# Network Topologies: From the Early Web to Human Mesh Networks

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## Network as a Paradigm, Network as a System

We live in a space of networks. The connections between people, data, spaces, and objects have become more apparent and even assumed thanks to the infrastructure that manifests its pulsating presence through our screens and LED-equipped devices. Yet despite their prevalence, how can we assign networks an adequately general definition that would be cross-disciplinary? Here’s one attempt to compose such a definition from various scientific and cultural domains: ‘elements, nodes, or sub-units connected as a whole.’ The ‘whole’ defines the total networked space, even in its potential size and shape, which is perhaps the most ungraspable element of the contemporary moment, thanks to the average network’s dimension and complexity. Its parts determine the individuality of its essential components, the nodes.

The space we inhabit is filled with mostly opaque active nodes (such as our devices), largely at a low hierarchy in the global grid of interconnections, which privileges centralized entities being in control of all the peripheral ones, and whose production and infrastructural use is ascribable to a relatively small number of online and hardware companies. Nonetheless, given that each node is individual, there remains an autonomous capacity to conceptually redefine networks and create sub- or separated networks at will. Using the same technical infrastructure, we can connect with peers on almost infinite nodes that are just a few steps away, while escaping the official ‘grids’.

The network structure must first be acknowledged as an abstract system, and second as a manifestation of an enormous implementation of information technology; as a paradigm, which reframes the technical structure as a conceptual model. In this text I will try to analyze the main changes in the evolution of network topologies through the past decades, in line with the experiments we have accomplished with *Neural* magazine over the same time frame. By ‘network topology’ I mean a blend of the mathematical and more general definition of topology, applied to networks, so something like: ‘spatial relations, whose constituent parts are interrelated, unaffected by the continuous changes in shape, size, or nodes.’ I will explore various embodiments of these topologies in the interplay of networked cultures, the networking practices of *Neural*, and the techno-cultural developments of networks.

## Early Utopia: Revealed Topologies and Personal Networks

In the first decade of the public and then mass internet (early 90s to early 2000s) the visualization of the network structure represented the new underlying digital structure that was forming behind the visual appearance of single pages (typically shown as browser content). The lack of any accurately compiled topologies, due to the constant growth and evolution of these rapidly expanding networks, resulted in the rapid obsolescence of any ‘visual map’ that tried to represent these network topologies. This inspired the first generation of net artists to develop their own visualizations, either fixed or dynamic, to express or createan overview of physically or conceptually interconnected nodes. The *Web Stalker* browser (1997) and JODI’s *Map* (1999) are among the most celebrated of these net art works.

7.backbone

Fig. 1: JODI’s Map (1999), http://map.jodi.org/.

The former, developed by I/O/D (Matthew Fuller, Colin Green, and Simon Pope), was a fully functioning alternative web browser whose main feature was visualizing the links connecting to the requested page. Fuller compared the dissection and rendering of the network to Gordon Matta Clark’s ‘Splitting’ action (1974) where he literally bisected a whole house (already slated for demolition).[[1]](#footnote-1) The *Web Stalker* generated an abstract map of connections, ‘as a crawler function gradually moving through the network. We saw the logical structure of websites, established by the links, in and between them, as another key resource.’[[2]](#footnote-2) Unveiling the infrastructure and relations of the network in this way, the *Web Stalker* was antithetical to the page-centered, accurate layout of other browsers. Net art critic Josephine Bosma writes that ‘it embodies […] art as a process.’[[3]](#footnote-3) The browser was downloadable, and also distributed in other ways, like surreptitiously installed on office computers and passed, for example, via floppy disks during events, as I/O/D was also the name of a floppy-based publication by the trio, founded in 1994.

JODI’s iconic low-tech *Map* (http://map.jodi.org) has a different, subjective perspective, and was created by internet artist duo Joan Heemskerk and Dirk Paesmans. It was a clickable online network diagram representing the ‘landscape of domains and sites that most interested them at the time’, with subjective relationships.[[4]](#footnote-4) JODI’s *Map* accidentally formalized part of the net art avant-garde, and enlightened some of its obscure manifestations, such as the French PAVU collective, interested in détourning the web, and the fals.ch music/CD-ROM label. The *Map* diagrammatically compiles an interconnected visual ‘document’ which outlived the time and context of its making. In a way it was ‘JODI’s Internet’, frozen in time and expressed through a curated selection of entities, all within net art circles. This selection both scaled down the network to which they were referring, to a size and shape that could be manageably represented, and restricted it to a sphere of mutual influence. (Incidentally, the earliest version of the *Neural* website was one of the nodes of the JODI’s *Map*.)

Another couple of examples, developed to fill the gap between the imaginary around emerging networks and their actual structure, help to categorize different types of transparent network topologies further. Lisa Jevbratt’s *1:1* (1999) was a database with ‘the addresses of every Web site in the world and interfaces through which to view and use the database’.[[5]](#footnote-5) The topology is represented through pixels which make lines and stripes with various attributed colors, abstracted in order to contain the ‘whole’ on one screen. As Rachel Greene describes, in Jevbratt’s work ‘a landscape emerges’, which ‘tends towards the imagistic and the representational.’[[6]](#footnote-6)

Schoenerwissen/OfCD’s *Minitasking* (2002), developed by Anne Pascual and Marcus Hauer, was, in the words of its makers, a ‘graphical browser for surfing the Gnutella network.’[[7]](#footnote-7) It visualized through different color bubbles the evolution of a query and the ongoing activity and size of the Servents. The topology of *Minitasking* represented the structure of the first decentralized peer-to-peer network, used for the exchange of mostly copyrighted files. The network was transparent in size and form, while the anonymity of the participants was still protected through the abstractions of the rendering. Compared to *1:1*, it shows how the topologies of autonomous and mostly functional networks must be constantly reshaped and their representations compellingly dynamic.

Somewhat ironically, a side effect of the dissemination of early mass computer virus attacks were visualizations of the network, as they made its topology transparent. At the peak of their infections, they could reveal large parts of global interconnections – and indeed, weaknesses. As I wrote in *Neural* in 2002, ‘The more computers get infected (or in other words will accept the message), the bigger the impact and reaction on the network will be. The critical mass of data spread around the network, temporarily transforms the shape and the content of the network, so it varies its own conscience.’[[8]](#footnote-8)

Yet another example of a transparent sub-network is the webring, a circular chain of shared interest websites, at once horizontal and sequential. This was the underlying construction of *Refresh* (1996), a net art work by Alexei Shulgin, Vuk Ćosić, and Andreas Broeckman, which showed how the connection between nodes required a negotiation among the peers. Ćosić describes the work as follows:

The Refresh Project […] was a collaborative online performance done in October of 1996 during the opening of the St. Petersburg Biennial. Alexei Shulgin, Andreas Broeckman and moi have decided to create a loop between web pages using the simple & stupid <refresh> tag. Then we arranged for an IRC session with anybody interested to participate and have slowly woven something like 25 different sites in one global ring.[[9]](#footnote-9)

A floppy disk with a ‘snapshot’ of this work was then distributed on the cover of the third Nettime reader at the MetaForum III conference in Budapest that year – an offline sharing of the existence and topology of this network to other potential participants (and thereby nodes).

These works (with the exception of *1:1*) aimed to both autonomize and connect compatible nodes in independent sub-networks, transparent but protected, with the fascinating possibility of reconfiguring these same nodes in order to evolve their meaning and function. They can still be understood as what Hakim Bey (Peter Lamborn Wilson) defined in 1991 as ‘temporary autonomous zones.’[[10]](#footnote-10) A network ecology emerges from these practices, with some key elements: transparency, the creation of autonomous and negotiated sub-networks, the potential of interconnections and their temporary or stable reconfigurations and extensions, and the nodes and their respective roles.

## Networking Practices: The Interdependent Networks of *Neural*

Pre-internet alternative and radical networks of communications share the figure of the ‘networker’: subjects developing their own networks, within or outside predefined structures. In mail art, this figure predominates, with the networker replacing the ‘artist’, with the prerogative to create networks of artistic production, public sharing, and archiving. In the words of Vittore Baroni, one of the most prominent figures in mail art: ‘I saw the networker as a new cultural figure, a sort of meta-author who created contexts for collective expression rather than conventional individual works, and whose activities eluded the “vicious circle” of the art market and therefore needed new critical parameters and instruments to be fully analyzed and understood.’[[11]](#footnote-11)

The networker here can be related to the privileged early internet scenario of relationships (small scale, quite unregulated, so mostly free and still technically simple), and to the practices of net art. The networker and early net artists share an underlying structure and principles, if not the scope and nature of their tools. For example, the Decentralized World-Wide Networker Congress for mail art in 1992 was a bottom-up structure of gatherings and events, creating and expanding upon sub-networks, including a three-day performance of eighty-six artists exchanging copy art via fax around the world.[[12]](#footnote-12) Net artists meanwhile were creating dynamic sub-networks, performances, and initiatives globally, connected by the same spirit of distributed production, collaboration, and knowledge-sharing.

These practices all inspired *Neural* magazine, its production, economy, and associated activities. Founded in 1993, *Neural* began with one specific concept: to be a single node within a larger network of magazines and sources of information, all delivering content on digital culture, both investigating and expanding the established domains. The role of *Neural* has always been to weave together different data domains, in order to trigger a new awareness of digital culture and the growing network of entities producing this culture, which increasingly break the boundaries between fields of research.[[13]](#footnote-13) Phillip Gochenour defined this approach as ‘nodalism’, which ‘emphasizes the importance of links and connections and stigmatizes disconnectedness and solitude.’[[14]](#footnote-14) This is not meant as a description of a condition, but a whole system: ‘in a network model each unit, though different in itself, is part of an overall smoothly functioning system.’[[15]](#footnote-15)

The *Neural* project has been built to echo the networks it nurtures and connects with, in a critical, but also open and collaborative way. Moreover, the development of a proper focused network has transcended the many platforms it occupies, and has entered into fruitful dialogues with other ‘nodes’.[[16]](#footnote-16) *Neural* took a few years to develop into a fully fledged informal network. In 2002, a network of magazines was cofounded, whose members could support each other in their publishing efforts, and discuss their shared condition, particularly the nodal relationship between online and offline publishing. The network was called Mag.net (magazine network of electronic cultural publishers) and involved thirteen international editors whose collective slogan became ‘collaboration is better than competition’, recursively reflecting its structure. Apart from sharing knowledge and developing projects among groups of members, three anthologies (‘Mag.net Readers’) were co-edited on the changing role of print and its ongoing mutation.

The mutual support network of Mag.net subsequently facilitated one of its members, Springerin editor Georg Schöllhammer, to curate ‘Documenta 12 magazines’ in Kassel in 2007, which involved almost one hundred independent art magazines from around the world. *Neural* contributed to this project, also developing relationships with some of the other featured publications, sharing similar conditions, interests, and attitudes.

In *Neural*’s publishing practice, another networked layer was developed a few years later, stemming from several experiments scattered in time. The infrastructure of distribution meant that our 500 or so subscribers included more than 150 institutional, mostly academic, libraries. These libraries could be thought of both as a preservation strategy for the magazine, hosting ‘back-up’ copies in distant places, and as a distribution strategy for art works embedded within the magazine. These art works, sometimes involving quite controversial ideological components, mostly consisted in artists’ interventions into the space of the page, with or without extra materials added or attached. In this way the magazine became a limited-edition distribution platform, using the infrastructural network of library collections.

A further layer of the *Neural* project is the Neural Archive, which consists of the submissions and donations of publications the magazine has received over the last twenty-five years.[[17]](#footnote-17) It is a searchable online catalogue of print media and art publications, and acts as a progressively growing representation of the community to which *Neural* magazine belongs – it is an archive of this community’s production. In the near future, the Neural Archive may become connected with other similar archives, and already in itself shows the magazine’s connections with the producers (publishers), and the inner connections among publications that emerge when you search all the issues. Music is not yet included in the archive, but could well be catalogued in the future, given our already established network of record labels and their contributions.

7.bildsc

Fig. : Neural Archive, Screenshot.

The funding of *Neural* is also ‘networked’, in that economic support for the project comes from a strategic network of subscribers, rather than from application-based funding, which *Neural* never applied for or received. From the beginning, a kind of crowdfund *ante litteram* was nurtured, with direct relations and communication that goes beyond the mere exchange of goods and money. On top of this, there’s the community of reference, or the network of artists, curators, and institutions which periodically inform the magazine and/or are in dialogue about their productions.

All these intertwining networks support the publishing, artistic, and archiving practices, but they also need to be nourished. Their interconnection generates sometimes unpredictable positive effects – strategic information or support which resonates from one layer to another, and from one node to another, transversally – but this is only manageable as long as the size and complexity of the network is maintained within a certain scale. With one-to-one relationships between all the nodes, their incredible human capital – fueled by emotional as well as technological resources – can become too much at some point, and lead to dysfunctions and cracks.

What results is a cultural version of an ‘interdependent network’. The nodes depend on each other for their ecology and economy. The technical term for these type of networks, ‘cascading’, highlights their fragility in case of failure, potentially causing breakdowns of the whole system.[[18]](#footnote-18) However, when they are culturally constituted and mediated, the networks have a different structure, as the single parts are protected by their various roles, although still interdependent.

Such an interdependent network as we have built over time with *Neural* might represent a possible, hopeful model or strategy for managing our personal networks, preserving scale in direct relation to complexity, and creating long-term or short-term nurtured connections, instead of always looking for more – as is the pervasive commercial mantra.

## The Opaque Topology of Social Media

While these kind of interdependent networks have a relatively transparent topology, at least in their public parts, in the case of *Neural*, the last revolution in communication we have seen, social media, is a self-transforming beast, which is less easy to discern. Social media platforms structurally hide their inner topology, all the while pushing for growth in the upper layer of users’ connections, which boost profits, as a condition to thrive and survive. This process had already begun in the first decade of the world wide web, when the big players started to capitalize on the appropriation of the network topology, through indexes and search engines, or giving private space to host content, through ‘portals’. The topology of networks became lucratively opaque and increasingly impenetrable.

The early need and desire to be aware of the network topology has gradually shifted toward online corporations’ need to include an ever larger number of users and content as assets, which has exploded with the social media paradigm and the ‘appification’ of everything, reiterated by most online platforms. This phenomenon is epitomized in the near total mediation of the economy of relationships, and so of networking, by social media. These platforms and protocols have triggered the largest voluntary creation of valuable and contextualized digital content, capitalizing on keeping their internal infrastructure hidden. It is an ‘inclusive-exclusive’ model: inclusive in terms of the functional accessibility of other users’ data and connections (the capital of data), although dispossessing each user from their own data ownership; and exclusive insofar as the internal network is hidden and even adjusted by corporate technical and strategical algorithms (page rank, timeline order, etc.), which make any attempt to interpret or decode the model useless.

In this reality, the ‘whole’ topology is just too complex to map and detail, even at the level of single users with a relatively low threshold (or number of friends/followers/nodes): the user, pushed to increase his or her contacts/nodes, loses track of the ‘whole’ of their connections. The top-down inclusive-exclusive model works very well for the companies in this respect, handing management of the networks to the platform’s owners.

It is nonetheless very important to interpret these networks. If in this model, technically ‘conflict is non-functional’, as Gochenour stated, then we can consider that social media stores an inordinate amount of useful contacts, which could become nodes of other focused networks, once identified and extrapolated from the corporate platform’s rules.[[19]](#footnote-19) Using the existing infrastructure of social media as a source of possible nodes of new independent, and even possibly interdependent networks, rather than number-driven platforms that encourage obsessive self-promotion, might trigger a different economy of networks and build new topologies.

## Human Mesh Networks

It is important then to consider to build networks of connections creating meaning. With rising commercial attention on the amount of connections having an impact on self-confidence, building scaled-down networks, characterized primarily by the meaning of the exchange rather than the quantity of exchanged signals could dismantle the popularity paradigm. Indeed, if this paradigm evaluates the number of associations as capital, then we’d consider that ‘the more connected, the more individualized a point is.’[[20]](#footnote-20) The network is, as Latour affirms, a ‘privileged mode of organization thanks to the very extension of information technology.’[[21]](#footnote-21) It is a privilege to access infrastructures which reveal entities that could coalesce around specific ideas and projects, forming new independent networks and sub-networks, scaling down complexity through being aware of our networked topography, and enabling us to better explore it. The six degrees of separation from the potential meaningful nodes should guide us toward finding the ‘human capital’ we want to cooperate with, escaping the sick dream of being either a hyperactive celebrity or a hyperactive audience. In this scenario, we’d value our discoverability in chosen contexts, in order to gain and pass on proximity from the nodes we want to build networks with, acting mostly outside the industrialized platforms. We should build ‘human mesh networks’ with interdependences that would preserve multiple potential layers of application and collectivity. The network topology of critical cultural forms embodies the concept of the network as a supportive infrastructure, a flexible skeleton for vital action. Networks are collective agents that author, facilitate, and propagate content, an essential part of the strategies necessary for instigating rebellion and alternative visions of society, for rethinking digital limits and conceptual possibilities. Once we reclaim the infrastructures, and a human scale supersedes technological complexity, we can start to properly shape our own networks with trusted nodes, making alliances between trusted entities of information with an open, non-self-rewarding attitude.

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2. Matthew Fuller, ‘Crawl, Map, Link, Read, Copy, Repeat’, *Rhizome* (17 February 2017), https://rhizome.org/editorial/2017/feb/17/iod-4-web-stalker/. [↑](#footnote-ref-2)
3. Josephine Bosma, *Nettitudes: Let’s Talk Net Art*, Rotterdam: NAI, 2011, p. 76. [↑](#footnote-ref-3)
4. Alexander R. Galloway, ‘Jodi’s Infrastructure’, *e-flux Journal* 74 (June 2016),

   https://www.e-flux.com/journal/74/59810/jodi-s-infrastructure/. [↑](#footnote-ref-4)
5. Lisa Jevbratt, 1999, http://128.111.69.4/~jevbratt/1\_to\_1/description.html. [↑](#footnote-ref-5)
6. Rachel Greene, *Internet Art*, London: Thames & Hudson, 2004, p. 140.  [↑](#footnote-ref-6)
7. Schoenerwissen/OfCD, ‘Minitasking’,

   https://rhizome.org/art/artbase/artwork/minitasking/. [↑](#footnote-ref-7)
8. Alessandro Ludovico, ‘Infection as Communication’, *Neural* 22 (2002). [↑](#footnote-ref-8)
9. Ćosić, Vuk, ‘[-28] The Refresh Project’, 2015,https://free.janezjansa.si/blog/2015/01/28-the-refresh-project/. [↑](#footnote-ref-9)
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12. György Galántai, Júlia Klaniczay, and Kristine Stiles, *Artpool: The Experimental Art Archive of East-Central Europe; History of an Active Archive for Producing, Networking, Curating and Researching Art Since 1970*, Budapest: Artpool, 2013, p. 136. [↑](#footnote-ref-12)
13. Annette Wolfsberger, ‘Interview with Alessandro Ludovico’, in Nicola Mullenger and Annette Wolfsberger (eds) *Cultural Bloggers Interviewed*, Amsterdam: LabforCulture, 2010, pp. 69-80. [↑](#footnote-ref-13)
14. Phillip Gochenour, ‘Nodalism’, *Digital Humanities Quarterly* 5.3 (2011), http://www.digitalhumanities.org/dhq/vol/5/3/000105/000105.html. [↑](#footnote-ref-14)
15. Gochenour, ‘Nodalism’. [↑](#footnote-ref-15)
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17. The Neural Archive, http://archive.neural.it. [↑](#footnote-ref-17)
18. Alessandro Vespignani, ‘Complex Networks: The Fragility of Interdependency’,*Nature* 464.7291 (April 2010): 984-985. [↑](#footnote-ref-18)
19. Gochenour, ‘Nodalism’. [↑](#footnote-ref-19)
20. Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford: Oxford University Press, 2008, p. 133. [↑](#footnote-ref-20)
21. Latour, *Reassembling the Social*, p. 129. [↑](#footnote-ref-21)