

## Telecommunication Networks: Economy, ecology, rule

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### ABSTRACT

This essay deals with technologies, techniques, business models and legal structures governing telecommunications infrastructures. Megacities are especially vulnerable to shifting agencies in telecoms provision. This paper addresses the relation of the economics of growth, built-in obsolescence and product life cycles with the complex determinations of telecommunications governance in relation to the physical environment of megacities. It argues that an 'environmentalism of the poor' must be integrated into considerations of both ecological critique and analyses of telecommunications infrastructure and business practice.

### KEYWORDS

Network - systems - infrastructure - internet - media - mobile - telecommunications

Cities have always been sites of communication and of struggle over its control; antagonisms of gossip and ukase, common knowledge and hieratic secrecy.

Technologisation of communications from the letter post to electronic networks implies diminishingly visible channels with progressively more powerful disciplinary and expropriative functions. Initially disciplined by 'natural monopolies' over wired and wireless communications, standardisation and governance, today increasingly embedded technologies hide both discipline and exploitation underground, as if vulgar-Marxist infrastructural status made them invisible to ideology critique. Such blindness seems to hide celnet towers, exchanges and switching installations in broad daylight: the purloined letters of the dark fibre nets established by security, military and intranet elites.

Mechanisation and automation even nurtured their own theoretical paradigm of control: information theory, undermining both discipline and consensus, replacing them with engineering solutions. Today neither bandwidth scarcity nor the legal concept of spectrum as natural resource justify old business and control models. The invisibility of telecoms infrastructure makes it a laboratory for protocols and intellectual property rights as new forms of profit and power (and their evasion), creating new terrains of struggle in the

megacities and their hinterlands (Horst 2013).

Heirs to the telephone and telegraph, increasingly convergent telecommunications networks of the 21st century take on roles previously associated with broadcasting, print media and libraries. Recent developments include extensive rich-media streaming, initially for games but now extensively used as a supplement or substitute for broadcasting, massive expansion of Voice Over Internet Protocol (VOIP) video telephony for both computers and mobiles, and internet-connected devices with no human user, the so-called internet of things. Given their critical position as conduits for electronic funds transfer, banking and the financial markets, and the increasing use of telecoms both as a retail and business-to-business platform and as a medium connecting commodities in warehousing, freight and device-tracking, these networks are now also effectively utilities.

Archeologically, data networks thus unsurprisingly share their design and functionality with irrigation and sewer systems, and with later gas and electric supply. The early 21st century is reversing the historic split of wireless broadcasting and wired telephony: broadcast and broadband networks are increasingly cabled, with only the last metre handled wirelessly in domestic or office systems; while voice and text messaging have migrated to cellular networks, and long-distance traffic to satellite transmission. The spectrum freed up by television's migration to wire and highly compressed over-the-air digital formats is taken up by expanded rich-media content delivery to personal handsets. Personalisation of communication devices to individuals (rather than shared equipment in older domestic and office environments) leads one of the more recent, information-enabled trends in capital, custom consumerism, which not only transfers a growing proportion of the production of goods to their end-users (Ritzer and Jurgenson 2010), while exploiting long tail economics (Anderson 2004), but also produces cycles of planned obsolescence and associated environmental costs.

Vital to business, important to democratic participation, increasingly significant in education and cultural integration, these network developments pose generic challenges of exploitation, governance and aesthetics (the framing of perception), and the enclosure of a variety of commons including not only information and creative labour

but the electromagnetic spectrum and the protocols on which inter-operative networks function. They pose specific problems in the megacities: persistent problems of the digital divide, problems of autonomy and authority in network-controlled environments, and problems of formal, partial or conditional inclusion in network activities which can be as exploitative and demeaning as they can be exclusive. While cheap rental markets for mobile phones seem to have overcome the basic exclusions from the network society noted in the late 20th century, cycles of technological and financial dependency, low skill bases, poor adaptability to local circumstances, and illiteracy persist. The poor have finally gained entry to the electronic universe, but stand on the threshold of a world whose wealth is incomprehensibly protected by complex puzzles like search engines, clutching outmoded equipment they scarcely know how to use. Meanwhile the rich have faster, fatter pipes carrying deeper and richer media from ever vaster reserves of information, to which their education and skills grant them privileged access. Unlike electricity and water, these conduits cannot be tapped by slum-dwellers. Of course the poor can tap into the media, typically through NGOs and other representative agencies. The goals, as Verzola argues, 'may involve calling public attention to specific cases of poverty, raising public awareness and understanding of poverty's root causes, or actually getting people and decision-makers to act towards presumed solutions' (Verzola 2008: np). But tapping in only reveals the extent of the dependent relation: to be spoken for, to speak from weakness to power, to raise awareness in a political class whose attention is the subject of intense competition, and who thrive on this evidence of their importance. Not only are these tactical positions puny; they succumb to the media's own demand for incessant contributions from their most exploited and even most excluded clients (Dean 2009). The gap is widening, even when the information poor are allowed a tiny ration of data, and a tiny window in which their despair is named, salt in the feast of images.

### **Digital technology and the Network Society**

Technologies and societies interact in their mutual evolution (Mumford 1934). Digital technologies take on the specific forms they do because of the kind of society in which we live. In the megacities, this society characteristically employs information technologies for the biopolitical management of population on probabilistic and statistical terms. At the same time, it combats the falling rate of profit by expanding into

the last domains which had evaded exploitation, notably the field of affective labour. As Negri (nd; see also Hardt 1999) argues, affective labour is an extension of zones previously excluded from economic analysis. It aggregates women's domestic and reproductive labour with the exploitation of attention value (Smythe 1977) developed during the explosion of broadcast advertising markets in the 1950s. The greater interaction of online media not only increases the production of information (for example through trackable behaviours) and unpaid creative labours of content generation, but through the marketisation of affective expression. As online media evolved, the early affective media such as e-mail and blogs proved inadequate to the purposes of exploitation because they were, in the first instance, person-to-person, and in the second difficult to search. Social networking, the breakthrough medium for the monetisation of the internet after the débâcle of the dot.com crash, provides the ideal medium for exploiting unpaid affective labour.

The combination of biopolitics and custom consumerism with affective labour produces what we may call the contemporary database economy, which provides the formal template (or Deleuzian diagram) for the technical administration of the internet. Facilitated by and in turn shaping the evolution of digital and related technologies, the database economy structures and is structured by the media formations to which it has given rise. Even the closed feedback loop thus described is symptomatic of the system logic that governs the formation. It is this feedback that ensures the unstable equilibrium capital craves, in which perpetual pseudo-innovation at the level of fashion promotes perpetual consumption, waste and therefore profit. The integration of person-to-person communications with one-to-many and many-to-one, and the development of ubiquitous computing which includes non-human agents, are largely driven by three parallel desires: to control flows of data, of people, of commodities; to promote an 'immaterialisation' of labour, already established in the knowledge and creative industries, through inclusion of the affective; and to extract the last possible desire from the long tail of consumerism. Core to these three braided strategies is the maintenance of a fundamentally homeostatic system. Given that economies are either in crisis or in growth, economic homeostasis is not an option. The social is therefore the only potential site for homeostasis. But since economic growth (and indeed crisis) requires social change, the infrastructural stability needed to handle the growth-crisis cycle is

increasingly displaced onto objects and systems, now presumed to be crisis-prone and therefore requiring constant monitoring. Based on extensive modelling in geographical information and other biopolitical systems, the internet of things provides the basis for real-time planning, increasingly undertaken in container ports, data and power management, and management of traffic and crowds in high-level urban networks, where it is being layered over existing surveillance (disciplinary) systems.

It is important to understand the scale of these operations: for example, AT&T, just one of the companies competing in the US telecoms market, handles 18.7 petabytes (thousand million million bytes) on a normal business day (Bohn and Short 2009: 8). Such figures indicate a number of features of contemporary telecommunications. Firstly, there is no possibility of any power on Earth eavesdropping every conversation. Secondly, the generation of new content surpassed storage capacity for the first time in 2007: one commentator suggests that 'by 2011, almost half of the digital universe will not have a permanent home. (Gantz, 2008). The problem has been dealt with in network engineering since the earliest days of Arpanet, when packets, the units into which messages are broken down for transmission, are provided with a TTL or time-to-live code which instructs them to delete after a set time, regardless of whether they have arrived, so that they do not clog the network. Similarly, the digital video recorders used in domestic and retail surveillance have about 160Gb of storage: approximately 36 hours of video at compression rates standard for the purpose. Such systems regularly overwrite the hard disc storage with incoming data. Deletion, erasure – forgetting – are inherent in telecommunications networks. Thus surveillance, in actually existing biopolitical management, is no longer archival but real-time. Browsing histories, for example, are helpful devices for speeding up searches, but only the largest patterns and the most recent entries are of commercial interest. The rest is first compressed and later erased, except where it can be stored locally on a users computer, where bots can update without having to pay for storage.

### **Environmental issues**

The storage crisis, both effect and cause of the shift to real-time planning, is one aspect of a broader ephemerality characteristic of the contemporary media formation.

Conceptualisation of the network began in mechanistic terms, based on engineering

challenges posed by mass growth in telephone use in the post-war era of suburbanisation. Its first expression was mathematical (Shannon and Weaver 1949), but its second was organic (Maturana and Varela 1980), and its third and thus far most robust is ecological, the network as chaotic or emergent system (see for example Kelly 1994). If on the one hand this reading of networks shares a diagram with the invisible hand of the market espoused by neo-liberal economics, it also points towards the arena of externalities which are crucial to understanding the relations between information systems and the megacity.

The ephemerality of brand- and product-based affect, of fashion as public sphere, drives rapid turnover of consumer and workplace media devices. The storage crisis and real-time planning correspond to a loss of cathexis with old things and old information, a readiness to jettison the increasingly recent past. Children seem not to need the prompting of marketers to mock one another's lack of up-to-date phones. The wealthy inhabit a giddy whirlwind of rapid obsolescence. The costs of this are fourfold: materials extraction, manufacture, energy use, and recycling. Of these manufacture and recycling are in substantial degree undertaken in the megacities.

Manufacture here embraces both assembly, for example in the border *maquiladoras* that form the edge city of the Californian megalopolis (Moffatt 2005, Grineski et al 2010), and the preparation of key chemical and mineral materials for manufacture: critical chemicals such as arsenic for doping chips. Not only is the refinement of some of these extremely toxic materials concentrated in the Global South, but in megacities, slums sit cheek by jowl with such manufacture (Davis 2006: 128-34). The quantities required for manufacture are minuscule in any one consumer device, but the concentrations in manufacturing plants are considerable: 'According to Graydon Laraby of Texas Instruments, the manufacture of just one batch of chips requires on average 27 pounds of chemicals, 29 cubic feet of hazardous gases, nine pounds of hazardous waste, and 3,787 gallons of water, which requires extensive chemical treatment' (Chepesiuk 2005). Offshore plants producing chips, drives, screens and other components rarely have first-world standards of health and safety, or regulatory systems to prevent seepage into local environments ('The PCB [printed circuit board] industry requires chemical-intensive manufacturing processes. Toxic chemicals such as glycol ethers have been

phased out of some electronics industry manufacture in developed countries, while they are still commonly used in Asia'. Ladou and Lovegrove 2008: 1). While events of the scale of Union Carbide's Bhopal plant are mercifully rare, the less dramatic, constant degradation of air, water and soil by industrial gases and by-products is a key element of the impacts of information technologies on the poor.

Recycling has two variants. The more apocalyptic concerns the recycling 'villages', especially concentrated in the Pearl River Delta in China, in the outskirts of Lagos and Accra, and in Manila and Vietnam. Export of hazardous waste is barred under the Basel Convention, to which 173 countries are signatories (although Afghanistan, Haiti and the USA have yet to ratify), but continues almost universally, and always from rich to poor countries. The results are frightening: environmental degradation, species loss, increased rates of perinatal mortality, the world's highest incidences of leukemia and other toxicity-related cancers. Since the work is quasi-legal and is only profitable without investment in machinery, the labour is done by hand. Since the cash relates exclusively to the metals but not plastics, those tend to be burned, the quickest way to get at the valuable parts, releasing toxins into the air and water. With recycling rates of 18% for TVs and computer equipment, and even lower, 10%, for mobiles, something in the region of 3 million tons of un-recycled e-waste are produced per annum in the US alone (EPA 2008). Much of this end-of-life electronics has to be retrieved from the entropic mess of dumping, and then organised back into usable materials. This is filthy, dangerous work, leaving human and natural environments tainted.

In 2012, the number of mobile phone subscriptions worldwide passed 6 billion (ITU 2012), with continuing growth in the developing world, recorded as having 64% of subscriptions in 2008 (ITU 2009: comparative figures are not available). Global penetration of landlines had been stagnating at 20% for decades: cellular technology sparked a wave of new adopters with low entry price, opportunities to rent handsets, independence of regular electricity supplies and of literacy levels. In both rapidly expanding economies and in those that are not growing, the recycling industry is at an even lower level of organisation and efficiency than in the industrialised nations. The geography of freeways and gated suburbs observed by Davis (2006) suggest that there is no need to export from such areas because there is a dependent slum economy on

the doorstep ready to risk the consequences of burning PCBs and retrieving elements like lead, cobalt and germanium and chips doped with arsenic and other toxic metals.

On a more positive note, where industrial nations either throw or hoard their old computers (Hewlett Packard's 2005 Earth Day press release suggested that 68% of consumers stored their old computers and peripherals), in cities like Kingston and Delhi there are thriving markets for reconditioned and jury-built computers assembled out of junked parts (Sundaram 2009, Waller 2005). Sundaram's concept of 'pirate modernity' is especially important to the grey economies of illicit software, and the download component of music and film piracy in the megacities, where access to internet liberates the cottage industry of pirate cassettes and VCDs from dependence on corrupt employees of the legitimate industries (Lobato 2012). Like squatting, or syphoning electric power, accessing global flows of media and entertainment is an integral part of the slum economies (Larkin 2008). In this way, recycled files and software, and recycled computer parts, as well as recycled materials from the end of the digital lifecycle all touch more deeply on the megacities' slums than they do on the entrepreneurs and academics who pronounce on their weightless, frictionless, immateriality.

### **Internet Governance and the Information Economy**

The network society affords various kinds of access: to the rich consumer, video-on-demand (VOD), and to the genuinely wealthy subscription or sale models which avoid the dull necessity of paying attention to ads. For the Chinese masses, the protection of the Golden Shield; for the wealthy, Virtual Private Networks (VPNs) which fast-track past the firewall like express check-in at the airport. For the ordinary punter, a data feed from Bloomberg; for the wealthy subscriber, real-time data on every stock for sale on every market. The famed time-space compression and social acceleration associated with network communications must be tempered by understanding that the network slows down for those who do not pay the requisite premium. Unlike roads, where everyone travels at the same pace in gridlock, internet offers real-time speeds for the elite, and delays the arrival of news, and for that matter premium entertainment, while also diminishing the quality of the audiovisuals and density of information from high-definition to the degraded codecs of mobile video (Cubitt 2009). Networks are



fundamentally distributive, and distribution is about control over speed and territorial reach. Distribution and privacy – secrecy and private property, the act of privation as opposed to the act of publication – are twin faces of the same coin. Without distribution, privation doesn't come into existence. It is this flux between publication and privation that structures telecommunications networks in the megacity. Just as the pollution from road traffic hits non-users (like children or cyclists), so telecommunications impacts people who are excluded from it, especially those most deeply removed from access and its benefits. If Baudrillard was correct, and denizens of the new networks inhabit the hyperreal, then those excluded are the last who still inhabit the Real, and can see the network for what it is.

As Ned Rossiter (2009: 37) argues in a study of e-waste industries in Southern China,

In the case of the global logistics industries, the rise of secondary resource flows accompanying the economy of electronic waste is coextensive with the production of non-governable subjects and spaces. I suggest that the relation between these entities constitutes new regional formations that hold a range of implications for biopolitical technologies of control.

Writing in the same publication, one of the editors notes

The idea of nature as an aesthetic and normative exteriority appears to offer a safe position of ethico-epistemological privilege from which to condemn various aspects of information-technological modernization. But it is perhaps only by acknowledging that the contradictory consequences of the spread of electronics cannot be easily mapped onto an antagonism of nature versus technology that the idea of network ecologies becomes comprehensible (Zehle 2009: 4).

The non-governable of nature is then produced in the contemporary world as a network effect: this would explain why ecologies and networks are employed as metaphors in systems analysis and environmental science alike. Regionality might suggest a partition of the world between the urban or mega-urban and the preserved and conserved nature park, or at least the gap between lanes on the highway where wildflowers bloom and which in New Zealand is called 'the nature strip'. But it must also evoke divisions, especially the division of labour, a network form which predates and founds digital network logic. The ecology of the poor emerges, as pointed out above, in the interstices of networks: by rail tracks, under the fences of factories, on perilous

slopes where gullies carve a path of green into the city. The term 'pristine', which is almost invariably attached to the word 'wilderness', does not recognise the evolutionary genius of organic life, human or otherwise, that proliferates between paving stones and in the shit-piles of the slum. Rodents, insects, amoeba and bacteria do not usually figure in the cartography of the megacities' settlement with natural phenomena, yet they are as integral as urban foxes or the uncanny spectacle of zoo animals.

The emergence instead of 'ungovernable subjectivities' and the consequent need for a biopolitical management of material, energetic and informatic flows which Rossiter points us to, should evoke subjectivities which are no longer purely human. Some of these have been familiar to sociology since its birth: the crowd, the tribe, the family and the factory. In contemporary media formations, corporations constitute actually existing cyborgs comprising complex technical assemblages into which are plugged, *Matrix*-like, the human biochips on which they feed. Increasingly, the meta-assemblage which is the megacity requires a third term, the organic life which seeps in, as aesthetic (pets, gardens) , as functional (parks, waterfronts) but also as the ungoverned and unwanted weeds, pests and bugs which contaminate the ostensibly clean distinctions between parts (Clark 2000). In a network, the divisions are also media of translation between nodes, human, technical and organic. Smart objects, the internet of things is one response to this problematic explosion of unexpected subjectivities: indeed, a biopolitical recognition that our devices have indeed evolved a life of their own.

Including objects in the telecommunications infrastructure extracts the skills required, for example, to drive trains, employs lower skilled and therefore cheaper workers, and eventually replaces them with automated systems, just as occurred previously in the introduction of the electronic office (Braverman 1974). Smart objects also produce profits not just in the act of purchase, but by providing data on their use throughout their lifecycle, information which generates new profit streams from redesigned goods to additional services and intellectual property. Smart objects should be understood as elements of an information economy in which intellectual property rights (IPRs) in the product generate further IPRs from the use of that product, such that the physical object, other than as design (another IPR) or brand (the trademark IPR), is far less important than the abstract, intellectual machine, the network of which it is a node. The instability of

objecthood, and the alienation of the commodity form from its origins in production, here achieve a new form, one which points towards either completion of the project of enclosure of the general intellect as information commons, or to a 'weightless' economy of peer-to-peer exchange outwith the crisis-oriented tendencies of capital (monopoly tendency, tendency of the rate of profit to fall).

However it also points towards the biopolitical management of populations, including populations of newly subjective machines, and of the environment, now subject to intense and highly localised surveillance. But then again, it suggests an important feature for the study of megacities, beyond the increased ability to control massively complex transportation and logistical systems: the ability to tap into new patterns of behaviour. The internet of things is also a massive information gathering resource, but one whose key function is not merely control but to garner from the interactions of users the affect-laden interactions of social networking. The irony is not lost on the perpetrators: structured portals like Facebook constrain as much as they invite invention; while what capital really needs is novelty. Historically, it has always been the slums and ghettos that have generated the intense new cultural forms, from tango to samba, bhangra to B-boys, which drive the innovation and fashion economies. That is the function of slums in the global economy, at least as important than the arcana of long-tail custom consumerism.

### **Near Futures**

In the corridors of power, the infrastructures of the internet are on the brink of major rebuilding. The fundamental platform, the TCP/IP (transmission control protocol/internet protocol) suite must be updated to accommodate the growing number of connected devices. The current platform will be replaced with a new version with a far larger number of addresses ('address space') which, however, is not fully backward-compatible with the older system. However, as deNardis (2009) has shown, the US and some other early adopters have large repositories of unused addresses, and see no reason to undertake an expensive update. Thus ironically it is the new internet powers like Brazil, India and China who will move to the new address space first, threatening (not for the first time: see Goldsmith and Wu 2008) to split the internet. Control over address space has been at the centre of internet governance wars for a decade (Mueller

2004). Rather newer is the struggle over HTML5, the latest iteration of hypertext mark-up language, the layer of internet code which underlies the World Wide Web. Among disputed areas, the new <video> tag is especially fraught: will it recognise open-source codecs, or only those proprietary codecs controlled by the unlikely alliance of Apple and Microsoft and their peers in the MPEG-LA patent pool? Aesthetically, all codecs in competition are equally linked to spatialising and controlling the transmission of images; but the peer-to-peer economics and openness to innovation of the Ogg and On2 open source codecs makes them the choice of the hacker culture, and of major internet players like Mozilla and Google (which owns On2). Control over these fundamentals, far removed from public debate, will form the internet in the near future. At play is the relation between the civil society bodies that first established the internet we know; the corporations who have come to dominate it; and the national governments who both provide the legal underpinnings for commerce, and seek governmental power over the affective and informational flows traversing their populations.

This form of rule is known as protocological. In Galloway's (2004) analysis, protocol forms another epoch in the history of power, expanding on Deleuze's (1997) societies of control, providing systemic code which does not permit rules to be broken, replacing discipline and biopolitics with a mode in which, for example, copyright 'theft' is not just illegal but impossible (Lessig 1999). In the internet of things, the networking of everything, new protocols are needed, notably the ONS/EPC system (object name service/electronic product code). In theory such protocols, deliberated and decided among the wealthy and powerful, will be delivered silently, another technical marvel whose principles, we will be told, are those of engineering, not politics. The global poor will live at the borders of these protocological nets, in much the same structural position as the hackers whose constant gnawing criticism undermines the theoretical completeness of the network.

Economic, environmental and governmental aspects of telecommunications are connected through a system of inclusions and exclusions, internalities and externalities, regulation and deregulation. One typical movement is the enclosure of intellectual and creative commons in an effort to extend the operational terrain of the extraction of surplus value from new forms of affective labour. A second, ostensibly opposite, is the

exclusion of environmental effects from economic calculations, effectively shifting the burden of ecological disaster to the commons. Telecommunications governance meanwhile is riven by two competing paradigms. The BRICS countries and their allies strongly advocate a 'repatriation' of regulatory powers to the nation-state, especially through the UN and its key instrument, the ITU. The industry in general supports the self-regulating network model on which the Internet developed, while also using every legal, commercial and political instrument in struggles for control of network neutrality, address space, open source and patents, among others. Thus competition from Google's VP8 open-source codec forced the MPEG-LA consortium to announce that it would never charge for the use of its patents in online streaming in 2010. In 2011, however, a dozen members of the consortium announced that VP8 broached several of their patents, a move known as a 'poison pill' because it creates doubts about the legality of deploying the open-source alternative. The case of streaming video codecs, fought through law courts and the complex network of internet governance agencies, is exemplary not only of the intertwining of economics and rule, but of their implication for the ecologies of megacities.

It is especially important that environmental critique does not lose sight of the economic and governmental processes involved, for two reasons. Firstly, deep ecology's rejection of anthropocentrism is neither politically feasible nor intellectually convincing unless it can be articulated with the specific sufferings of the global poor. And secondly, the environment has begun to take on the position of God in a new theological politics, for which acclaim of 'Nature' takes the place of faith in the divine origins of Law. As Agamben argues, however

the real problem, the central mystery of politics is not sovereignty, but government: it is not God but the angle; it is not the king, but ministry; it is not the law, but the police – that is to say, the government machine that they form and support (Agamben 2011: Appendix 1.7)

If it is true that 'we are all nature', it is also a truism of environmental critique that nature is a concept, constructed in opposition to the technological, the urban and the economic domain that excludes it as externality. Thus in environmental economics, the excluded returns as the basis for all transactions (Hanley et al 2006). But as Timothy Morton

(2007: 5) expresses it, 'Putting something called Nature on a pedestal and admiring it from afar does for the environment what patriarchy does for the figure of Woman'. The ecological metaphor, taken to its conclusion, demands that we understand all human networks as embroiled in terrestrial processes, and vice versa. Excluding the human from nature is the counterpoint to the abstraction of nature as inhuman.

In telecommunications, this imbrication of networks in one another means that, for example, a governance decision should be understood in terms of its implications for both human and economic environments. The struggle between proprietary and open-source codecs in HTML5 could shift power from corporations to users, in line with the migration to prosumption. Open-source codecs can be customised, and any element of the code can be taken and reused for new projects, if those projects remain in the public domain. Equally importantly, typical uses of open source in the developing world include customising discarded phones and other equipment, so creating local craft-based industries, providing affordable access to services, and increasing the lifespan of otherwise jettisoned equipment (incidentally removing the excuse for near-universal tax subsidies for writing-off equipment after a mere few years of use, subsidies which propel the cycle of built-in obsolescence in digital equipment). It is cleaner and safer to reuse a phone, tablet or laptop than to break it down into constituent elements and freight them back to offshore sweatshops to be rebuilt as a new generation of ephemeral equipment. Discarded machines in effect become open-source hardware, to the benefit of all concerned, except the profit-growth of corporate manufacturers, premised on increased consumption of increasingly finite physical resources and the brutality of existing recycling regimes.

The telecommunications network thus includes not only its externalities, positive and negative, but also its exterior: the exclusions it operates and on which it depends. While battles over the technical underpinnings of the future are conducted at the strategic level, we should not dismiss the struggles of those excluded from the net as merely tactical. Out of their desperation, we may gain only a few new dance steps. Or we might witness the emergence, from the slums, of a new hybrid that does not fit the fantasy of endless growth and endless exploitation of the last uncolonised abilities of human beings.

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