

Internet interconnection: how the Economics of Convention can inform the discourse on internet governance

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Abstract: Internet governance research has a tradition of focussing on institutions and formalised steering processes. But modes of coordination which do not fit these criteria also shape the operation and evolution of the internet and should also be included in an analytical framework for internet governance. In this article, the *Economics of Convention* is presented as a theoretical backdrop for the analysis of such phenomena. This analytical perspective is then used to shed a detailed light on internet interconnection arrangements. The findings of this exercise are then discussed with regard to their meaning for internet governance.

Keywords: internet interconnection, peering, economics of convention, reflexive coordination, internet governance

1. Introduction

Internet governance research often focusses on institutions (van Eeten & Mueller, 2012) and intentional, attributable steering processes (Mayntz 2005). A broader understanding of governance, to include unintentional coordination faces the problem of being so inclusive that for the purpose of analysis, it becomes lost in irrelevance. Hofmann, Katzenbach and Gollatz (2014, forthcoming) suggest a conception of governance as reflexive coordination. This analytical perspective encompasses both attributable, intentional processes of regulation as well as coordination which occurs as a side-effect of processes that are not explicitly designed to deploy regulatory functions.

But how can we empirically assess reflexive coordination in the administration of the internet where it is not represented in organisations and designed into intentional processes?

Interconnection agreements have been described in some instances as embodying internet governance (DeNardis 2012a) because they are regarded as “activities that shape the evolution and use of the Internet“ (Working Group on Internet Governance 2005, p. 4). But how can we understand interconnection arrangements in terms of internet governance specifically? How can we go beyond the broad notion of technology as a means of ordering as it is implied in the statement that “arrangements of technical architecture are always arrangements of power“ (DeNardis 2012b)?

I argue that the school of *Economics of Convention (EoC)* can inform the discourse on internet governance in a threefold way: (1) by challenging an understanding of the market as the only mode of coordination in internet interconnection; (2) by bringing conventional practices and processes to the fore that accompany and shape the operation and evolution of the internet; and (3) by grounding an understanding of internet governance as reflexive coordination.

In what follows I will briefly delineate in which part of the internet interconnection takes place. I will then introduce the main theoretical vantage points of the EoC in order to explain how this perspective can help unlock internet interconnection as internet governance.¹

1. Throughout the text preliminary findings from an ongoing empirical study are depicted to give an impression of interconnection practices. They are based on a set of interviews which were conducted as a pretest with peering coordinators from Germany and Austria in July 2014. All of the interviewees were at that point in time responsible for interconnection arrangements at organisations as different as hosting providers, small and large access providers and internet exchange points. The interviewees' work experience ranges from five to 14 years.

2. Internet interconnection

Interconnection is the center piece of what makes the internet a network of networks. The overarching premise of the internet is to connect all access providers so that all end systems can send packets to each other. Interconnection arrangements concern the core of the network.² Feldmann et al. (2013) estimate that more than 200.000 so-called peering links existed between the Autonomous Systems (AS) that make up the internet as a network of networks in June 2012.

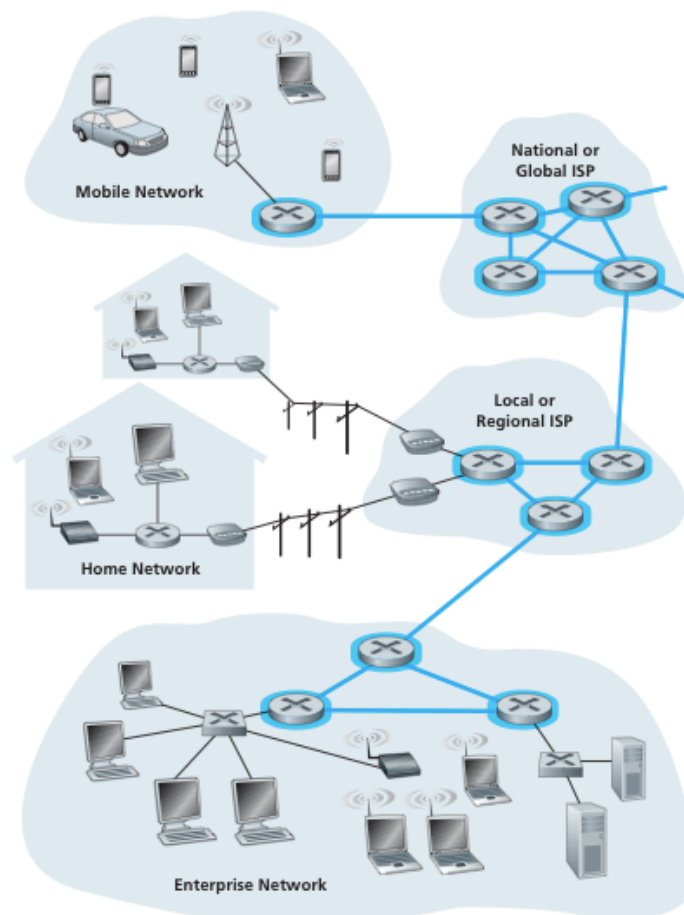


Figure 1: The network core (Kurose & Ross, 2003/2013, p. 23)

Interconnection arrangements in the context of this article comprise the social beings, artefacts and relationships that are mobilised to facilitate traffic flow between two or more network actors. Network actors are entities who connect AS to the internet. The term “arrangement” differs from “agre-

2. For an introduction to internet interconnection see Kurose & Ross. (2013, pp. 22-35).

ement” in so far as the latter only points to the negotiated content of the business relationship between two organisations and sometimes to its contractual form. Therefore, I refer to arrangements in order to capture all the resources that are involved in internet interconnection.

3. Theoretical vantage point: The perspective offered by Economics of Convention

The EoC is a research perspective that allows for an investigation into how actors achieve coordination in situations. This French school of thought’s origins go back to the works of a research group which, in the mid 1980s conducted studies at the crossroads of economics, sociology and statistics. It involved Luc Boltanski, Francois Eymard-Duvernay, André Orléan, Robert Salais and Laurent Thévenot and has gained traction since, especially in French social sciences, but also in Germany (e.g. Díaz-Bone, Mützel) and Sweden (e.g. Aspers).

The EoC have been developed with awareness of the *New Economic Sociology*, as brought forward by US American Sociologist Mark Granovetter who introduced the concept of the social ‘embeddedness’ of economic action (Granovetter 1973, 1985, 2005). However, the methodological approaches differ significantly. The EoC do not focus on social ties and networks as Granovetter does but on the quality of those ties, i.e. human action and interaction. Even though the EoC perspective was regularly applied to the economic sphere, the perspective comprises a set of concepts which offer a further means of analysing what even constitutes ‘economic action’.

One of the EoC’s starting points is the notion that human action happens under the condition of fundamental uncertainty. Neither external structures such as political institutions, norms or values are assumed to determine human action; nor does a single rational striving for the maximisation of personal utility provide absolute orientation. The EoC present a pragmatist approach in which situations are the unit of investigation (Knoll 2013, p. 40) while actors, objects and conventions are the beings of interest. Other than in structuralist or neoclassical economic thinking, actors are assumed to not only be equipped with a cognitive but also a critical, i.e. political capacity (Boltanski & Thevenot, 1999) which allows them to evaluate situations with regard to the legitimacy of the interpretive frame that is applied. This interpretive frame, that is: the convention, facilitates coordination. As a hypothesis Boltanski and Thévenot note:

[T]he same persons have, on the same day and in the same social space, to use different devices for assessment, including the reference to different types of worth, when they shift from one situation to another. (1999, p. 369)

The concurrence of evaluation and uncertainty is regarded as the source for social change, because this means that interpretive frames have to be open to testing in reality. The EoC therefore emphasise dynamics before

stability, albeit not denying the latter, as we will see later (Thevenot 2001, p. 406).

The openness for testing cannot be underestimated in so far as one of the pivotal hypotheses that the EoC stress is that there is a plurality of orders. Actors are endowed with the capacity to draw upon different so-called *orders of worth* depending on their assessment of a situation. There is not one single legitimate action but a plurality of possible ways of coordination. It is the conflict, the moment of disagreement about the resources that are mobilised to support a certain action, which prompts the participants to justify their reasoning and action by elaborating the principles upon which their judgement relies.

In **ON JUSTIFICATION** (Boltanski & Thévenot, 2006, original in French, 1991) which is one of the foundational works of the EoC Thévenot and Boltanski present six ‘worlds of justification’, also referred to as orders of worth: the *inspired*, *domestic* and *civic* order of worth as well as the order of the *opinion*, the *market* and the *industrial* order. This is not a closed list; worlds of the *environment* and *communication* were proposed later. Actors call upon orders of worth and the orders imply criteria of what is considered worth (which is equivalent to common interest) and what is deemed worthless (harmful or irrelevant). Each order of worth includes a set of beings (humans, objects, but also conceptual things) which are to be regarded as relevant ‘inventory’. Finally, they differ by the forms of coordination and conventions they draw upon in order to make judgement about worth. So testing, as mentioned above, may mean that a test according to one order of worth is executed. But it may also turn into a conflict in which the legitimacy of the interpretative frame itself is questioned and judgment based upon another order of worth is demanded (Boltanski & Thevenot, 2007, pp. 222-276).

Worlds of justification

	Inspired	Domestic	Civic	Opinion	Market	Industrial
Mode of evaluation (worth)	Grace, non-conformity	Esteem, reputation	Collective interest	Renown	Price	Productivity efficiency
Format of relevant information	Emotional	Oral, exemplary, anecdotal	Formal, official	Semiotic	Monetary	Measurable criteria, statistics
Elementary relation	Passion	Trust	Solidarity	Recognition	Exchange	Functional link
Human qualification	Creativity, ingenuity	Authority	Equality	Celebrity	Desire, purchasing power	Professional competency and experience

Figure 2: Orders of worth. Source: (Boltanski 1999, p. 386)

In addition, two concepts are central in the EoC: *qualification* and *form investment*. *Qualification* is a prerequisite for evaluation in so far as evaluation involves comparison, classification and an assessment in how far processes or features are to be treated as equivalent or not. The concept of qualification marks an analytical point of entry to the investigation of markets, because the existence of a market must be anteceded by the qualification of goods in order for them to be exchanged. Eymard-Duvernay coined the term *quality conventions*. He argues that “the existence of stable goods markets is linked to implicit collective agreements between buyers and sellers, on what defines quality: these ‘quality conventions’ are translated by firms into coherent ways of management, whose pure forms are studied as ‘enterprise models’.” (Favereau, Biencourt, & Eymard-Duvernay, 2002, p. 13) So the approach of the EoC not only suggests a relational concept of economic goods (Díaz Bone 2008, p. 5) but also suggests that organisational features of market actors correspond to quality conventions.

Through the term *form investment* Thévenot developed an understanding of how the scope of coordination is extended over time and space with a certain solidity (Thévenot 2007, p. 4). Investment refers to the cost that is caused by the act of constructing an equivalence between time and space, leading to formats of information. Examples of such forms are codes, standards, rules, trademarks or customs. They serve as conventional resources which allow types of coordination to become generalised and enhance efficiency (Thévenot 2002, p. 9, 2007, p. 4).

As long as the conventional object is accepted the speculative dynamic is simplified, for in order to predict what the others are going to do, it is enough to refer to the convention. Through the game of self-validation of beliefs, there follows a relative stability of the convention that, for the agents, becomes second nature. (Eymard-Duvernay, Favereau, Orléan, Salais, & Thévenot, 2003, p. 19)

4. How can the Economics of Convention be applied to internet interconnection?

Recalling the conceptual pillars of the EoC this perspective offers analytical vantage points to explore how coordination is reflected in and enacted through interconnection arrangements.

4.1 Modes of evaluation

The EoC rest on the assumption that actors draw upon different principles of ordering – depending on their assessment of a situation. Six major principles of ordering are listed in Section 3 (p. 6). They all relate to an understanding of the common good, albeit differently. With regard to interconnection agreements, an assumed plurality of orders changes the analytical perspective significantly. In this case market order is only one of the principles which serve actors to evaluate situations – even in the economic sphere in which in-

terconnection agreements between companies take place (Thévenot 2002, p. 3). If this is true, we may ask: What forms of evaluation do actors use with regard to their interconnection relationships? What principles of equivalence underlie evaluation?

A general answer to these questions deserves further empirical research. Studies on internet interconnection and its value tend to focus on the market mode of evaluation which is the price.³ However, some aspects have been acknowledged to influence network actor's interconnection decisions on peering. But these aspects have not been grounded systematically and integrated into a coherent scheme. Scholars quite broadly allude to peering practices as "black art" that depend on "factors that are neither technical nor economic" (Dhamdhare, Dovrolis, & Francois, 2010). In that vein, a number of more specific principles of evaluation besides price have been found, namely information exchange (Lippert & Spagnolo, 2008), trust and geographic proximity, "which helps the enforcement of implicit contracts" (Giovannetti, Neuhoff, & Spagnolo, 2006), as well as the uniqueness of interconnection options and redundancy (Sowell 2013, p. 21).

In interviews further aspects were brought to the fore:

Tradition. The aspect of tradition may be easy to overlook. However, several network actors mentioned that their organisation's peering relationships grew over time and remain in place "till the cows come home". These actors do not reflect on or see established agreements as ongoing decisions. Instead, they share a sense of history, especially with regard to initial interconnection agreements of a company. History therefore remains effective coordination which means that there is a certain path dependency for internet interconnection. To not change "a running system" of interconnection coincides with the industrial notion of efficiency because new transaction costs are avoided.

Personal relationships. Social relationships between peering coordinators were assessed quite differently by the interviewees – which is an interesting finding in itself. All interviewees agreed that knowing one's peering partner in person generally is good because it puts their operational activities into perspective. Yet, they did not consider a personal relationship as necessary for starting an interconnection relationship.⁴ The opinions diverged extremely when it came to social gatherings, the occasions where personal relationships become live: Some said they would make sure not to miss annual fora like the Global Peering Forum, the European Peering Forum, RIPE meetings or gatherings for internet exchange point operators. These peering coordinators

3. See for example (Clark, Lehr, & Bauer, 2011).

4. As actors follow a procedure for conflict resolution, they also follow a procedure of inquiring about a peering. All interviewees delineated this procedure similar to the description in Bill Norton's Internet Peering Playbook (2012).

especially seek opportunities to socialise informally, so called “beering” meetings – as from “beer” and “peer”.⁵ Other interviewees – all senior peering coordinators as well – never attend such meetings and regard them as not important. Notably, one interviewee had not ever heard of the word “beering”.

Collective interest. While the workload of day-to-day activities may not prompt many network engineers to reflect upon their work, particular cases can trigger them to apply critical, political reasoning to what they do. What follows is a slightly redacted excerpt of an interview I conducted with a medium size hosting provider. Before the situation that is depicted here, the peering coordinator had been contacted by a customer from a former USSR state. The customer experienced poor internet quality:

“Usually, we would have answered: Sorry, but we cannot treat every customer specially. However, in this case, we went into the matter and inquired: What is this customer trying to do? We discovered: He provides telephony services in a structurally weak area. Based on firm conviction we decided to treat his case specially. We made an effort and arranged a specific peering which we had not had before. Also, we tried to optimise our routing so things would work better for him. Our management was not involved. We decided on our own account, thinking: Having standards is good, but there are always exceptions. And some are just worth doing.”

This anecdote is relevant for a number of reasons: (1) The peering coordinator distinguishes between two interpretive frames. One which he sees appropriate for day-to-day business, the other he draws upon in this specific situation. (2) The desire to help is triggered by an understanding of the internet as a common good, as an essential means of communication. Underlying his “conviction” is a sense of equality between people. (3) There is a slight notion of disobedience because the engineers decided not to involve their management team. In terms of the EoC, the peering coordinator relied on a civic order of worth by showing solidarity with people in less developed regions in the world. However, it should also be noted that he did not challenge the validity of the standard procedure.

To sum up this section on modes of evaluation, let us see how the examples for valuation above fit with the concept of orders of worth and the modes of evaluation suggested therein. The following figure depicts how the examples mentioned in the previous section can be tentatively mapped to orders of worth. The grey text in the middle notes the reason for mapping. The graphic does by no means resemble a comprehensive account of modes of evaluation in interconnection agreements. Nor does it imply a hierarchy of modes of evaluation. It does however show that there is not one general mode of evaluation but a multitude of possible arrangements.

5. Internet exchange point operators know this and have been actively promoting such meetings. Interviewees believe that these promotional activities have been intensified within the last couple of years.

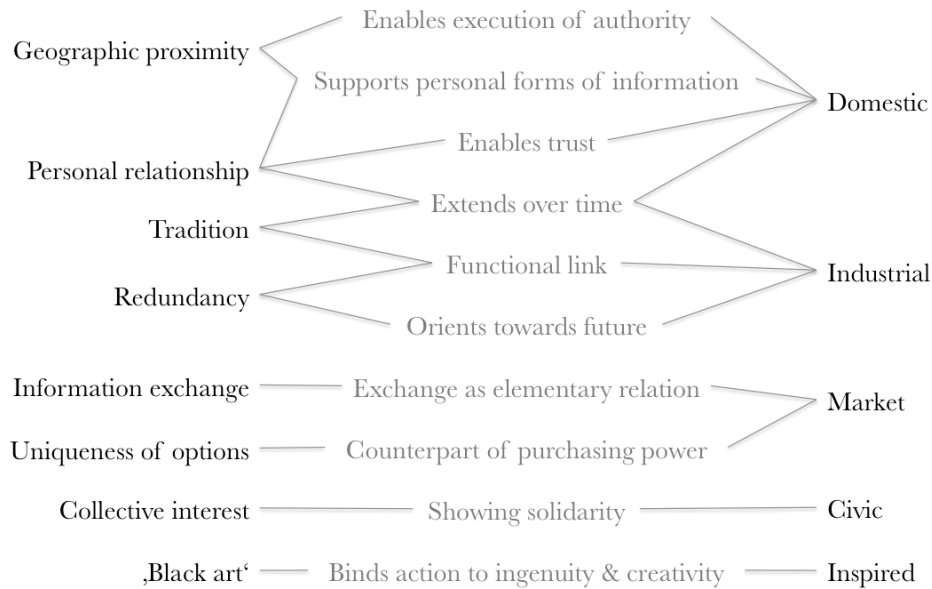


Figure 3: Mapping valuations to orders of worth

A preliminary analysis of the justifications that were given for entering or maintaining interconnection relationships alludes to an actual plurality of orders of worth. This exercise gives weight to the notion that internet interconnection practices can be thought of as arrangements in which different orders of worth are called upon by individual actors.

4.2 Quality conventions

In the EoCs markets are understood as “places where the quality of goods is tested and evaluated“ (Eymard-Duvernay et al., 2003, p. 12). In order for goods or services to be tested on a market, they need to be conditioned by “collective agreements between buyers and sellers, on what defines quality” (Favereau et al., 2002, p. 13). That is the definition of quality conventions. How can we conceive of the goods or services that are being exchanged through interconnection practices? And what are common quality conventions?

A generic answer to the question of what is being exchanged would be: (1) IP packet transport; (2) the termination of IP packets; and (3) connectivity. Network actors exchange the service of IP-packet transport through peering – be it paid peering or settlement-free. The service of terminating IP-packets at any end-point of the network is called transit. And the routes one network offers to another (technically: prefixes) mounts to connectivity.

The generic quality convention would be the best-effort principle – which actually is a *non*-quality convention. The best-effort principle is encoded in the Internet Protocol (IP): IP “makes its ‘best effort’ to deliver segments between communicating hosts, but it makes no guarantees. In particular, it does not guarantee segment delivery, it does not guarantee orderly delivery of seg-

ments, and it does not guarantee the integrity of the data in the segments. For these reasons, IP is said to be an unreliable service.“ (Kurose & Ross, 2003/2013, p. 190) Beyond this architectural application of the term “best effort”, network actors also referred to the best-effort principle when talking about their peering relationships:

“Usually, the peering sessions are best-effort connections. By this I do not only mean the class of service ...”

In this quote, best effort has a broad meaning because it does not only denote a technical standard but it refers to the way two actors view their business relationship in peering: i.e. with no obligations. This is especially true for so-called hand-shake agreements. Most interconnection relationships are based on these informal agreements with no written contract (Weller & Woodcock, 2012, p. 9).

However, some developments lead to questioning a simple view of “quality”. There is the rise of business models such as content delivery networks; content caches spread at the edges of the network (described by one interviewee as “alternative to peering”); there is software-defined networking which, by allowing to for easier control of network configurations, may lead to new dynamics.

A direct example for how “quality” is being re-framed is the implementation of service classes in IP-packets. Network actors flag IP-packets as important or critically important.⁶ This way they are able to realise the so called Quality of Service, albeit over direct peering relationships only and based on contractual Service Level Agreements (SLAs). At public peering facilities, network actors do not feel bound to adopt the prioritisation requests.

And then there is what I call internet infrastructure’s turn to content: For reasons of monetisation, some network actors have become interested in the content they are mandated to deliver. Clark et al. (2011) describe this as “ P_c ”, where c denotes a (new) price component which relates to the content and may be found in arrangements between content providers and access networks.

If the description of quality conventions up to here has been one of general elements, Díaz-Bone has pointed out an important aspect for further research:

Conventions can be seen as differentiating principles for markets, different conventions separate regions where the logic of production differs (2008, p. 8).

In other words: By analysing specific regional markets as distinct configurations, the details and characteristics of coordination become visible. Such an analysis would go beyond the scope of this article. But it seems worthwhile

6. One way this is done is by DiffServ, an architecture for “Differentiated Services” - http://en.wikipedia.org/wiki/Differentiated_services

to follow-up on the idea that internet interconnection as reflexive coordination may take different shapes around the world.

Summarising on quality conventions, there seems to be a well-established common ground, partially underpinned by the architecture of the internet. Yet, recent developments indicate that the common grounds which are needed for markets to function, are already starting to be challenged.

4.3 Conflicts

Analytically, I suggest to distinguish two types of conflicts, because only one type of conflict alludes to change: On the one hand, conflicts which prompt actors to conduct a test according to the prevalent interpretive frame; on the other hand, conflicts over the interpretive frame itself, including calling into question the modes of evaluation and the arrangement of orders. For the former I use the term testing; the latter I refer to as disputes or struggles. Conflicts signal the reflexive, political capabilities of the actors who are involved because they prompt them to justify their action. Thus the mode of coordination itself becomes an issue.

Which kinds of conflicts are network actors subjected to in internet interconnection arrangements? What justifications do they mobilise in cases of conflict? What is the scope of claimed legitimacy of the thereby articulated orders of worth?

According to the interviewees, the interconnection landscape seems to be rather peaceful. Settlement-free peering has some characteristics which support a friendly climate: the expectation that both parties mutually benefit from interconnection, the attitude to cater for the interconnection partner's needs with the best of effort and without contractual obligations. Such peerings are hardly ever subject to an argument, according to all interviewees. But also with regard to other kinds of interconnection such as private peerings or uplink interconnections (transit), the arrangements appear stable. From their experience, none of the interviewees recalled a dispute which involved external agency, such as law enforcement.

However, just recently US network actors have started to address peering conflicts in public. The pure act of involving the public leads to characterising these conflicts as disputes. Why exactly? Because by addressing the public as stakeholders these companies allow or even ask the public to have a voice in the conflict. For instance, US carrier Level3 put peering disputes in a context with net neutrality, asking the regulator to step in.⁷ According to the interviewees it is a "no go" among network operators to call for public oversight. "None of us wants to be regulated" and "my network, my rules" were phrases used in this context. In terms of the EoC, involving the public as stakeholders in internet interconnection equates to challenging the interpretive

7. See <http://blog.level3.com/global-connectivity/chicken-game-played-child-isps-internet>

frame that is applied by (the) other network actor(s). It introduces a civic order of worth in the arrangement of internet interconnection. The tension occurs because behaviour no longer follows the conventional mode of coordination in this economic field.

The less challenging type of conflicts only involve a test according to an accepted frame. They may arise in situations when an interconnected AS announces significantly more routes than agreed upon or when the link between two ASes is congested. Then, the procedure of conflict resolution as described in 4.5 (p. 14) may be triggered, that is the conventional test. If the situation can be identified as a technical error or mis-configuration, both parties will work towards a solution and continue the peering. If the problem cannot be solved, one of the peering partners will likely take the BGP session down until further notice. If the interconnection link is full, a common solution will be that both peers upgrade their links.

4.4 Uncertainties in internet interconnection

Architectural opaqueness: Conceptually, the technological architecture of the internet is characterised by a separation of network and application layers (Kurose & Ross, 2003/2013, pp. 49-52). A meaningful relationship between the IP packets can only be reconstructed in the end-user's computers. For network actors whose activities purely take place in the core of the network, the data is largely stripped of coherence. The standards and design principles of the internet hardly allow the qualification of the *content* in market terms. Exceptions of this general statement are starting to surface – traffic analysis based on the protocols that are used; software-defined networking; content-centric networking; placement of content caches in ISP facilities. But in comparison to app-layer businesses, network operators have fewer and different handles available to qualify data as content, i.e. as exchangeable, immaterial goods. This type of uncertainty marks a boundary zone of the interconnection market.

Systemic uncertainty: The internet is live. Network actors who are interconnected interdepend on each other in a dynamic way since each system itself is subject to changing demands which it ultimately cannot control. Examples for such incidents include heavy end-user demand due to media events such as a soccer world cup, engineering mistakes like accidentally harming router configurations or, DDOS attacks which network operators have a hard time distinguishing from regular traffic. Therefore one network actor is affected by other network's abilities to handle such instances. Uncertainty thus relates to the availability of contact persons and their personal qualifications.

Incomplete information: In internet interconnection, actors technically have access to a lot of information about the network and connections between other ASes – provided they have the qualification to acquire and interpret the data. Even the existence of private peerings can be re-engineered. However, there is one type of information that is not accessible: the content of

agreements between competitors. Network actors are very secretive about this.⁸

In order to interact with each other and achieve coordination, network actors have to make architectural opaqueness, systemic uncertainty and incomplete information manageable and create common expectations for each other. They do so by investing in forms, by constructing products and stabilising “expectations that are the mediums of the commercial interaction and productive activity of firms“ (Jagd 2004, p. 6). The following sections will address how this is done.

4.5 Investments in form

Form investments serve as conventional resources. They allow types of coordination to become generalised and enhance efficiency, because “people rely on the coded form or the invested form“ (Thévenot in Blokker & Brighenti, 2011, p. 5). If form investments may include codes or standards which lead to formats of information: what form investments extend which kind of coordination over time and space in internet interconnection?

Any standard or protocol of the internet bears witness to an investment in form as it allows two or more entities to coordinate. Investors firstly include those who engage in developing a protocol, like members of the Internet Engineering Task Force (IETF). Secondly, any network actor who adjusts her action in order to adhere to a standard makes an investment as well. The following is just one example of a potentially wide range of form investments that exist in the field of internet interconnection. It concerns the Border Gateway Protocol (BGP).

BGP is one of the most important protocols specifically related to internet interconnection. For Kurose & Ross, BGP is “the protocol that glues the whole thing together” (2013, p. 391). It is one of the oldest protocols of the internet. In BGP pairs of routers exchange routing information. This way the AS that make up the internet learn which destinations are attainable through their neighbouring networks (2003/2013, p. 393). BGP is necessary for any packet on the internet to be routed to its destination. Experts consider this protocol both “extremely complex” and “absolutely critical” (2013, p. 391). Deceitful or incompetent use of BGP, such as advertising routes that the network actor in fact does not have at her disposal, can lead to severe disruptions on a global scale.⁹ As preliminary empirical findings suggest, network actors

8. Network actor’s sensitivity about the content of interconnection agreements not only concerns competitors but also regulators, as a presentation at the Global Peering Forum illustrates: PEERING AND REGULATION – A EUROPEAN VIEW (Blanche 2012).

9. An example of how BGP can be used deceitfully is the “YouTube Hijacking” incident of 2008. In this case, a Pakistani AS started to announce routes via BGP that would lead to YouTube. As a consequence, the global traffic that was meant to reach YouTube was temporarily directed to Pakistan. For details, see this case study by RIPE: <http://>

adhere to the high demands of the BGP protocol by relying on at least three form investments. Each caters for efficiency in its own way, and they all lead to specific forms of knowledge:

- (1) *Procedure for resolution of irregularities.* When network actor *A* becomes aware that peer *B* causes irregularities in *A*'s network, there is a common procedure on how to establish a conversation. *A* will send an e-mail to an address she acquired through PeeringDB¹⁰. That is a database which holds information about networks which are interested in peering. It consists of user-contributed information and can be considered a wiki-like directory for peers. Several interviewees described that conventionally, the e-mail requests should be polite in tone, always assuming a technical problem in the first instance. For example: "Is this an intentional situation? Will it last? Or could there be a routing problem?" Yet, network *B* will be expected to follow an informal rule: to rectify the problem in a timely manner. Thus this investment is directed at the procedure of conflict resolution. It includes the effort to maintain accurate records in PeeringDB and a 24/7 available network operation centre (NOC).
- (2) *Expert knowledge.* Several descriptions of internet interconnection highlight that a specific type of knowledge is necessary to safely administer a network's routing algorithms and develop a peering strategy. While acknowledging the complexities of BGP, a manager described the expert culture he encountered when joining the company in the following way:

"Everything that has got to do with peering, let's say: BGP ... Those who are in charge make it a conspiracy. They think it is something really great which nobody knows how to do but them. (...) They tried to position themselves in a way that rendered them irreplaceable."

Asked how he would impart his knowledge about peering, a network engineer answered:

"This is something you have to experience, you cannot teach it."

I suggest to consider the cultivation of expert knowledge an ambivalent investment in form because this knowledge is contained within persons and thus extends the legacy of routing practices over the timespan of an expert's employment at a company. In Thévenot's words: Expert knowledge is an investment in form because it is "an implementation of the future in the present" (Thévenot in Blokker & Brighenti, 2011). On the other hand, expert knowledge is the exact opposite of generalisation since it is encapsulated in persons. So it is debatable if it can count as an investment in

[/www.ripe.net/internet-coordination/news/industry-developments/youtube-hijacking-a-ripe-ncc-ris-case-study](http://www.ripe.net/internet-coordination/news/industry-developments/youtube-hijacking-a-ripe-ncc-ris-case-study)

10. PeeringDB can be accessed at <https://www.peeringdb.com>. Another source for information about network actors within the European sphere is RIPE Network Coordination Centre's Routing Information Service, available at <http://www.ripe.net/data-tools/stats/ris>

form. For sure, it is a format of knowledge that shapes how information about routing can be disseminated as its acquisition is limited to experience-based forms. As long as expert knowledge is prevalent, network engineers are critical figures in the workings of internet interconnection. The manager's statement above also alludes to an organisational caveat of expert knowledge: within an organisation, experts activities are not as open to review as other, standardised processes. In other words: Experts enjoy an unusual degree of freedom to act – even in ways that may not be in line with a company's strategy.¹¹

- (3) *Common best practices*: In order to try to restrict damage *to* their network as well as *from* their network, network actors propagate best practice rules. This can be interpreted as an effort to achieve collective coordination. Ranging from internet exchange point operators to router manufacturers, many industry actors have published BGP best practice documents. A recent initiative is the Routing Resilience Manifesto¹². The initiators call upon network operators to commit to some “relatively small steps [that] could pave the road to more significant actions on a global scale“ (Freedman, D., George, W., Livingood, J., Robachevsky, A., Snijders, J., & Tauber, T. 2014). The manifesto explicitly demands “Collective Responsibility and Collaboration“, thus relating individual action to some sense of a common good. In the same vein, an older document compares BGP best practices in civic terms to “being a good Internet citizen” (Upadhaya, G.J. 2006). Through common best practices network actors clearly reflect and try to mitigate their interdependencies by trying to foster stability and resilience through mutual awareness.

Investments in form facilitate coordination by making things more general.¹³ With regard to the demanding protocol BGP, network actors have invested in forms such as procedures for operational conflict resolution, expert knowledge and best practices aka informal rules of the game. Referring to these forms allows them to reduce complexity in their day-to-day interactions and make future scenarios easier to assess. It should be noted, however, that any investment in form points to a sacrifice, i.e. the options that have been excluded from the standard, the rule or the agreement. Therein lies “the possibility of doubt and criticism, of making sensible the oppression of what has been disregarded” (Thévenot in Blocker 2011). In this sense, what is deemed best practice may, in fact, not describe the best overall routing practice, but rather

11. One interviewee recalled how he sealed a peering which clearly was not equally big of an advantage for the partnering network. But the coordinator's personal relationship had some tradition and his business partner had “expert freedom”. So he arranged the peering under the hood.

12. The Routing Resilience Manifesto is accessible at <https://routingmanifesto.org>

13. It is “an implementation of the future in the present.” (Thévenot in Blokker & Brighenti, 2011)

a low common denominator. Relying on expert knowledge in a critical aspect of network management may trigger unwanted personal dynamics within a company. And following a universal procedure for error resolution may prevent network actors from reacting immediately to an alarm by unilaterally adjusting their networks.

4.6 Summary: Conventional dimensions in the field of internet interconnection

By analysing internet interconnection against the backdrop of EoC it is possible to identify ingredients of the “glue” that makes the internet stick together as a network of networks.

Specific uncertainties condition how network actors realise internet interconnection: systemic uncertainty and architectural opaqueness. Systemic uncertainty is caused by strong interdependencies between network actors. Despite technical provisions, any network actor can become the subject of irregularities caused by someone else. Architectural opaqueness results from the separation between application and link layer in the internet architecture. This type of uncertainty creates a boundary zone for (the) interconnection market(s), because it prevents network actors from extending markets by further qualifying the traffic they transport, e.g. as “content”. Those who seek commodification, however, will further engage in processes of qualifying goods or services as this is a prerequisite for market exchange. The best-effort principle as a quality convention is at odds with processes of further commodification at the core of the internet.

The EoC focus on how actors mitigate uncertainty. One of the conventional resources that allows them to extend coordination over time and space are investments in form. In internet interconnection, investments in form are conveyed through codes, rules or protocols that network actors adhere to. Taking the BGP protocol as an example, the actors manage systemic uncertainties by commonly referencing at least three form investments: a procedure to resolve irregularities; the cultivation of expert knowledge; and common best practices. Network engineers play a critical role in internet interconnection, as knowledge that is attached to experience cannot be spread easily. Therefore gateways to the expert communities become points of interest for further research. To some degree common best practices counter expert knowledge, because they are a means of sharing knowledge, pushing for a discourse and, albeit voluntarily, enabling collective coordination that is global in scope.

Investments in form cater for stability, but any interpretive frame is open to testing in reality. Tests require modes of evaluation. Following the situative focus of the EoC, actors are endowed to draw upon a plurality of orders of worth – not based upon their individual characteristics but based on their assessment of a situation. Preliminary findings suggest that this is also true for internet interconnection. While stories of internet interconnection are

often told in terms of price and competition, there are further conventional frames besides the logic of the market. Network actors also seek trust, they mobilise personal relationships, keep up traditions and even show solidarity in their professional doings. This does not detract from the widely accepted role market coordination plays. Rather, it is an invitation to explore how varying modes of evaluation are applied in interconnection arrangements – be it by peering coordinators or within their organisations. In the anecdote noted in section 4.1 (p. 7) the peering coordinator who had arranged a peering for reasons of solidarity admitted that while he did not abide by the standards of his organisation in that instance, he also chose not to challenge them.

In this case, an open conflict of conventions was avoided. However, where disputes are brought to the public, they automatically involve the public as a stakeholder in interconnection. It is noteworthy that in the case of Level3 it was a network actor who put the current mode of coordination publicly under tension. In the past, network actors have been all but keen on involving the public, let alone calling for the regulator. But justifications of current practices can also be triggered by external actors. When German Chancellor Angela Merkel called for a “Schengen-Routing” as an answer to the Snowden revelations about blanket surveillance, tensions ran high in the community of network operators.

5. Conclusion and learnings for internet governance

This paper set out to follow-up on the complaint that internet governance researchers lean towards analysing organisational, institutionalised forms of governance. As Hofmann, Katzenbach and Gollatz point out, this focus is backed up by a research tradition that conceives of governance as intentional processes of steering. On the other hand, opening up the term governance for all kinds of coordination, as a sociological understanding would imply, divests the concept of its analytical strength. Hofmann et al. suggest to narrow down the wide understanding of coordination to “reflexive coordination”. Both regulatory but also non-intentional processes of coordination can be captured this way. This understanding of governance is quite dynamic as it does not attach itself to certain structures but to the critical capacity of actors who reflect upon circumstances situationally as orienting action.

Scholars critical of a purely organisational anchoring of governance demanded that internet interconnection agreements also be seen as internet governance as they contribute to how the internet is operated, shaped and developed. What these scholars left unanswered is just *how* internet governance is carried out through internet interconnection practices. One reason for this gap may be that a steering-understanding of governance would not accommodate distributed action that does not have an explicit governance agenda.

In this paper I introduced the EoC as a perspective of inquiry that allows for an understanding of how internet interconnection arrangements can be conceived of as internet governance. The EoC start from a notion of instability, of uncertainty and of humans who are endowed with a critical capacity. This capacity both makes it necessary and allows them to evaluate how to coordinate with others to overcome uncertainty. Starting from there, means to mitigate uncertainty (aka conventional resources) become interesting for analytical purposes as they stabilise modes of coordination – at least until the legitimacy of a mode of coordination is questioned. That is the moment of reflexivity, which marks an entry of speaking of governance in the sense presented by Hofmann, Katzenbach and Gollatz.

In the field of internet interconnection high interdependencies between network actors around the globe demand coordinated efforts. By working through specific uncertainties and by identifying conventional resources such as procedures, forms of knowledge, best practices or quality conventions these efforts and therefore potential themes of governance through interconnection arrangements become visible. Communicative processes around these resources can serve as indicators for “governance in action” because they resemble the moments of reflection in which the coordination itself becomes a topic – easily recognised in public disputes between network actors.

In such public conflicts, the scope of claimed legitimacy is at a maximum. However, there may be disputes about the applicability of a standard, a protocol, a procedure, or a mode of evaluation where actors do not (need to) claim an overall legitimacy for their action but only a certain degree of “commonality” (Eymard-Duvernay et al., 2003, p. 20; Thévenot 2007). It will be a task for future research to integrate this second dimension of plurality: the scope of claimed legitimacy, into the analysis of internet governance. It concerns the relationship between local governance arrangements and global ones.

6. References

- Blanche, M. (2012). Peering and Regulation - a European View. Presentation to Global Peering Forum 2012. Retrieved from <https://www.peeringforum.com/presentations/GPF7.0/gpf-2012-regulation-z.pdf>.
- Blokker, P., & Brighenti, A. (2011). An interview with Laurent Thévenot: On engagement, critique, commonality, and power. *European Journal of Social Theory*, 14(3), 383-400.
- Boltanski, L., & Thevenot, L. (1999). The Sociology of Critical Capacity. *European Journal of Social Theory*, 2(3), 359-377. doi:10.1177/136843199002003010.
- Boltanski, L., & Thevenot, L. (2007). *Über die Rechtfertigung: Eine Soziologie der kritischen Urteilskraft*. Hamburg: Verlag Hamburger Ed.
- Boltanski, L., & Thévenot, L. (2006). *On justification : economies of worth*. Princeton: Princeton University Press.
- Clark, D., Lehr W., Bauer S. (2011). Interconnection in the Internet: the policy challenge. TPRC 39 - Research Conference on Communication, Information and Internet Policy. Retrieved from: http://groups.csail.mit.edu/ana/Publications/Interconnection_in_the_Internet_the_policy_challenge_tprc-2011.pdf.
- DeNardis, L. (2012a). Governance at the Internet's Core: The Geopolitics of Interconnection and Internet exchange points in Emerging Markets. Retrieved from: <http://ssrn.com/abstract=2029715>.
- DeNardis, L. (2012b). Hidden Levers of Internet Control. *Information, Communication & Society*, 15(5), 720-738. doi:10.1080/1369118X.2012.659199.
- Dhamdhere, A., Dovrolis C., Francois P. (2010). A value-based framework for internet peering agreements. 22nd International Teletraffic Congress (ITC). Retrieved from: http://www.caida.org/publications/papers/2010/framework_peering_agreements/framework_peering_agreements.pdf.
- Díaz Bone, R. (2008). Quality conventions as structuring principles in markets. Relational sociology: Transatlantic impulses for the social sciences. Retrieved from: http://www.rainer-diaz-bone.de/DiazBone_QualityConventions.pdf.
- Eymard-Duvernay, F., Favereau O., Orléan A., Salais R., Thévenot L. (2003). Values, Coordination and Rationality: The Economy of Conventions or The Time of Reunification in the Economic, Social and Political Sciences. Presented at *Conventions et institutions: approfondissements théoriques et contributions au débat politique*.
- Favereau, O., Biencourt, O., & Eymard-Duvernay, F. (2002). Where do markets come from? From (quality) conventions!. In Favereau, O. & Lazega, E. (Eds.), *Conventions and Structures in Economic Organization. Markets, Networks and Hierarchies* (pp. 222-252). Cheltenham, UK; Northampton, Mass.: Edward Elgar.
- Feldmann, A. (2013). *On the Importance of Internet eXchange Points for Today's Internet Ecosystem*. International Computer Science Institute Berkeley. Retrieved from <http://youtu.be/LjR9x5Vc3S4>

- Freedman, D., George, W., et al. (2014). Draft: Collective Responsibility and Collaboration for Routing Resilience and Security. Routing Resilience Manifesto. Retrieved from <https://www.routingmanifesto.org/>
- Giovannetti, E., Neuhoff, K., & Spagnolo, G. (2006). Agglomeration in Internet cooperation peering agreements. Cambridge Working Papers in Economics. University of Cambridge. Retrieved from: <https://www.repository.cam.ac.uk/bitstream/handle/1810/131633/cwpe0505.pdf?sequence=1>
- Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology*, 78(6), 1360-1380.
- Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *The American Journal of Sociology*, 91(3), 481-510. Retrieved from <http://www.jstor.org/stable/2780199>
- Granovetter, M. (2005). The impact of social structure on economic outcomes. *The Journal of Economic Perspectives*, 19(1), 33-50.
- Hofmann, J. et al. (2014). Internet governance as reflexive coordination. (forthcoming)
- Jagd, S. (2004). Laurent Thévenot and the French Convention School. A Short Introduction. *Economic Sociology: European Electronic Newsletter*, 5(3), 2-10. Retrieved from <http://econsoc.mpifg.de/archive/esjune04.pdf>
- Knoll, L. (2013). Justification, Conventions, and Institutions in Economic Fields. *Economic Sociology - European Electronic Newsletter*, 14(2), 39-45.
- Kurose, J. F., & Ross, K. W. (2013). Computer Networking. A Top-Down Approach. New Jersey: Pearson Education. (Original work published 2003)
- Lippert, S., & Spagnolo, G. (2008). Internet peering as a network of relations. *Telecommunications Policy*, 32(1), 33-49.
- Mayntz, R. (2005). Governance-Theorie als fortentwickelte Steuerungstheorie. In Mayntz, R. (Ed.), *Schriften aus dem Max-Planck-Institut für Gesellschaftsforschung: Über Governance. Institutionen und Prozesse politischer Regelung* (Vol. 62, pp. 41-52). Frankfurt/Main: Campus.
- Norton, W. B. (2012). *The Internet Peering Playbook: Connecting to the Core of the Internet* (2nd ed.). Palo Alto, California: DrPeering Press.
- Sowell, J. (2013). Framing the Value of Internet Exchange Participation. TPRC 41: The 41st Research Conference on Communication, Information and Internet Policy. Retrieved from: <http://ssrn.com/abstract=2241841>
- Thevenot, L. (2001). Organized Complexity: Conventions of Coordination and the Composition of Economic Arrangements. *European Journal of Social Theory*, 4(4), 405-425. doi:10.1177/13684310122225235
- Thévenot, L. (2002). Conventions of co-ordination and the framing of uncertainty. In E. Fullbrook (Ed.), *Intersubjectivity in Economics. London and New York: Routledge* (pp. 181-197). London: Routledge.
- Thévenot, L. (2007). The plurality of cognitive formats and engagements moving between the familiar and the public. *European Journal of Social Theory*, 10(3), 409-423.

Upadhaya, G.J. (2006). BGP Best Practices for ISPs. Retrieved from <http://archive.apnic.net/meetings/22/docs/tut-routing-pres-bgp-bcp.pdf>

van Eeten, M. J., & Mueller, M. (2012). Where is the governance in Internet governance? *New Media & Society*.

Weller, D., & Woodcock, B. (2012). Internet Traffic Exchange: Market Developments and Policy Challenges. *OECD Digital Economy Papers, No. 207*. doi:<http://dx.doi.org/10.1787/5k918gpt130q-en>

Working Group on Internet Governance. (2005). *Report of the Working Group on Internet Governance*. Château de Bossey. Retrieved from <http://www.wgig.org/docs/WGI-GREPORT.pdf>