 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 is 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.[5] 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 Actor-Network Theory (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.[6]

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

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[5] Sarah Green, Penny Harvey, and Hannah Knox, "Scales of Place and Networks" in *Current Anthropology* 46 2005:805-26.

[6] Bruno Latour, "On Recalling ANT," in John Law and John Hassard eds, *Actor Network Theory and After* (Oxford, UK ; Malden, MA, USA : Blackwell/The Sociological Review, 1999: 15-16). He has since repudiated the repudiation cf *Reassembling the Social*, Oxford University Press, 2005.

differently, ANT and other approaches have been content to think of networks as having one

form: *any-network-whatsoever.* 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 scientfic 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, Actor-Network Theory (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 ("actor-network *theory*'), 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).[7] 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 and/or assert) facts over time.

Science in Action paid careful attention to the details of science (using several core examples from chemistry, molecular biology, computer engineering, the history of navigation) and to the practices of scientists and engineers in both their everyday activity and in the non-human materials they work with (papers, machines, living and non-living objects, abstractions and inscriptions). Among the conceptual terms in the book, perhaps the most well-known is the concept of the **black box**. Students confronted with Latour for the first time inevitably pick up on this concept immediately, perhaps because it is not a philosophical but an engineering concept: an opaque box, which takes input of some kind and transforms it into output of another. In engineering terms, it is a tool of simplification. Inside the black box, a complicated circuit that amplifies, transforms, inverts, or otherwise fondoculates a signal and outputs a new

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[7] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society,* (Cambridge, MA.: Harvard University Press, 1987).

one. How it does so is much less important than the ability to reduce cognitive complexity in

favor of practical complexity: to string together a number of such black boxes to create a

complex system that achieves some goal based on the simultaneously real existence of materials

and the theoretical claims instantiated in the various black boxes. The black box represents a

modicum of certainty. It is a point of trust. It reduces the risk of making related claims in a

chain of reasoning or the risk of cobbling related components together in an experiment. It can

be left alone or expected to speak for itself; it can be built upon to create new black boxes, test

others or sit on the shelf waiting for the creative scientist or engineer to employ it. It can be

broken open in case of controversy, and its contents disputed until the disagreements of

scientists and measurements are settled—or new "paradigms" required. It represents the

claims of scientists and it remains firm but mobile (Latour's most elaborated version is the

"immutable mobile" or the "mediator").[8]

Of course, while real black boxes exist only in airplanes (which share an eerie, but

entirely accidental similarity to the fact-as-black box), the social scientist's black boxes are

conceptual tools—convenient labels that allow the analyst to jettison—or only casually employ—

the freighted terms handed down from the philosophy of science: theory, data, experiment,

reality, technology, logic, genius. The *concept* of a black box has the advantage that what it

describes (a fact) does not depend on the reasoning capacities of any particular human for its

existence (what Latour refers to as the "cognitive explanation" of facts) but instead represents a

contingent conglomeration of people, materials and ideas that in turn coordinates other actors

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[8] See Bruno Latour, "Drawing Things Together," in *Representation in Scientific Practice,* ed. Michael Lynch and Steve Woolgar (Cambridge, MA.: MIT Press, 1990); and Bruno, Latour, *We Have Never Been Modern*, (Cambridge, MA.: Harvard University Press, 1993).

and other objects. Black boxes give the analyst a way of understanding the means by which facts can be both durable, efficacious aspects of science and engineering, and *at the same* time the history and the problematic that gives rise to them, without needing to pronounce upon, or pledge allegiance to their universal truth. They provide a way of describing science and society *symmetrically*, rather than relying on *a priori* assumptions of directions of influence or of cause and effect. It has proved as effective for understanding scientific failures as for the successes. Rather than insisting on the solid, irrefutable homogeneity and given-ness of The Fact, the concept of the black box allows us (scientists) to seal up and hide from view the variety of actions, materials, ideas, and histories that have (through a series of always fascinating and usually dramatic contests) given the fact its very appearance of irrefutability. The fact that facts appear to be true is not a feature of the facts, or of nature, but of the tremendous *work of connection (*hence, perhaps, net-work) that renders them stable over a particular time and place. Facts contain worlds and make new ones.

Such a description is largely a negative one: it says "facts are not universal truths in the way that epistemologists and scientists assert that they are, although they are no less efficacious for that." The epistemologist's version (and this is usually a straw epistemologist in most science studies) suggests that facts are truths about nature that are everywhere true. For the sociologist or anthropologist, this epistemology sets up an unacceptable divide between those people who *know* these truths, and others who *believe* something else, something wrong or irrational. These could be exotic African natives with magical beliefs, or new-agers with their crystals, or under-educated poor people easily manipulated by propagandistic mass media. In this version, the explanation for why someone does not *know* the truth is that they are trapped

in a kind of bubble, which, if only they were given the chance, scientists could easily puncture to let in the cleansing air of truth.

Contra this version, 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 folk-life) stand up to the arguments and tools of science and technology. For Latour, the word that captures this power is **network.**

> If technoscience may be described as being so powerful and yet so small, so concentrated and so dilute, in means it has the characteristics of a **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. Telephone lines, for instance, are minute and fragile, so minute that they are invisible on a map and so fragile that each may be easily cut; nevertheless the telephone network 'covers' the whole world. The notion of network will help us to reconcile the two contradictory aspects of technoscience, and to understand how so few people may seem to cover the world.[9]

Those considered irrational, or trapped in misrecognition are so for no other reason than

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[9] Latour, *Science in Action* p. 180

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. As a method, it has a fairly simple rule—either you are in one network, or

in another. Such a move introduces symmetry into our methodological approaches. Study the

actors-networks and see how they are made to confront other actors-networks. The analyst, too,

is in one network or another—and this simultaneously solves the problem of either adopting

the "scholarly" point of view of Bourdieu, or disappearing into the aporias of self-reflexivity:

either the analysts explanation of the network will help expand/contract one or another

network, or it will not.

Thus can the entirety of science (and many other endeavors) be described in this fashion

—theories are built of facts and 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: "A calculation on

paper can apply to the outside world only if this outside world is itself another piece of paper of

the same format… Metrology is the name of this gigantic enterprise to make of the outside a

world inside which facts and machines can survive" and "No science can exit from the network

of its practice. The weight of the air is indeed a universal, but a universal in a network. "[10]

"Network" is thus a term that unifies "local" and "global" without relying on universality. In

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[10] Latour *Science in Action* p. 251 and Latour *We Have Never Been Modern* p 24, respectively.

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 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 pre-determined 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; nor are they (it is asserted) pre-determined by notions of civilization, East and West, ancient-classical-modern-postmodern; by secularization or disenchantment; by capitalist stages or imperial ones. 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.[11] 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. This is because, as Bruno Latour

repeatedly points out, it is a *method* not a *theory*. It is intended to guide the analyst into the very

heart of the activities of humans and their machines without pre-designating the reasons that

people mis-recognize, mis-understand, or are determined by forces outside their control, which

then only the superior gaze of the social scientist can resolve. Here, there are only networks.

Internet killed the network.

Fast-forward twenty years. If "network" wasn't confusing to begin with, then it should

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[11] 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), q.v see Roar Høstaker, "Latour—Semiotics and science studies" at http://ansatte.hil.no/roarh/artiklar/latouroggreimas.htm

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 "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
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> 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
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> network, like Deleuze and Guattari's term rhizome, clearly meant a series of
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> *transformations*—translations, transductions—which could not be captured by any of the
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> traditional terms of social theory. With the new popularization of the network it now
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> 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.[12]

So, what were all these sociologists and historians saying? Love-struck 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 didn't 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.

In the good old days of science studies, digital software and computer networks were one or two techno-scientific objects among many — and they provided a convenient and hip enough metaphor for use in widely disparate areas, and one capable of analytically distinguishing contemporary global, technical and social relations from the faded and repudiated pre-digital language of Weber, Durkheim, Parsons or Pareto. Science studies liked networks way before they were cool.

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

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[12] Bruno Latour, "On Recalling ANT," in John Law, *Actor Network Theory and After,* p. 15-16.

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:

For ideas, knowledge, laws, and skills, however, the model of the technological network seems inadequate to those who are highly impressed by the effects of diffusion, those who believe what epistemology says about the sciences… It seems, then, that ideas and knowledge can spread everywhere without cost. Certain ideas appear to be local, others global.[13]

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*. When information is measured in bytes and bauds, when one subscribes to a data bank, when one can plug into (or unplug from) a network of distributed intelligence, it is harder to go on picturing universal thought as a spirit hovering over the waters. Reason today has more in common with a cable television network than with Platonic ideas.[14]

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

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[13] Latour *We Have never been Modern* p. 118

[14] (Latour *We Have Never been Modern*, p. 119, emphasis added.

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 tele-phone (understood as the model medium of all human communication and control)—

all else is metaphysics.

Latour's definition of network, it seems, actually has quite a bit to do with Shannon and

the cyberneticians' definition of communication: there is no such thing as "content" in a

message, there is only its structure before it enters a network, and its structure after it emerges

from one. "There is no such thing as the post-modern, only the modern post." Latour has

simply added humans into the mix as one "channel" among others.[15]

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 distinctivness 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

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[15] Indeed, this might be the interpreted either as a criticism or as a kind of powerful genealogy, depending on one's interpretation of cybernetics and its discontents. Often, Shannon is critiqued by interpreters in the humanities as having no theory of meaning, but this is also heralded by some (Friedrich Kittler, for instance) as one of the most innovative philosophical aspects of his work. The fact that Shannon gave to information and communication a precise definition (one that millions of students now uncritically memorize yearly) hardly means that the overthrow of metaphysics has been successful; for Latour, the "materialization of spirit" effected by "distributed intelligence" should be read in a much more mundane sense—namely, that in science and elsewhere information is standardized and trackable today, and that this is where one should look for explanations of its efficacy—not to the epistemologists who claim logic or history as the animus of science or knowledge.

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.[16]

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 *which networks for what goals?* We

should be investigating not only the particular configurations that rely on networks, but the

networks themselves. In addition to "how is this stem cell created and made stable?" we

should add "what difference does the Internet make to the circulation of stem cells; what

difference does the postal system, or the system of customs or the legal system make to the

circulation of stem cells" and ultimately be able to identify how particular networks such as the

Internet format and constrain the production and circulation of knowledge. One powerful

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[16] On ontological politics, see 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) and Charis Cussins, "Ontological Choreography: Agency Through
Objectification in Infertility Clinics," *Social Studies of Science* 26 (1996): 575-610

reason for exploring the *this network here* as an ANT Network—which the question of stem cells, and where one can get them. actually makes clear—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 pre-suppositions about the cognitive structure of science, then perhaps it is time to get empirical with *networks* and to jettison pre-suppositions 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 and

standard and 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 (has anyone yet written the history of the manifest, that old bar-

code of yore?): sender, addressee, postage, cancellation, bar-code, 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, don't 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.*

The brown box, thus, might serve as a more tangible, everyday figure for what STS has

considered under the label of "metrology" or the production and use of standards. They would

be, however, standards-in-action, standards in the making and unmaking, rather than

standards made. Standards, like all forms of science and technology, are contests of value, and

do not occur only in national or international contexts, but anywhere a system of representation

(programmed language) is created to manage or control a particular network.[17] Standards can

be as local as a firm, a lab, or even an individual, or as global as ISO or as national as ANSI.

These "little" standards—programmed languages—make particular networks extensible

and stable. This is a point well demonstrated by any number of studies in the history of

technology. When two different networks, with two different standards confront each other,

this is where the interesting aspects of scientific controversy, or technical controversy emerge

(such as the contests of AC vs. DC; or over railroad gauges). The agonism that results may have

a national character, and may require a single solution for the sake of national power—for

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[17] On the subject of standardization in science, see Ken Alder, *Engineering the Revolution : arms and Enlightenment in France, 1763-1815 (*Princeton : Princeton University Press, 1997). M. Norton Wise ed., *The Values of Precision* (Princeton, N.J.: Princeton University Press, 1995); Peter Galison, *Image and Logic: A Material Cultue of Microphysics* (Chicago: Chicago University Press, 1997) on particle detectors; Harry M. Collins *Changing Order: Replication and Induction in Scientific Practice,* (Chicago*:* Chicago University Press, 1990) on tacit knowledge and the TEA laser; Robert Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life,* (Chicago: Chicago University Press, 1994) on flies and Kelty *Scale and Convention: Programmed Languages in a Regulated America* (PhD thesis, Massachusetts Institute of Technology 2000).

instance, the creation of NTSC and PAL television standards that have separated the US and

Japan from Europe for 50 years (with France a hyper-nationalist outlier using its own SECAM

standard).

In laboratory science in particular, and specifically in a Latourian light, there can be only

one successful standard—someone has to win. Either black box A 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.[18] To the extent that black boxes are equated with

truth or with the settled facts of an empirical science, "standard" is the wrong word, for it

implies concepts like consensus, compromise and decision—concepts that do not square with

most theories of scientific knowledge. Nonetheless, the array of machines and tools,

standardized reagents and animals, materials and devices, make up a metrologically stabilized

environment in which science is capable of validating and extending one network rather than

another.

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. Time-Warner *and* Comcast. Verizon *and* Sprint. 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

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[18] The Latourian ontology is built on "trials of strength", as in *Pastuerization of France*, an approach much

critiqued, see Donna Haraway *Modest_Witness@Second_Millenium*, (New York: Routledge, 1997).

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, anti-trust 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. In the past, some kinds of networks (telephone, telegraph, roads, rails, power) have been both provided and run solely by sovereign entities, or (as in the case of AT&T) designated "natural monopolies" and become regulated industries with sovereign control over a network. In recent times, such "infrastructures" have become more and more common, diverse and troubling especially to economists and lawyers, but as of late, by defense and security analysts, civil engineers and many other professionals (Collier and Lakoff Vital Systems Securit). 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 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.[19] It is not self-evidently a nation, a government, an

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[19] 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. The story of the Internet's strange military origins is available in Mitchell Waldrop in *The Dream Machine: JCR Licklider and the Revolution that made computing personal*, (New York: Viking, 2001); Arthur Norberg and Judy O'Neill provide a detailed account of the institutionalization of the ARPA program that funded ARPAnet development in *A History of the Information Techniques Processing Office of the Defence Advanced Research Projects Agency* (Mineapolis MN: Charles Babbage Institute, 1992) and Janet Abbate's history of the Internet also suggests that the military's involvement was peculiar, and uncharacteristically aloof, Janet Abbate, *Inventing the Internet* (Cambridge, MA: MIT Press, 1999). And while the early ARPAnet was indeed "controlled" in some loose sense by the Defense department, that control did not give them the power to *terminate* the network—instead, the

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 inter-network.

As an "inter-network" 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. [20]

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military split the ARPAnet into two halves—a research network that continued to be called ARPAnet, and a classified Miltary network called Milnet (which split received attention in the press: "Global Computer Network Split as Safeguard" By William J. Broad, *New York Times* October 5, 1983, A13).   By contrast, Paul Edwards suggests the origin story is true, but he can't reveal his sources, adding to the conspiracy-like appeal to its military origins: Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems" in *Modernity and Technology*, ed. Thomas Misa, Philip Brey, and Andrew Feenberg (Cambridge MA: MIT Press, 2003), pages 216ff and 225n13.

[20] 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," in *IEEE Transactions on Communications* 22(5) May 1974. Over the years a number of people have developed more

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

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sophisticated theories of why these protocols work the way they do. The most common notion is that of the "end-to-end" design (also called a "stupid network" or a network that migrates computation to the edges). This argument was first laid out in J.H Salzer, D.P. Reed and D. D. Clark, "End-to-End Arguments in System Design" in *ACM Transactions on Computer Systems*, 2(4) November 1984 p. 277-288, and remains a strong argument against centralization of control: David D. Clark and Marjory Blumenthal "Rethinking the design of the Internet: The end to end arguments vs. the Brave New World," and Hans Kruse, William Yurcak and Lawrence Lessig, "The InterNAT: Policy implications of the Internet Architecture Debate" both in *Communications Policy in Transition: The Internet and Beyond* (Cambridge, MA: MIT Press, 2001). See also RFC 3724: "The Rise of the Middle and the Future of End to End" by Kempf and Austein, March 2004.

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— that

overseen by the Geneva-based ISO, International Standardization Organization—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. In this

sense, the struggle between TCP/IP and OSI is indicative of a very familiar 20th century struggle

over the role of government planning and regulation, perhaps best represented by the twin

figures of Friedrich Hayek and Maynard Keynes. In this story, it is Hayek's aversion to

planning, and the subsequent privileging of spontaneous order that eventually triumphed. One

of the reasons for this is the so-called "religious war" between the industries of

telecommunications and computing.

The "religious war" between the DARPA-funded TCP/IP protocols and the International

Standards Organization's (ISO) OSI standard began in the early 1970s, in a period of period of

vibrant experimentation with computer networks worldwide.[21] An important aspect of this

experimentation, however, was that rather than build new infrastructure—new wires and

physicial networks, these experiments piggy-backed on the existing tele-communications

networks, such as the legal monopoly (and heavily regulated) network of AT&T. IBM's System

Network Architecture (SNA); DEC's DECNet/DNA, Univac's DCA, Burroughs' BNA and other

were, like the proprietary operating systems these companies made their money selling, closed

networks that interconnected a centrally planned and specified number of machines of the same

type made by the same manufacturer. These networks were generally designed to serve

businesses, for making connections internal to a firm, even if that involved geographically

widespread systems, using existing telecommunications links built by national

telecommunications corporations. This situation more or less inevitably spelled grief, since the

telecommunications providers (even after 1984) were highly regulated entities, while the

computer industry was almost totally unregulated. Since an increasingly core part of the

computer industry's business involved transporting signals through telecommunications

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[21] The term "Internet religious war" is the title of an article by William Drake, "The Internet religious

War" *Telecommunications Policy*, December 1993, p 643-649, it is a review of a book by Carl Malamud,

Exploring the Internet, A technical travelogue Englewood Cliffs, N.J. : PTR Prentice Hall, 1993 that charts

Malamud's travels around the world, and in particular his struggles with ISO in Geneva (THE shepherd

of the OSI standard).

systems, all the while without being regulated to do so, the telecommunications industry

naturally felt themselves at a disadvantage.[22]

The fact that these emerging networks needed to make use of highly regulated

technological systems specifically designed to carry voices around the globe has been the source

of decades long tension between the telecommunications companies of the world and the

nascent computer industry, which were interested primarily in creating new forms of data

communications:

> As in the Houses of Montague and Capulet, the parents of voice and data don't get along.
>
> Rarely have computer and communications providers shared a common set of beliefs
>
> and purposes… Never Have these differences of culture and philosophy been more
>
> obvious than during the development of Open Systems Interconnection, during which
>
> the debates between the Houses of Voice and Data were often more religious and
>
> political than technical.(4)[23]

Telecommunications companies were not slow to respond to the need for data

communications—but because the telecom industries were either nationally run (so-called Post,

Telephone and Telegraph agencies or PTTs), or very highly regulated by government (in the US

case, especially), their ability to experiment with products and practices outside the scope of

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[22] Again, Brock, *The Second Information Revolution* is a good introductory source for this conflict, at least in its policy outlines. The FCC issued two decisions (known as Computer I and Computer II) that attempted to deal with this conflict by trying to define what counted as voice communication and what as data.

[23] *Open Systems Networking TCP/IP and OSI*, David M. Piscitello and A. Lyman Chapin, Reading, MA: Addison-Wesley, 1993.

telephony and telegraphy was often hindered by concerns about anti-trust and monopoly

(Brock 2003). The computer industry, by contrast, was completely unregulated, and saw the

tentativeness of the telecommunications industry (or national PTTs) as either bureaucratic

inertia or desperate attempts to maintain control and power over existing networks—though no

computer manufacture relished the idea of building their own physical network when so many

already existed.

OSI, then, along with a handful of other national and international standards for data

traffic on telecommunications networks, began primarily as initiatives of the telecom industry,

which had long had its feet firmly planted in the international standardization organizations

like ISO and the ITU (an organization as old as telecommunications itself, dating to the 1860s).

The system of national control or regulation, and industry ownership of the networks dictated

that the standardization effort be conducted primarily by the telecom companies themselves,

through the standards processes that had been sedimented in these organizations over many

years. The legitimacy of these processes was more or less unquestioned. As a result, the

telecommuincations industry was hard at work, throughout the 1970s and 1980s on one of the

most complete and comprehensive standards in networking history, OSI. The fact that it was

never adopted per se, as the standard for networking is key to understanding one aspect of the

sudden and dramatic growth of the Internet in the 1990s. While OSI was never adopted, it has

also never disappeared. It's most enduring legacy is not the protocols themselves (some of

which are still widely used today, such as ASN.1), but the OSI *Reference model*, or the "7 layer

stack" that is ubiquitous in networking classes and textbooks, and describes the abstract

"layering" (which implies dependency) of the different components of a network: a physical

link (a copper wire), on top of which are build Data, Network, Transport, Session, Presentation, and Application layers in order. So even though the OSI protocols "failed" (for reasons that are discussed below), the model "succeeded" in becoming the standard pedagogical tool for teaching networks—a fact that is clearly also a problem if one examines the evolution of networking textbooks from the 1970s to the 1990s, as they try to develop ways to teach OSI in terms of TCP/IP, and create elaborate mappings from one to the other.[24]

TCP/IP, however, emerged from very different conditions.[25] The first elaboration of them was in the context of the DoD funded ARPAnet in the early 1970s as a replacement for the first ARPAnet protocol called the Network Control Protocol (NCP). In particular, they emerged from the need to interconnect two different experiments in "packet-switched networks"—the ground line-based ARPAnet network and a radio-wave network called Packet Radio.[26]

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[24] This can be clearly seen, for instance, by comparing the various editions of the main computer networking textbooks: Andrew S. Tanenbaum, *Computer networks* Englewood Cliffs, N.J. : Prentice-Hall, c1981. c1988 c 1996 c2003; Stallings, William, *Data and computer Communications* Macmillan Pub. Co. ; London c1985. c1991. c1994. c. 1997 c. 2004; and Douglas E. Comer *Internetworking with TCP/IP* Upper Saddle River, N.J. : Prentice Hall, c1991-c1999.

[25] The story and significance of the TCP/IP protocols has been told in several places: Abbate *Inventing the Internet*, Salus *Casting the Net* 1996, Galloway, *Protocol, or How control exists after decentralization,* MIT Press 2004; Brock, *The Second Information Revolution* 2003. Robert Kahn et. al., "The Evolution of the Internet as a Global Information System", *International Information and Libraries Review* 29 1997, p 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.

[26] Kahn "The Evolution of the Internet as a Global Information System" 134ff; see also Abbate, *Inventing the Internet* pgs 114ff.

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 "inter-network"—a system that would interconnect several diverse and autonomous packet-switched (or even circuit-switched) networks together, without requiring them to be transformed or re-designed or standardized. In the first paper describing the protocol, Kahn and Cerf say:

> Even though many different and complex problems must be solved in the design of an
>
> individual packet-switching network, these problems are manifestly compounded when
>
> dissimilar networks are interconnected. Issues arise which may have no direct
>
> counterpart in an individual network and which strongly influence the way in which
>
> Internetwork communication can take place.[27]

The explicit goal, for DARPA researchers, 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

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[27] Robert Kahn and Vint Cerf, "A protocol for packet network intercommunication: *IEEE Transactions on Communications*, Vol Com-22, No 5 May 1974.

(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.[28]

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. (54)" 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. (55)" 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:

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.

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[28] Adapted from Kahn et.al. "The Evolution of the Internet as a Global Information System" pg 134-135.

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. For example, since this network was designed to operate in a military context, which implied the possibility of a hostile environment, survivability was put as a first goal, and accountability as a last goal. During wartime, one is less concerned with detailed accounting of resources used than with mustering whatever resources are available and rapidly deploying them in an operational manner.[29]

Clark's focus on the ordering of goals is important for understanding why the Internet ended up looking so much different than 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.[30] 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

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

[30] Unless of course one wished to suggest that we are now in a state of permanent war, in which survivability is the only truly shared global goal; however the physical loss of networks or gateways as a result of warfare is perhaps the least common problem that now exists on the global Internet.

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 making 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, anti-trust 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 collquial sense. As the example of Clark's ordered set of goals makes clear, at 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 absense) 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 with today: Napster, 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.