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First Report on Economic Future Internet Coordination Activities

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V1.3	Sep 8, 2011	Costas Kalogiros, Patrick Poullie, Burkhard Stiller, Martin Waldburger	Major changes due to discussion after internal review, document finalization

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1 Executive Summary

The SESERV project coordinates the work on Future Internet socio-economics (SE) within the European Future Internet community. This report is deliverable "D2.1 First Report on Economic Future Internet Coordination Activities" which describes coordination activities related to the economics of the Future Internet during the 1st year of the SESERV project, focusing on incentive mechanisms for effective collaboration and high-speed accounting.

D2.1 is driven by both the wide area of socio-economics and Future Internet research projects addressing associated challenges either marginally, partially, or in more depth. By studying a subset of Challenge 1 projects the most popular socio-economic challenges are identified and a consolidated overview and classification of Future Internet stakeholders is presented along with an analysis of how such stakeholders interact by exploiting Future Internet technologies to advance their economic interests and influence economic outcomes. Thus, the core of this deliverable is the development of tussle analysis itself and the analysis of Challenge 1 research projects with respect to socio-economic issues, in order to obtain a structured and broad overview of socio-economic dimensions.

For this purpose, 16 socio-economic key aspects of the Future Internet have been carefully assembled in collaboration with SESERV's WP3 and then ranked for 92 survey respondents with respect to relevance to their project. It turns out that Cloud computing receives the highest interest, followed by Privacy and data protection, Security of communications, Internet of things, and Online identity in that order. Furthermore, the results indicate that those dimensions covered reflect the range of European research projects and their diverse scopes well.

The tussle analysis introduced in this deliverable allows for an investigation of target projects in detail. After evaluating the questionnaires and answers by each profiled project, stakeholders affected by the developed technology and tussles among these are identified. The profiling methodology is applied to 16 Challenge 1 projects and the respective results are described in form of project profiles that also include their socio-economic priorities, focused and illustrated in form of a spider graph allowing for a direct comparison to other projects. These numerous profiles enable improved project coordination, a deep understanding of socio-economic interactions in the Future Internet, and an evaluation and improvement of the tussle analysis. Most notably, we observe that the technologies proposed by the profiled research projects increasingly blur the distinction across stakeholders and, at the same time, promote collaboration across different stakeholders resulting in more complex value chains/networks. We also identify that several projects study interactions between stakeholders that can be categorized into a limited number of groups, such as network security, controlling content/service delivery and responsibility for agreement violation, among others. Moreover, several projects are found to study interactions between stakeholders that can be categorized into a limited number of groups, such as network security, controlling content/service delivery and responsibility for agreement violation, among others. Overall, the tussle analysis method is perceived to offer projects a structured approach to identify, communicate, and address socio-economic aspects of their research and the relevant impact of their developed solutions, the sustainability of their adoption, *etc.*

Apart from studying and interacting with research projects, standardization activities undertaken within the ITU Study Group 13 (SG13) on "Future Networks Including Mobile and Next Generation Networks (NGN)" helped the coordination of socio-economic issues. SESERV's contribution, especially the inclusion of the tussle concept as a potential model to look at stakeholder interactions within future networks, has ensured that the concept of socio-economic assessment is now part of the new ITU-T recommendation Y.3001.

Many socio-economic issues encountered raise questions in relation to traceability of Internet traffic and services, since such information provides facts as a quantifiable basis on network data to analyze, judge, and even regulate a considerable number of tussles. In the second part of the deliverable we consider the managerial and technical feasibility and other socio-economic challenges of high-speed Internet accounting in a world of increasing volumes of real-time communication. Two frameworks are proposed to assess socio-economic demand drivers of high-speed accounting, and a stress-field between those is presented.

Future work during the second year will strive for depth in terms of a detailed design for tussle assessment by completing the tussle analysis for eight or more projects. The common research themes of projects that were identified and the associated tussles will be utilized in coordinating the discussion with those projects, *e.g.*, during the second SESERV workshop to be held in Athens on February 2012. Furthermore, the deliverable at hand and the respective results will be communicated to the involved projects. Their feedback received will be taken into consideration in upcoming work in SESERV and especially WP2. Deliverable D2.2 will see the received feedback from the addressed community documented and implemented.

2 Introduction

The Internet is a platform that can be studied as a system composed of multiple technologies and an environment where multiple stakeholders interact by using these technologies, and thus, the Internet is interesting from both the technological and the socio-economic viewpoint. Even though this deliverable focuses on the economic aspects of the Internet, it is not possible to neglect the social dimension (which is the focus of D3.1 [24]). The reason is that stakeholders express their interests by making choices not only governed by laws of economics (*e.g.,* supply and demand), but also laws of sociology, psychology, etc.

Each of those choices will affect the technology layer by deciding which technologies will be introduced, how these will be dimensioned, configured, and finally, used. Then all these collective decisions will determine how technology components will operate and produce outputs that are valuable for these stakeholders. For example the DNS (Domain Name System) associates domain names to network addresses in a distributed way, based on each administrator's configuration of a local DNS server's entries. These entries can affect the level of caching achieved and be used for other purposes, such as load balancing and optimized delivery of services and content to end-users. Similarly, routers interconnected through physical links forward data packets (Best effort or QoS-enabled) based on each ISP's configuration of the Border Gateway Protocol (BGP), the outcome of which is, in turn, affected by several factors including the mapping of addresses performed by the DNS.

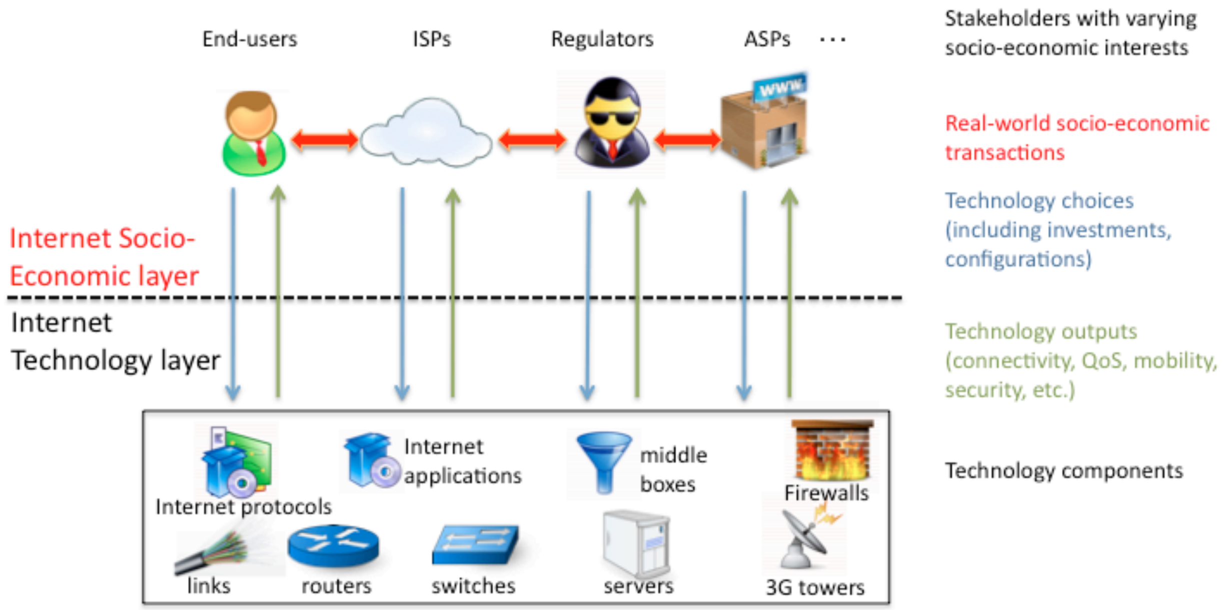

Figure 1: Internet as a Platform

Technology outputs are assessed by each stakeholder individually and can affect real-world interactions (*e.g.,* payments, price competition, price regulation, collaboration) or trigger new technology decisions. All these interactions allow the Internet to evolve and act as a living organism.

There is a growing debate over the last years on whether and how the Internet should be governed or policed in order to deal with socio-economic issues related to privacy protection, security, access to content and services, just to name a few of them. Jensen

[15], for example, argues that the Internet should be governed by an intergovernmental organization in a way striking the right balance between all relevant stakeholders.

Other studies, such as [29] suggest that policy makers should keep the Internet available and open, should aim at raising awareness rather than coercive intervention and promote self- and co-regulation. In a similar line of thought, Clark et al. [6] identified the critical role of technology developers in determining the set of available technologies and their functionality, which in turn defines the super set of possible technology decisions and other real-world interactions. As a way to achieve this balance they introduce the "Design for Tussle" goal, which pursues building interest-neutral technologies that do not impose a specific outcome not only across space (stakeholders) but, since the stakeholders' interests are rarely static, across time as well.

The rationale behind the "Design for Tussle" goal is that Internet is a rather unpredictable system and it is very difficult to assess whether a particular outcome will remain desirable in the future. The difficulties of implementing this goal have been highlighted by [20] stating that "*Fair advice, but currently almost impossible to achieve as we lack clear rules for identifying tussle spaces and for forecasting how tussles might spill into surrounding contexts*". A group of experts participating in a survey about the Future of the Internet [1] agreed that *"… innovation will continue to catch us by surprise because even though there are basic trends evident now, spotting key technologies ahead of time has proved to be difficult*", supporting the difficulties arising when designing technologies in a forward-looking way.

2.1 Scope and Outcomes

The deliverable focuses on coordination activities among the large set of Challenge 1 and more specifically FI (Future Internet) projects. Coordination happens in different ways and by use of multiple instruments. A very prominent task that this deliverable addresses, in particular when considering the amount of projects to be coordinated, comprises the assessment of a subset of Challenge 1 projects for their socio-economic priorities, the list of stakeholders envisioned, and the respective set of tussles emerging. The latter two aspects are addressed using a tussle analysis methodology, which also is evaluated at this point.

Therefore, a generic and structured socio-economic profiling method to investigate projects developing Future Internet technology (*e.g.*, protocols, platforms, architectures) is developed and applied to several projects. Input to this methodology are answers given by the respective project to the SESERV on-line survey [22] and tussle-oriented questionnaire (*cf*. Annex A), as well as project deliverables and publications. These answers are compiled to a project profile consisting of a graph, nicely illustrating socio-economic priorities of the project, a set of stakeholders affected by the technology that is developed by the project, and the respective tussles emerging between those stakeholders.

Stakeholders encountered in the project profiles are gathered comprehensively and are aggregated to meta-stakeholders. These stakeholders interact in several ways and we focus on a subset of self-interested interactions that we call tussles. Most projects are related to more than one tussle, while several overlaps exist between different projects. The interacting stakeholders in the tussles of interest to each project can be graphically visualized in the so-called FISE Map, allowing for an illustration of tussle boundaries. By comparing the FISE Maps of two, or more, research projects we can identify common themes and different assumptions. As the results are clearly structured and highly descriptive, a substantiated feedback to profiled projects is possible.

The deliverable completes the picture on economic Future Internet activities by an overview of progress made and next steps planned in bringing methods for socio-economic analysis, in particular the design for tussle principle and the tussle analysis method, into standardization.

Moreover, since the profiling activities reveal a demand for a quantifiable basis on network data to analyze, judge, and even regulate a considerable number of tussles, high-speed (Internet) accounting, that provides such data, is also investigated in D2.1. The demand to high-speed accounting is contrasted to managerial and technical feasibility and, similar to a project profile, stakeholders interested or affected by Internet accounting are identified and possible tussles outlined.

2.2 Structure

The profiling methodology proposed in this deliverable is outlined in Section 3. Socio-economic priorities are essential for this methodology and therefore first discussed in Section 3.1. Internet Stakeholders are introduced in Section 3.2. The methodology of tussle analysis is presented in 3.3. The FISE Map, that associates stakeholders and tussles, is motivated in 3.4.

The application of the profiling method defined and introduced in Section 3 leads to the documented set of socio-economic profiles for a wide range of Challenge 1 of which four are presented in Section 4 and the remainder in Annex C. Section 5 draws conclusion from the project-specific profile data by discussing the FISE Stakeholders in Section 5.1, giving a tussle consolidation in Section 5.2, and drawing further conclusions with the help of the FISE Map in Section 5.3

While standardization activities in the ITU with respect to the proposed tussle concept are outlined in Section 6, Section 7 contrasts socio-economic demand-drivers for high-speed accounting to its managerial and technical feasibility constraints. Finally, main activities are summarized, key conclusions are drawn and next steps outlined in Section 8.

3 Profiling Methodology

The key instrument used in the deliverable to obtain an overview of socio-economic dimensions among Challenge 1 projects in a structured and comprehensive manner consists in profiling different projects. A socio-economic project profile covers three thematic areas:

- Socio-economic priorities: Each profiled project is assessed with respect to the priorities it makes in a set of 16 given socio-economic dimensions. Socio-economic priorities for each project are identified and compared with the respective average. The base data originates from the SESERV on-line survey available at [22].
- Stakeholders: Each profiled project is asked to list and describe the set of stakeholders playing an important role with respect to the technology that a project is developing, or provide references to related project deliverables. Project-specific answers either originate in written form by the project answering a SESERV questionnaire or from interviewing project representatives and asking them a directly comparable set of questions.
- Tussles and potential tussle spillovers: Profiled projects are introduced to the concept of tussles and the tussle analysis method. Based on this information, projects are asked for the set of tussles (and potential tussle spillovers) emerging among the stakeholders identified previously or references to related project deliverables. Base data originates again in written form from a questionnaire or from project interviews.

The profiling procedure is illustrated in Figure 2. The profiling of a target project was initiated by a SESERV partner by contacting the target project. In an e-mail or telephone conference the target project answered a questionnaire that was analyzed by the SESERV partner to derive information about stakeholders and tussles encountered by the project. Furthermore, the target project answered an online-survey, whose input data was gathered by the survey administrators (UOX) and later compiled to a spider graph. Both, the stakeholder and tussle information, as well as, the online-survey answers were sent to the D2.1 editors (UZH) who compiled a socio-economic profile for the target project.

The following sections provide further methodological details. This includes the procedure of obtaining, treating, and visualizing socio-economic priorities per project (Section 3.1), an introduction of stakeholders (3.2) and the tussle analysis method (3.3). Out of all socio-economic project profiles compiled and analyzed, the second major analysis instrument used in this deliverable embraces a cartography activity: Stakeholders and tussles are mapped by means of a consolidated FISE Map. The FISE Map aims at outlining key tussle boundaries that were aggregated from the set of available socio-economic project profiles. Section 3.4 explains how the FISE Map is drawn and how it may be instantiated for specific projects.

3.1 Socio-economic Priorities

Key Issues for Future Internet technologies may be best determined by aggregating priorities of projects developing them. Therefore the following sixteen socio-economic issues [2],[16] relevant to the Internet were carefully chosen to cover all major concerns to the Future Internet:

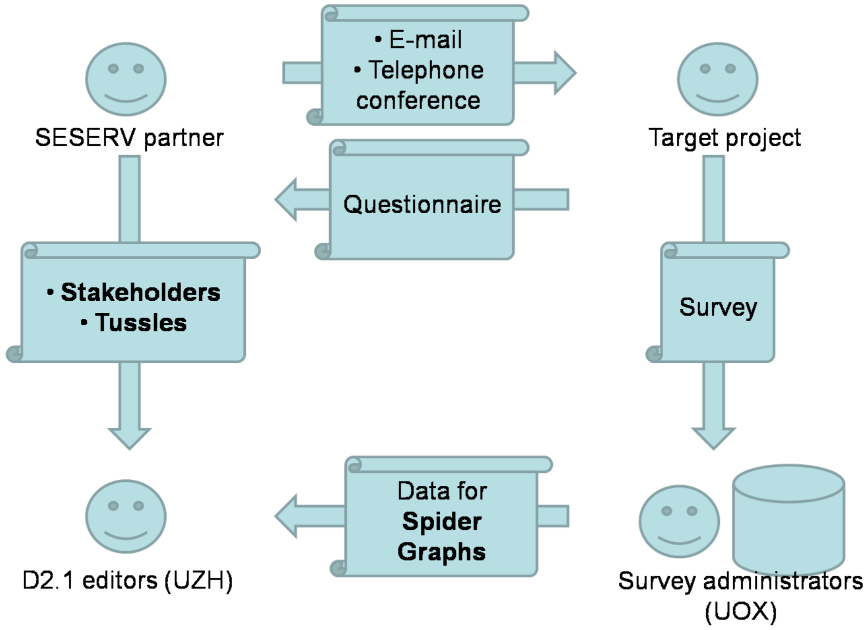

Figure 2: Profiling Procedure

- Online Identity, including anonymity, digital presence, rights to delete information, etc.
- Security of communications, including legal implications
- Cloud computing, including the risks and benefits of virtual access to information, etc.
- Green Internet issues, including reducing the carbon footprint of the ICT sector, e-waste, etc.
- Content regulation, including copyright, licenses, open access, etc.
- E-democracy, including transparency, open government data, empowered citizenship, services to citizens, etc.
- Digital citizenship, including individual and corporate rights and responsibilities, etc.
- Digital inclusion, including access and use of Internet by vulnerable populations, etc.
- Trust, including risk drivers, actors at risk, risk management, etc.
- Online communities, including social networks, virtual relationships, etc.
- Internet of things, and the connections between people and devices
- Relationships between consumers and suppliers online
- Distributed knowledge production, including e-science, e-learning, etc.
- Cybercrime and Cyberlaw, including phishing, cracking, cyberterrorism, etc.

Even though these priorities emphasize the social aspects of the Internet, like Online Identity and Online Privacy, there is significant correlation with major economic issues. For example, “Relationships between consumers and suppliers online” lies at the heart of discussions on future value chains and business models in general. Furthermore "Regulation of the Internet", "Content regulation" and "Green Internet" have a fundamental impact on several economic aspects, including:

- the role of intermediaries and monopolies in service provision (for example "walled gardens", technologies that bypass existing monopolies, *etc.*);
- the debate for an open versus a closed Internet (for example network neutrality);
- the debate for a single **I**nternet versus multiple **i**nternets;
- providing incentives for investment on new (greener or more efficient) technologies based on industrial organization theory (for example allow investors achieving a return on investment and gradually enable competition by helping competing providers to climb the "ladder of investment" [3]).

The "Cloud computing" priority has its roots in pursuing cost reduction through economies of scale and scope, while "Internet of things" and "Distributed knowledge production" can enable new services by extending, for example, the sources of information to include sensors and consumers of other services in the case of recommendation systems.

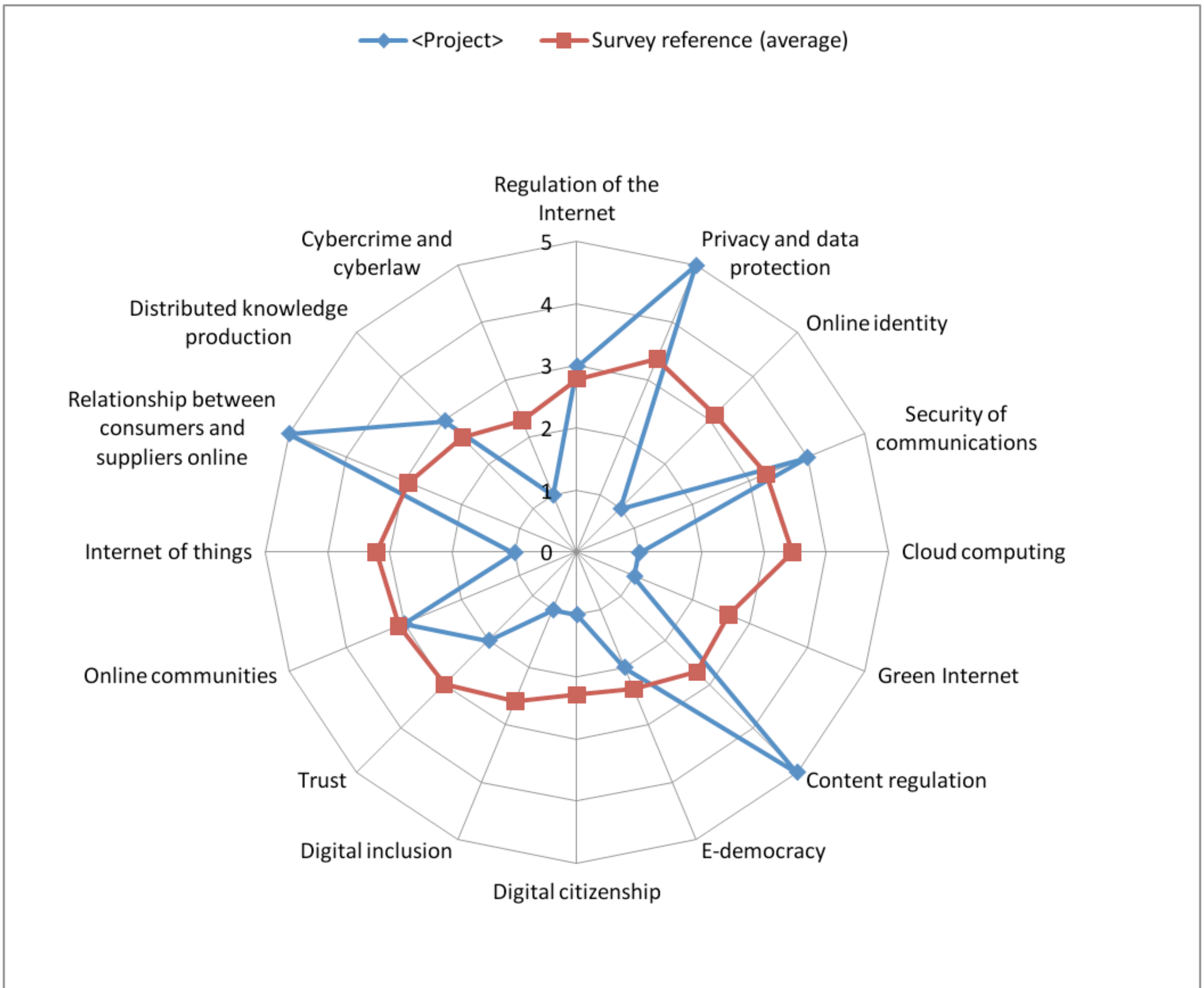

Figure 3: Sample Spider Graph Visualizing Socio-economic Priorities Compared with Average

The survey that can be found under [22], was designed and implemented by SESERV's WP3 partners. SESERV deliverable D1.2 [23] describes the survey questions, while deliverable D3.1 [24] contains the survey analysis data in further detail. By answering the survey 92 experts from the FISE community and representatives of Challenge 1 projects expressed the relevance of these issues to their project in five different grades reaching from *irrelevant* to *key issue*. This great feedback was used to calculate the mean relevance of each issue in order to predict key socio-economic priorities for Future Internet technologies. Per project the priorities are illustrated as a spider graph; furthermore, it is contrasted to the mean relevance to outline relative focal points of the respective project.

Figure 3 shows an example of how such spider graphs are built. Each of the 16 socio-economic dimensions build a spoke in the graph, labeled from 0 to 5:

- Value 0: No answer was provided
- Value 1: “Not relevant”
- Value 2: “Only somewhat relevant”
- Value 3: “Moderately relevant, but not key”
- Value 4: “Relevant and important”
- Value 5: “Absolutely relevant, a key issue”

Out of 92[1] individual answers to the SESERV survey, the average rating for each socio-economic dimension has been calculated (representing the survey reference in the spider graph) as Table 1 illustrates.

Table 1: Socio-economic Dimensions and Average Rating out of 92 Individual Answers to the SESERV On-line Survey

Socio-economic Dimension	**Average Rating (N=92, rounded)**
Regulation of the Internet	2.74
Privacy and data protection	3.33
Online Identity	3.08
Security of communications	3.23
Cloud computing	3.41
Green Internet	2.58
Content regulation	2.68
E-democracy	2.34
Digital citizenship	2.25
Digital inclusion	2.54
Trust	2.97
Online communities	3.04
Internet of things	3.20

[1] State as of July 29, 2011.

[2] It is obvious that the definition of fairness is very important when interpreting tussle outcomes. For

Relationships between consumers and suppliers online	2.87
Distributed knowledge production	2.59
Cybercrime and cyberlaw	2.25

The averages calculated show a highly balanced valuation of socio-economic dimensions among respondents. The lowest ranked dimensions (Digital citizenship and Cybercrime and cyberlaw rated at 2.25 on average) are only 1.16 points lower ranked than the highest ranked dimension (Cloud computing at 3.461). This average result is perceived very positive as a narrow distribution of the 16 socio-economic dimensions selected in the on-line survey indicates that dimensions covered reflect the range of European research projects and their diverse scopes well. Accordingly, the top five socio-economic priorities (on average) have only a slight edge over the other 11 dimensions:

1. Cloud computing
2. Privacy and data protection
3. Security of communications
4. Internet of things
5. Online identity

3.2 Stakeholders

Stakeholders are entities supervising or making decisions that affect how the Internet ecosystem operates and evolves. The importance of identifying Internet stakeholders has been recognized long ago. For example the M3I research project described back in 2002 the stakeholders of the Internet connectivity market, focusing on economic entities only and their interactions [19], as shown in Figure 4. On the other hand the study performed by the Internet Society in 2009 and shown in Figure 5, focused on the entities governing and standardizing aspects of the Internet, such as naming and addressing [13]. Similarly, Figure 7 gives a detailed view on the stakeholders of the mobile services sector [9]. A more balanced view was offered by Leva [17] (Figure 6) describing market entities, policy setters and technology makers, as well as their interactions.

Figure 8 provides a classification of Internet stakeholders combining aspects from all previous studies, but not their interactions. These entities provide services, technologies or policies. A usual phenomenon is that the same entity plays multiple roles, for example ISPs offer connectivity services but at the same time can provide entertainment content services. Thus, stakeholder *roles* instead of specific entities are of interest. For sake of brevity stakeholder roles are referred to as stakeholders in the rest of the deliverable, unless explicitly mentioned.

Connectivity Providers refer to the entities responsible for the delivery of traffic from its source to the ultimate destination. This traffic may involve *Users* consuming services in order to meet their business and personal needs or *Information Providers* that offer service applications to address other, non-networking needs. Both Connectivity and Information providers may depend on *Infrastructure Providers* for leasing the necessary components (computational, network and storage resources). *Content Owners* produce content items such as movies. *Technology Makers* make available Internet protocols, software and hardware that seeds new needs and services. Last but not least, *Policy Makers* supervise the operation of the Internet and intervene when necessary.

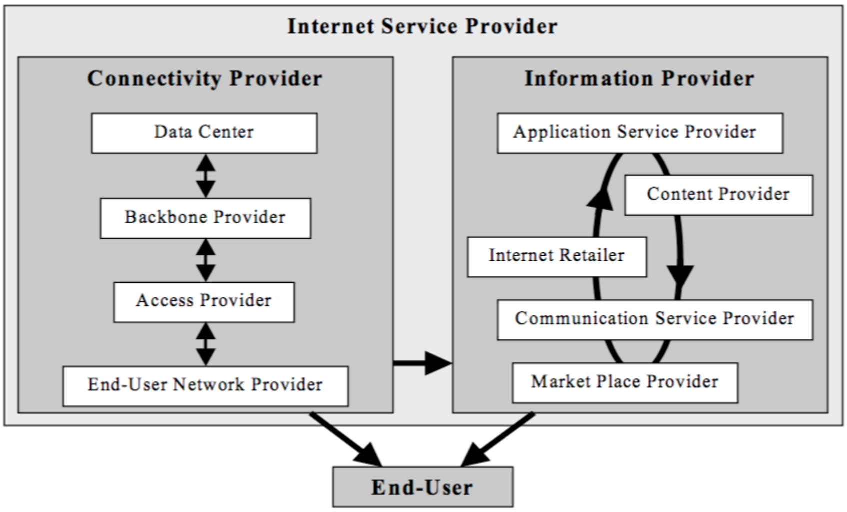

Figure 4: Internet Stakeholders by M3I project [19]

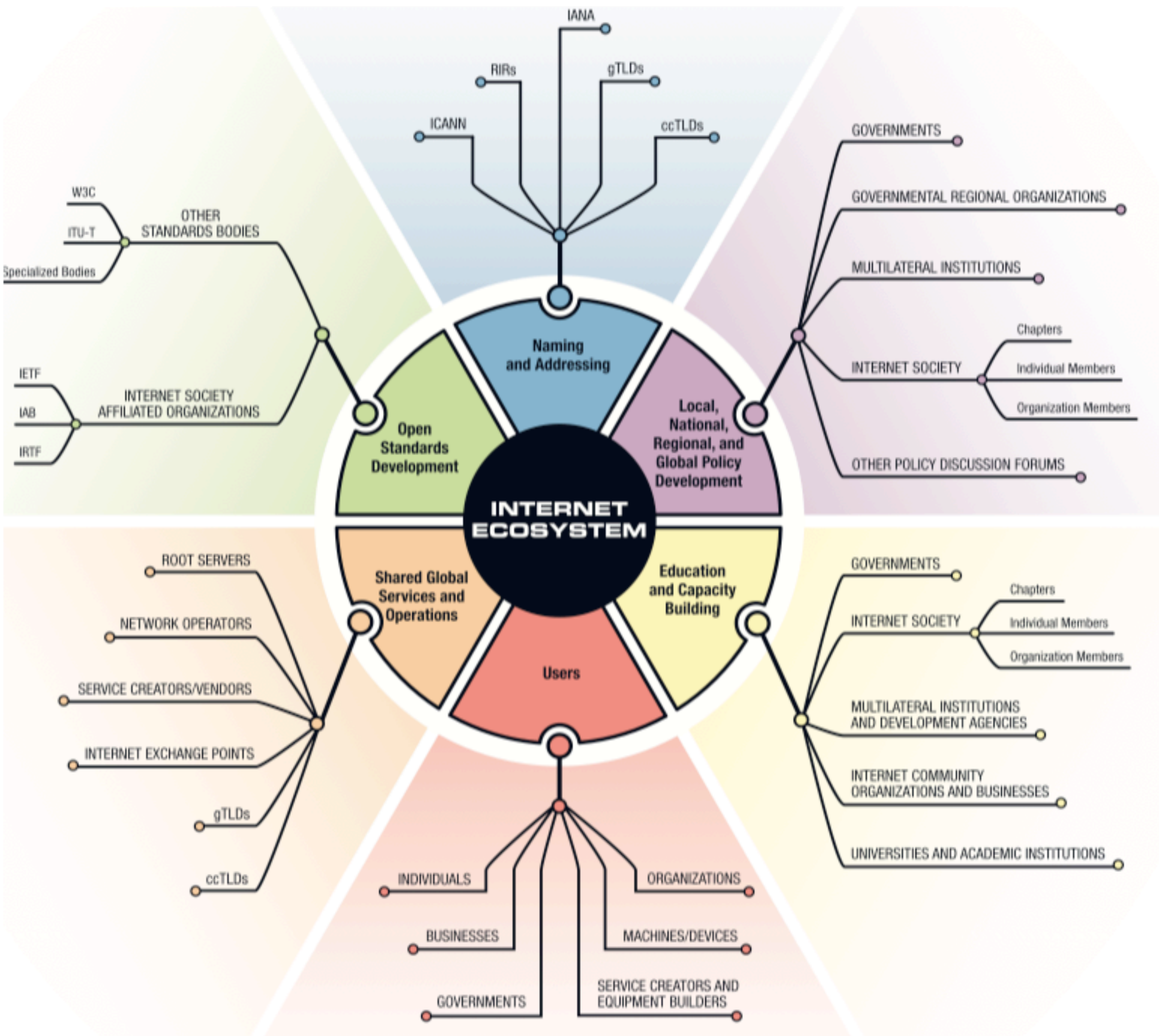

Figure 5: Internet Stakeholders by Internet Society [12]

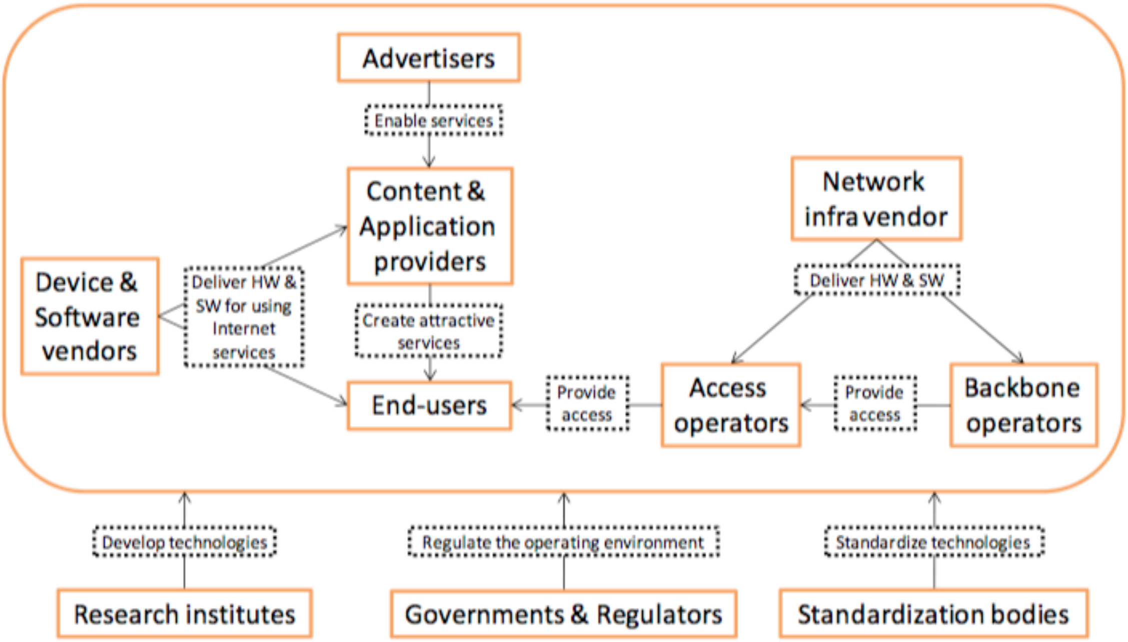

Figure 6: Internet Stakeholders by T. Leva [17]

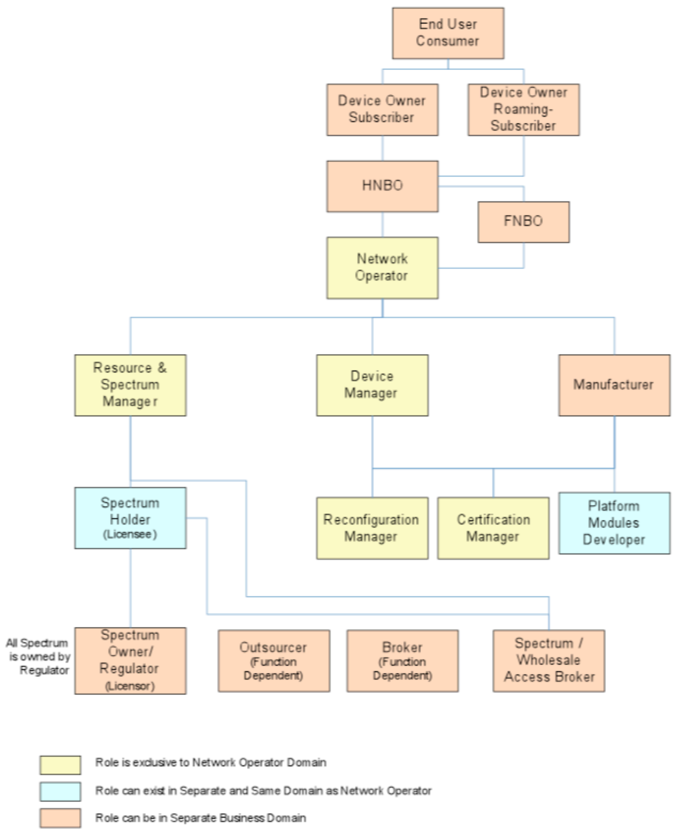

Figure 7: Internet Stakeholders by E2R II project [9]

Figure 8: Internet Stakeholders by SESERV

The need for global connectivity and economic sustainability led to the appearance of a hierarchical Internet connectivity market. Following this rationale it is discriminated between

- *Edge ISPs* (or Tier-3 ISPs) who provide Internet connectivity services to Users and Information Providers. xDSL, 3G and 4G providers are such examples.
- *Transit ISPs* who provide Internet connectivity services to Edge ISPs and Information Providers.

Information Providers refer to entities that deliver services or content via the Internet infrastructure perhaps at different levels of QoS. Such instances include:

- *Application Service Providers* that follow the X-as-a-Service model for proprietary or standardized services.
- *Content Distribution Networks* that use advanced techniques for selecting the most suitable source of content for a particular user request.
- *Communication Providers* that offer real-time services such as VoIP or social networking.
- *Gaming Providers* that offer interactive games.
- *Brokers* that provide added value services as intermediary organizations in B2B, B2C marketplaces and other user groups.

- *Internet Retailers* that use the Internet as a marketing and dissemination channel.
- *Search Engines* like Google.
- *Financial Service Providers* that provide methods for secure handling of payments.

Infrastructure Providers include the following representative instances:

- *Network Component Providers* that can be further decomposed into
  - *Network Exchange Points* that provide the necessary networking facilities and other complementary services for allowing the interconnections of several Connectivity Providers.
  - *Last Mile Providers* that operate access networks based on copper, fiber or wireless technologies.
  - *Dark Fiber Providers* that set up optical fiber links at the metropolitan or wide-area level.
  - *Gateway Providers* like those that operate equipment for interoperation of traditional telephone and VoIP networks.
- *Cloud Operators* who offer computation and storage as a service.
- *Venue owners* who provide the location where another operator can setup the necessary infrastructure for providing services (such as WiFi equipment in a restaurant).
- *Sensor Operators* who establish a network of sensors for collecting raw data.

Users include the following representative instances:

- *Customers* (residential or business) who buy Internet connectivity on behalf of many single end-users.
- *End-users* who are permanently given the right to use a consumer's Internet connection to meet their communication needs.
- *Roamers* who may be given access to use a consumer's Internet connection to meet their communication needs.

Policy Makers include bodies that are able to shape the legal and regulatory landscape of the Internet such as:

- *Regulators* who are in charge of setting and enforcing competition and privacy policies and performing spectrum management.
- *Security Agencies* who pose privacy and security constraints.
- *Administration Authorities* like IANA, ICANN, and RIRs that are responsible for coordinating critical Internet functions (such as IP address allocation and naming).
- *Researchers* who study aspects of the Internet and affect decisions of other Policy makers.

Content owners who have the right to control how content items are made available to the public. These can be either:

- *Professionals* such as movie makers, or
- *Amateurs* who can upload items to social networking sites.

Technology Makers include:

- *Industry Standardization Organizations* who decide on the functionality of Internet protocols and technologies.
- *Manufacturers* of Network Elements, Consumer Electronics, Operating Systems, etc who decide on the technologies to develop or adopt.
- *SDK (Service Development Kit) Publishers* who provide platforms easing application development.
- *Application Developers* who decide which technologies will be adopted and how these will be configured.
- *Research Projects* who develop and/or evaluate new technologies.

3.3 Tussle Analysis

It is natural that some stakeholders have conflicting interests when making technology decisions. The long-term goals of each stakeholder with respect to a specific Internet functionality define his strategy that is, finally, implemented by policies. These policies take into account the technology restrictions and other stakeholders' socio-economic aspects. The decisions contained in these policies can be mostly grouped into the following categories (in practice):

a. Adopt a suitable technology from the set of available ones for the functionality in question.
b. Dimension dedicated resources to support the goals of the stakeholder.
c. Configure parameters of the technology that affect how functionality in general is provided.
d. Configure parameters that affect how functionality for a specific instance is provided.

This process defines a "tussle" between the stakeholders, reflecting their conflict of goals at the socio-economic layer. However a tussle does not involve the interests of the stakeholders only, but how these conflicting interests are expressed through the available technologies. The combination of actors' policies leads to a tussle outcome.

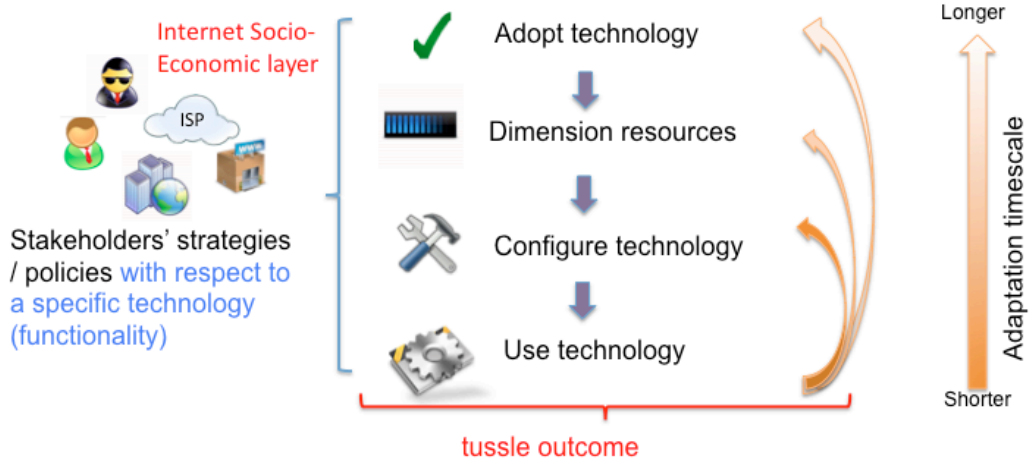

Figure 9: Basic Technology Cycle due to Conflicting Socio-economic Interests

For example, end-users may:

a. choose to use a specific application for content distribution based on its ability (or not) to download from multiple sources simultaneously,
b. select the upper and lower limits of the upload/download capacity for that application (based on its connectivity profile),
c. configure maximum number of TCP connections per downloaded file, and/or
d. set priority for queued files based on number of available sources.

ISPs may:

a. measure the performance of web-browsing connections and observe that these obtain a small bandwidth share, and
b. add capacity to alleviate the problem.

In general, policies are applied in an order similar to the one presented above and may evolve using feedback from the history of the system. The exact order depends on the specific context; *e.g.*, due to outsourcing, it can be easier for a service provider to dimension resources at the desired level rather than reconfigure a technology to support a new policy. The timescales that such relatively minor adaptations (that don't affect the basic technology and socio-economic context of the tussle) take place depend on the social and technical "inertia" of the system and the given technologies. For example it may take some time for the stakeholders to experiment in using a new technology to meet their objectives. Eventually the process is expected to lead to a tussle outcome, which is characterized by the benefit or satisfaction that each stakeholder gets, defined by appropriate utility functions at the socio-economic layer. The level of benefit can vary substantially among stakeholders, some of which may consider the outcome of a tussle as unfair. Different concepts of fairness may apply depending on the social context. For simplicity it is assumed that all stakeholders agree on what constitutes a "fair" outcome.

So far the structure of the basic cycle is determined. As shown next, if the given outcome is not stable, because it is considered as unfair by certain stakeholders, then it is likely to trigger a new tussle cycle, where some other (possibly, more radical) changes take place in the space of the adopted technologies. We must emphasize to the reader that sometimes this separation of the socio-economic technology evolution into distinct cycles is not so clear, since cycles themselves may include some degree of technology adaptation and/or common policies. Many times it is a matter of judgment to define the boundaries between cycles and the corresponding tussle outcome for each cycle. Nevertheless we believe that such a process helps the analyst understand the complexity of the underlying system and predict its evolution.

3.3.1 Tussle Evolution

According to our previous discussion, a tussle can be described as a process determined by the strategies of involved stakeholders to resolve their conflicts of interest in a particular technology context. It was assumed that a tussle, after some adaptation from the stakeholders involved, leads to some outcome. In analogy to game theory, a tussle corresponds to a game where agents are the stakeholders in the given context. The outcome of the tussle may be one of the possible "Nash equilibria" of the game. Our model of the Internet ecosystem assumes that tussles may evolve over time. Evolution occurs either because of instability or because of externalities. Study of such evolutions is what makes tussle analysis more powerful than a game-theoretic model.

If the tussle outcome is considered “unfair” by a subset of stakeholders, it can evolve into a new tussle based on:

- socio-economic decisions alone, *e.g.*, stop using that functionality, stop doing business,
- out-of-band actions, *e.g.*, asking a regulator to intervene, making coalitions for taking coordinated technology decisions, or
- new socio-techno-economic decisions following the basic socio-economic technology cycle described before, *e.g.,* introduce a radically different technology, use a technology option in an unforeseen way.

All these reactions characterize an unstable tussle outcome. It is likely that unstable outcomes will lead to a new tussle and possibly destabilize other functionality spaces as well. This is called a “spillover effect”. It should be noted that stable tussle outcomes can also create spillovers to other functionalities, in case some users of the established functionality find some new uses of it, not anticipated before, which interfere with other functions of the ecosystem. These are cases of negative externalities (i.e. adverse effects) between different functionality spaces. Positive externalities may also appear, for example more resources become available to a functionality due to the introduction of a more efficient technology to another related functionality. In the sequel, consequences of negative externalities are studied, unless explicitly mentioned.

Figure 10 illustrates how tussles can evolve inside a single functionality space or affect another functionality. Let us assume a discrete-time model and that initially only Functionality B is observed to be in a stable state. At some time T1 both tussles A1 and C1 (for Functionalities A and C respectively) reach equilibrium, but only the latter is a stable one. Furthermore, the unstable outcome of tussle A1 has a spillover effect and triggers a new tussle B1 in functionality B. At some later time T2 both tussles A2 and B1 have reached equilibrium. Even though Functionality A has now reached a new and stable outcome, it has a spillover to functionality C and makes the previously stable outcome of C1 unstable. Thus, the tussles of functionalities B and C evolve further in time (not shown).

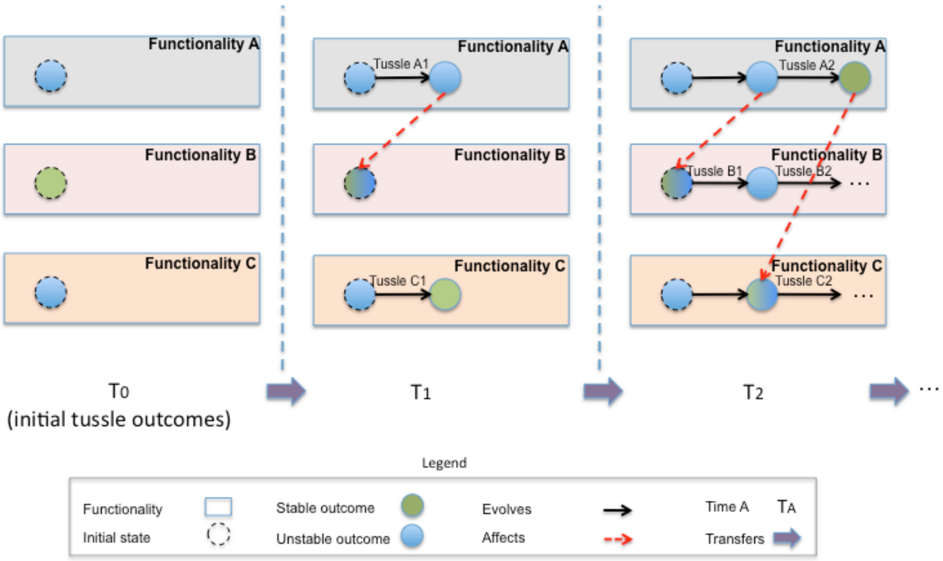

Figure 10: Tussle Evolution due to Instability and Externalities

A detailed example of the evolution of the tussle related to sharing the bandwidth on a common link with TCP is given in Annex B.1.

SESERV believes that analyzing the anticipated tussles can shorten unstable periods and help the adoption of a long-term successful technology and configuration. Tussle Analysis defines a systematic approach for understanding the impact of introducing new Internet technologies, by trying to answer the following questions:

- Is a new technology needed today and why?
  - What are the interests of existing stakeholders today?
  - What options do existing technologies offer to stakeholders?
  - What are the properties of existing outcome in terms of performance and stability?
- What would be the effect of a new technology to the ecosystem in the future?
  - How would the interests of existing and new stakeholders be affected?
  - How would the options of existing and new stakeholders be affected?
  - Can this technology help reaching a “fairer” outcome regarding this functionality, or increase efficiency in case of an already stable outcome?

3.3.2 A Tussle Analysis Methodology

SESERV project has defined a systematic approach for analyzing and assessing the importance of socio-economic tussles in the Internet. This methodology, initially outlined in [16] and compared to other related approaches in Section B.4, can be useful when designing new Internet technologies for understanding the expected impact to the stability and efficiency of that particular functionality space and possible spillovers to other spaces. Selecting the features of a technology in a more holistic way, by taking into account the socio-economic layer of, Figure 1 would lead to more attractive outcomes and increase the chances of that technology to be adopted in the long-term.

The proposed methodology is the following:

1. Identify all primary stakeholder roles and their *characteristics* for the functionality under investigation.
2. Identify tussles among identified stakeholders.
3. For each tussle:
   a. Assess the impact to each stakeholder (short-term, mid-term or long-term depending on the context);
   b. Identify potential ways for stakeholders to circumvent negative impacts, and the resulting spillovers.

For each new circumventing technique, apply the methodology again.

Figure 11 gives a high-level view of tussle analysis methodology. Each step is shown as a horizontal rectangle with arrows denoting transitions. All steps are applied in the context of one, or more, functionalities (rounded vertical rectangles). The first step suggests composing the socio-economic and technology layers of Figure 1 for each particular functionality. Starting from the top of that figure identifying and studying the properties of the most important stakeholder roles is necessary**.** Besides recognizing the set of stakeholder roles their characteristics must be understood. The most important attribute of a role is the goal to be met through this functionality, even though differences on the intensity may exist depending on the technology literacy and expectations, openness to risk and innovation. Information about the group population and other qualitative measures may be useful during the next steps of the methodology. Finally technologies (complementary or substitute ones) that can be used for a service or application instance related to that functionality must be specified. These technologies, or technology sets, usually follow a different logic or may not even be designed for implementing this functionality.

Identifying such alternative technology schemes will be useful in performing the second step, which refers to identifying tussles among the set of stakeholders. More specifically when a conflict of interest is found to exist between some stakeholders, we should seek for policies – enabled by the technologies – that these rational entities would select in order to meet their goals. Thus, this step is about instantiating Figure 9 in the specific context of this functionality. To address this step in a more systematic way, an initial set of tussle patterns was identified. These tussle patterns, described in more detail in [16] (including their relationship to situations that are well known in the economic theory literature known such as "information asymmetry"), are:

- **Contention** where two or more actors compete for access to a shared resource.
- **Repurposing** where an actor would want to use a resource for an interest or in a way not envisaged by the resource's owner.
- **Responsibility** where an entity attempts to identify who should be accountable for an action that is against its interests when many actors are involved.
- **Control** where two or more actors have different views on how a set of complementary resources should be combined**.**

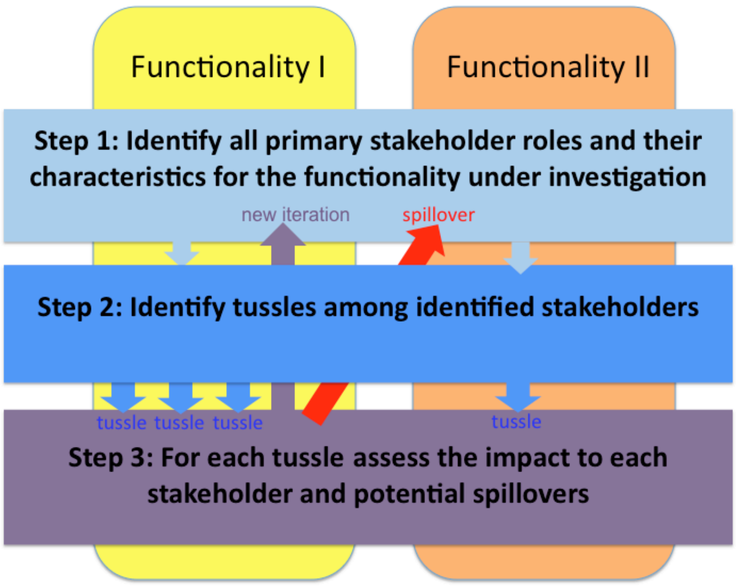

Figure 11: High-level View of Tussle Analysis Methodology

The third step of the methodology aims to evaluate each tussle outcome from the perspective of each stakeholder (in order to infer the stability properties of the functionality under investigation) and understand its effects on the stability of other functionalities. It thus can be depicted using a diagram like the one in Figure 10. In the ideal scenario of a tussle outcome is an equilibrium point, where:

a) all stakeholders of *this* functionality derive a fair[2] payoff (thus no one will select another policy) and;

b) no stakeholder of *another* functionality, who was receiving a fair payoff before, gets an unfair payoff after this tussle equilibrium has been reached.

If both conditions hold then the analysis of this particular tussle is completed and we can move on to the remaining tussles identified in Step 2. In case condition (a) is not met, a new iteration of the methodology must be performed by making assumptions on the most probable policies adopted by unhappy stakeholders. Similarly, a new iteration must be performed for each spillover to other functionalities when condition (b) is not met.

Ideally a new technology should lead to a stable outcome without spillovers to other functionalities. In case where no such improvement takes place, the technology designer should examine whether a change in the implementation details would lead to a better outcome. In respect to that, Section B.3 in the annex discusses how the Design for Tussle goal can be achieved by following the principles of "Design for choice" and "Modularize the design along tussle boundaries".

The tussle analysis method introduced in this section is of interest to European research projects since one of the key findings made from the SESERV Oxford workshop (*cf.* [24] for details) shows that "many of the projects interviewed focused solely on direct controlling parties, those providing the funding, regulators and the consortium partners themselves. This means that some relevant considerations are missed, not least in considering the specific impact of the technology on those who will use or be affected by it." The tussle analysis method constitutes a suited tool for research projects to do exactly that, namely to assess socio-economic dimensions in a structured manner considering *all* stakeholders of relevance to the technology a project develops or studies. This is in line with Dewandre's key-note address in which she stated that "all stakeholders should engage [8]".

3.4 FISE Map

The profiling of a large set of Challenge 1 projects as described previously results in a broad overview of socio-economic priorities, stakeholders, and tussles of interest identified. This broad result sees the objective of consolidation by means of a suited instrument, for instance in visual form showing a consolidated set of key stakeholders with the primary tussle profiles among them. For this purpose, the FISE Map was designed to provide for a static cartography representing the main engaged stakeholders and to allow for a dynamic illustration of different tussles.

For each project profiled in this deliverable, several stakeholders and tussles among these stakeholders are determined. Stakeholders embrace those actors that are affected by the technology developed by the project, and stakeholders may be involved in different tussles. As a matter of fact, some stakeholders are observed to be more often involved

[2] It is obvious that the definition of fairness is very important when interpreting tussle outcomes. For example, a challenging scenario is to assess fairness when the conflicting interests come from different paradigms such as social values vs. economic goals.

than others. This interlacing of stakeholders and tussles implies a “tussle profile” for each investigated project. Since stakeholders appear across tussle profiles of numerous projects, the tussle profiles may be compared using these recurring stakeholders as pivots, *i.e.*, it may be evaluated if the same set of stakeholders is involved in (similar) tussles encountered by different projects and if there are projects that have several of these similar tussles in common. Therefore, just as spider graphs allow illustrating priorities and comparing these between projects, an illustration method that enables a comparison of tussle profiles and makes the identification of recurring tussles easier is eligible. The FISE Map was designed to suit these needs by providing a uniform alignment of main stakeholders encountered in the profiling activities, while shapes that cover the affected stakeholders represent tussles. Below, further motivation for our FISE Map is provided, both with respect to its purposes and to the gap it fills in the field of Internet socio-economic studies.

Although many projects that engage with the socio-economic aspects of the Future Internet have proposed maps aligning the different stakeholders, we found that none of these maps were feasible to nicely combine the findings derived from the socio-economic profiles and tussle analyses. For example the Internet Society proposes a model that can be found under [12] and captures the stakeholders involved in the shaping of the Future Internet. However, the map is not suitable to model socio-economic conflicts between Internet stakeholders, if these are listed at all since it focuses on Internet standardization. ICANN often refers to the Internet ecosystem but does not propose a concrete model. The model of the Internet ecosystem proposed by ETICS is not suitable for our purposes, as it is more an accumulation of assumptions about the Internet and not a concrete map. The Unified Business Model (UBM) provides a meta-model for use in business modeling of large mobile ecosystems but yields a presentation of the Internet that is far too complex to clearly illustrate tussles investigated by SESERV.

For the reasons above a stakeholder map that is simpler and therefore more convenient was compiled. To achieve simplicity only the meta-stakeholders from Figure 8 are shown on the FISE Map by default. These are aligned on the map with users being centered, as they are involved in most tussles. A tussle is represented by a shape on the map that exactly covers the stakeholders involved in the tussle. By using transparent shapes, stakeholders involved in more tussles are automatically highlighted by stronger background color. To allow a fine-grained tussle illustration, meta-stakeholders are expanded to concrete stakeholders, if necessary. If, for example, a tussle appears between Users in different roles (*e.g.*, Uploaders and Downloaders, Roaming Users and Non-roaming Users), a shape around Users may not be meaningful to represent the tussle. Therefore, Users, or in general meta-stakeholders, may be expanded to show the respective concrete stakeholders and a shape better representing the tussle is drawn around these (*cf.* Figure 19).

4 Socio-economic Profiles

Driven by the three areas of interest as explained in the previous methodology section (socio-economic priorities, stakeholders, and tussles), the following Challenge 1 projects have been selected for coordination by means of socio-economic profiling:

- BONFIRE: Building service test beds on FIRE
- C2POWER: Cognitive Radio and Cooperative Strategies for POWER saving in multi-standard wireless devices
- CHANGE: Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions
- CLOUD4SOA: A Cloud Interoperability Framework and Platform for User-centric, semantically-enhanced Service-oriented Applications Design, Deployment and Distributed Execution
- ETICS: Economics and technologies for inter-carrier services
- OPTIMIS: Optimized Infrastructure Services
- P2P-NEXT: Next generation peer-to-peer content delivery platform
- PURSUIT: Publish Subscribe Internet Technology
- RESERVOIR: Resources and services virtualization without barriers
- RESUMENET: Resilience and survivability for future networking: framework, mechanisms, and experimental evaluation
- SAIL: Scalable & Adaptive Internet solutions
- SMOOTHIT: Simple economic management approaches of overlay traffic in heterogeneous Internet topologies
- STRONGEST: Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport
- TRILOGY: Re-Architecting the Internet. An Hourglass Control Architecture for the Internet, Supporting Extremes of Commercial, Social and Technical Control
- ULOOP: User-centric Wireless Local Loop Project
- UNIVERSELF: Realizing autonomics for Future Networks

These projects cover several thematic areas, as shown in Figure 12. For each of the above listed Challenge 1 projects, a socio-economic profile is compiled as fully documented in Annex C. For each of the tussles discussed in the project profiles, a variety of single or multiple instances of stakeholders, that are previously outlined, may be involved. Furthermore, depending on the tussles, the stakeholders may be in charge of various positions and benefits/drawbacks. Section 4.5 draws preliminary conclusions from this profiling task, providing insight obtained while coordinating different projects for this approach to socio-economic dimensions.

A total of 16 projects have been profiled according to the profiling methodology documented in Section 3. Consequently, for each of the 16 profiled projects, the respective project's socio-economic priorities, the set of addressed stakeholders, and the analysis of project-specific tussles among stakeholders have been determined. Out of the 16 socio-economic project profiles compiled, 4 profiles are placed as sub-sections here, and 12 profiles are fully documented in the Annex C.

The reason for placing most project profiles in the Annex C and for placing only 4 project profiles here is a purely pragmatic one: a small set of profiles supports a reader in understanding a profile's contents and how one profile compares to another, while the selection of profiles placed here is kept small in order to not overwhelm a reader. It is of utter importance to note that the four profiles placed here are not valued by SESERV to be of higher interest than any of the profiles placed in the Annex C.

The 4 project profiles placed here are, thus, not perceived different in quality from the other profiles. The only (content-wise) reason that has led to the selection of the 4 profiles for C2POWER, P2P-Next, SmoothIT, and ULOOP is that these 4 projects form an exemplary case for 2 pairs of projects with comparable project objectives (but potentially different tussles looked at; see Section 5.3 for a consolidated analysis).

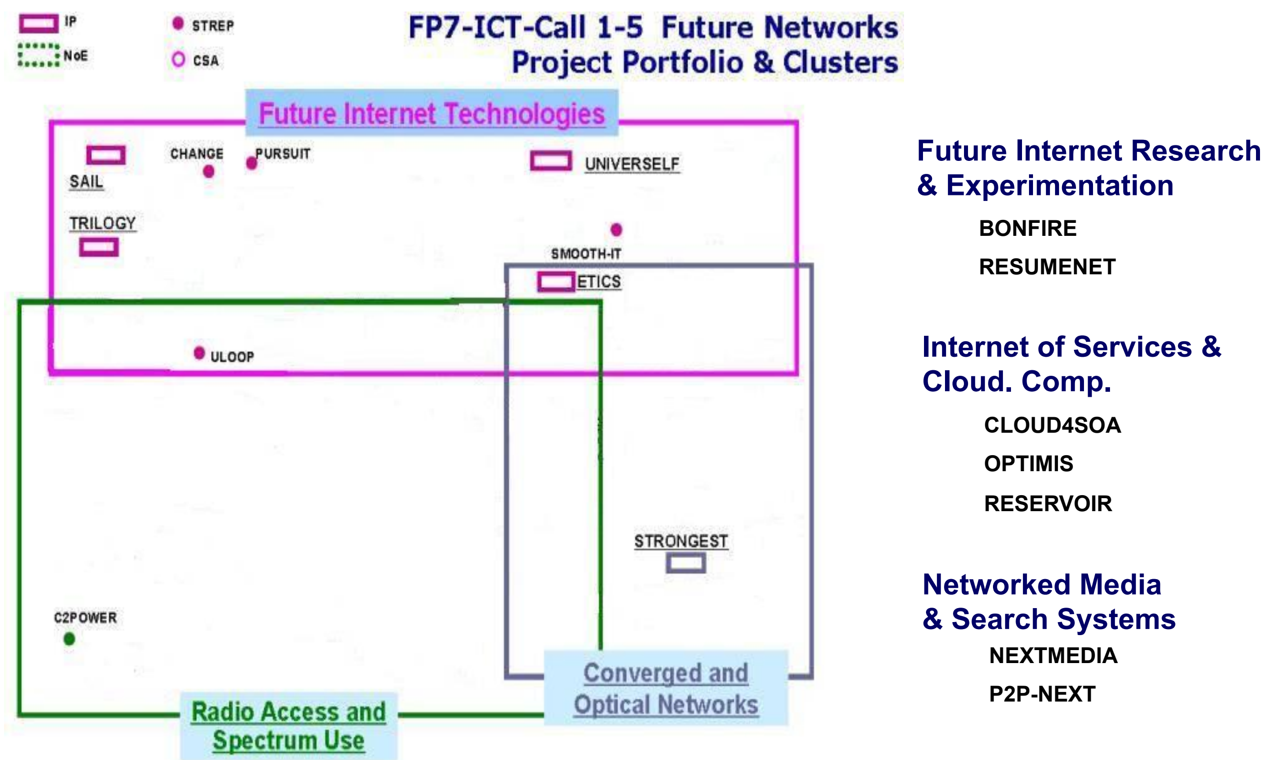

Figure 12: Profiled Projects and Thematic Areas

4.1 Socio-economic Profile for C2POWER

- Project acronym: **C2POWER**
- Project name: **Cognitive radio and Cooperative strategies for POWER saving in multi-standard wireless devices**
- Duration: From 2010-01-01 to 2012-12-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&DOC=10&CAT=PROJ&QUERY=011d20e28b9c:d1e4:0cbedcf4&RCN=93762

- Project website: http://www.ict-c2power.org/

4.1.1 Project Focus and Relevance to SESERV

The objective of the C2POWER project is to investigate, develop and demonstrate how cognition and cooperative strategies can be extended to decrease the overall energy consumption of multi-standard mobile devices while still enabling the required performance in terms of QoS. The topic is particularly important for 4G mobile users, due to the expected rise of power demand for 4G devices, which will render energy supply as a critical factor for maintaining network access. C2POWER has already specified the two complementary techniques studied to increase power efficiency at the wireless interface of handsets: a) Cooperative power saving strategies between neighboring nodes using low power short range communications, and b) Cognitive handover mechanisms to select the Radio Access Technology with the lowest energy demand in heterogeneous environments. In both cases, there are conflicting interests among the involved players, which are shaped by the use of technologies, thus giving rise to economic and partly social tussles. At the same time, there is also a regulatory flavor in the project. Therefore, C2POWER is considered highly relevant for SESERV.

4.1.2 Socio-economic Priorities for C2POWER

From the C2POWER socio-economic profile, as drafted by SESERV based on the publically available material of C2POWER, and its comparison with the average socio-economic profile determined from 92 participants in the SESERV survey, it turns out that C2POWER *emphasizes beyond average* basically only Green Internet (*cf*. Figure 13), which is expected given the project’s high focus on energy efficiency. However, privacy and security issues are also relevant, *e.g.,* due to the fact that it may be more efficient to relay the data of a certain user over multiple hops (implemented by independent and possibly non-trusted nodes) in the wireless network, rather than sending them directly but using a higher power level.

4.1.3 C2POWER Stakeholders

The set of stakeholders C2POWER involves includes:

- The Wireless Access Service Provider (WASP) supporting a variety of wireless technologies. Multiple such Edge ISPs (instances of the Connectivity Provider meta-stakeholder) can be active in the C2POWER scenarios.
- The End-user, who is equipped with a multi-technology wireless device that can both provide access through certain WASPs and relay the data of other end-users by means of the low power short-range communications technology, *e.g.,* UWB. Users interact with each other, and with WASPs, *i.e.,* they make decisions about which WASP to join. In a particular connection an end-user may either be Passive (receiving transport service) or can be Active and relay data of other end-users.
- The Regulator, as a member of the Policy Makers meta-stakeholder, who is in charge of spectrum management and of setting the values of associated parameters that influence its use, such as power levels.

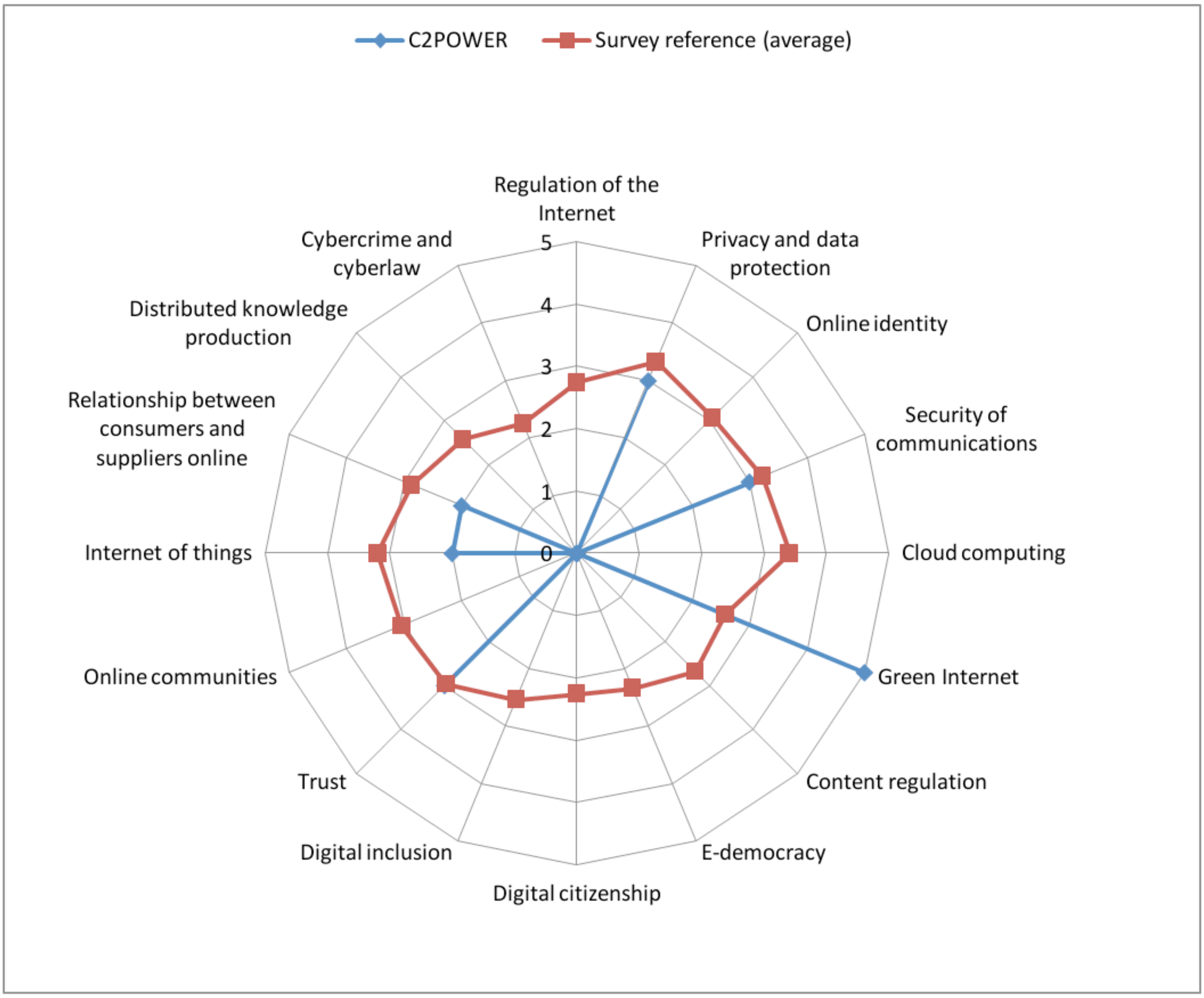

Figure 13: Socio-economic Profile for C2POWER[3] in Comparison with Survey Reference

- A Broker: The possibility for involvement of such a role is implied in [21], where it is stated that due to the need for cooperation, an accounting system for clearing payments for relaying, or a reputation system for revealing, non-cooperative nodes should be in place. Such a system can either be provided by each WASP itself, or by other Information Providers acting as a trusted-third party.

4.1.4 C2POWER Tussles

Below, we provide some characteristic tussle examples for C2POWER:

A tussle applies in the use of spectrum (which is a scarce resource) by different users of the same WASP, or by different WASPs in case they operate in the same band. Each such player also encounters a trade-off between range of communication and power level, with the latter influencing the use of spectrum. Also, there is a tussle among WASPs competing for users, which is influenced by the various spectrum and power parameters set by each WASP.

[3] SESERV estimates based on publically available material of C2POWER [21],[30].

A tussle applies to the relaying of other End-user's data by means of the low power wireless technology. The relaying (Active) End-user is capable of copying this data, and using it for a different purpose. We can also view this tussle as a consequence, *i.e.,* spillover, of the introduction of the low-power short-range technology in order to increase the efficiency of spectrum usage in the tussle for spectrum.

A tussle arises again due to the possibility for relaying data. If a Passive End-user opts to employ the short-range technology, and his data does not actually reach the base-station, then this may be due to: a) either the fact that this was not actually possible, *i.e.,* there did not exist a path of cooperative nodes that could reach the destination with successive relays, or b) the fact that such a relaying path did exist but one of the nodes did not actually perform the relay in order not to consume its own power. Identifying the reason for such a failure gives rise to a responsibility tussle.

A tussle is applicable due to the possibility for relaying data. Once an End-user has decided *to make* use of this possibility, rather than sending his data directly to the base-station, then the relaying End-user has higher control (if not full), regarding whether he will fulfil this action, *e.g.,* what power level he will choose.

4.2 Socio-economic Profile for P2P-NEXT

- Project acronym: **P2P-Next**
- Project name: **P2P-Next**
- Duration: From 2008-01-01 to 2011-12-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&DOC=5&CAT=PROJ&QUERY=0130f98b5582:a71c:598f3d56&RCN=85326
- Project website: http://www.p2p-next.org/

4.2.1 Project Focus and Relevance to SESERV

P2P-Next develops an open source, efficient, trusted, personalized, user-centric, and participatory television and media delivery system with social and collaborative connotation using the emerging Peer-to-Peer (P2P) paradigm, which takes into account the existing EU legal framework. The P2P-Next integrated project will build a next generation Peer-to-Peer (P2P) content delivery platform, to be designed, developed, and applied jointly by a consortium consisting of high-profile academic and industrial players. P2P-Next is highly relevant to SESERV for an interaction on economic and social tussles, as these arise by the very nature of P2P networks and content distribution. The economic factor is enforced by the fact that P2P-Next is aimed at developing an *efficient* media delivery system; the social factor by almost every other aim of the P2P-Next project.

4.2.2 Socio-economic Priorities for P2P-Next

When comparing P2P-Next's socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, P2P-Next is found to *emphasize several socio-economic topics beyond average, whereas most significant are (cf.* Figure 14*)*:

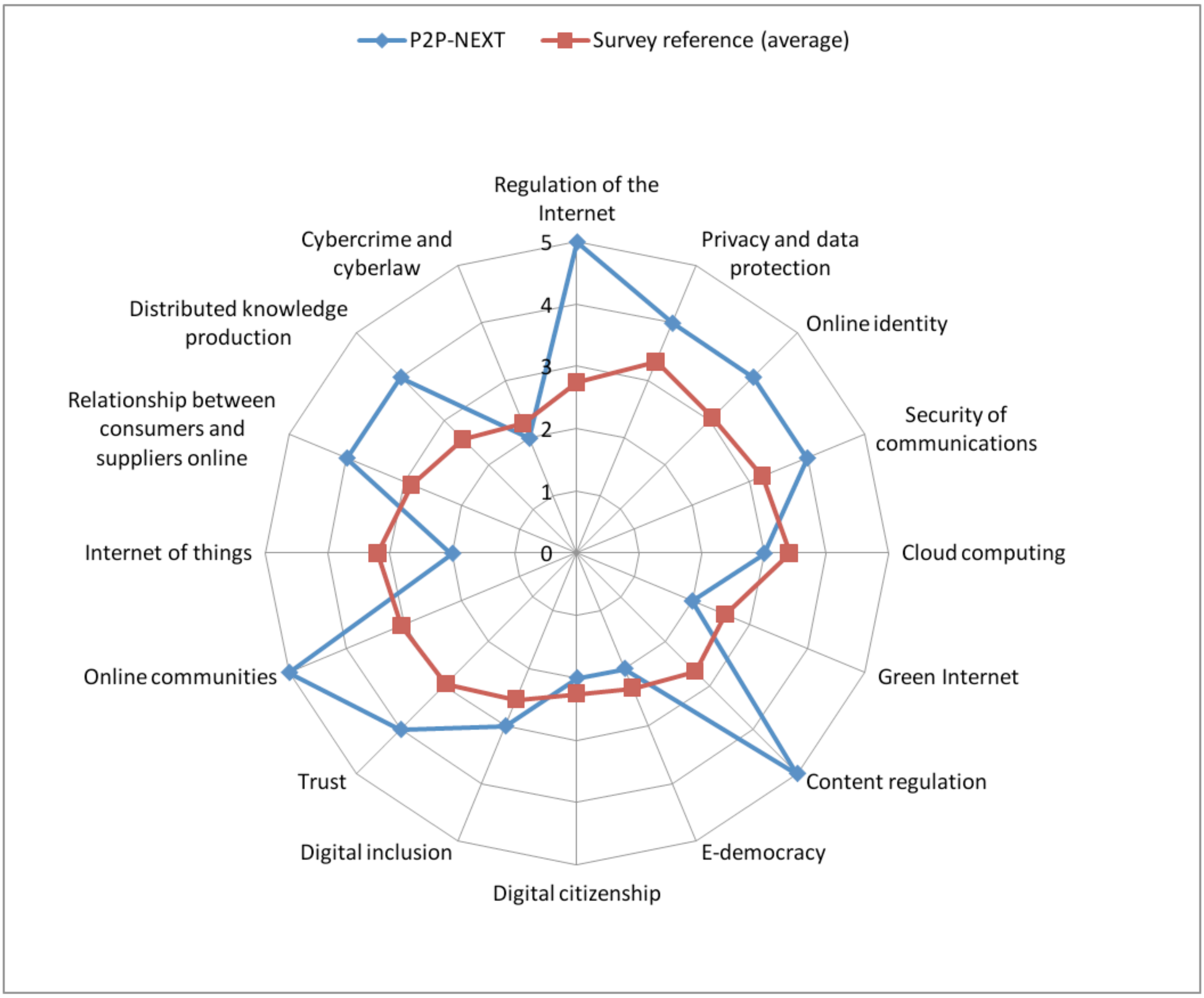

Figure 14: Socio-economic Profile for P2P-Next in Comparison with Survey Reference

- Regulation of the Internet
- Content regulation
- Online communities

The high relevance of content regulation (and regulation of the Internet in general) to P2P-Next is due to the goal to develop a media delivery system. Furthermore, the sharing mechanism provided by the developed P2P protocol may be used to illegally distribute copyrighted content. Online communities are a key-feature, as the designed P2P protocol is designated to embed online communities and community distribution. The latter allows for users explicitly participating in the distribution of a resource.

4.2.3 P2P-Next Stakeholders

The set of stakeholders P2P-Next involves includes:

- A Connectivity Provider in terms of an instance of Access ISPs or Transit ISPs, which offers the physical connectivity to users (customers) as well as the Internet as a whole.

- The content creator (CC) or content owner (CO) that creates or owns content potentially distributed via the developed system. A CC or CO is mostly not involved in the technical process of sharing content, but interested in being paid or for sharing his content or preventing the sharing at all.
- A member of the User meta-stakeholder, that is an end-user acting as an individual, or a Customer on behalf of many single individuals, who is interested in receiving content through a P2P network.

4.2.4 P2P-Next Tussles

Tussles for P2P-Next arise at the top level created by the very nature of unmanaged P2P networks. Designated features of the developed P2P system such as reputation and recommendations allow for countless tussle scenarios depending on the technical implementation of the features. A tussle of each kind is outlined below.

A resource under contention is the available bandwidth to move bits between the peers, which are consumers as well as providers. This contention is caused by asymmetric connections offered to users. Therefore, End-users compete for upstream bandwidth from other End-users. The contention arises, as the mean user-upstream is much lower than mean user-downstream. Since a file initially has only a few or even just one upstream provider but possibly lots of requesters the contention is amplified.

A tussle is identified when End-users illegally share copyrighted files bypassing the COs and CCs. Another tussle arises, when End-users heavily share files thereby exceeding the bandwidth scheduled to them by their Edge-ISP. The disadvantage for the Edge-ISP increases, when the destination of the user's upstream traffic is located in the domain of another Edge-ISP. Furthermore as the End-user utilizes upstream of the ISP in order to share intellectual property of a CO/CC, the CO/CC may ask from ISP to inhibit the user from doing so, whereas the ISP denies responsibility for the behaviour of its users.

Another tussle emerges when a Connectivity Provider caches traffic, in order to reduce inter-domain traffic with other ISPs. It is obviously not in the interest of the CO or CC that an ISP – which might deny or ignore responsibility for the impact of its action – reduces her inter-domain traffic, when this leads to an even faster illegal content distribution.

Out of similar considerations, a tussle arises in the situation of an unmanaged service over controlled ISP networks. It remains an optimization problem for Connectivity Providers – network neutrality issues make this even harder for ISPs.

As one can see, the discussed tussles are not unique to P2P-Next but rather arise in many P2P-file-sharing systems. However, since P2P-Next is developing a P2P-based content delivery platform these typical P2P tussles are amplified by the project's context of multimedia delivery systems. Furthermore, discussing tussles specific for P2P-Next would go beyond the scope of this profile, as many technical details have to be considered. Tussle *spillovers* may result in media delivery platform hopping of both, users and CO/CC.

4.3 Socio-economic Profile for SMOOTHIT

- Project acronym: **SmoothIT**
- Project name: **Simple economic management approaches of overlay traffic in heterogeneous Internet topologies**

- Duration: From 2008-01-01 to 2011-03-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=85329
- Project website: http://www.smoothit.org/

4.3.1 Project Focus and Relevance to SESERV

SmoothIT designs, develops, implements, and investigates mechanisms for Economic Traffic Management (ETM) as a collaborative approach of inter-ISP optimizations to align characteristics of overlay-based Peer-to-Peer (P2P) applications with technical and economic requirements of network and traffic management. SmoothIT is highly relevant to SESERV for an interaction on economic and partially also social tussles, for instance with respect to the control and re-use tussle patterns and socio-economic issues of overlay-based applications.

4.3.2 Socio-economic Priorities for SmoothIT

When comparing SmoothIT's socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, SmoothIT is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 15):

- Privacy and data protection
- Security of communications
- Content regulation
- Relationship between consumers and suppliers online

These priorities are a consequence of the set of three ETM mechanisms investigated by SmoothIT; note that in total about 13 different ETM mechanisms have been defined, from which the three most relevant and innovative as well as comparable ones had been refined into many levels of details. These embrace inter-ISP optimizations in relation to P2P applications, where the handling of personal and potentially sensitive data is important, where security concerns are raised, where the sharing of potentially copyrighted material constitutes an important scenario, and where incentives and the contractual relation among stakeholders (*e.g.,* ISP, P2P Application User) play an important role.

4.3.3 SmoothIT Stakeholders

The set of stakeholders SmoothIT involves includes:

- A member of the Connectivity Provider meta-stakeholder in terms of an instance of an Edge ISP or a Transit ISP, which offer the physical connectivity to users as well as the Internet as a whole.
- An Application Service Provider, called Overlay Provider (OP) in terms of the P2P-based application or system provider, which provides relevant means to share in decentralized manner content – mainly in case of streaming content as well as for comparison reasons file content.
- A Content Owner who produces content items of interest to end-users.

- A member of the user meta-stakeholder, thus an end-user or an individual, or in some cases as an organization on behalf of many single individuals, who access the Internet via Edge ISPs to gain access to OPs and their content.

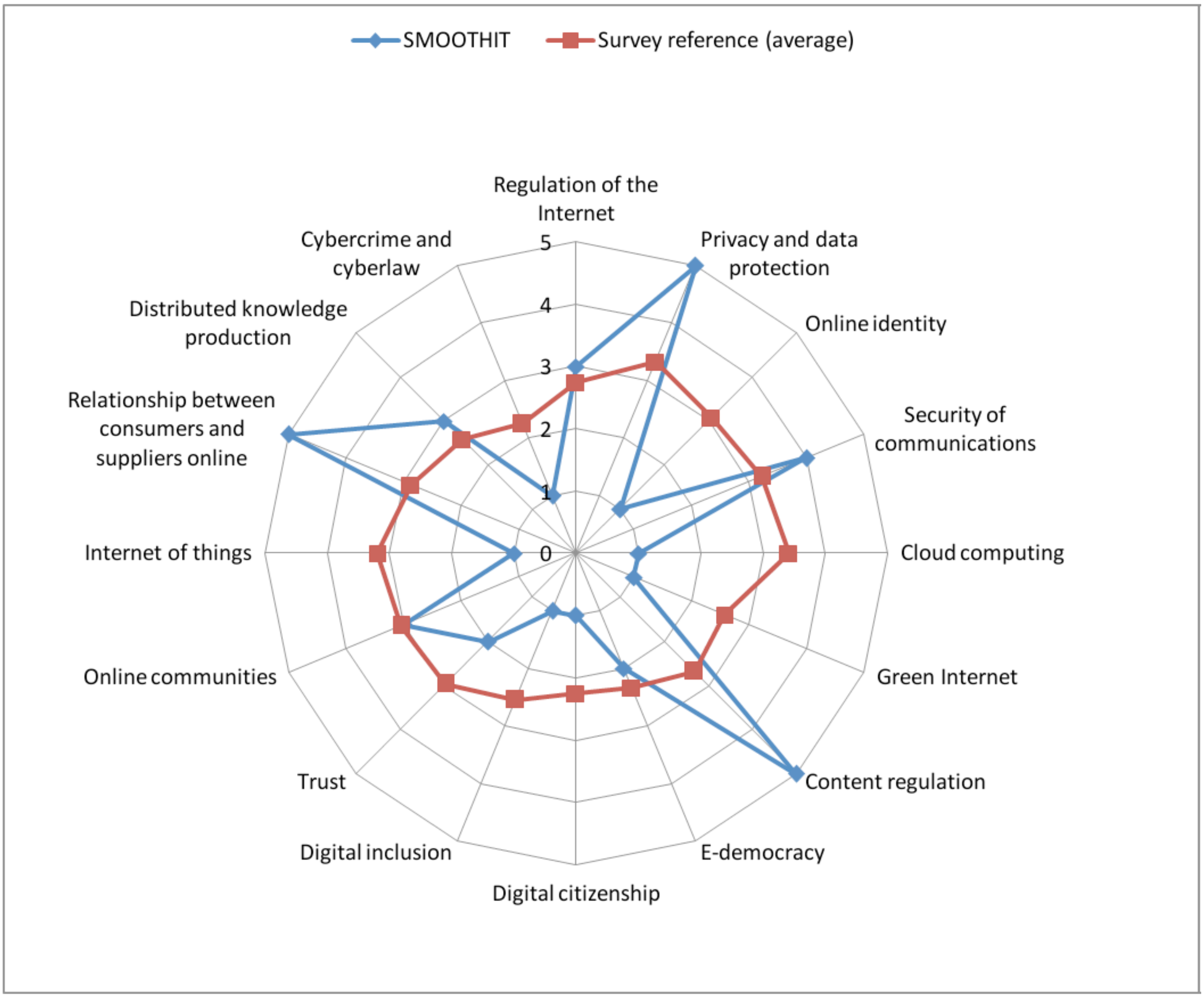

Figure 15: Socio-economic Profile for SMOOTHIT in Comparison with Survey Reference

4.3.4 SmoothIT Tussles

A tussle for SmoothIT is, *e.g.,* identified in the BGP (Border Gateway Protocol) Locality (BGPLoc) ETM[4] as well as in the Highly Active Peer (HAP) ETM[5]. Involved stakeholders embrace in both ETMs Edge ISPs and Transit ISPs. Contention prevails in both ETMs in relation to the scarce resource bandwidth, which may exist in the inter-domain link

[4] "*The BGP-based locality promotion (BGPLoc) ETM mechanism […] aims at providing locality information to overlay applications and by that reducing unnecessary and non-optimal traffic in and between ISP domains and at the same time achieving a better performance for overlay applications*" SmoothIT Deliverable D3.3 (Documentation of Engineering and Implementation (Final)).

[5] „*The Highly Active Peer (HAP) ETM mechanism [D2.3] aims at improving the overlay performance in the network of an ISP by increasing the upload capacity of selected local peers. Thus, local peers will experience a shorter download time while the interdomain traffic of the ISP will be reduced as well.*" SmoothIT Deliverable D3.3 (Documentation of Engineering and Implementation (Final)).

between an Edge ISP and the next Transit ISP or multiple of those. Even further, a bandwidth bottleneck may exist between Transit ISPs in terms of too high costs being involved in utilizing this bandwidth efficiently. Thus, an economic bottleneck may determine the reason for a tussle, too. Technically speaking, the scarce resource is not the bandwidth itself, meaning, an Access ISP would probably get enough bandwidth from a Transit ISP. The "scarcity" is in that the Access ISP has to pay for it and that it wants to minimize these payments. The ETM mechanisms of SmoothIT help reducing the amount of expensive connections through a Transit ISP.

A tussle is identified in the HAP ETM as well as in the IoP[6] ETM. Involved stakeholders embrace in both of these ETMs Access ISPs, Content Owners, and P2P Application Users. In a P2P file sharing scenario, P2P Application Users may share copyrighted material for which the Content Owner has the copyright. The exchange of such content may infringe copyrights. The Edge ISP may support (indirectly or directly, depending on the legal view of such an approach) – for inter-ISP optimization reasons – copyright infringement by providing more resources to highly active peers (highly active P2P Application Users) and by caching copyrighted material (IoP case). However, in legal terms, the HAP acts as a jurisdictional unit, which is not identical to the ISP, thus, can behold responsible for illegal activities independent of any Edge ISP serving the HAP.

A tussle identified for all SmoothIT ETMs, involves Edge ISPs, P2P Application Users, and Overlay Providers. The tussle finds expression in Quality-of-Experience (QoE) parameters, such as delay and stalling time, *e.g.,* for video streaming, which the ETMs will influence, but for which an Overlay Provider cannot hold responsible an Edge ISP.

Another tussle identified for all SmoothIT ETMs, involves Edge ISPs and Overlay Providers. The tussle exists in incompatible optimization dimensions, *e.g.,* delay optimizations of an Access Provider versus load optimizations of an Overlay Provider, due to an unbalanced control.

Tussle *spillovers* may result in ISP hopping and/or overlay hopping. Thus, of interest for SmoothIT is more generalized investigation of tussles and their mapping into well-known and understood economic principles, such that the derivates of those may be mapped one-to-one to a result of the application of a SmoothIT ETM in an investigated scenario.

4.4 Socio-economic Profile for ULOOP

- Project acronym: **ULOOP**
- Project name: **User-centric Wireless Local-Loop**
- Duration: From 2010-09-01 to 2013-08-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=95374
- Project website: http://www.uloop.eu/

[6] „*The insertion of ISP-owned Peers (IoP ETM) implies the deployment of special peers in the ISP domain. Those peers are controlled by the local ISP and act as locality-aware ultra-peers to bias the overlay traffic for higher locality degree. The IoPs require both underlay and overlay information to be able to join the right swarms and connect to local peers.*“ SmoothIT Deliverable D3.3 (Documentation of Engineering and Implementation (Final)).

4.4.1 Project Focus and Relevance to SESERV

The ULOOP project follows an evolutionary approach for the Future Internet, suggesting that overlapping Wi-Fi access networks, operated mostly by end-users, could form a “wireless local-loop” that complements or in some cases substitutes the ISPs’ infrastructure. The idea is to develop the necessary software and networking mechanisms that would foster the creation of a collaborative environment allowing robust, trustworthy, low-cost, and energy-efficient communications. Two main case studies are considered; this new wireless local-loop offering expanded network coverage including 3G offloading, and assisting context-aware information sharing among nearby users.

ULOOP is highly relevant to SESERV for studying the socio-economic issues arising in such user-centric environments with interfaces to the rest Internet. For example the telecommunications legislation can have significant impact to the adoption and operation of this system. Similarly, if ULOOP succeeds in gathering a critical mass of users it could trigger changes to the regulatory landscape[7]. An important factor driving its adoption is the cooperation incentives among Wi-Fi owners. Furthermore, trust issues exist when a roamed user can connect to the Internet through another user.

4.4.2 Socio-economic Priorities for ULOOP

When comparing ULOOP’s socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, ULOOP is found to *emphasize all socio-economic topics beyond average, except the* Relationship between consumers and suppliers online (*cf.* Figure 16).

4.4.3 ULOOP Stakeholders

The set of stakeholders interested in ULOOP ([27],[28]) includes:

- Connectivity Providers such as Edge ISPs (including 3G Operators) who provide Internet connectivity services.
- Information Providers, including Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Brokers and Internet Retailers who need Internet connectivity in order to offer their services.
- Members of the Users meta-stakeholder, which includes residential and business customers who buy connectivity to Internet, as well as End-users and Roamers who use a consumer’s Internet connection to meet their communication needs. Furthermore an end-user can act as a ULOOP Operator and relay data of ULOOP roamers.
- Infrastructure Providers: Venue owners, Access network provider.
- Policy makers such as Regulators, Security agencies who set competition policy and pose privacy, security constraints.

[7] ULOOP Deliverable D2.1 performs an analysis of the regulatory impact of such architectures

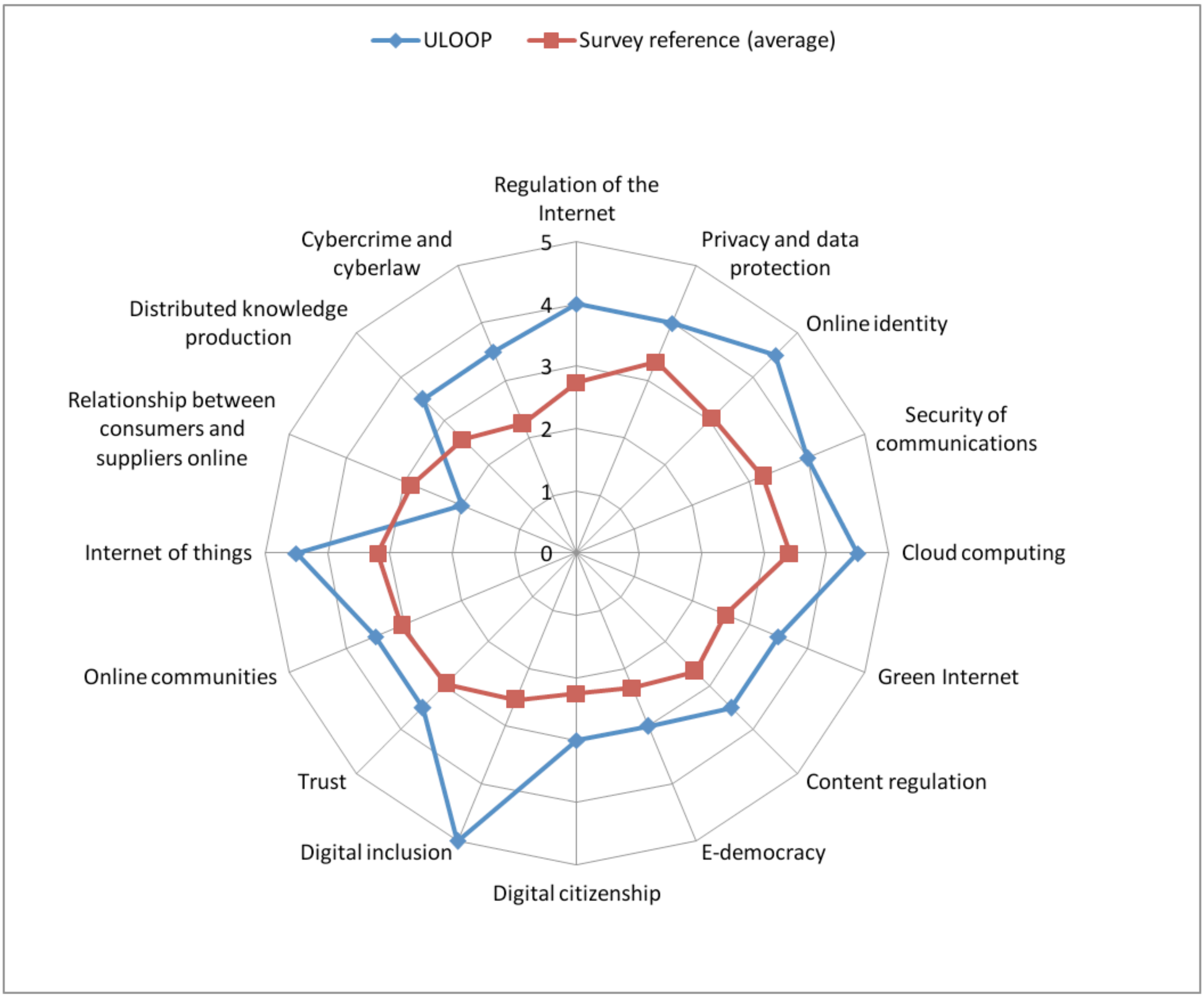

Figure 16: Socio-economic Profile for ULOOP in Comparison with Survey Reference

4.4.4 ULOOP Tussles

A tussle may arise between a ULOOP Operator and a ULOOP roaming user for allowing the latter to connect to the Internet using the former's connection. This is expected to appear when the ULOOP Operator is charged based on volume transmitted or time connected (for example a 3G connection shared using a dual-band mobile phone). In case of an unlimited data plan this tussle may refer to how bandwidth is being shared. Even though an entity can frequently switch between the roles of a ULOOP Operator and that of a ULOOP roaming user, a reciprocative scheme may be necessary in order to mitigate the effects of free-riding incentive issue and boost adoption.

A tussle may arise amongst a ULOOP Operator and its Connectivity Provider for sharing its connection with other potential customers of the latter, *e.g.,* ULOOP users that live nearby the ULOOP Operator and don't have to buy their own subscription or two ULOOP users that bypass their Providers by using the WLAN/mesh network. A Connectivity Provider, assuming that can identify which customers participate to the ULOOP system, could react by asking a regulator to intervene or artificially degrading quality of offered services to ULOOP Operators. This may be the case if the Connectivity Provider participates to the Authentication, Authorization and Accounting of ULOOP system.

A tussle can arise amongst a Connectivity Provider who wants to optimize resource usage and ULOOP users forced to handover to another access-point, consuming more energy or suffering from congestion.

A tussle can arise amongst an ISP who wants to offload its 3G network and a ULOOP Operator who prefers to save energy by turning-off the Wi-Fi access point.

4.5 Profiling Conclusions

SESERV profiled 16 projects with respect to socio-economic priorities, stakeholders affected by the developed technology, and potential tussles between the latter. The number of compiled profiles allows for an overview of socio-economic aspects relevant for the Future Internet in a short, though embracing way. The broad viewpoint that was achieved, may be extended by profiling further Challenge 1 projects. Beside this overview, the profiling activity allows to identify projects that qualify best for detailed design for tussle analysis in D2.2.

We have learned from projects (OPTIMIS being very explicit on that) that the tussle analysis method may offer a structured approach to identify, communicate, and address socio-economic aspects of their research. Some projects discussed and considered such aspects before and the tussle analysis provided them with key ideas to better express those aspects. Additionally, the tussle analysis may help projects to identify adoption chances of the developed technology; to this end, the project or rather the technology developer itself has to be captured as a stakeholder.

We found that stakeholders are central for addressing socio-economic aspects, whereat in some cases, an additional level of detail that differentiates stakeholders with respect to their roles becomes necessary. For instance, some projects emphasize the user in his potential role of a malicious user.

We have learned that for a small number of projects, the notion of stakeholders and their incentives is a slightly different one. For example, when an important “stakeholder” actually reflects a force rather than a (natural/legal) person, a subsumption of incentives becomes difficult. An important case here is the one of nature, disastrous events, outages and the like: Nature is not likely to have a will, thus its incentives are unclear. However, since the tussle analysis was introduced to predict socio-economic interactions between individuals and enterprises, the lack of parameters to capture highly arbitrary events like natural disasters is venial.

Comparing profiles, many of them show repeated appearance of stakeholders and their engagements in tussles. For example, the infringement of copyrights by users is a tussle that frequently appears in many profiles. A consolidation of spotted patterns becomes available by the profiling activity in the next section.

The conclusions drawn as documented here constitute conclusions in terms of general lessons learned and experiences made while profiling a large set of projects with different objectives. This process-oriented conclusions perspective is complemented in Section 5 with a more content-driven perspective in drawing conclusions: Section 5 adopts a consolidation approach in that it looks at patterns spotted among stakeholders, tussles, and their analyses. Hence, Section 5 consolidates findings from the profiling activity and sketches the respective Future Internet landscape with a dedicated focus on socio-economic aspects in the Future Internet.

5 Future Internet Ecosystem

After providing a detailed description of the Internet stakeholders (3.2), a methodology for studying their socio-economic interactions (3.3) and a visualization tool bringing these two aspects together (3.4), this section aims at exploring how the Internet ecosystem will be affected by the research projects profiled in Section 4 and Annex C. We do this by identifying research trends related to the set of Internet stakeholders and their interactions and comparing the focus of selected, related research projects.

5.1 FISE Stakeholders

Figure 17 presents an extended set of stakeholder roles resulting from, or examined, by the technologies investigated by the profiled research projects. These stakeholder *roles*, or stakeholders in short, are expected to give a more representative idea of the Future Internet ecosystem but providing the complete picture is beyond the purpose of this document.

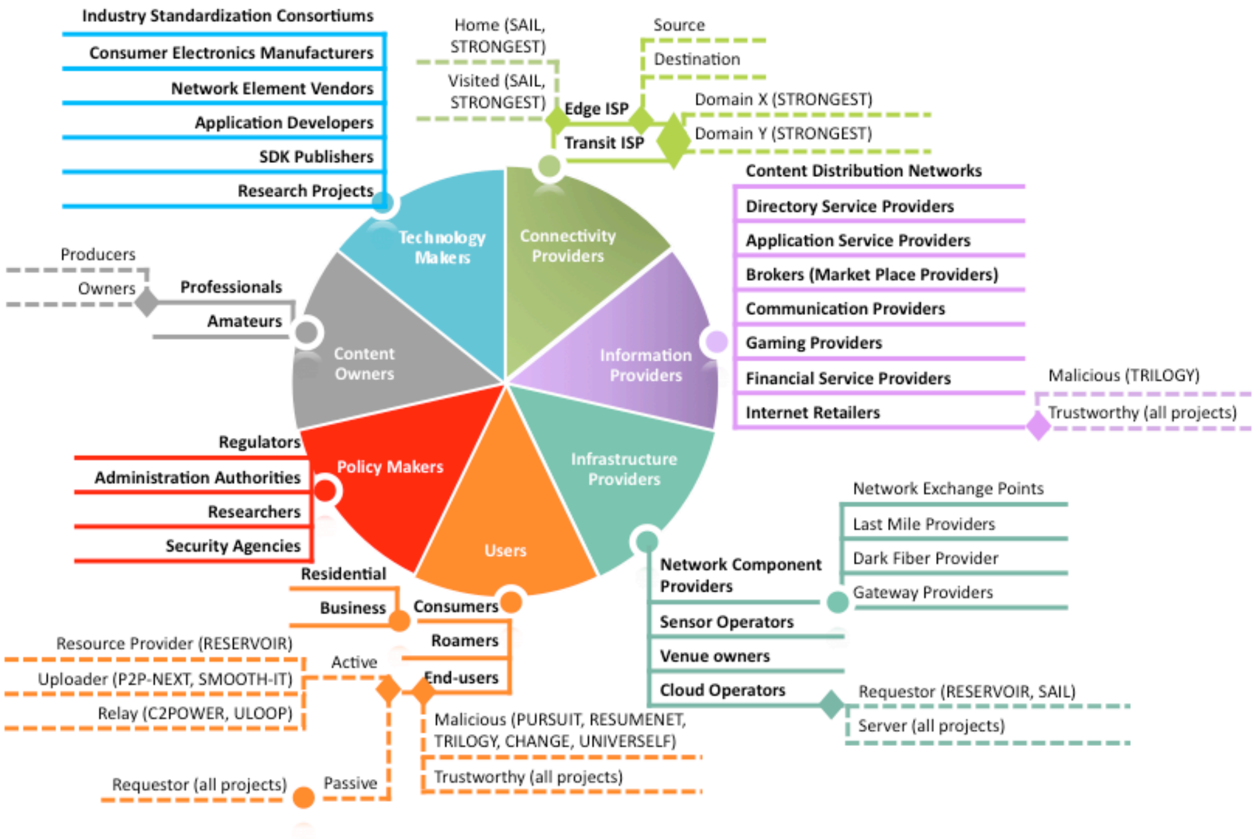

Figure 17: Future Internet Socio-Economic Stakeholders

The new roles are described as further categorizations of more generic roles, where a diamond is used to denote this relationship. Furthermore, the research projects interested in a particular characterization are provided in parenthesis. These roles may be enabled by new technologies or may trigger new technologies to deal with potential issues. An End-User, for example, may be characterized by its active or passive role in the delivery of a particular content item when using a peer-to-peer application, but new technologies may also be necessary to deal with malicious users who deliver corrupted files. Furthermore, multiple categorizations may be related to a single, more generic stakeholder, like the End-Users in the example before.

We observe the following trends:

Proposed technologies increasingly blur the distinction across stakeholder roles. Several projects developing or studying technologies allow a single entity to perform multiple roles. For example each End-User in the era of peer-to-peer applications can act both as content requestor and server. Similarly, several projects dealing with wireless technologies allow end-users to act as connectivity providers by relaying traffic towards a gateway or the final destination. Besides storage and network resources, End-users (especially large enterprises) could also make available their idle processing power to the ecosystem. This trend seems to be valid for instances of other meta-stakeholders as well. For example, Cloud Operators can cooperate by delegating to each other service requests in case of limited local resources.

Proposed technologies promote collaboration across different stakeholder roles. Several projects develop technologies to coordinate the activities of multiple stakeholder roles in order to extend the reach of existing services or offer new ones and compete with other stakeholders. For example, the ULOOP project works on building the appropriate systems that promote participation of end-users in traffic forwarding, which means less investments for infrastructure by an ISP and thus increased ability to climb “the ladder of investment”. Similarly, the SAIL project plans to develop the necessary technologies that will allow a specialized Broker to learn about content items cached by several connectivity providers, possibly in cooperation with Cloud Operators, and compete with traditional Content Delivery Network Providers since they will have extended reach.

In the following we summarize the instances of each meta-stakeholder that each profiled project is interested in. We also investigate how each project and its technologies can affect an entity and expand the main operations it performs by adding those of another meta-stakeholder.

All profiled projects are related to Connectivity Providers. Several projects, including OPTIMIS, BONFIRE, CLOUD4SOA, P2P-NEXT, RESERVOIR, RESUMENET, TRILOGY, ULOOP, consider Edge ISPs, Transit ISPs to provide best effort Internet connectivity services. CHANGE, ETICS, STRONGEST and UNIVERSELF study Edge and Transit ISPs who cooperate in order to provide advanced packet delivery services. A unique characteristic of STRONGEST (in relation to other profiled projects) is that it examines issues between separate administrative authorities of the same ISP that operate parallel networks of different technology and may follow different policies. Furthermore, SMOOTHIT considers Edge and Transit ISPs who provide Internet connectivity services and at the same time act as Brokers of information that balance content downloading time and inter-domain transit traffic. SAIL and PURSUIT study Edge and Transit ISPs who apart from providing Internet connectivity services can act as Cloud Operators for caching video content and cooperate with other Brokers for content delivery. C2POWER focuses on Edge ISPs supporting a variety of wireless technologies and possibly acting as trusted third parties (brokers) that provide incentives to end-users for relaying traffic, *e.g.,* based on payments or reputation. Finally, BONFIRE treats ISPs as experimenters requesting cloud services for test purposes.

Similarly, all projects but RESUMENET study instances of Information Providers. CHANGE, ETICS, STRONGEST, TRILOGY and UNIVERSELF focus on any type of

Information Provider that needs Internet connectivity (possibly with different features, *e.g.,* QoS or security, in order to offer their services. OPTIMIS, BONFIRE, CLOUD4SOA, RESERVOIR are interested in Application Service Providers, Content Distribution Networks, Communication Providers and Gaming Providers who access cloud resources via Internet in order to provide their retail services. SMOOTHIT focuses on Brokers operating systems that allow decentralized content distribution. C2POWER specializes in Brokers operating systems that provide incentives to end-users for relaying traffic, *e.g.,* based on payments or reputation. PURSUIT and SAIL is interested in all types of Information Providers for enabling content to be searched for, published, subscribed to and delivered to requestors.

Instances of Infrastructure Providers are examined by a subset of research projects, especially the Challenge 1.2 (Internet of Services and Cloud Computing) ones. OPTIMIS, BONFIRE, CLOUD4SOA and RESERVOIR focus on Cloud Operators who offer compute resources under an infrastructure as a service model and possibly cooperate in order to deal with periods of excessive demand. BONFIRE studies Cloud Operators acting as test-bed providers, while ULOOP is interested in Venue owners and Last-Mile network providers.

As expected members of the Users meta-stakeholder are affected/interested by all projects profiled. Most of them and specifically C2POWER, CHANGE, ETICS, P2P-Next, PURSUIT, RESUMENET, SAIL, SMOOTHIT, STRONGEST, TRILOGY, ULOOP and UNIVERSELF examine Customers who buy connectivity to Internet and End-users who use a consumer's Internet connection to meet their communication and entertainment needs (perhaps with differentiated quality of service). C2POWER and ULOOP enlarge the role set of End-Users by examining technologies that could allow them to relay the data of other end-users acting as Connectivity Providers. Finally, BONFIRE, CLOUD4SOA and OPTIMIS focus on End-users and Consumers as experimenters requesting cloud services via Internet.

Policy Makers are examined by a significant number of projects. C2POWER, CHANGE, ETICS, PURSUIT, TRILOGY, ULOOP and UNIVERSELF deal with Internet competition aspects where Regulators are expected to intervene. CHANGE, PURSUIT, TRILOGY and UNIVERSELF deal with security issues possibly set by a Security Agency. Furthermore, TRILOGY is interested in Administration Authorities that control how Internet operates, *e.g.,* global IP address allocation.

Several projects focus on Content owners that are interested in controlling how content is made available by P2P applications or Information-centric networks. These projects include P2P-Next, PURSUIT, RESERVOIR, SAIL and SMOOTHIT.

Finally, Technology Makers are related to most of the profiled projects since vendors of Operating Systems, Network Elements, Consumer Electronics, Personal Computers Mobile Devices and Application Developers are members of those consortiums. However projects paying particular attention to this meta-stakeholder are PURSUIT, SMOOTHIT and TRILOGY. They investigate the attractiveness of the technologies implemented to the Users – which is a significant factor considered when a Technology Maker decides about which Internet protocols and technologies to implement. For example in the case of PURSUIT, router manufacturers may have to update their functionality, *e.g.,* by adding larger caches or new routing protocols. Furthermore, BONFIRE considers members of that meta-stakeholder as experimenters requesting cloud services for test purposes.

5.2 Tussle Consolidation

This section provides a categorization and listing of the tussles that were identified during project profiling, allowing for a basic comparison to be made regarding the assumptions at the tussle-level. Many projects appear to study the same tussle, perhaps from a different technology perspective. For example, CHANGE, UNIVERSELF and PURSUIT rely on different technologies/systems for dealing with the tussle surrounding Distributed Denial of Service Attacks (DDoS). This seems to be quite straightforward given that, for example, several projects were classified in the same cluster of FP7 ICT Objective 1.1 (Future Networks). The next section suggests that a higher-level comparison of projects is possible by using the FISE map tool.

Several tussle groups where found, including the following: Network Security, Interconnection Agreements, Routing (in the broader sense of selecting a provider to fulfill a customer request), Responsibility for agreement violation, Allocation of scarce resources, Controlling content/service delivery (referring to possible anti-competitive tactics) and Controlling access to sensitive data.

Note that the tussle description mentions the stakeholders that are interested in the initial tussle outcome. Other stakeholders (such as Policy makers) that may be involved in subsequent tussle outcomes and/or tussle spillovers will be the focus of deliverable D2.2.

Network security

Project	Tussle
CHANGE	Tussle among ISPs for controlling traffic being part of a DDoS attack near its source, using a flow management scheme across ISPs.
UNIVERSELF	Tussle among ISPs for controlling traffic being part of a DDoS attack near its source, using a reputation system for senders.
PURSUIT	a) Tussle among ISPs for controlling traffic part of a DDoS attack near its source using network level mechanisms. b) Threat to the ecosystem by issuing many fake requests to service directories.
STRONGEST	Tussle for controlling information announced to other ISPs, *e.g.,* about network topology, and preventing attacks by aggregating sensitive information.

Interconnection agreements

Project	Tussle
ETICS	Tussle among ISPs controlling interconnection agreements that support QoS-enabled inter-provider services, by allowing many configuration options and pricing.
PURSUIT	Tussle among Edge ISPs, Transit ISPs and CDNs for achieving favourable interconnection agreements, assuming that content can be cached inside the network.
SAIL	Tussle among Edge ISPs, Transit ISPs and CDNs for achieving favourable interconnection agreements, assuming that content can be

	cached inside the network.
TRILOGY	a) Tussle amongst an Edge and a Transit ISP for becoming peers by using MPTCP to make such an agreement more attractive to the transit ISP. b) Tussle for assessment of different pricing schemes on ISPs' cost and revenue structure.
SMOOTHIT	Tussle among Edge ISPs, Transit ISPs and Brokers for achieving favourable interconnection agreements, assuming that content can be cached inside the network.

Routing

Project	Tussle
ETICS	Tussle among ISPs for composing efficient end-to-end, QoS-aware paths (so that the maximum number of requests can be fulfilled) even if this strategy is in contrast to an ISP's short-term benefit.
PURSUIT	Tussle between an ISP and a (routing) Broker, where the former gives inaccurate or partial information in order to influence the routing path or fearing that such sensitive information will be used for espionage.
SAIL	a) Tussle among an ISP and a (service delivery) Broker, where the latter's routing decisions (content/service source selected) can increase the former's transit costs. b) Tussle between an ISP and a (service delivery) Broker, where the former gives inaccurate or partial information in order to influence the selected cache or fearing that such sensitive information will be used for espionage.
P2P-NEXT	Tussle among an Edge ISP and an ASP, where the latter's routing decisions (seeders/leechers selected) can increase the former's transit costs or cancel-out its traffic engineering effort.
SMOOTHIT	Tussle among an Edge ISP and an ASP, where the latter's routing decisions (seeders/leechers selected) can increase the former's transit costs or cancel-out its traffic engineering effort.
STRONGEST	Tussle among two ISPs who send biased advertisements in order to favour the crossing of some domains/ISPs even though other paths could be more appropriate.
C2POWER	A tussle exists between a source user and each relaying user since the latter have complete control over the rest path of the data.
BONFIRE	Tussle between a Broker and Experimenters when the former's "routing" decision (regarding the Cloud Operator an experiment will be run) is in conflict with the user's ability to repeat an experiment (for achieving the same conditions and allowing the results to be compared).
CLOUD4SOA	Tussle between a Broker and Cloud Operators for controlling how End-User requests are "routed" to Cloud Operators.

OPTIMIS	Tussle between a Broker and End-Users when the former's "routing" decision (regarding the Cloud Operator an experiment will be run) is in conflict with the user's interests (such as eco-efficiency, risk and trustworthiness).

Responsibility for agreement violation

Project	Tussle
ETICS	Tussle among Edge ISPs and Transit ISPs for under-dimensioned backup paths (thus lower cost) due to absence of inter-ISP SLA monitoring mechanisms.
RESERVOIR	Tussle between two Cloud providers where tasks unable to be served by one of them receive low priority by the other in order for the latter to be prepared for sudden workload peaks.
STRONGEST	Tussle between an upstream and a downstream ISPs where the latter devotes lower effort in packet forwarding due to absence of inter-ISP SLA monitoring mechanisms.
P2P-NEXT	Tussle between Edge ISP and Content Owner in case the former caches content items to reducing inter-domain traffic.
SMOOTHIT	a) Tussle between an ISP and a Content Owner where the former caches illegally distributed content items for reducing its transit costs. b) Tussle between an ASP who has deployed the SmoothIT mechanisms and an ISP, who in absence of an end-to-end SLA monitoring mechanism, has no incentive to provide effort enough to improve the QoE of the former's customers.
ULOOP	Tussle between an ISP and a Consumer where the latter shares/rents its Internet connection with/to other users.
C2POWER	A tussle exists between a source user and the relaying users in case the data did not reach the destination, which may be due to a legitimate reason or a relaying user who free-rides.
SAIL	a) A tussle arises between an End-user (or a Community Infrastructure Provider) relaying traffic of another End-User and a Community Operator (a type of broker), if the former one does not follow the policies established by the latter, e.g. traffic prioritization. b) A Network Operator and a Content Owner and a CDN provider, if the last one does not offer the agreed content/service, or when the Network Operator/Network Infrastructure Provider in purpose degrade the performance of the CDN service in order to other traffic.
BONFIRE	Tussle between a Cloud Operator (called Testbed provider) and End-Users (called Experimenters) in case the latter violate the terms of service when running an experiment.

Allocation of scarce resources

Project	Tussle
C2POWER	Tussle among users who may increase the power level on their devices, and thus consume more resources of the shared wireless spectrum, in order to reach a distant user.
ULOOP	Tussle for fair bandwidth share of an Internet connection among roaming and non-roaming users.
P2P-NEXT	Tussle between users who download a file for upstream capacity of that file's seeders.
PURSUIT	Tussle for fair bandwidth share on a common link between a set of multicast users and a unicast user.
RESERVOIR	Tussle between customers of a cloud provider on the bandwidth of the latter's connection to the Internet.
TRILOGY	Tussle for fair bandwidth share on a common link between interactive users and users of peer-to-peer applications.
RESUMENET	Tussle between roaming users for upstream capacity of relay nodes.
BONFIRE	Tussle between experimenters (End-users) for a Cloud Operator's resources.

Controlling content/service delivery

Project	Tussle
P2P-NEXT	Tussle between Information Providers and an ISP for deteriorating QoE that customers of the former get by using middleboxes.
PURSUIT	a) Tussle between subscribers (, publishers) and service discovery brokers due to the ability of the latter to filter/screen user requests for content/services. b) Tussle between publishers (,subscribers) and service discovery brokers due to the ability of the latter to filter/screen announcements for content/services filters/screens for content/services. c) Tussle between publishers (a legitimate and a fraudulent one) for performing 'phising' through cache-poisoning.
SAIL	a) Tussle between subscribers (,publishers) and service discovery brokers due to the ability of the latter to filter/screen user requests for content/services. b) Tussle between publishers (,subscribers) and service discovery brokers due to the ability of the latter to filter/screen announcements for content/services filters/screens for content/services.
TRILOGY	a) Tussle between Information Providers (a legitimate and a fraudulent one) for performing 'phising' by advertising more specific BGP prefixes. b) Tussle between Information Providers (an ASP and an ISP acting as

	an ASP as well) for deteriorating QoE that customers of the former ASP get by using middleboxes.
ETICS	Tussle between an Information Provider, who does not buy ETICS services, and an ETICS ISP because the latter does not invest in Best-Effort Internet connectivity services so that ETICS services become more attractive.
ULOOP	a) Tussle between end-users and Edge ISPs in hand-over to a different cell, technology, *etc.* b) Tussle between an Edge ISP and an Infrastructure Provider for traffic offloading in the latter's network.
RESERVOIR	Tussle between an End-User and its Edge ISP in case the former wants to connect to a high-quality but distant Cloud Operator, whereas the latter performs traffic shaping in order to lower transit costs and make a low-quality but local Cloud Operator more attractive.
BONFIRE	Tussle between a Cloud Operator (termed test bed provider) and experimenters when the former's allocation of resources, even though maximises their utilisation, is in conflict with the user's desire for controlling how experiments will be run.

Controlling access to sensitive data

Project	Tussle
PURSUIT	Tussle between a service discovery broker and Subscribers due to the former's ability to collect and capitalize this transactional data.
RESERVOIR	a) Tussle between a Content Owner (or Security Agency) and a Cloud Operator (or Information provider depending on the implementation) for having access to content stored by the latter in order to identify End-Users distributing illegal content. b) Tussle between an ASP and a cloud provider who can keep processed data for other purposes.
STRONGEST	Tussle for controlling information announced to other ISPs, *e.g.,* about network topology, and preventing customer stealing by aggregating sensitive information.
C2POWER	Tussle between the source user and a relaying user because the latter is capable of copying the transferred data, and using it for a different purpose.
RESUMENET	Tussle between a malice user and a Content Owner where the former illegally capitalize the information stored in the caches of a content-centric network.

5.3 FISE Map Consolidation

In this section we utilize the FISE Map to illustrate tussle profiles for C2POWER, ULOOP SmoothIT, and P2PNext; the maps are shown in Figure 18, Figure 19, Figure 20, and

Figure 21, respectively. All tussles for these projects as consolidated in the previous section are illustrated. The introduced grouping of the tussles is reflected in the maps by the colors of the respective tussle shapes: Routing-tussles are illustrated by yellow shapes, Responsibility for agreement violation-tussles by red shapes, Allocation of scarce resources-tussles by green shapes, Controlling content/service delivery-tussles by blue shapes, and Controlling access to sensitive data-tussles are illustrated by turquoise shapes.

The set of four projects – C2POWER, ULOOP SmoothIT, and P2PNext – was selected for illustration, since C2POWER and ULOOP pursue similar technology goals (opportunistic forming of wireless-node networks), just as P2P-Next and SmoothIT do (next-generation P2P networks that adapt to the physical underlay network). Hence, two of the four projects each build a pair, when looking at the respective goals those two projects in a pair follow. Other pairs can be found easily among the other profiled projects based on the consolidation found in Section 5.2. The specific selection of two pairs made here, thus, is exemplary and shall serve illustrative purposes.

Although goals of the two projects in a pair are similar, the produced FISE Maps show, that encountered tussles profiles differ: while C2POWER seems to encounter inter-user tussles, only, ULOOP sees a broader range of meta-stakeholders involved: two tussles between users and connectivity providers are encountered and one between the latter and Infrastructure providers. In general ULOOP appears to consider more stakeholders and their interactions than C2POWER. For example [25] studies the conformance of the ULOOP system to the regulatory setting across several European countries. Furthermore, ULOOP include in their analysis members of the Infrastructure meta-stakeholder. This deviation in tussle profiles gives rise to the question whether it is useful to evaluate whether tussles encountered by the ULOOP project may also apply to C2POWER, *e.g.,* the tussle between an Edge ISP and an Infrastructure Provider for traffic offloading in the latter's network.

When comparing the FISE Maps of SmoothIT and P2P-Next the projects' similar design goals become visible: both encounter a tussle for traffic-caching in order to reduce inter-domain traffic. Furthermore, the same stakeholders are involved in both projects in a tussle regarding routing decisions. As in the case of C2POWER and ULOOP, it should be evaluated, if the tussles encountered only by one of the projects, may also apply to the other.

It may be mentioned, that the FISE Maps given in this section also show that tussles for the allocation of scarce resources always involve users.

The conducted pair-wise consolidation based on FISE Maps allows for the key conclusion to be drawn as follows: Clustering different research projects according to their goals may lead to valuable project classifications. Considering socio-economic issues encountered by associated projects will likely show similarities but also differences will be encountered. These differences may be used as feed-back for associated projects. In general, a different clustering will emerge when looking at the same set of projects and assessing the socio-economic priorities and tussles that these projects are concerned with instead of their research goals. Consequently, making a classification available and consolidating along socio-economic dimensions provides added value to both the projects (e.g. in order to cooperate and coordinate with projects with similar socio-economic interests) and the funding body (e.g. to identify key research issues among the European research landscape).

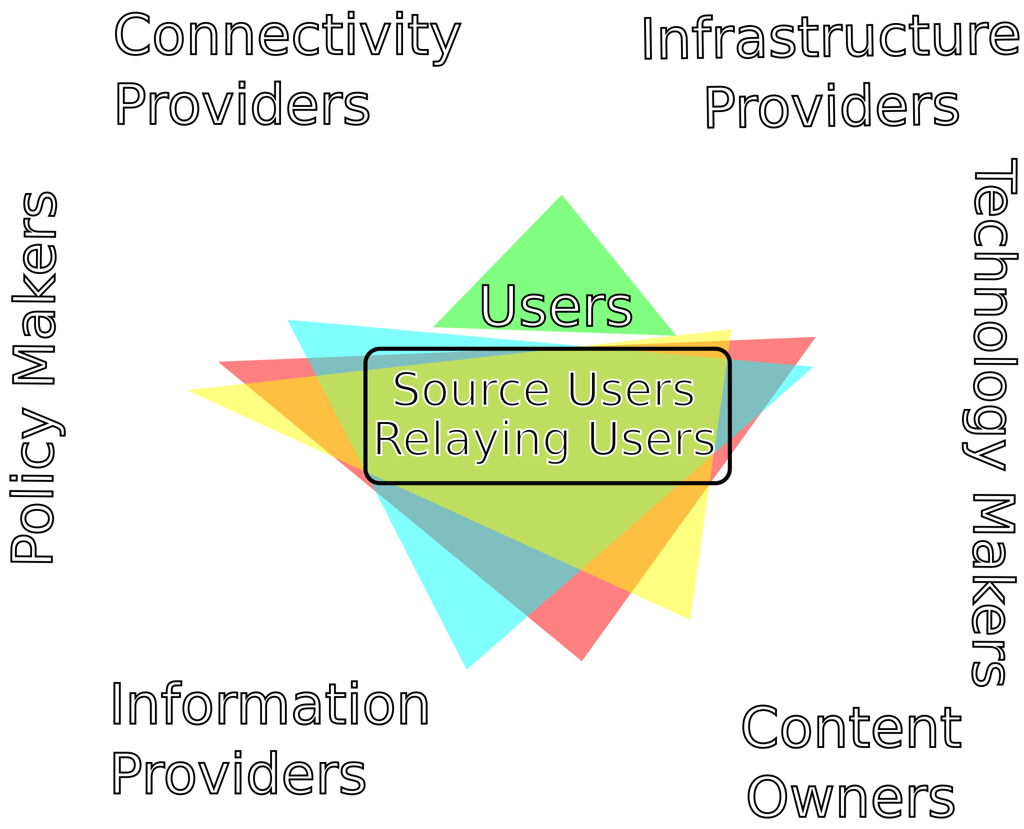

Figure 18: FISE Map for C2POWER

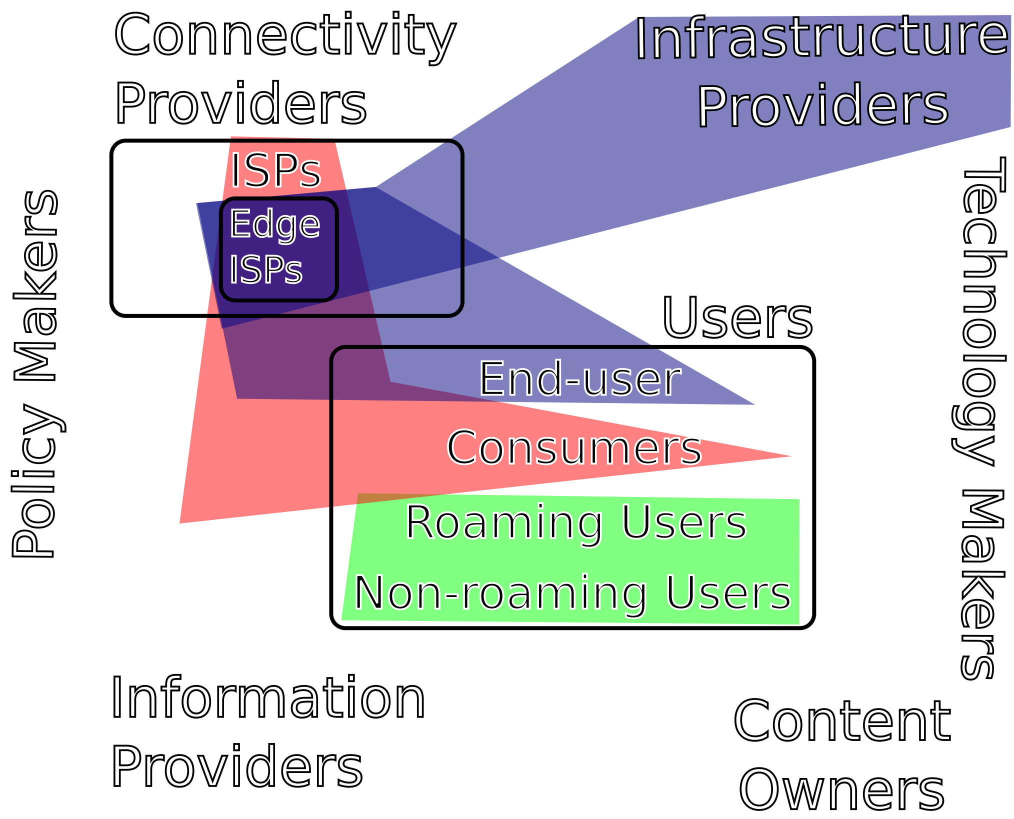

Figure 19: FISE Map for ULOOP

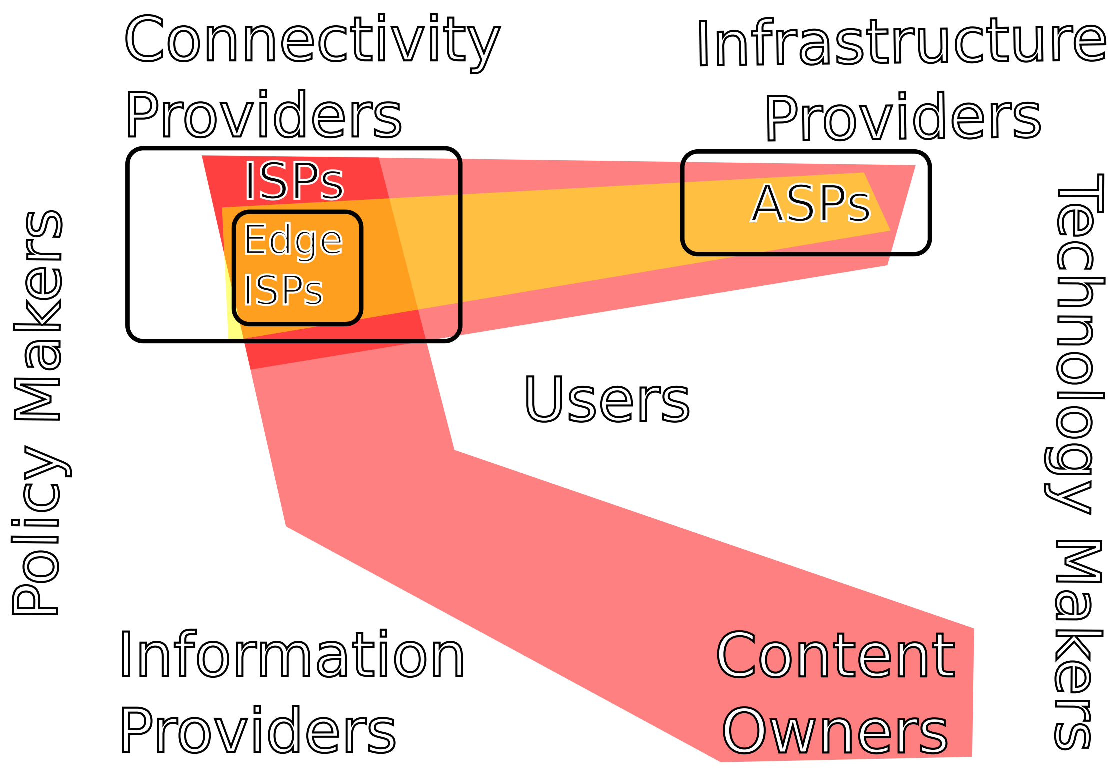

Figure 20: FISE Map for SmoothIT

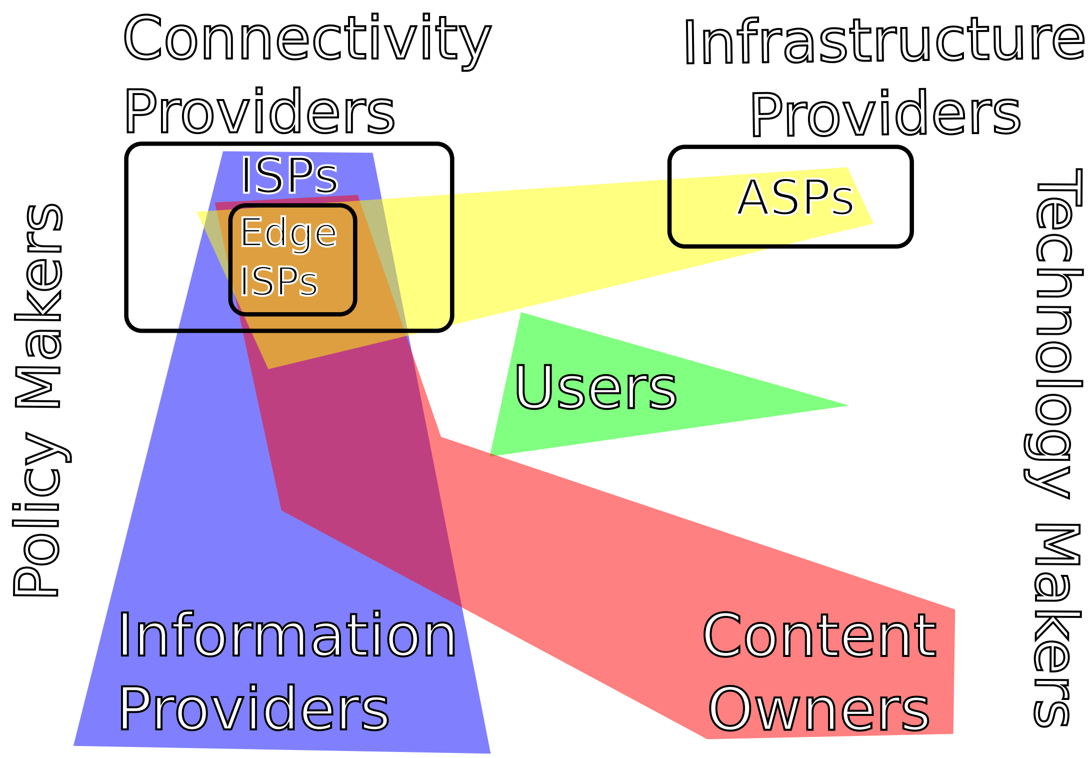

Figure 21: FISE Map for P2P-Next

6 Standardization Activities in ITU

Y.3001 is part of the “Y SERIES: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS, Next Generation Networks - Future networks”, thus, of relevance to the FISE community and SESERV, and it can be found at [14]. This is of relevance, since the International Telecommunications Union (ITU) Study Group 13 (SG13) works on "Future Networks Including Mobile and Next Generation Networks (NGN)".

SESERV was represented in the two last steps of its finalization, amongst other reasons due to the EC Concertation meeting in December 2010, where contact was made with Alojz Hudobivnik, Slovenia, an Assistant Rapporteur of ITU-T Q.21/13. Later on, the contact was deepened with Takashi Egawa, who is chairing SG 13. Thus, a tussle analysis input was prepared and after negotiations included into the final Y.3001 version. During the final editorial meeting as well as during its final content preparation by the Swiss Delegation, in which University of Zürich UZH had been appointed to, the input was completed and voted for. Note that ITU rules enforce the membership of a contributor to any SG and work within the ITU. Therefore, the Swiss Delegation lead accepted the membership of the SESERV coordinator UZH in their national delegation for the purpose of contributing this technical input.

6.1 Completed Input from SESERV into Y.3001

As the standardization activities undertaken from SESERV within the ITU Study Group 13 on "Future Networks Including Mobile and Next Generation Networks (NGN)" have been run with respect to the proposed tussle concept of SESERV, the new ITU-T recommendation Y.3001 especially sees the inclusion of the tussle analysis as a potential method to investigate different stakeholders' interests within future networks.

- Formally spoken, the initial input prepared contained a Section 7.4 input, a Section 8.7. input, and an appendix input, combined with a definition of tussles.
- The preparative discussion for the final Y.3001 approval meeting revealed that it is not useful to propose all such updates, as the progress of the document has reached the so-called “editorial changes” state, in which too many changes may decrease chances of acceptance. In addition, ITU policies tell that any Oxford and Cambridge dictionary word entry – here “tussle” – does not need to be defined specifically in a recommendation.
- Thus, the final input offered for a final inclusion into Y.3001 was Section 8.7, but no longer Section 7.4 and the appendix. This compromise does not affect the major goal of SESERV to see the tussle analysis being mentioned and included into this recommendation.

These changes to Section 8.7 are kept as focused as possible (cf. the issue with non-editorial changes above), while tussles are reflected explicitly. The resulting Section 8.7 – the contribution of SESERV – reads finally as follows:

“FNs are recommended to be designed to provide a sustainable competition environment for solving tussles among the range of participants in the ICT/telecommunication ecosystem—such as users, various providers, governments, and IPR holders—by providing proper economic incentive.

Rationale: Many technologies have failed to be deployed, flourish, or be sustainable because of inadequate or inappropriate decisions of the architect, concerning intrinsic economic or social aspects (e.g., contention among participants), or because of the lack of surrounding conditions (e.g., competing technologies) or incentive (e.g., open interface). Such failures have sometimes occurred because the technologies did not provide mechanisms to stimulate fair competition.

One example of this is the lack of QoS mechanisms in the initial IP network implementation needed in real-time services such as video streaming. IP layer did not provide a means to its upper layer to know if QoS was guaranteed from end-to-end. They also lacked proper economic incentives for the network providers to implement them. Coupled with other reasons, these have provided obstacles for introduction of QoS guarantee mechanisms and streaming services in IP networks, even when telecommunications ecosystem participants have tried to customize networks or asked others to provide customized networks to start a new service and share its benefits.

Sufficient attention therefore needs to be paid to economic and social aspects such as economic incentives in designing and implementing the requirements, architecture, and protocol of FNs in order to provide a sustainable competition environment to the various participants.

Ways of resolving economic conflicts, or tussles, in cyberspace that include economic reward for each participant's contribution are becoming increasingly important [6]. The use of networks is considered a means of producing economic incentives in various fields as the Internet, generally speaking, grows and puts together diverse social functionalities. Different Internet participants often pursue conflicting interests, which has led to conflict over the Internet and controversy in international/domestic regulation issues."

6.2 Next Inputs from SESERV into SG13

A new call for items and contributions has been received, since the next SG13 meeting will take place in October. In detail, the following contributions are considered of relevance as of today:

- New proposal of socio-economic dimensions of investigation in the FN domain.
- Support of other new proposals in SG13, which will address the social as well as economic facets of next generation networks.

Thus, the support of SESERV, mainly WP4 and especially UZH, will be best suited to ensure that

(a) the work of SESERV will be reflected in standardization,

(b) the telecommunications branch of network operators is made aware of socio-economic aspects besides their frequent focus on technology, and

(c) the results from the coordination and support in socio-economics are archived.

Therefore, a sub-set of SESERV's dissemination goals can be reached in this approach.

7 Position on High-speed Accounting in the Future Internet

This section presents the initial outcomes of interactions between SESERV members and a team of European experts on accounting mechanisms for understanding and addressing the socio-economic dimensions of high-speed accounting in the Future Internet. These outcomes constitute selected contents of a draft white paper being produced currently. High-speed accounting is considered a critical challenge to network engineers, as its necessity arising from socio-economic factors often exceeds its technical feasibility. In terms of the overall terminology developed in SESERV and introduced in this deliverable, the technical feasibility of high-speed accounting will play a decisive role how several stakeholders in the Future Internet will interact, as high-speed accounting provides facts as a quantifiable basis on network data to analyze, judge, and even regulate a considerable number of tussles. Although the focus of the paper is on socio-economic and technical factors influencing an ISP in adopting high-speed accounting, the relevance of this section for the FISE Community and Challenge 1 Projects is given by the fact that accounting is an inevitable task in future networks and seems to become less and less feasible in a fine-granular manner for increasing network speeds. Note that this work is still in progress and a paper is under preparation, scheduled for completion in the second half of 2011. It is intended to feed into the discussion about high-speed accounting in the FISE Community.

In closer detail, the current abstract of the paper is presented in Section 6.1 and the respective introduction and motivation are provided in Section 6.2. Those two sections already allow for a good notion of key issues raised in the paper. In Section 6.3 relevant demand drivers of an ISP to adopt high-speed accounting are discussed and aggregated to a figure constituting the first assessment framework of this work. The main assessment framework is discussed in Section 6.4 and allows for an identification of stress fields between different socio-economic demand drivers influencing an ISP with respect to high-speed accounting decisions to be taken. Section 6.5 applies the framework to contrast flat-rate offerings to volume-based charging from an ISP's point of view.

While previous sections looked at tussles emerging among arbitrary sets of stakeholders, in this section the focus is on the interactions between a connectivity provider and a regulator. More specifically, cases (termed stress fields) are investigated where the managerial as well as technical feasibility of high-speed accounting in the Future Internet is affected by several (*e.g.*, regulatory) constraints. Consequently, the set of stress fields discussed reflect a connectivity provider's range of action in terms of what a connectivity provider can, may, must, or shall do in order to address a given requirement. In this light, stress fields relate to tussles in that a stress field may originate from a tussle. For instance, a regulator may impose the maximum frequency or content-wise granularity of accounted resource usage data in order to protect privacy needs of a connectivity provider's users. This regulation might inflict with operational needs of the connectivity provider. This exemplary tussle between regulator and connectivity provider results in a stress field for the connectivity provider, and the connectivity provider will assess available options in order to cope with and limit the 'stress' imposed.

7.1 Abstract

Traffic traversing high-speed links is of great interest to different Internet stakeholders, such as network operators, policy makers, and users. With the Internet becoming

ubiquitous and a critical infrastructure in the service economy, the demand for high-speed monitoring and accounting increases for manifold reasons while feasibility becomes more and more problematic due to bandwidth growing faster (Gilder's law) than computing power (Moore's law).

This paper adopts the perspective of a network operator and determines a position towards managerial and technical feasibility of accounting in high-speed networks. To this aim, stress fields between identified socio-economic drivers and possible technological solution approaches are investigated. This leads to two major contributions being made. First, a framework for socio-economic assessment of high-speed accounting is provided. Second, by application of the framework, key conclusions with respect to needed future research in demand for and feasibility of high-speed accounting are drawn.

7.2 Introduction and Motivation

An in-depth understanding of the traffic generated in and transported by the many autonomous systems that build the Internet is critical to multiple stakeholders. Network operators are interested for operational and strategic managerial reasons in a number of monitoring and accounting applications. Examples include, but are not limited to, packet capturing- or flow-based reports and threshold alerts, for instance for Quality-of-Service monitoring, intrusion detection, denial of service detection, or the accounting of resource and service usage for cost optimization and charging purposes [4],[7]. Users, both in terms of individuals as well as service and content providers, are affected by a working and efficient monitoring and accounting as they are interested in a reliable, secure, and available network for whose use they want to be charged correctly, whereas personal data collection and profiling activities shall be kept minimal. Policy makers are interested in Internet monitoring and accounting for the development of policy decisions (*e.g.,* with respect to privacy concerns) as well as the enactment of policies (*e.g.,* with respect to data retention and legal interception). These different demands to high-speed accounting and the diverging aims for the deployment of gathered data constitute a source for numerous tussles.

Given a clear demand for Internet monitoring and accounting, on the one hand, the observed shift from 10 Gbit/s to 40 Gbit/s backbone link speed (and 100 Gbit/s in the future) [11] raises considerable challenges to monitoring and accounting on high-speed links, on the other hand. Technical feasibility of high-speed monitoring and accounting becomes problematic for network operators. At a link speed of 10 Gbit/s only, the time left for handling a single packet is approximately 5 ns. and the data volume collected is extremely large. Technical feasibility is becoming more and more challenging, since bandwidth is found to grow three times faster (*cf*. Gilder's law) than computing power (*cf*. Moore's law). Furthermore, the increase of encrypted traffic renders high-speed monitoring and accounting very difficult.

As many stakeholders shape the demand for Internet monitoring and accounting, technical as well as non-technical aspects are being highly relevant for high-speed monitoring and accounting. Non-technical aspects of concern embrace economic incentives, legal constraints, and regulatory demands. Hence, this paper is motivated to investigate emerging stress fields between demand for high-speed monitoring and accounting (socio-economically driven) and possible (technological) solution approaches in consideration of Gilder's law. The paper's main objective, thus, is to determine a position with respect to managerial and technical feasibility of monitoring and accounting in high-speed networks, on high-speed links.

In order to achieve this objective, the following basic assumptions apply. The perspective adopted reflects the supposed viewpoint of a network operator, as he is the stakeholder to implement accounting and therefore proves to be essential for many tussles around high-speed accounting. By means of this assumption, only communication services (as opposed to information society services, also referred to as value-added services or content services) are considered. Communications services are also referred to as telecommunications services or basic services. They provide connectivity and transport of bits and bytes. Finally, the monitoring and accounting in high-speed networks and for high-speed links is envisioned only. This implies the need for a definition of what high-speed means as high-speed constitutes a relative term whose understanding is prone to changes over time.

With this motivation, objective, and scope outlined, a number of questions need to be addressed:

1. How is high-speed monitoring and accounting defined and delineated?
2. Which technological approaches to high-speed monitoring and accounting exist and how scalable is each approach (*cf*. Gilder's law)?
3. How is the demand for high-speed monitoring and accounting influenced by the relevant set of stakeholders?
4. Can the demand raised be satisfied, both from a managerial and technological point of view of a network operator?

These four questions relate to the approach developed for and adopted in this paper. Initially, the basic terminology with the respective relevant background information is defined and delineated (question 1). Terminology relates to the respective applicable understanding of monitoring, accounting, and high-speed. In addition to terminology, the technological dimension of high-speed monitoring and accounting is introduced (question 2). This covers an overview and analysis of existing and emerging technological approaches to high-speed monitoring and accounting. Demand-influencing dimensions for high-speed monitoring and accounting originating from a network operator, its users (private and corporate), and policy makers are identified and described in Section 7.3 (question 3). These dimensions denote socio-economic drivers for high-speed monitoring and accounting, out of which some increase demand while others limit demand. The identified drivers embrace the complete set of major perspectives for a network operator, namely what a network operator wants, can, must, and shall account on a high-speed link. These identified demand drivers form the basis for the first major contribution of this paper: a socio-economic analysis framework of stress fields which may emerge among the drivers. The assessment framework is presented in Section 7.4, while its application is demonstrated for a specific example in Section 7.5. The stress fields addressed constitute important cases for high-speed accounting, while the set of cases addressed is not to be understood comprehensive. These example cases are meant to show how the assessment framework is used and to what results application may lead.

7.3 Drivers

The considerations below are illustrated in Figure 22. An ISPs demands high-speed accounting arises for manifold reasons, whereat the motivation to apply high-speed accounting can be split into intrinsic and extrinsic factors. Purely intrinsic motivations to apply high-speed accounting arise from the goal to gather traffic information in order to optimize the network and plan for elaborated upgrades. But also knowledge about its customer base may help an ISP to stay more competitive. These motivations obviously increase the demand for high-speed accounting, but also industry recommendations and best practices may give incentives to an ISP to apply accounting. However, the latter factors may also be considered extrinsic. Note that all demand drivers mentioned so far have strategic origins, wherefore an ISP will only apply accounting for those reasons if the expected benefit exceeds the costs. Stakeholders that greatly influences an ISP in applying high accounting are legislative authorities, whereat they may influence an ISP in contrary ways: on the one hand, Legislative Authorities may limit the demand for high-speed accounting, when they approve laws to protect user rights and thereby limit the acceptable granularity of accounting data. On the other hand, they can also increase the demand by approving data retention laws and telecommunication laws.

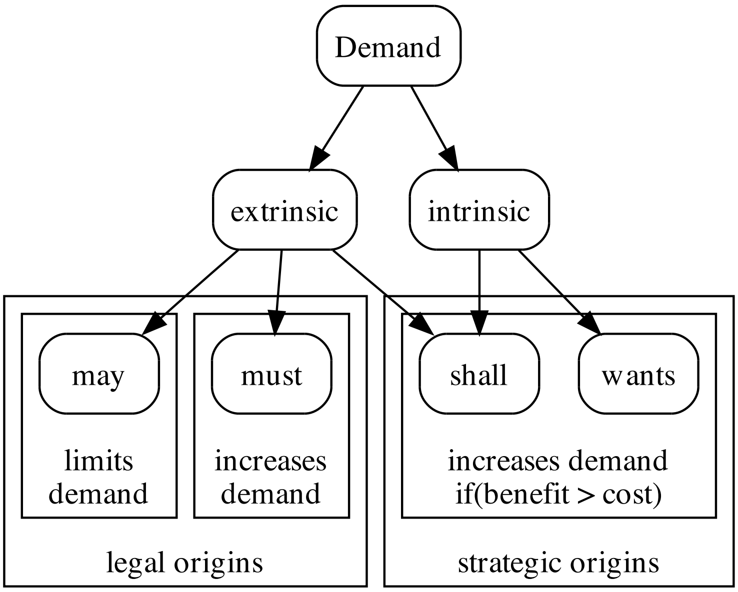

Figure 22: Socio-Economic Demand-Drivers for High-Speed Accounting

7.4 Assessment Framework

In order to assess an ISP's freedom of action – in terms of the socio-economic feasibility of an ISP's accounting system implemented or planned for – the set of socio-economic demand drivers has been translated into the respective four main fields determined to influence an ISP with respect to high-speed accounting decisions to be taken. Figure 23 depicts these four main fields which cover managerial (what an ISP wants to account; increasing demand), economic (what an ISP is able to account, economic-wise, *i.e.*, with the premise of a zero-balance or better a positive cost-benefit analysis; limiting demand), technological (what an ISP is able to account, technically; limiting demand), and legal (what an ISP may and must account; limiting and increasing demand, respectively) dimensions.

These four main fields and their counter-wise influence constitute an analysis framework for socio-economic accounting feasibility. This analysis framework reflects both the ISP-internal perspective (economic, technological, and managerial dimension, the latter subsuming short-term operational and long-term strategic aspects) and the ISP-external perspective.

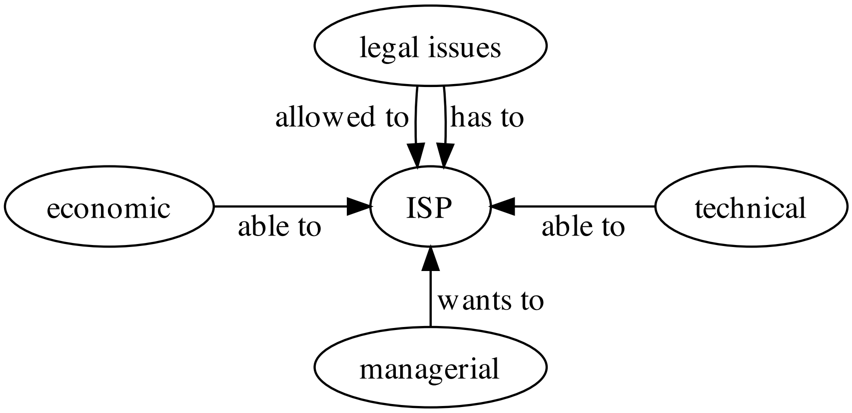

Figure 23: Main Fields for High-Speed Accounting

7.5 Example and Outlook

In order to demonstrate the use of the assessment framework given in the former section, we apply it to discuss incentives for an ISP in switching from flat-rate offers to volume-based charging. The motivation for an ISP to offer volume-based tariffs arises in the managerial field of the framework: A common tussle between an ISP offering flatrates and a customer is encountered when the latter exceeds the traffic volume scheduled to him by the ISP, *e.g.,* by heavily sharing data. Volume based charging obviously eliminates this tussle and allows to charge each user fairly with respect to the produced traffic. In contrast to flat-rates, volume-based charging gives an incentive to reduce traffic production. Since the ever growing Internet congestion is a serious threat to its operability (and thereby may trigger large scale bandwidth contention tussles) a further managerial motivation to offer volume-based charging is encountered. A draw-back of volume-based charging is that it requires according accounting data. Therefore, the question if collecting such data is *technical* feasible arises. Furthermore, out of *economic* considerations the question arises, if the revenue gained by volume-based charging outweighs the cost of the necessary infrastructure. It also is relevant, if the temporal resolution, that is required to realize the designated charging model, is feasible with respect to data privacy. The latter constraint obviously arises in the legal field of the framework. The posed considerations are illustrated in Figure 24.

Figure 24 gives an exemplary glimpse at how to apply the assessment framework to a specific question originating from accounting challenges in the Future Internet. The full paper will embrace multiple application examples, all of which will be discussed in full detail in order to develop a position on the technical and managerial feasibility of high-speed accounting in the future. The paper is work in progress among a European team of accounting experts, and it is planned for finalization by end 2011.

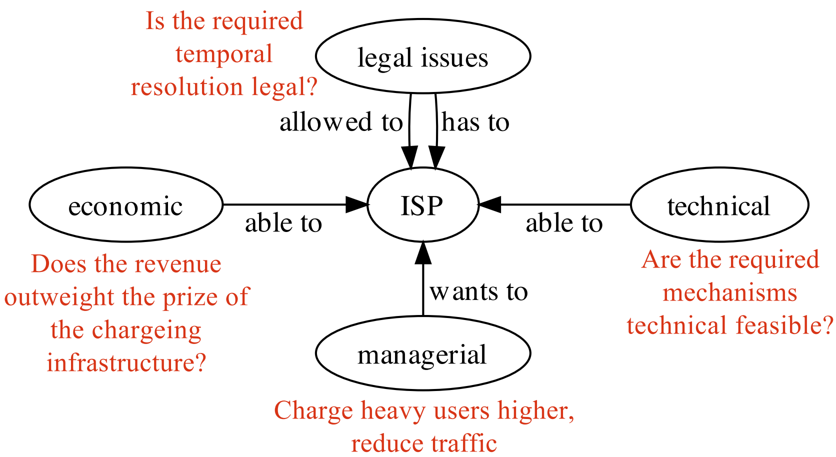

Figure 24: Volume-based charging Drawn to the Assessment Framework

8 Summary, Conclusions, and Next Steps

SESERV's WP2 supports and coordinates the economic dimension of the socio-economic field under the incentives and high-speed Internet accounting viewpoint. Therefore, this deliverable D2.1 has described these coordination actions and results, which have been undertaken and achieved within the first SESERV project year (*cf*. Figure 25).

D2.1 has developed a consolidated overview and classification of relevant stakeholders, which cover the different parties involved in services and communications with different economic interests. Furthermore, we observe that the technologies proposed by the profiled research projects increasingly blur the distinction across stakeholders and, at the same time, promote collaboration across different stakeholders resulting in more complex value chains/networks. Additionally, the related analysis approach – termed tussle analysis – has been refined to enable an investigation of the process of interactions between those stakeholders that are part of the considered Internet set-up. Since those stakeholders do have economic interests that are typically adverse to each other, they vie with each other to favor their particular interests.

Thus, the core of this deliverable is the development of the tussle analysis itself and the analysis of Challenge 1 research projects with respect to socio-economic issues, in order to obtain a structured and broad overview of socio-economic dimensions. For this purpose, sixteen socio-economic key aspects of the Future Internet have been carefully assembled in collaboration with SESERV's WP3 and then ranked for 92 survey respondents with respect to relevance to their project. It turns out that Cloud computing receives the highest interest, followed by Privacy and data protection, Security of communications, Internet of things, and Online identity in that order. Furthermore, the results indicate that those dimensions covered reflect the range of European research projects and their diverse scopes well.

The tussle analysis introduced in this deliverable allows for an investigation of target projects in detail. After evaluating the questionnaire and answers by the project, stakeholders affected by the developed technology and tussles among these are identified. The methodology is applied to 16 projects and the respective results are described in form of project profiles that also include their socio-economic priorities, focused and illustrated in form of a spider graph allowing for a direct comparison to other projects. These numerous profiles enable improved project coordination, a deep understanding of socio-economic interactions in the Future Internet, and an evaluation and improvement of the tussle analysis. For example, we identify that several projects study interactions between stakeholders that can be categorized into a limited number of groups, such as network security, controlling content/service delivery and responsibility for agreement violation, among others. Furthermore, the tussle analysis method offers projects a structured approach to identify, communicate, and address socio-economic aspects of their research and the relevant impact of their developed solutions, the sustainability of their adoption *etc.* However, for a small number of projects, mainly those addressing accidental threats to network operations, *e.g.,* disastrous events, a tussle analysis may not be applicable.

The FISE Map introduced in this deliverable allows to illustrate the interactions of stakeholders with respect to encountered tussles for profiled projects. For a project profile tussles are visualized by drawing shapes on this map, that initially only shows meta-stakeholders; a shape covers exactly those stakeholders, which are involved in a certain tussle. In this way, profile results can be clearly structured and, by using meta-stakeholders as pivots, tussle profiles of different profiles can be compared.

Finally, those standardization activities undertaken within the ITU Study Group 13 (SG13) on "Future Networks Including Mobile and Next Generation Networks (NGN)" have integrated the input of WP2 into the new ITU-T recommendation Y.3001. This did especially cover the inclusion of the tussle concept in Y.3001 and the proposal made to cover the tussle analysis method as a potential method to investigate different stakeholders' interests within future networks.

In terms of the overall terminology developed in SESERV and introduced in this deliverable, the technical feasibility of high-speed accounting will play a decisive role how several stakeholders in the Future Internet will interact, as high-speed accounting provides facts as a quantifiable basis on network data to analyze, judge, and even regulate a considerable number of tussles. Accordingly, selected contents of a white paper in progress depict the key set of socio-economic dimensions of high-speed accounting in the Future Internet. Socio-economic demand-drivers for high-speed accounting are contrasted to its managerial and technical feasibility. In addition, since the socio-economic demand for high-speed accounting often exceeds its technical feasibility – a trend that will grow worse in the future –, two frameworks are proposed to assess socio-economic demand drivers of high-speed accounting. In particular, an assessment framework is introduced to analyze stress fields from an ISP's perspective in terms of what an ISP may, shall, can, or must account in order to document the resource and service usage of its customers correctly.

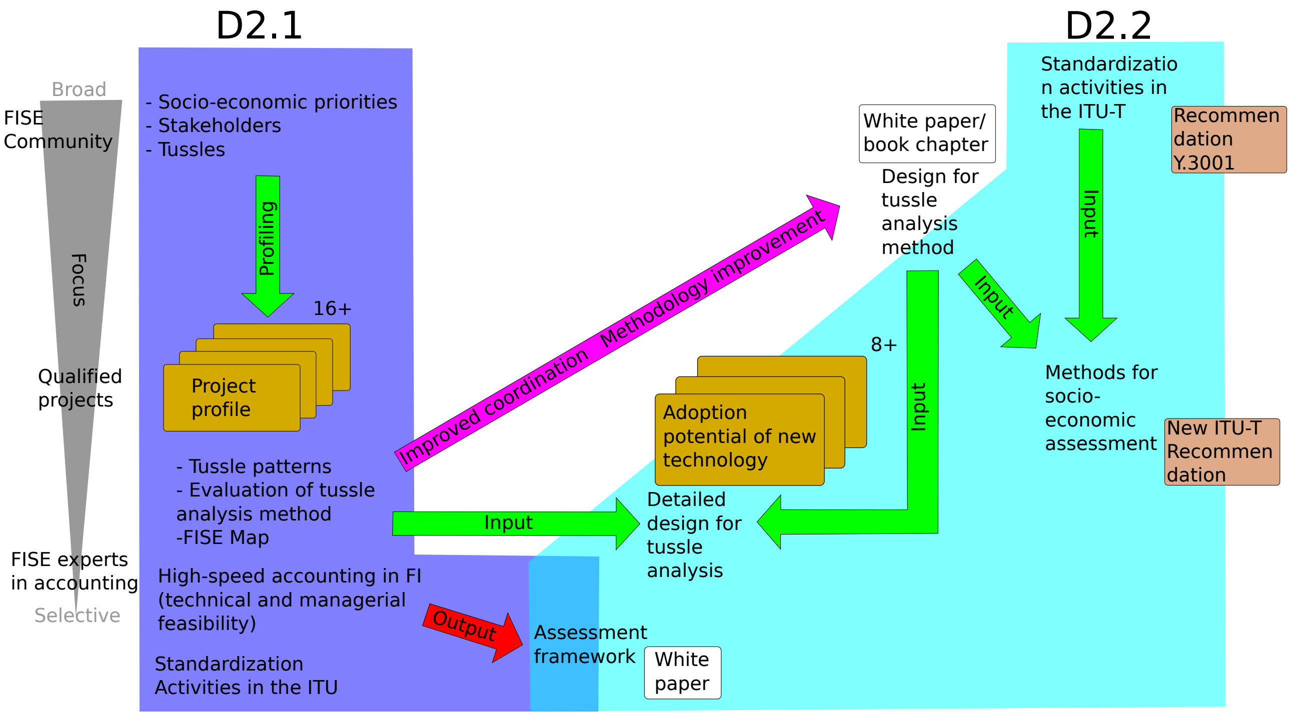

Figure 25: Progress Made and Planned for in WP2

In conclusion, the first project year of SESERV's WP2 has achieved methodologies and results to promote understanding about other projects' socio-economic facets, depth, or even relevance, and has also supported a number of projects in this direction. Accordingly, the deliverable at hand and the respective results will be communicated to the involved projects which will thereby receive a valuable SESERV feedback to their work, enabling them to categorize, analyze, or even re-think solution approaches they favor. Their potential feedback will be taken into consideration in upcoming work in SESERV and especially WP2. Deliverable D2.2 will see the received feedback from the addressed community documented and implemented. Thus, WP2 work in the first project year of SESERV is leading to the intended, planned for, and successful coordination of economic aspects in Challenge 1 projects. This work will be continued in the second (and final) project year, during which interaction with interested projects will be intensified and relevant analysis will go into further detail and depth, leading also to the necessary refinements of the methodologies developed and applied. In particular, the consolidated analysis of key stakeholders in the FI ecosystem already started in D2.1 will see an in-depth study in D2.2. Similarly, the detailed 'design for tussle' assessment of a smaller number of projects and their tussles is planned for D2.2.

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10 Abbreviations

3GPP	3rd Generation Partnership Project
AAA	Authentication, Authorization, Accounting
BGP	Border Gateway Protocol
BONFIRE	Building service testbeds on FIRE
C2POWER	Cognitive Radio and Cooperative Strategies for POWER saving in multi-standard wireless devices
CC	Content Creator
CDN	Content Distribution Network
ConEx	Congestion Exposure
CHANGE	Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions
CloNe	Cloud Networking
CLOUD4SOA	A Cloud Interoperability Framework and Platform for User-centric, semantically-enhanced Service-oriented Applications Design, Deployment and Distributed Execution
CO	Content Owner
DNS	Domain Name System
DoS	Denial of Service (Attack)
DPI	Deep Packet Inspection
DynDNS	Dynamic Domain Name System
ETICS	Economics and technologies for inter-carrier services
ETM	Economic Traffic Management
FIRE	Future Internet Research Experimentation
FISE	Future Internet Socio-economics
IaaS	Infrastructure as a Service
IAP	Internet Access Provider
IBP	Internet Backbone Provider
ICT	Information and Communication Technology
IoP	ISP-owned Peer
IP	Internet Protocol
IPR	Intellectual property right
ITU	International Telecommunication Union
ITU-T	International Organization for Standardization - Telecommunications Sector
ISP	Internet Service Provider

MPTCP	Multi-Path Transmission Control Protocol
NAT	Network Address Translation
NAP	Network Access Point
NetInf	Network of Information
NGN	Next Generation Network
NGN-GSI	Next Generation Networks Global Standards Initiative
NSP	Network Service Provider
OConS	Open Connectivity Services
OPTIMIS	Optimized Infrastructure Services
P2P-NEXT	Next generation peer-to-peer content delivery platform
PURSUIT	Publish Subscribe Internet Technology
RaaS	Routing as a Service
RESERVOIR	Resources and services virtualisation without barriers
RESUMENET	Resilience and survivability for future networking: framework, mechanisms, and experimental evaluation
RP	Rendezvous Point
SaaS	Software as a Service
SAIL	Scalable & Adaptive Internet soLutions
SE	Socio-Economic
SG	Study Group
SLA	Service Level Agreement
SMOOTHIT	Simple economic management approaches of overlay traffic in heterogeneous Internet topologies
STREP	Specific Targeted Research Project
TCP	Transmission Control Protocol
STRONGEST	Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport
TRILOGY	Re-Architecting the Internet. An Hourglass Control Architecture for the Internet, Supporting Extremes of Commercial, Social and Technical Control
ULOOP	User-centric Wireless Local Loop Project
UNIVERSELF	Realizing autonomics for Future Networks
VoIP	Voice over IP
WASP	Wireless Access Service Provider
QoS	Quality of Service

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Annex A ICT Tussles Questionnaire

Please have a look at the paper attached, which shows a part of the initial approach of SESERV project with respect to the socio-economics point of view of ICT and its socio-economics analysis. Comment on that one with a sort of formal <PROJECT> reply to the following questions about existing, realistic tussles in the context of the <PROJECT>. See Section 1 ("Introduction") for an explanation of the term tussle and references therein. Please send feedback for the following aspects:

a) Tell SESERV, which tussle patterns – contention, repurposing, responsibility, and control (cf. Section 3.1 and examples given in Section 3.2 and Section 3.3) – <PROJECT> is analyzing, interested in, or does know of. Please add for each tussle pattern spotted a short description of the tussle and a short list of stakeholders involved (cf. Section 4).

b) Tell SESERV, if such an analysis methodology (cf. Section 2) will be applicable within <PROJECT>.

c) If yes,

(1) what are the benefits <PROJECT> may see

(2) do you see potential tussle spill-overs from the determined tussles (and which ones)

If no,

(3) why is there no <PROJECT>-specific output supported or strengthened with such an approach

(4) did you apply a different methodology or plan to do so in the near future

(5) any other explicit reason, which may apply

d) Provide references of <PROJECT> publications performing socio-economics analysis

e) In case of any other issues you may consider in this context of being important, please let us know.

Your feedback will be valuable in compiling a profile of FP7 projects with respect to socio-economic challenges addressed (see attached case study for the SmoothIT project). Finally, since we are in the process of settling the social analyzing methodology for respective facets of FP7 projects, we may get back to you with such type of questions to come.

Annex B Tussle Analysis

B.1 A Case Study

Figure 26 shows the tussle evolution due to instability and externalities when using TCP for sharing the bandwidth on a common link. Stakeholders appear on the left of each rectangle, while the positioning of an outcome denotes whether it considered fair or not. For this reason we assume that a neutral stakeholder exists, placed near the middle of each rectangle, and we use a white background colour to denote this.

When TCP (Transmission Control Protocol) was proposed in the early 80s, it was assumed that hosts would initiate a single connection for each session. The algorithm suggested for controlling how instantaneous bandwidth is being shared can be considered fair in the sense that if k connections are instantaneously active in a bottleneck link, then each of them would take 1/k of the bandwidth.

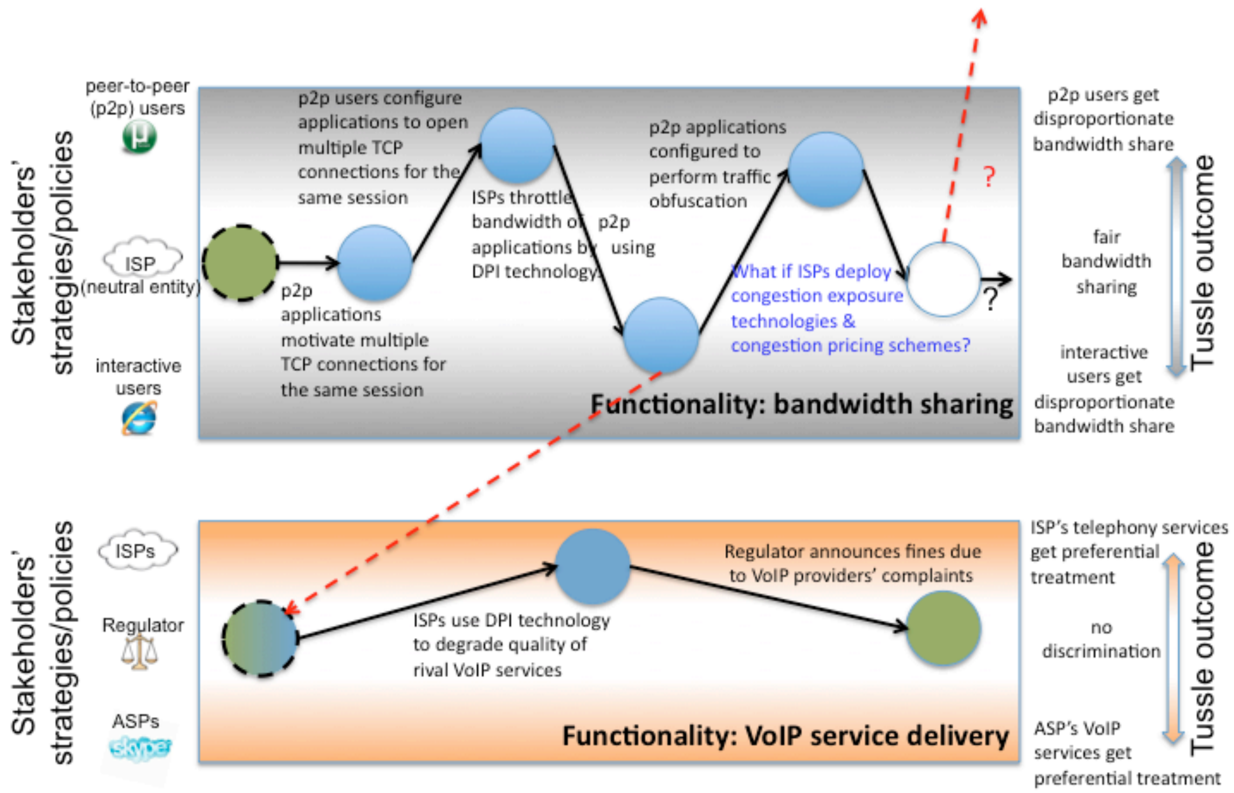

Figure 26: Tussle Evolution due to Instability and Externalities for the Bandwidth Sharing Case Study

But this outcome cannot be considered stable anymore, due to the introduction of peer-to-peer applications for file sharing. Users of such applications (called Heavy users) can open multiple TCP connections for the same file and get disproportionate bandwidth share in relation to traditional users (called interactive).

This new outcome cannot be considered stable either, since the ISPs' ability to offer other services was threatened by the great increase of peer-to-peer traffic. ISPs responded by introducing middleboxes for inspecting data packets. These dedicated machines use advanced technology (Deep Packet Inspection techniques) in order to identify and throttle peer-to-peer traffic.

Even though this new bandwidth allocation outcome can be considered fair, it is not stable either. Peer-to-peer applications started performing traffic obfuscation, *e.g.,* by encryption, in order to decrease downloading time.

At the same time, DPI technology allowed ISPs to identify traffic that directly competes with complementary services they offer. A famous example has been an ISP's attempt to degrade quality of third-party VoIP services that threatened traditional telephony services often offered by an affiliate of the ISP. This is an example of a spillover to another functionality, which was solved by affected users asking the Regulator to intervene for discouraging anti-competitive tactics. The "VoIP service delivery" functionality was assumed to start and finally reach a stable outcome in order to keep the complexity as low as possible. In reality the situation can be more complicated.[8]

Tussle analysis aims to understand the impact that a newly deployed technology (or set of technologies) would have:

a. on the stability of the tussle outcome for that particular functionality,
b. on the stability of outcomes for other functionalities (spillovers to existing or new tussles).

For example, what would happen if ISPs deployed congestion exposure technologies and congestion pricing schemes? The former technology (for example ConEx[9]) would inform all parties along the path about the congestion that a packet would experience/cause. The latter technology would charge users based on the congestion they cause. Would the deployment of this technology set:

a. lead to a stable outcome regarding the bandwidth sharing functionality?
b. create spillovers to other functionalities (*e.g.,* routing)?

More research may be necessary to provide solid answers to those questions, but a qualitative analysis of the anticipated tussle outcomes will give useful feedback to those who design and develop Internet technologies. For example, slightly adjusting the algorithmic content of the targeted technology at design-time could prevent such unstable periods.

B.2 A Questionnaire for Interacting with Challenge 1 Projects

If any of the conditions above does not hold we need to examine the specific tussle in some detail to establish what might be done to restore equilibrium between the stakeholders involved. Technologies proposed by research projects should be assessed in this respect and designed to be stable accordingly. SESERV prepared a questionnaire for collecting the views of several FP7 projects on the research issues being tackled and the associated tussles (if those exist in the project's context) in order to encourage the tussle analysis. The questionnaire is provided in the Annex A.

[8] The Internet Architecture Board (IAB) has examined a famous tussle surrounding the configuration of DNS Servers to respond for non-existing web-pages [10].

[9] http://tools.ietf.org/html/draft-ietf-conex-abstract-mech-02

A second questionnaire has been prepared for acting as a guide in performing the tussle analysis, consisting of the following questions:

[Q1] **Understand stakeholders' interests in current ecosystem**: Translating Figure 1 into your context, which functionality/functionalities does your proposed technology performs and what are the interests of the main stakeholders?

[Q2] **Understand stakeholders' interests in new ecosystem**: Repeat all steps of Q1, if **your** technology is deployed.

[Q3] **Identify policies in current ecosystem:** Using Figure 9 for the desired functionality, can you identify the most probable policies of each main stakeholder enabled by *existing* technologies (if your technology is not deployed)?

[Q4] **Identify policies in new ecosystem:** Repeat all steps of Q3, if *your* technology is deployed.

[Q5] **Assess current ecosystem**: Translating Figure 10 into your context, can you foresee the stability of *existing* tussle outcome and potential spillovers to other functionalities, if your technology is not deployed? What about expected efficiency?

[Q6] **Assess new ecosystem**: Repeat all steps of Q5, if *your* technology is deployed.

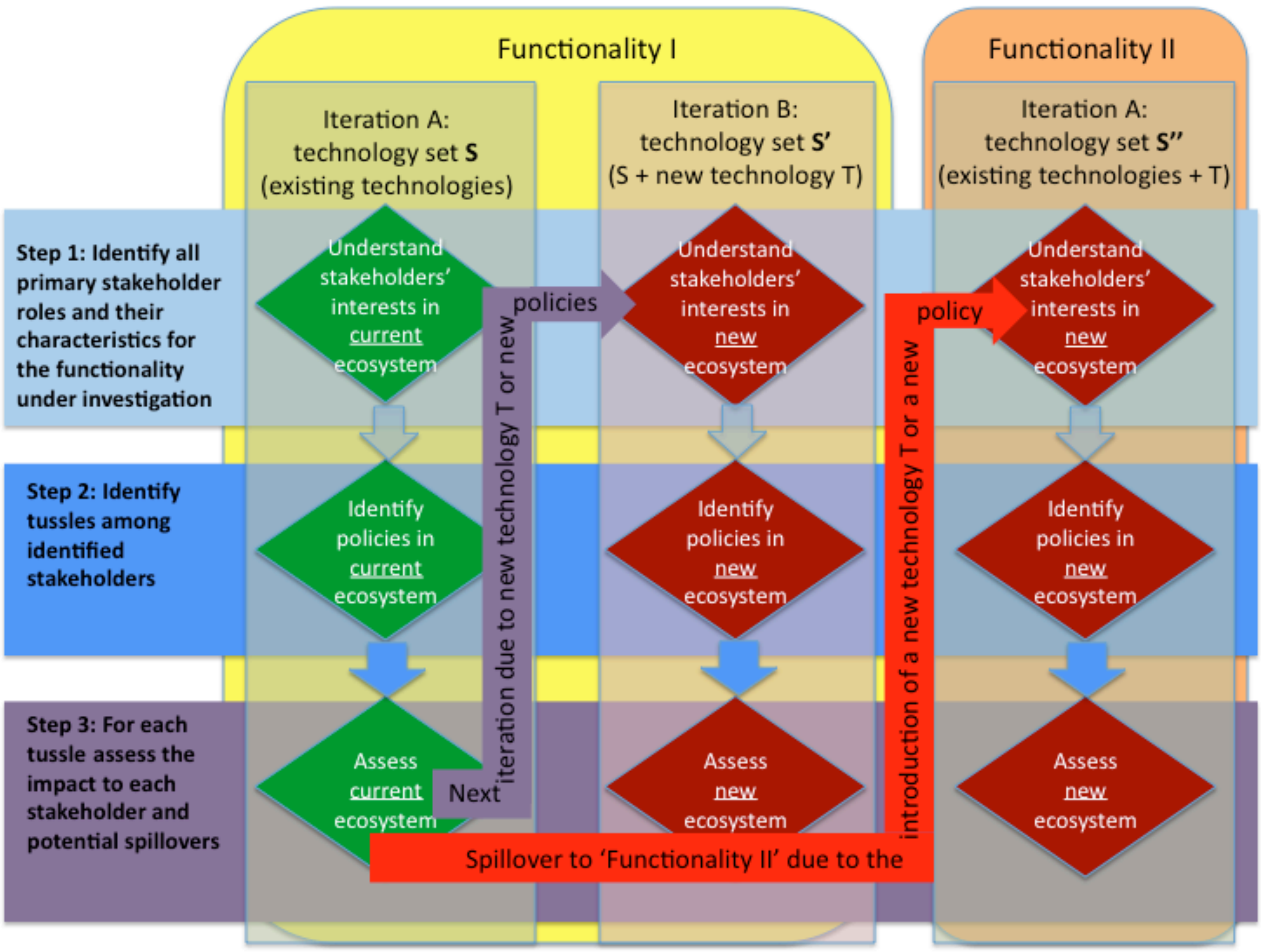

Figure 27: Mapping the Second Questionnaire to Tussle Analysis Methodology

Figure 27 gives a combined view of the tussle analysis methodology and the questions asked. Each question is depicted as a diamond while the colour determines whether that task refers to the present situation or a future ecosystem. Initially we apply the methodology for Functionality I, based on the responses to the relevant questions, for a technology set S that covers existing technologies. The following possibilities apply with respect to how the analysis will proceed:

- If some stakeholders do not consider the tussle outcome fair, then we have to perform another iteration after the introduction of the proposed technology (technology set S').
- If some stakeholders consider unfair the tussle outcome of Functionality II due to a spillover, then we have to perform an iteration for the technology set S'', which includes the initial technology set and the proposed technology.

B.3 The "Design for Tussle" Goal

Ideally a new technology should lead to a stable outcome without spillovers to other functionalities. In case where no such improvement takes place, the technology designer should examine whether a change in the implementation details would lead to a better outcome.

Clark et al. [6] suggested that Internet technologies should be designed for allowing variation in outcome and do not impose a particular outcome. The rationale behind the "Design for Tussle" goal is that Internet is a rather unpredictable system and it is very difficult to assess whether a particular outcome will remain desirable in the future.

The tussle analysis methodology described previously helps in designing protocols that are designed for tussle. A technology being designed for tussle, such as an Internet communication protocol, should:

- lead to a stable outcome by allowing all involved stakeholders to express their interests and affect the outcome ("Design for Choice" Principle).
- avoid spillovers to other functionalities ("Modularize along the tussle boundaries" Principle).

The "Design for choice" principle provides guidance in designing protocols that allow for variation in outcome. Useful properties are:

- "Exposure of list of choices" suggesting that the stakeholders involved must be given the opportunity to express multiple alternative choices and which the other party should also consider.
- "Exchange of valuation" suggesting that the stakeholders involved should communicate their preferences in regard to the available set of choices (for instance by ranking them in descending order).
- "Exposure of choice's impact" suggesting that the stakeholders involved should appreciate what the effects of their choices are on others.
- "Visibility of choices made" suggesting that both the agent and the principal of an action must allow the inference of which of the available choices has been selected.

The "Modularize the design along tussle boundaries" principle helps in identifying whether tussle spillovers can appear. A protocol designer can check any of the following two conditions:

- "Stakeholder separation", or whether the choices of one stakeholder group have significant side effects on stakeholders of another functionality (another tussle space), for example creates economic externalities between stakeholders of different tussle spaces.
- "Functional separation", or whether different stakeholders use some functionality of the given technology in an unforeseen way to achieve a different goal in some other tussle space, *i.e.*, the functionality of technology A interferes (and possibly cancels) with functionality of technology B.

B.4 Relation to Other Approaches

We have already seen the objectives, rationale and steps of tussle analysis. We can summarize our definition thereof as follows: Tussle analysis is a more complete analysis of the ecosystem where we analyse all potential conflicts and their interactions. It defines a framework, which together with the "Design for Tussle" principles introduced in [6], can be used for designing Internet technologies that balance technical and socio-economic objectives. The value of the analysis lies in providing some guidelines (principles) for identifying which aspects of the technology under test are responsible for poor tussle outcomes.

Table 2 provides a comparison of several approaches that can be employed in modelling of systems with interacting stakeholders, including value network analysis, risk analysis and assessment, and game theory. In particular:

- Value network analysis is a methodology for understanding and depicting actor relationships as well as the processes that take place in dynamic and complex economic ecosystems in order to help identify what roles and interactions are needed to improve the overall effectiveness.
- Risk analysis is a method for identifying candidate factors that can have a negative effect on a system and quantitatively or qualitatively evaluate those effects in order to take precautions.
- Game theory is a mathematical tool for finding and evaluating the possible equilibrium outcomes of a specific scenario in a system with rational participants.

Table 2: Comparison of Tussle Analysis to other Approaches for System Modelling

	Value Networks	**Risk Analysis & Assessment**	**Game Theory**	**Tussle Analysis**
Purpose	Understand business opportunities in value creation due to technology	Understand vulnerabilities and effectiveness of countermeasures	Understand outcomes of multi-party interactions	Understand technology bottlenecks in dealing with conflicts of interest
Type of	Empirical	Empirical	Theoretical	Empirical

results	assessment of opportunities	assessment of risks and countermeasures	assessment of interactions	assessment of interactions
Interests captured	Competition for market share, Expansion to other/new markets	Threats from competitors (intended) & random events (unintended)	Any	Any
Actors' space	Very detailed (many actors including their interactions)	Very detailed (many actors including their interactions)	Limited to main actors due to complexity	Very detailed (many actors including their interactions)
Point-of-view	Effects on single actor	Effects on single actor	Effects on multiple actors	Effects on multiple actors
Evolution over time	Limited (a snapshot is examined, possible chained reactions are not explicitly described)	Limited (a snapshot is examined, possible chained reactions are not explicitly described)	Multiple rounds of actions are possible	Multiple rounds of actions are possible
Interesting to	Providers	Providers, Policy makers	Policy makers, Providers	Policy makers, Providers, Vendors
Complexity	Low	Low	High	High

We should emphasize that besides being more holistic and complete, tussle analysis is oriented to the impact of technologies, which is not necessarily the case with the other approaches.

Annex C Socio-economic Project Profiles

Driven by the three areas of interest as explained in the previous methodology section (socio-economic priorities, stakeholders, and tussles), the following Challenge 1 projects have been selected for coordination by means of socio-economic profiling:

- BONFIRE: Building service testbeds on FIRE
- C2POWER: Cognitive Radio and Cooperative Strategies for POWER saving in multi-standard wireless devices
- CHANGE: Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions
- CLOUD4SOA: A Cloud Interoperability Framework and Platform for User-centric, semantically-enhanced Service-oriented Applications Design, Deployment and Distributed Execution
- ETICS: Economics and technologies for inter-carrier services
- OPTIMIS: Optimized Infrastructure Services
- P2P-NEXT: Next generation peer-to-peer content delivery platform
- PURSUIT: Publish Subscribe Internet Technology
- RESERVOIR: Resources and services virtualization without barriers
- RESUMENET: Resilience and survivability for future networking: framework, mechanisms, and experimental evaluation
- SAIL: Scalable & Adaptive Internet solutions
- SMOOTHIT: Simple economic management approaches of overlay traffic in heterogeneous Internet topologies
- STRONGEST: Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport
- TRILOGY: Re-Architecting the Internet. An Hourglass Control Architecture for the Internet, Supporting Extremes of Commercial, Social and Technical Control
- ULOOP: User-centric Wireless Local Loop Project
- UNIVERSELF: Realizing autonomics for Future Networks

These projects cover several thematic areas. For each of the above listed Challenge 1 projects, a socio-economic profile is compiled as fully documented in this annex.

C.1 Socio-economic Profile for BONFIRE

- Project acronym: **BonFIRE**
- Project name: **Building service testbeds for Future Internet Research and Experimentation**
- Duration: From 2010-06-01 to 2013-10-31

- CORDIS information: http://cordis.europa.eu/fp7/ict/fire/docs/fp7-factsheets/bonfire_en.pdf
- Project website: http://www.bonfire-project.eu/project

C.1.1 Project Focus and Relevance to SESERV

The BonFIRE (Building service testbeds for Future Internet Research and Experimentation) Project will design, build and operate a multi-site cloud facility to support applications, services and systems research targeting the Internet of Services community within the Future Internet. The BonFIRE Project aims to give researchers access to an experimental facility, which enables large-scale experimentation of their systems and applications, the evaluation of cross-cutting effects of converged service and network infrastructures and the assessment of socio-economic and other non-technological impact.

The main relevance of the project to SESERV is in its tussles between testbed providers, and experimenters wishing to gain access to testbed resources. The project will look at socioeconomic issues as part of the experimentation cycle. This includes both analysis of SE factors within the experiments, factors (such as tussles) between the provider and the experimenter, and potentially also future experiments using the infrastructure to investigate a SE hypothesis.

C.1.2 Socio-economic Priorities for BonFIRE

When comparing BonFIRE socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, the project is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 28):

- Cloud computing
- Security of communication
- Online identity,
- Distributed knowledge production

These priorities are a consequence of the focus of the project, which seeks to offer a cloud computing testbed to users – brokering between providers to allow consumers to tailor their testing site according to requirements. The project is therefore focused on economic issues associated with lowering the cost of researching and developing new service technologies through the cloud computing paradigm. The socio-economic themes themselves largely focus on societal aspects of the Future Internet rather than economic challenges. In general there is lower than average relevance to socioeconomic themes, particularly around social inclusion, digital citizenship and e-democracy, as the project is dealing with B2B relationships rather than B2C where there are large numbers of public users. However, the cloud is as much about business models as it is about technology, so many of the economic challenges and tussles can be discussed within this theme. It is expected that by providing a general purpose testing facility for European researchers, BonFIRE will achieve greater efficiency, reduce replication of efforts and investment within the research ecosystem.

C.1.3 BonFIRE Stakeholders

The primary set of stakeholders in this project is based on includes:

- Testbed providers who offer computation, storage and networking under a federated testbed infrastructure as a service model. Such entities are termed Cloud Operators (members of the Infrastructure Provider meta-stakeholder) in our ontology of Section 3.2.
- Experimenters that access testbed resources in order to carry out tests, and retrieve system information regarding the results of that test. Such customers can be instances of the Information Provider meta-stakeholder and in more extreme cases Connectivity Providers, Users and Technology Makers.
- Brokers, who provide added value services as intermediary organisations (under the Information Provider meta-stakeholder) supporting a market of testbed providers and experimenters

C.1.4 BonFIRE Tussles

On-demand allocation vs. In-advance allocation for elasticity experiments (Experimenter vs. Testbed Provider)

There is inherent contention in the facility due to the demand on limited resources by the experimenters. For certain experiments to be viable, they require a highly scalable and elastic infrastructure. In certain experiment set-ups, in order to not bias the experiment these cannot be reserved in advance – the resources must be called up on demand. In order to explore the limits of the applications within the virtual machines of an experiment, it may be necessary to stress the system to the point of failure. As resources are finite, there is contention over these and it is necessary to carefully coordinate the running of experiments so that one experiment does not affect another.

The tussle scenario results from BonFIRE's elasticity functionality, as described in the table below:

Table 3: Tussle between On-demand Allocation vs. In-advance Allocation for Elasticity Experiments

Tussle state	**Stakeholder Action**
On demand testbed resources	Experimenter: requests huge capacity in advance to ensure sufficient resource for elasticity tests
Denial of service for most users and under-utilised resources	Testbed provider: limits resources that can be allocated in advance
Experiments fail due to insufficient resources and under-utilised resources	Experimenter: immediately grabs extra resources after the experiment execution starts
Denial of service for most users, some experiments fail and under-utilised resources	Testbed provider: introduces a charging mechanism for on demand and elastic resources
BonFIRE prices increase to a point they are uncompetitive in relation to commercial offerings.	The facility fails

The tussle outcome can have significant consequences when there is scarcity. The cloud paradigm allows developers to assume that capacity will be available on-demand and hence the emergence of elasticity functionality. Commercial cloud computing can support the situation where scale is not known in advance because providers have capacity, the ability to dynamically scale and a pay-per-use model to monetise the process.

BonFIRE cannot support this case because of limited resources. The consequence is that an accurate estimate of resources is needed in advance. This requires greater attention on how resources are allocated and is a potential cost to experiments. Another concern is that if there are no charges for resource usage, experimenters will always request as much resource as they can, not worrying about the accuracy of their estimates. If no estimate for elasticity requirements is provided in advance there can be no guarantees that an experiment will complete successfully.

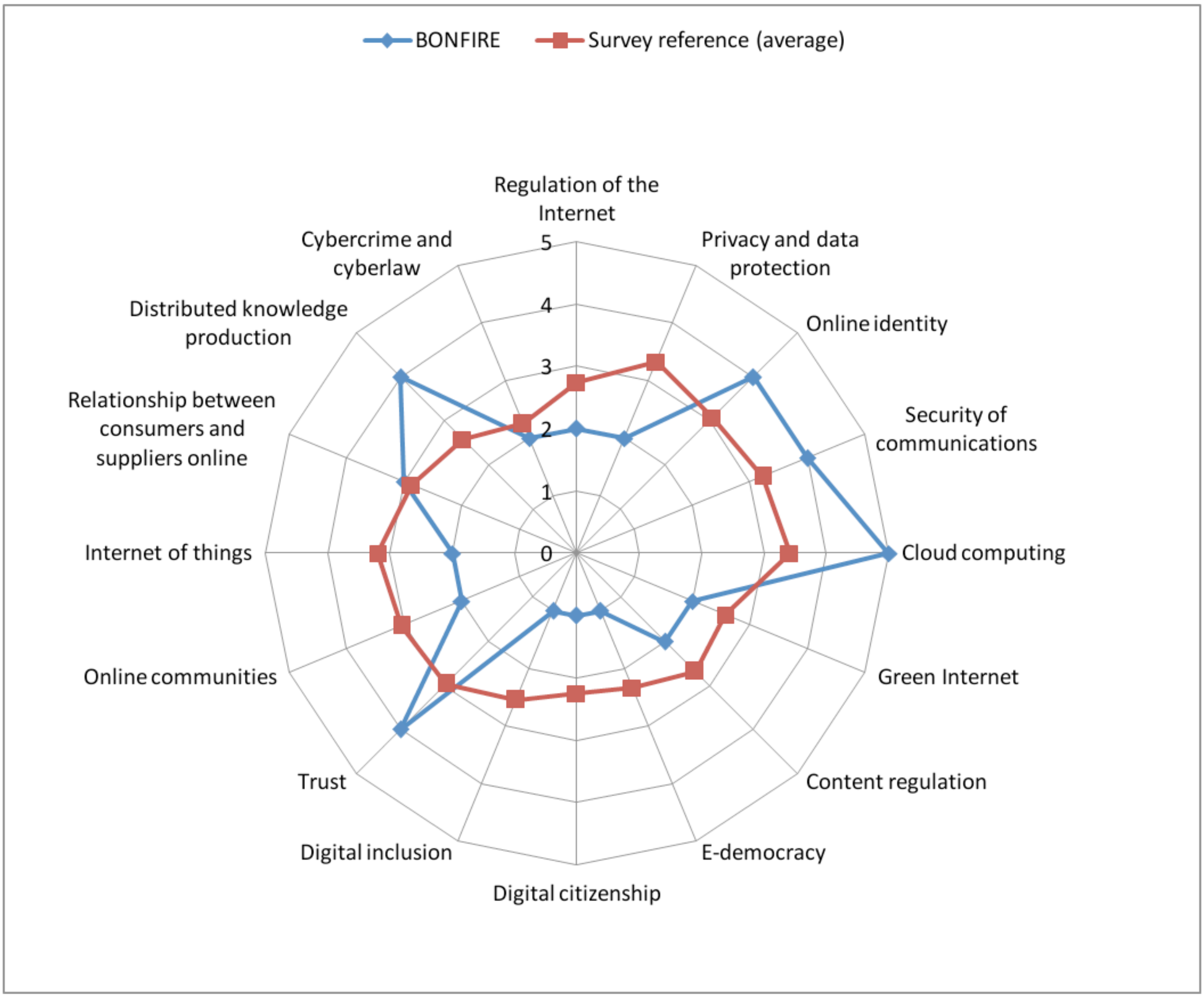

Figure 28: Socio-economic Profile for BonFIRE in Comparison with Survey Reference

If the BonFIRE facility is highly utilised then the likelihood of an elasticity experiment without advanced allocations completing successfully will be low. Even if a testbed provider introduces a charging scheme for on-demand and elastic resource usage to incentivise accurate resource estimates and competition the tussle will not be resolved. There is no getting away from the fact that BonFIRE cannot provide infinite elasticity without sufficient on-demand capacity. Charging for resources will ensure experimenters ask for what they need but it will only increase the likelihood of experiment success and will not guarantee it because the capacity limits will be hit at some point. There is also a limit on price as determination is based on supply not only by BonFIRE but also in the wider commercial cloud market where resources are cheap and not scarce. If the price is too high then experimenters will seek alternatives to BonFIRE.

The only sensible solution for BonFIRE is to ensure that experimenters bound their elasticity experiments…

Experiment control vs. business flexibility (Experimenter vs. testbed provider)

A testbed provider wants to control resources allocated to experimenters in a way that maximises their utilisation. High utilisation of compute, storage and networking resources is a desirable and efficient state for a testbed provider and reduces per experiment cost. Virtualisation is a key technology to increase utilisation of resources by sharing physical hosts between processes but typically this is achieved through policies not controllable by an experimenter.

An experimenter typically wants to create controlled conditions for tests minimising the impact of extraneous variables. This is a challenge for virtualised infrastructures that often allow multiple processes, *i.e.*, multiple experiments, to run on the same physical host. For some types of experiments, *e.g.,* performance tests, such interference between processes would be unacceptable. There are also experiments that need to control physical, virtual and application resources to fully understand the behaviour of a system.

So the tussle is to strike the balance between the experimenter who wants control of everything to increase confidence in measurements and reproducibility, and the service provider who wants to maximise utilisation of resources and deliver a profitable services business. The tussle scenario is described in the table below.

Table 4: Tussle between Experiment Control vs. Business Flexibility

Tussle state	**Stakeholder Action**
On-demand virtualised infrastructure resources (cloud model)	Experimenter: continues to deploy their own solution to control physical resources to ensure predictability and understanding of system
Limited take-up of the facility	Testbed Provider: supports controllable physical and virtualised infrastructure
Increased take-up but low utilisation of resources (hosts are not shared between experiments through virtualisation) and increased cost of experiments	Testbed Provider: implementation of QoS guarantees for virtualised infrastructure such as temporal isolation between processes in virtualised compute resources, *e.g.,* IRMOS

Experiment repeatability vs. business flexibility (Experimenter/Broker)

There is a tussle inherent in any brokerage service in relation to selection of upstream testbed providers. In some models, *e.g.,* a supply chain, a broker can encapsulate their provider choices, selecting the “best” provider according to their business objectives and some experiment requirements. Encapsulating suppliers allows the broker to maintain and control (lock-in) the relationship with the experimenter. With other models the Broker just acts as a matchmaker allowing for an experimenter to control which providers are selected but these are more difficult to monetise. The cloud computing paradigm promotes the message that consumers don't care where the processing is done which provides greater flexibility for brokers in their operations

In the case of BonFIRE, an experimenter requires BonFIRE to provide the resources as specified in the experiment design and in most cases to know the exact operational conditions for confidence in results and repeatability of experiments. Failure to meet these requirements could not only invalidate the experimental results but makes repeated experiments under different controlled conditions impossible. The broker however has an incentive to reduce costs (also good for the experimenter if other requirements are met) and to maximise the number of experiments in parallel. Brokers don't want constraints on which suppliers to use and don't want to reveal how they provision resources. However, given that invalidating experimental results through such means may be highly detrimental to BonFIRE in the long-term, such practice is unlikely to occur in reality unless the costs rise sufficiently to make a Brokering service unviable.

Table 5: Tussle between Experiment Repeatability vs. Business Flexibility

Tussle state	**Stakeholder Action**
BonFIRE brokering service (with encapsulated provisioning)	Experimenter: withdraws from ecosystem as experiments run with low levels of confidence and reproducibility
Low usage of the BonFIRE facility	Broker: allows experimenters to select providers
Increased usage but reduced viability of the broker	Broker: withdraws from the ecosystem
European BonFIRE facility as envisaged is unsustainable	

Other Operational Tussles

The BonFIRE testbed has been conceived for experimentation, but what that experimentation consists of is defined, at present, more by the limitations of the testbed then by norms or regulations. A tussle may arise should an experimenter have requirements or uses of the testbed that have not been considered in advance. The testbed is composed of multiple test sites ran by distinct administrators, *e.g.,* the University of Edinburgh, HP labs, HLRS, and the provisional use of their resources has been agreed. However each administrator has their own regulations concerning the use of hardware, *e.g.,* that it is not used for commercial purposes, that it is not used for cybercrime, that individuals resident in certain countries may not access it, and so on. Should an experimenter require some use of those resources that potentially infringes those rules, a tussle will result. In the scope of the project the use of resources has been planned and authorised in advance and so this tussle has not arisen. However a future scenario with a commercial testing facility could potentially present such a situation.

C.2 Socio-economic Profile for CHANGE

- Project acronym: **CHANGE**
- Project name: **Enabling Innovation in the Internet Architecture through Flexible Flow-Processing Extensions**
- Duration: From 2010-10-01 to 2013-09-30
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=95594
- Project website: http://www.change-project.eu/

C.2.1 Project Focus and Relevance to SESERV

The CHANGE project suggests an evolutionary approach for introducing a programmable control layer at the core of the Internet, based on a flow processing architecture called Flowstream. The idea is that a general-purpose platform for controlling behaviour across network layers and players will deter the need for point solutions that can have detrimental effect on other aspects of the Internet, or be an obstacle for its future evolution. Interested parties could use such a common signalling platform to suggest, negotiate and mutually agree on the end-to-end treatment that a particular traffic will experience.

CHANGE is highly relevant to SESERV for studying the socio-economic issues arising in adoption and operation of this new platform. Such a platform can have significant impact on how suppliers and consumers of services (at any layer) can interact and consequently on the value they get by participating.

C.2.2 Socio-economic Priorities for CHANGE

When comparing CHANGE's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, CHANGE is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 29):

- Cloud computing
- Security of communications
- Regulation of the Internet
- Green Internet
- Trust
- Internet of things

C.2.3 CHANGE Stakeholders

The set of stakeholders interested in CHANGE [5] includes:

- Edge ISPs, Transit ISPs as Connectivity Providers who provide Internet connectivity services (virtualized or not), while the former ones can be further categorized to Source and Destination depending on traffic direction.

- Members of the Information Provider meta-stakeholder (Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Market Place Providers and Internet Retailers) who need Internet connectivity in order to offer their retail services.
- Members of the Infrastructure Provider meta-stakeholder who offer virtualized (or not) services to other Connectivity Providers
- A member of the User meta-stakeholder, that is an end-user acting as an individual, or a Customer on behalf of many single individuals, who buys connectivity to Internet to meet its communication needs.
- Policy makers such as Regulators and Security agencies who set competition policy or pose privacy, security constraints.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

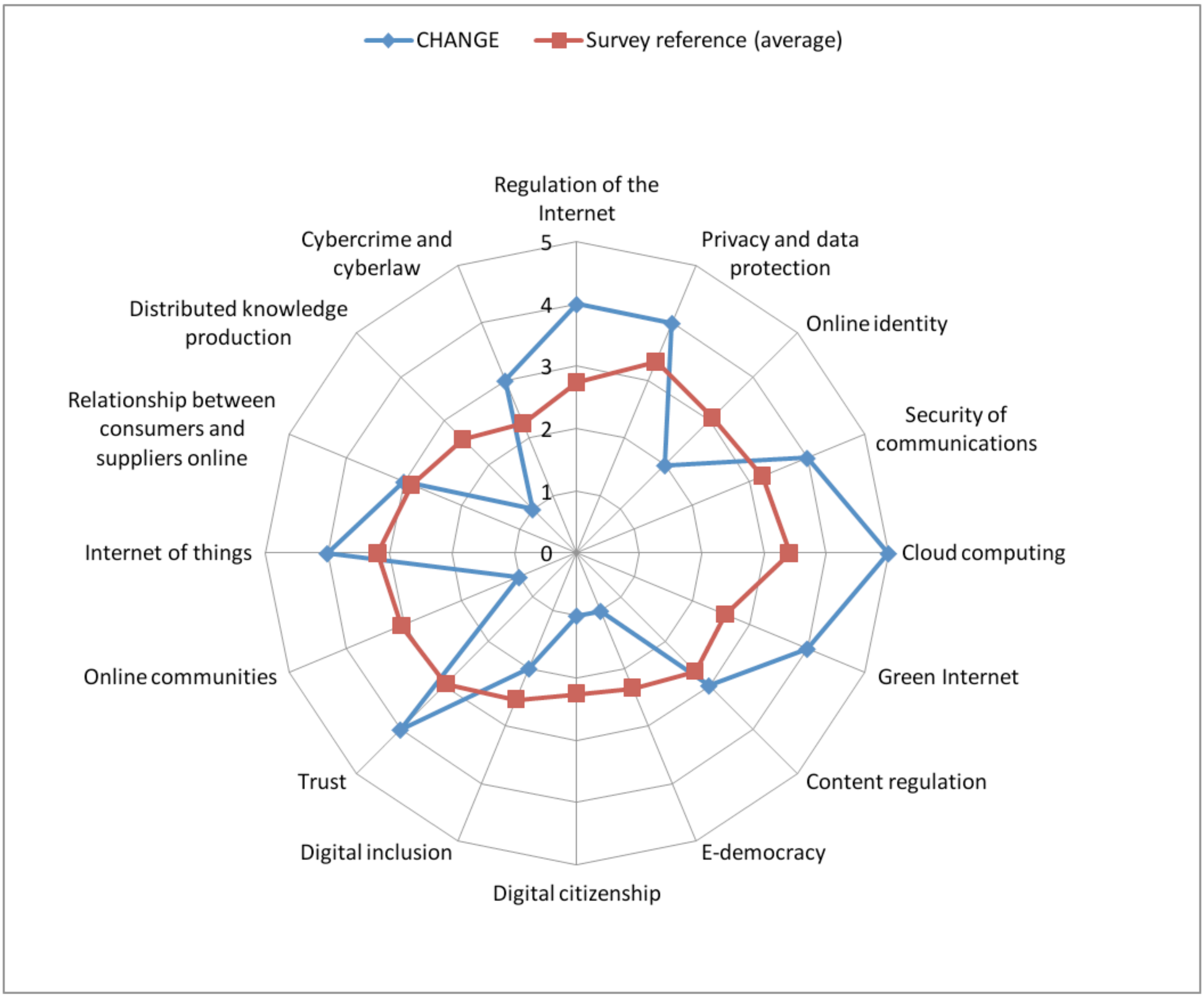

Figure 29: Socio-economic Profile for CHANGE in Comparison with Survey Reference

C.2.4 CHANGE Tussles

A tussle exists between the involved ISPs if a set of infected end-users performs a Distributed Denial of Service (DDoS) attack to a targeted end-user by sending unsolicited traffic[10]. Internet is sender-driven which means that the traffic destination has limited control over incoming traffic. Existing technologies that mitigate the effects on the receiver, such as firewalls and NAT servers, cannot avoid the waste of significant network resources. This is especially true for the Destination Edge ISP (the ISP who serves the targeted end-user) that receives all this traffic. Thus each Destination Edge ISP wants to block malicious incoming traffic at the entrance point, but the rest ISPs on the path may not have the incentive to do this at their entrance point. The reason is that a Source Edge ISP wants to forward its customers' traffic and Transit ISPs usually charge their customer ISPs based on the volume of traffic. Using the suggested flow management scheme, a Destination Edge ISP could signal back to a Source Edge ISP that a particular connection is suspicious for a DDoS attack. A Destination Edge ISP could offer an added-value service to its customers; while at the same time reduce congestion on its network and transit payments to the Transit ISP. ISPs could share the retail revenues in case this security service is offered at a fee.

C.3 Socio-economic Profile for CLOUD4SOA

- Project acronym: **CLOUD4SOA**
- Project name: **A Cloud Interoperability Framework and Platform for user-centric, semantically-enhanced service-oriented application design, deployment and distributed execution.**
- Duration: From 2010-09-01 to 2013-07-31
- CORDIS information: http://cordis.europa.eu/fp7/ict/ssai/docs/call5-soa4all.pdf

  (Note that this URL currently directs to the cloud4soa brochure but is an error, SOA4All is a different project. This URL may be changed in the future).
- Project website: http://www.cloud4soa.eu

C.3.1 Project Focus and Relevance to SESERV

Cloud4SOA focuses on resolving the semantic interoperability issues that exist in current Clouds infrastructures and on introducing a user-centric approach for applications which are built upon and deployed using Cloud resources. To this end, Cloud4SOA aims to combine three fundamental and complementary computing paradigms, namely Cloud computing, Service Oriented Architectures (SOA) and lightweight semantics. The project will propose a reference architecture and deploy fully operational prototypes.

The main relevance of the project to SESERV is in its economic tussles between platform as a service providers, brokers and users. The project does not have a specific activity analyzing socio-economic issues in the project. The exploitation team is studying economic and business motivations for the actors.

[10] This tussle may be considered an instance of the more general case for controlling incoming traffic.

C.3.2 Socio-economic Priorities for CLOUD4SOA

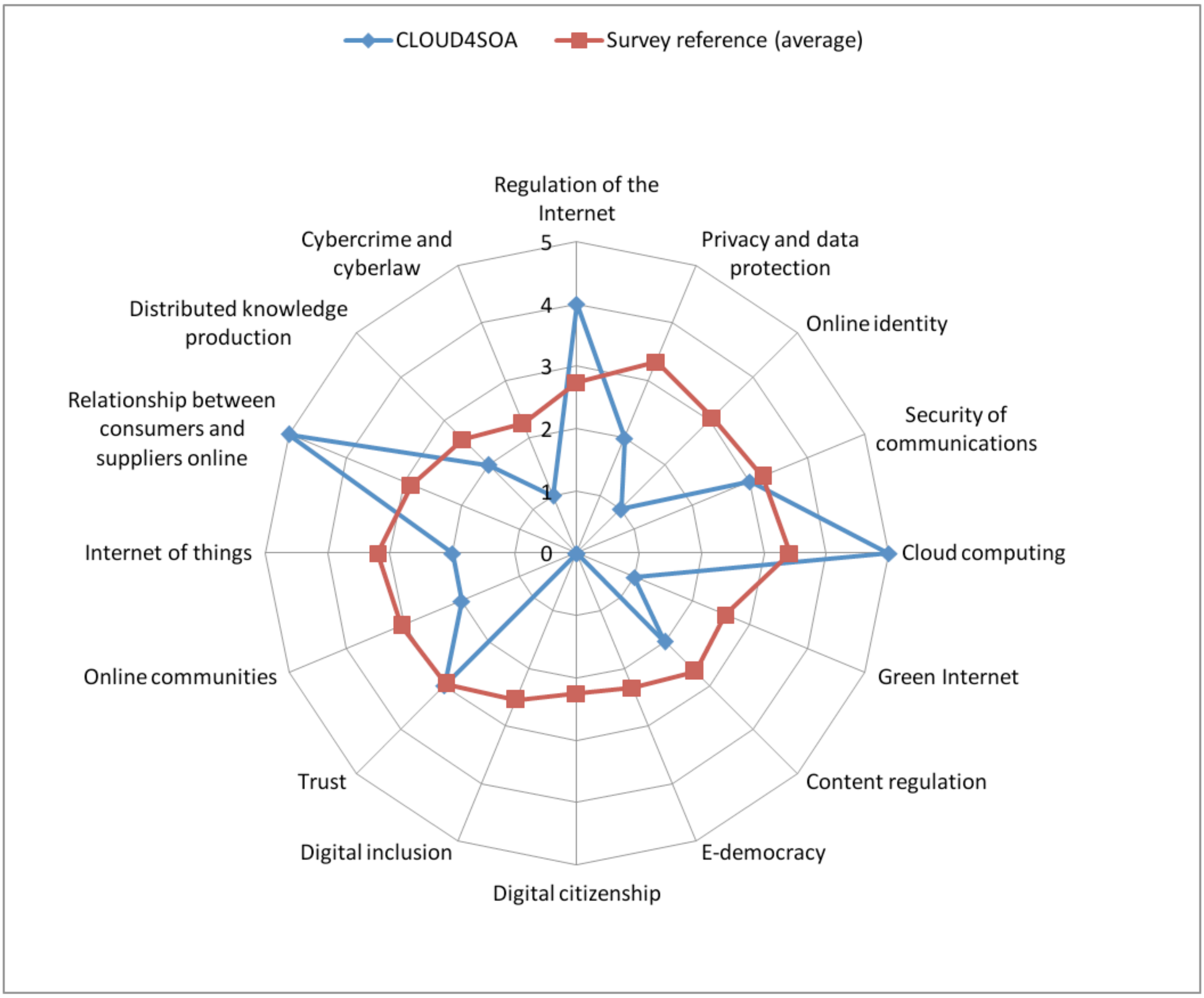

Figure 30: Socio-economic Profile for CLOUD4SOA in Comparison with Survey Reference

When comparing CLOUD4SOA socio-economic profile with the average socio-economic profile determined from 55 participants in the SESERV survey, The project is found to be atypical and to *emphasize the following socio-economic topics beyond average* (*cf. Figure 30*):

- Cloud computing
- Relationship between consumers and suppliers online
- Regulation of the Internet

These priorities are a consequence of the focus of the project, which seeks to allow interoperability between platform as a service cloud providers. Clearly cloud computing is by definition relevant. The relationship between suppliers and consumers is the heart of the business model and the regulation of the Internet is relevant as subtopics such as lock in, standardisation and user control are involved.

C.3.3 CLOUD4SOA Stakeholders

The set of stakeholders in this project is based on includes:

- Cloud computing providers who offer compute resources under an platform as a service model (PaaS).
- The user (or customer), acting as an organisation or individual, who access cloud platforms via internet. In general these will be used to develop applications for internal use or for provision to end users under a software-as-a-service (SaaS) model.
- Members of the Connectivity Providers meta-stakeholder (ISPs) on the grounds that the PaaS /cloud computing model is based on Internet delivery.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.3.4 CLOUD4SOA Tussles

Cloud4SOA does not identify any tussles in their research work. They do however identify an issue which is potentially a tussle and could be better understood using SESERV methods.

The Cloud4SOA solution is provided using two distinct pieces of software. The End-User writes code which is deployed through a central hub running centralised software and this is then translated by a Cloud4SOA component at the Broker site into the correct format for that provider's system. This allows the user to change between PaaS providers, eliminating lock in. However the solution design means that for the system to be viable, the platform-as-a-service providers must be participants in the solution: users cannot migrate to PaaS providers who are not running the Cloud4SOA component.

The issue that is currently unresolved in the project is whether or not the providers have an incentive to participate or not. The project believes there may be some tussle between the central hub provider and the independent PaaS providers. This comes down to issues of control and responsibility – once a PaaS provider is participating in the solution, what control is lost and how much responsibility will be exhibited in terms of what the central hub lets its users do.

C.4 Socio-economic Profile for ETICS

- Project acronym: **ETICS**
- Project name: **Economics and Technologies for Inter-Carrier Services**
- Duration: From 2010-01-01 to 2012-12-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=93071
- Project website: https://www.ict-etics.eu/

C.4.1 Project Focus and Relevance to SESERV

The ETICS project follows an evolutionary approach to creating a new ecosystem of innovative QoS-enabled interconnection models between Internet Service Providers. The new network control, management and service plane technologies for the automated end-to-end QoS-enabled service delivery will be complemented with economic mechanisms that allow for a fair distribution of revenue shares among all the actors of the service delivery value-chain.

ETICS is highly relevant to SESERV for studying the socio-economic issues arising in adoption and operation of this new ecosystem. The significance of these factors can be demonstrated by the lack of inter-carrier support for Quality of Service (QoS) in today's Internet, despite the existence of many technologies dealing with this issue.

C.4.2 Socio-economic Priorities for ETICS

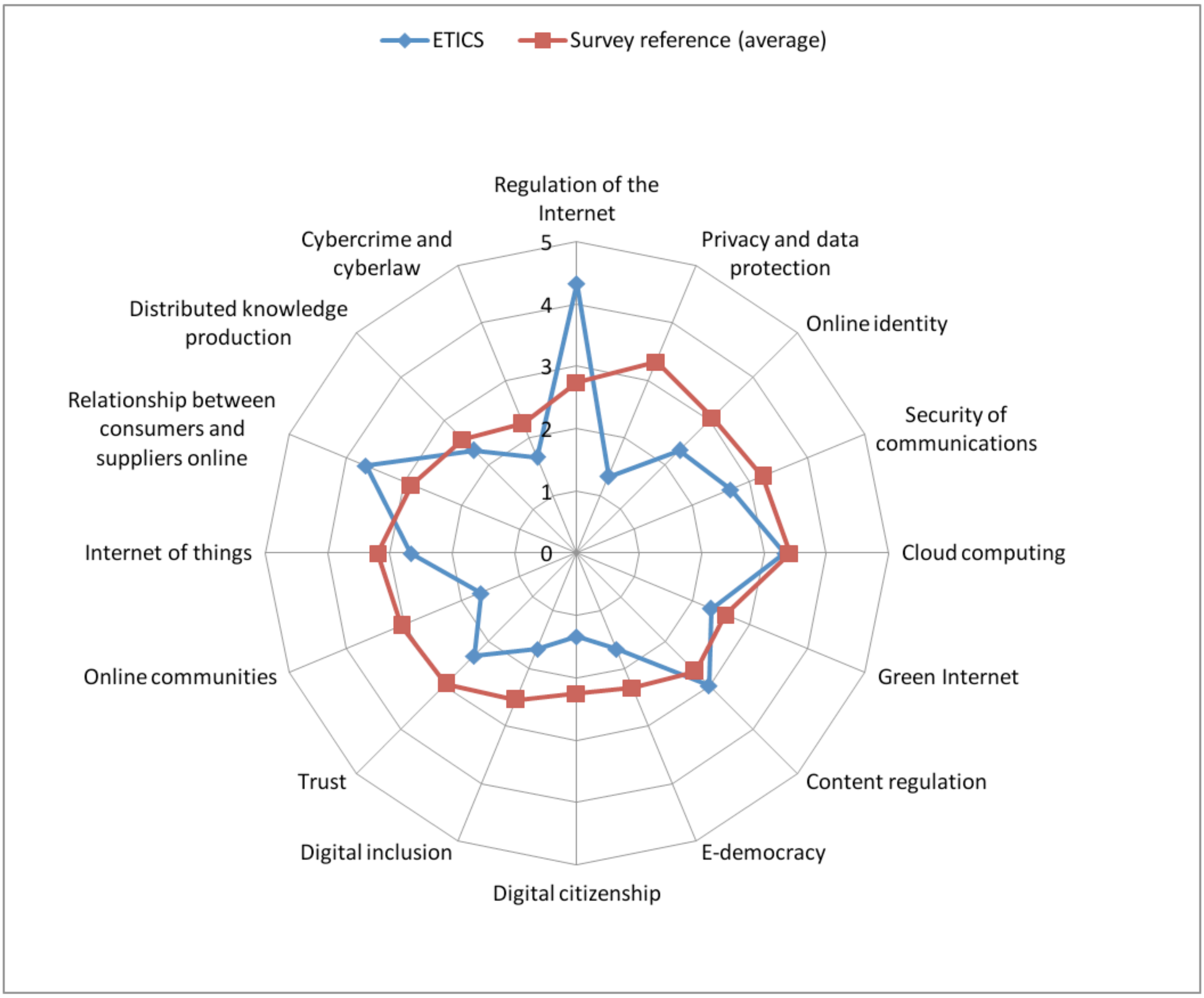

Figure 31: Socio-economic Profile for ETICS in Comparison with Survey Reference

When comparing ETICS's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, ETICS is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 31):

- Regulation of the Internet
- Content regulation
- Relationship between consumers and suppliers online
- Cloud computing

The first 2 priorities are a consequence of the regulatory framework's importance to the operation of the Internet ecosystem. The restrictions posed by regulatory bodies regarding the Internet architecture may affect how technologies will be designed, their attractiveness and how they will be finally configured and used by the involved parties. Furthermore, content regulation can restrict demand for traffic, interconnection agreements among ISPs and business models of important stakeholders, such as Content Delivery Networks.

The relationship between consumers and suppliers can be considered a fundamental aspect when designing a marketplace. In the ETICS case, consumers can be either providers such as ISPs requesting services at the wholesale Internet connectivity market, or service providers (such as VoIP providers) and end-users asking Internet connectivity.

Finally, the trend of virtualization for storage and network services drives the interest of ETICS for the cloud-computing paradigm.

C.4.3 ETICS Stakeholders

The set of stakeholders interested in ETICS includes:

- Edge ISPs, Transit ISPs as Connectivity Providers who provide Internet connectivity services, while the former ones can be further categorized to Source and Destination depending on traffic direction. Another distinction can be based on technology adopted for QoS-aware traffic delivery and more specifically we can have ETICS-based Connectivity Providers and Traditional Connectivity Providers (non-ETICS).
- Members of the Information Provider meta-stakeholder (Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Market Place Providers and Internet Retailers) who need Internet connectivity in order to offer their services (perhaps at different levels of QoS).
- Residential and business (small, medium, and large) Users who buy connectivity to Internet to meet their communication needs. Since these may benefit from QoS-aware services, a distinction can be made based on whether they select the ETICS service offerings based or traditional ones.
- Policy makers such as Regulators, Security agencies who set competition policy and pose privacy, security constraints.
- Technology Makers such as Industry Standardization Consortiums and Organizations who decide on the functionality of Internet protocols and technologies and Application Service Provider, Manufacturers of Network Elements, Consumer Electronics, Personal Computers Mobile Devices or Operating Systems vendors who decide on which Internet protocols and technologies to adopt.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.4.4 ETICS Tussles

A tussle can appear amongst two Connectivity Providers (where at least one of them has adopted the ETICS platform) regarding the properties of their interconnection link. The ISPs, who are assumed to use a peering link for exchanging best-effort traffic among their customers at no extra cost, can have conflicting interests if they were simply to increase the link's capacity in order to support premium traffic (for instance Video on demand services). This may be the case if ISP A, for example, has better connectivity to a popular content provider and upgrading the peering link without any means of control would result in losing his competitive advantage for attracting retail customers (*cf*. Figure 32).

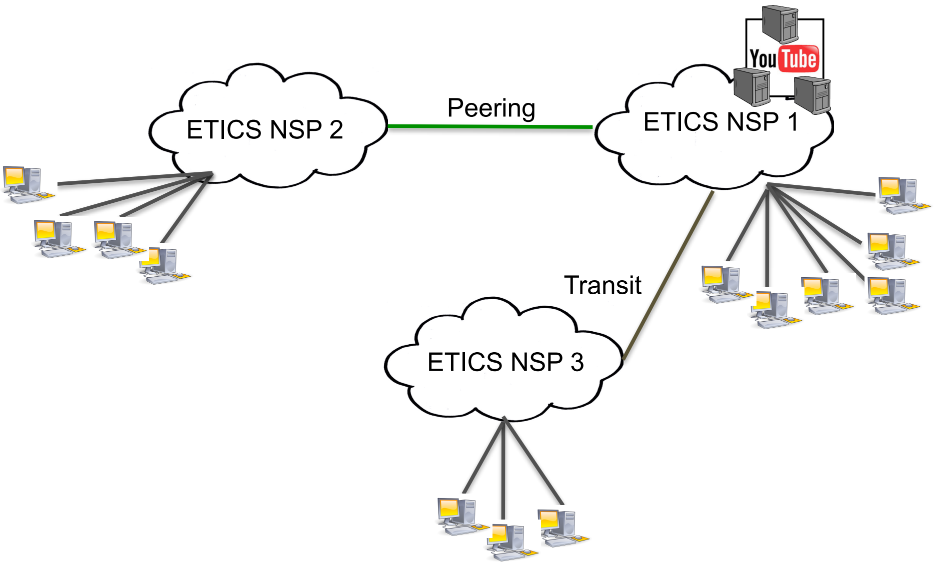

Figure 32: Tussle Regarding the Properties of the Interconnection Link among ETICS NSP 1 and ETICS NSP 2

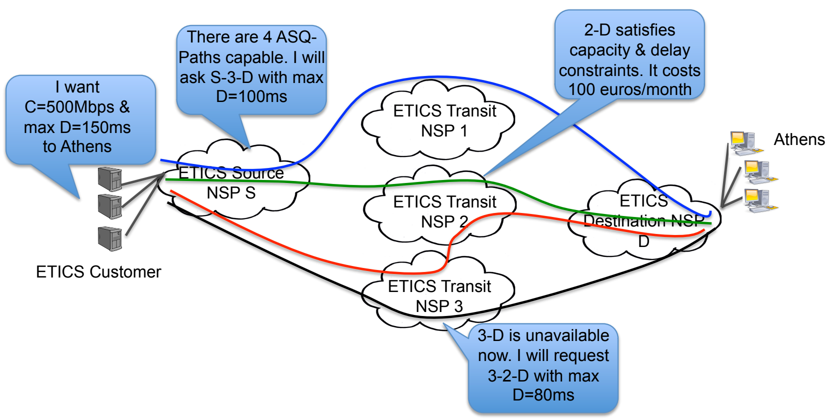

Figure 33: Tussle among ETICS ISPs over Long-term Routing of Customer Requests

A tussle can appear among ETICS Connectivity Providers over network resources that will be used for creating an end-to-end path towards a destination, on-demand. A selfish ISP will try to participate during service provision even if more efficient paths could be available. Myopic routing decisions are sub-optimal, while globally optimal decisions may not be preferable individually for the ISP that receives a request. For example, ISP 3 in Figure 33, who cannot setup the particular QoS-aware path[11] (S-3-D) asked by ISP S, may not have the incentive to indicate its unavailability and finally setup a different path that reserves more resources.

A tussle may arise amongst two ETICS Connectivity Providers (like a Source and a Transit ISP) for SLA violation responsibility. In case of a network failure, the upstream ISP needs to reroute the traffic of the ASQ agreement, which might cause an SLA violation if the downstream ISP did not reserve enough backup capacity. Assuming no adequate monitoring technology exists; if policy suggests that the penalty of the violation is assigned to the service originator then the Transit NSPs have the incentive to free-ride. Similarly, if penalty is divided equally among the ISPs then all NSP have the incentive to free-ride.

A tussle may arise between an ETICS Edge Connectivity Provider, its Users buying traditional services and a Regulator in case the ISP keeps investing on network resources for the premium customers only, in order to make customers buy more profitable services.

C.5 Socio-economic Profile for OPTIMIS

- Project acronym: **OPTIMIS**
- Project name: **Optimized Infrastructure Services**
- Duration: From 2010-06-01 to 2013-04-31
- CORDIS information: http://cordis.europa.eu/fp7/ict/ssai/docs/call5-optimis.pdf
- Project website: http://www.optimis-project.eu

C.5.1 Project Focus and Relevance to SESERV

The motivation for OPTIMIS is the vision that hybrid clouds will become commonplace, realized by private clouds interacting with a rich ecosystem of public and other cloud providers. OPTIMIS is aimed at enabling organizations to automatically externalize services and applications to trustworthy and auditable cloud providers in the hybrid model. Consequently, OPTIMIS believes its activities will support and facilitate an ecosystem of providers and consumers that will benefit from the optimal operation of services and infrastructures. The optimization covers the full lifecycle of services and their interactions.

The main result of the project is a toolkit:

The OPTIMIS toolkit will offer innovative capabilities in the different stages of the service lifecycle, enabling customers to support these and indeed shape new market characteristics. The toolkit will allow infrastructure and information providers to build, deploy and operate services in different cloud environments (private, hybrid, bursted, federated, multi-cloud) based on a range of parameters such as trust, risk, eco-efficiency and cost (TREC).

The main relevance of the project to SESERV is in its economic tussles between cloud providers, brokers and users. The project covers a range of socioeconomic issues including legal regulations, environmental responsibility, trust and economic models.

[11] called Assured Service Quality path or ASQ path

C.5.2 Socio-economic Priorities for OPTIMIS

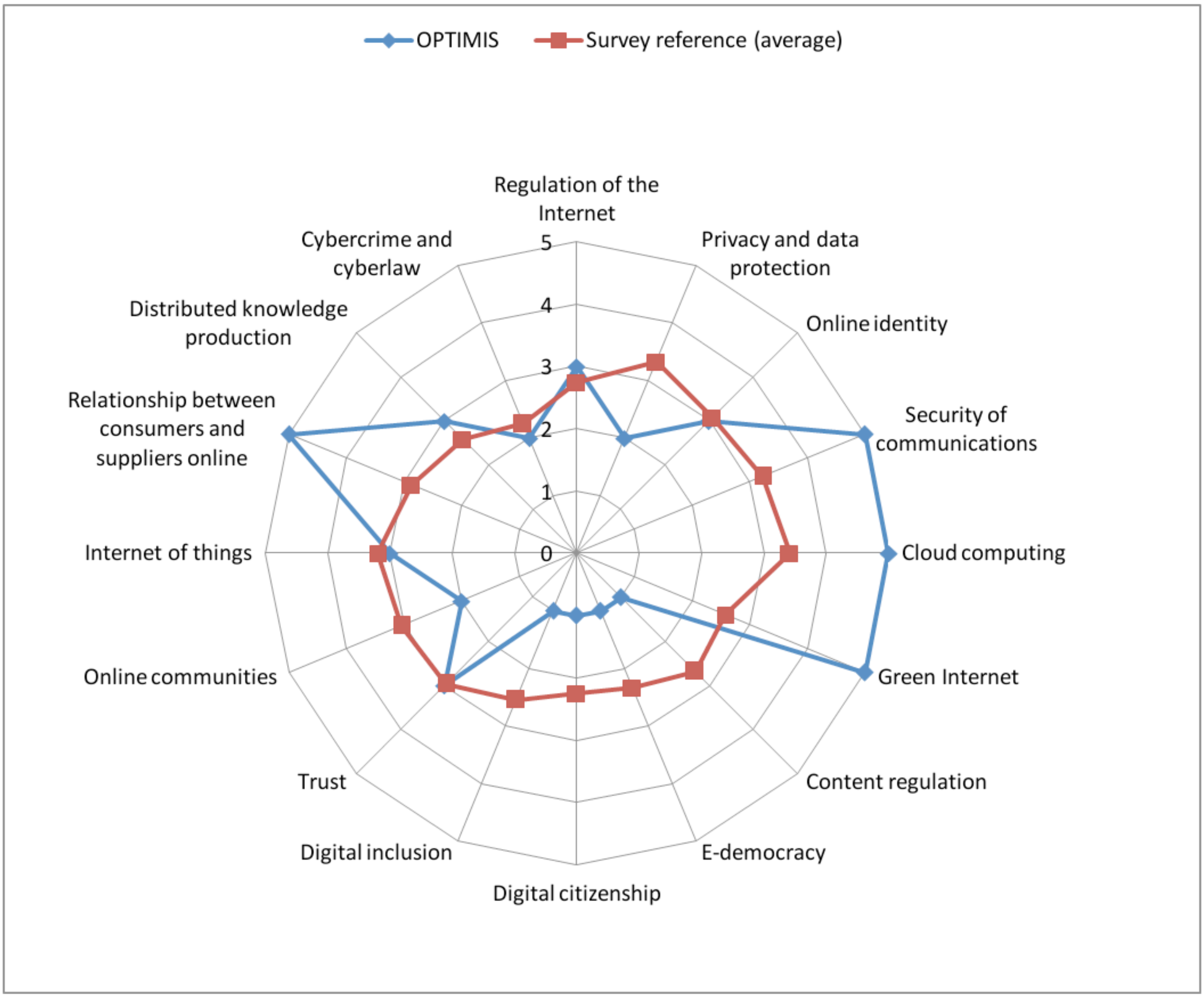

Figure 34: Socio-economic Profile for OPTIMIS in Comparison with Survey Reference

When comparing OPTIMIS socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, the project is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 34):

- Cloud computing
- Green IT
- Relationship between consumers and suppliers online
- Security of communications

These priorities are a consequence of the focus of the project, which seeks to offer hybrid cloud computing models to users – brokering between providers to allow consumers and suppliers to modify and tailor their relationship according to trust, reputation, cost and eco-efficiency. Security is a priority because of the requirement in cloud computing.

C.5.3 OPTIMIS Stakeholders

The set of stakeholders in this project includes:

- Cloud Operators, as members of the Infrastructure Provider meta-stakeholder, who offer computing resources under an infrastructure as a service model (IaaS).
- The End-user, acting as an organisation or individual, who accesses cloud resources via the Internet. These may be accessing resources for internal purposes, *e.g.,* pay-roll calculations, or as an input to their business, as is the case of Software-as-a-Service (SaaS) providers.
- Members of the Information Provider meta-stakeholder who access cloud resources via Internet in order to offer their retail services and Brokers who provide added value services (increasing for example the trust level of the marketplace).
- Members of the Connectivity Provider meta-stakeholder on the grounds that the IaaS/cloud computing model is based on Internet delivery.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.5.4 OPTIMIS Tussles

The OPTIMIS project centres around a problem found in the general broker model in cloud infrastructure provision. In a typical broker the algorithms used for matching demand and supply are based on price or availability. Although never described in the language employed in SESERV, OPTIMIS considers this to be a *tussle*: The cloud user has other interests beyond mere price and availability. The principle ones are trust, risk, and eco-efficiency.

Eco-efficiency

In a tussle regarding eco-efficiency a user may have policies regarding environmental targets (carbon emissions) or this may be part of company ethos, *e.g.,* a environmental agency may wish to use only ‘green’ clouds) or marketing, *e.g.,* an airline offsets high-polluting activities (fuel consumption) through additional focus on always sourcing green where possible for all other services.

Trust

Does the provider really offer the service they say they will? Do they have a reputation for fulfilment or non-compliance?

Risk

What is the likelihood of the system failing?

OPTIMIS addresses this tussle by allowing the user to specify their preferences of these three characteristics along with cost through the TREC model and then selects providers according to this. Consequently the competitive advantage of the OPTIMIS broker vis-á-vis other brokers is overcoming this tussle.

C.6 Socio-economic Profile for PURSUIT

- Project acronym: **PURSUIT**
- Project name: **Publish Subscribe Internet Technology**

- Duration: From 2010-09-01 to 2013-02-28
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=95665
- Project website: http://www.fp7-pursuit.eu

C.6.1 Project Focus and Relevance to SESERV

The PURSUIT project follows the paradigm of information-centric networking, where as a clean slate approach for the Future Internet, nothing – not even IP – is taken for granted. According to this new paradigm, the network becomes aware of the information being transmitted. Each packet contains the necessary meta-data for travelling inside the network, such as the (statistically) unique identifier of the target information item (called Rid) and the identifier of a context (called scopeID or Sid) that knows how the target object can be reached. This pair of identifiers could be acquired through a new breed of search engines.

PURSUIT is highly relevant to SESERV for studying the socio-economic issues arising in this new architecture, where the intelligence moves from end-systems to networking elements.

C.6.2 Socio-economic Priorities for PURSUIT

When comparing PURSUIT's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, PURSUIT is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 35):

- Privacy and data protection
- Online Identity
- Security of communications
- Content regulation
- Cloud computing
- Internet of things

The first 4 priorities are a consequence of the inherent ability of information-centric networks to be aware of the information being transmitted. This feature provides advanced protection to communicating entities, including unauthorized access to content and other services. This poses also significant requirements on the ISPs for privacy and data protection. Similarly the pivotal role of identities (like instances of Rid and Sid) in realizing communication services requires carefully designed approaches for distributing and authorizing them.

The last two priorities can be attributed to the potential synergies of information-centric networks to, *e.g.,* cloud computing for processing requests, storing content, and to Internet of things as a source for raw data.

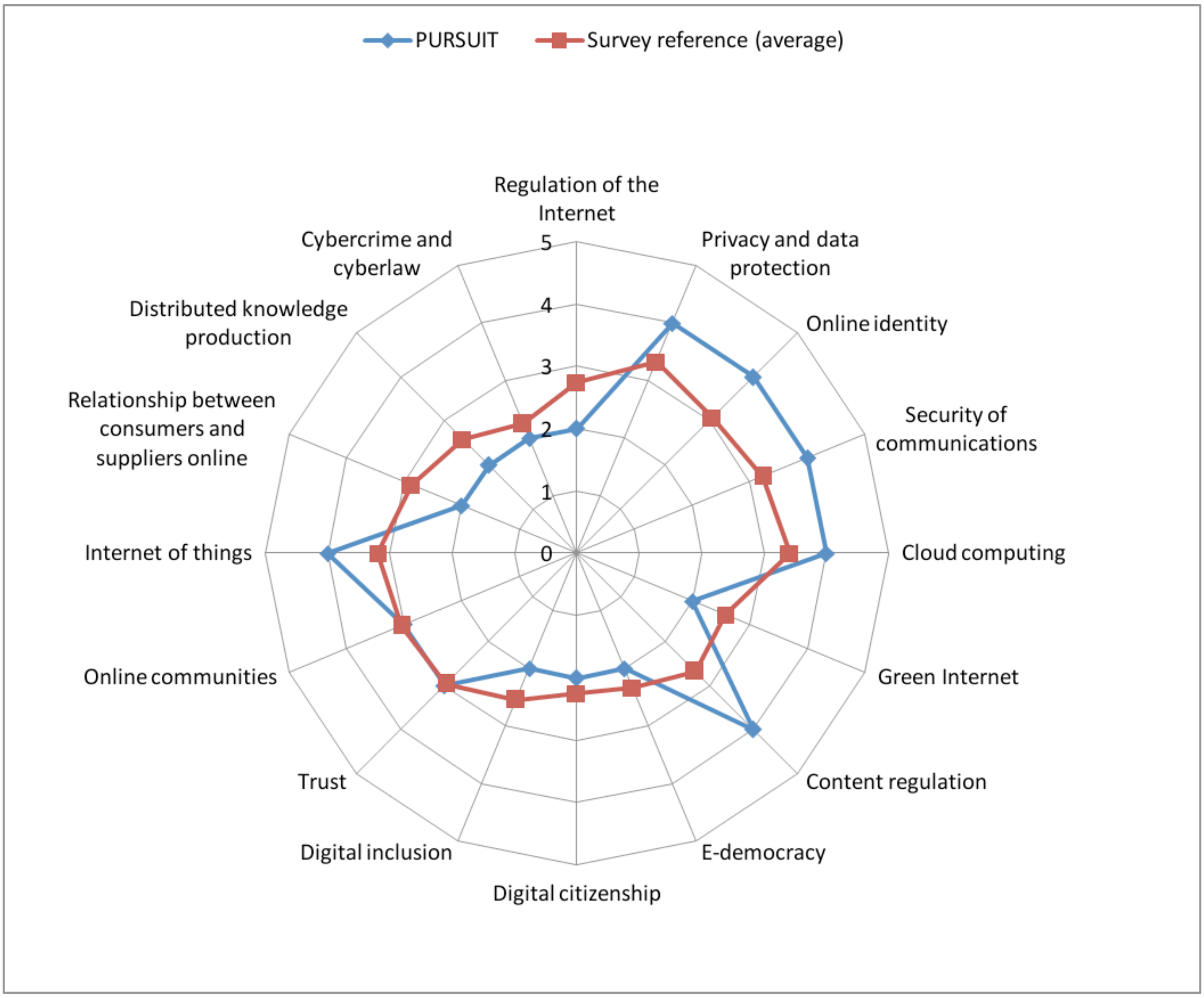

Figure 35: Socio-economic Profile for PURSUIT in Comparison with Survey Reference

C.6.3 PURSUIT Stakeholders

As a revolutionary project PURSUIT introduces several new functions or *roles*, including:

- Publishers of information/content and services who publish information elements to the system and make it available to requestors when needed. What is actually published to the system is the publication's metadata, which contain information about the data of the publication and not the data itself (for instance, the author of the publication and its size). Publishers can be included in the Information Provider meta-stakeholder.
- Subscribers who issue subscription messages containing all the necessary information for the request to be authorized, the object, *e.g.,* a webpage, a movie, a two-way communication service[12], to be identified and subsequently to be forwarded to a publisher. Subscribers can be included in the User meta-stakeholder.

[12] In the case of two-way communication services each party is both a subscriber (for incoming traffic) and a publisher (for outgoing traffic).

- Brokers operating servers, called rendezvous nodes, that do the following:
    - They match '*publish*' and '*subscribe*' messages so that information items can be delivered. These nodes are logically grouped into 'scopes', while scopes can have hierarchical structure. Prior to publishing an information element, publishers have to locate the rendezvous nodes that are responsible for managing the desired scope. One of these nodes will be the Rendezvous Point (RP) for the publication's Sid. A publication's Rid can be derived by an application specific function, *e.g.,* a hash function over the data to be published. A subscriber expresses her interest in a specific publication by issuing a subscription message towards the scope Sid and the publication's RP is identified by the Rid.
    - They perform distribution decisions by selecting the source of the item and indicating the path to be followed (either unicast or multicast). Upon receiving a subscription message, and provided that an appropriate publication exists, source selection can take place since publications may be cached along the path from a previous request.

  In both cases, brokers are members of the Information Provider meta-stakeholder.
- Routing-as-a-Service providers (RaaS or topology managers) that create a forwarding path from the suggested publisher towards the subscriber. In case that more than one subscriber subscribe for a specific Rid, a multicast tree is created in order to deliver the publication. They are members of the Information Provider meta-stakeholder.
- Search Engines who provide pairs of Rid, Sid to End-users and are members of the Information Provider meta-stakeholder.
- Cache providers who offer the infrastructure enabling content to be stored near the end-users and are members of the Information Provider meta-stakeholder.
- The Connectivity providers who offer transport services (packet forwarding towards their destination).

For each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and they are in these different cases in charge of various positions and benefits/drawbacks.

The set of stakeholders interested in PURSUIT includes:

- Traditional Application Service Providers or even end-users participating in two-way communication services (like voice over Internet) that perform the role of publishers for information/content and services. These stakeholders will have to adapt their services to the new paradigm of information-centric networking.
- End-users performing the role of Subscribers.
- Application Service Providers (like DynDNS) and Billing Service Providers acting as brokers.
- Application Service Providers, Content Distribution Networks (CDNs) and Edge ISPs acting as Routing-as-a-Service providers.
- Edge ISPs, Transit ISPs acting as Connectivity Providers.

- Content Distribution Networks, Cloud Operators and member of the Connectivity Provider meta-stakeholder acting as Cache providers. Information-centric networking is expected to pose significant risks to the existing business model of CDNs because it creates the opportunity for Cloud Operators and ISPs (especially Edge ones) to enter this market.
- New and traditional search engines like Google.
- Content owners.
- Regulators and security agencies that pose privacy restrictions and security constraints.
- Members of the Technology Maker meta-stakeholder that manufacture network elements, *e.g.,* traditional routers and routers equipped with large caches.

C.6.4 PURSUIT Tussles

A tussle exists between a network operator and a broker when performing source selection for a particular content item. The broker may neglect to use the item being cached locally at the network provider, increasing the latter's cost in case the content is received from a transit provider. This situation may arise if the broker (used by the content requestor) is run by a competing CDN with PURSUIT technology or the same entity that transits traffic.

A tussle may appear between a malicious user and a rendezvous node if the former performs DDoS attacks by issuing many fake service requests (those that do not match an Rid).

A tussle may appear between a rendezvous node and subscribers for filtering/screening user requests for content/services. The targeted content/service may be competitive to an ISP who performs the role of the rendezvous node, as well (a case known as "walled-garden"). In another case, the subscriber may be identified as a malicious user because participated in a past DDoS attack[13].

A tussle may appear between a malicious user, the content owner and a rendezvous node if the former performs "cache poisoning" by supplying a legitimate Rid to the system for a fake content item.

A tussle may appear between a rendezvous node and publishers for filtering/screening announcements for content/services. Similarly, a rendezvous node could filter/screen requests for publishing content/services[14].

A tussle exists among end-users whose traffic crosses the same bottleneck link. For example, what should be the rate (or prices computed) if a set of multicast users was competing with a unicast user on a common's link bandwidth share?

A tussle may arise amongst a network operator and a RaaS provider regarding the accuracy of the information revealed about the topology, its capabilities and interconnection agreements. The network provider may give inaccurate or partial information in order to influence the routing path or fearing that such sensitive information will be used for espionage.

[13] This means that the particular tussle can be related to the previous one.
[14] This means that the particular tussle can be related to the previous one.

A tussle exists between a rendezvous node, a regulator and subscribers for collecting transactional data in order to sell it to marketing companies.

C.7 Socio-economic Profile for RESERVOIR

- Project acronym: **RESERVOIR**
- Project name: **Resources and Services, Virtualization without Barriers**
- Duration: From 2008-02-01 to 2011-03-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=85304
- Project website: http://www.reservoir-fp7.eu/

C.7.1 Project Focus and Relevance to SESERV

The goal of the RESERVOIR project is to increase the competitiveness of the EU economy by introducing a powerful ICT infrastructure for reliable and effective delivery of services as utilities, analogously to electricity and telephony. This infrastructure will support the setup and deployment of services on demand, at competitive costs, across disparate administrative domains, assuring quality of service. RESERVOIR is relevant to SESERV for an interaction on economic and social tussles, as these arise by the great utility of cloud computing and distributed systems.

C.7.2 Socio-economic Priorities for RESERVOIR

When comparing RESERVOIR's socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, RESERVOIR is found to *emphasize most socio-economic topics beyond average, whereas highest priority receive* (*cf.* Figure 36):

- Cloud computing
- Privacy and data protection
- Online identity
- Security of communications
- Green Internet

When broadly integrating different machines into cloud services, as investigated by RESERVOIR, anonymisation of machines is important. Also, those who execute services via such an opportunistic cloud want their data private, wherefore privacy and data protection is a key issue for RESERVOIR. Since cloud nodes must be accountable for their behaviour in the cloud online identity is as important to RESERVOIR. Because RESERVOIR seeks to achieve energy efficiency by flexible utilization of resources, say cloud nodes, green ICT is also a key issue. The high relevance of security of communications arises since clouds are economically highly relevant and therefore an attractive target for attackers.

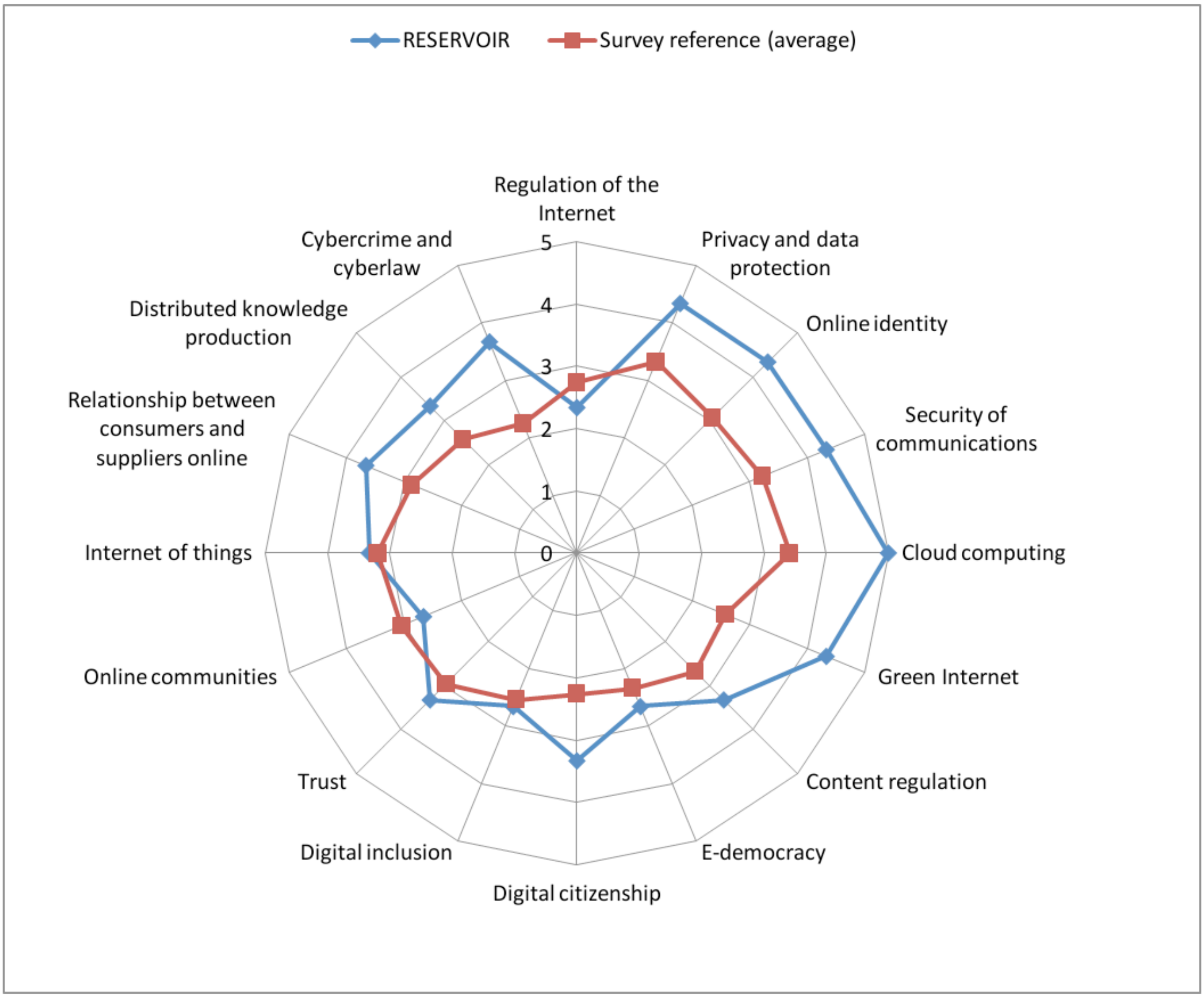

Figure 36: Socio-economic Profile for RESERVOIR in Comparison with Survey Reference

C.7.3 RESERVOIR Stakeholders

The set of stakeholders RESERVOIR is based on includes:

- Information providers, such as ASPs, are the entities that understand the needs of users and offer service applications to address those needs. Service providers do not own the computational resources needed by these service applications, instead, they lease resources from a computing cloud, which provides them with resources (computational, network, and storage).
- Cloud operators own and manage the physical infrastructure on which service applications execute. This infrastructure is organized into autonomous sites. Note that cloud providers may be for example companies sharing their idle resources.
- End-Users accessing the services offered by a service provider.
- Content owners may see their interests infringed by cloud applications as seen in the next section.
- User's Acces ISPs, when shaping traffic.

C.7.4 RESERVOIR Tussles

Two resources under *contention* are bandwidth that connects a cloud and the computational power provided by it. Also storage space provided by a cloud may get scarce, but since storage capacity utilization does not show as significant peaks as network contention or required computational power, storage capacity may be upgraded in time and therefore contention is much less likely. However, the competitors for these resources are users that access services offered by Information Providers via a cloud. The avoidance of this tussle is a main goal to RESERVOIR and addressed by developing dynamic ways to add further resources, *i.e.*, cloud nodes or entire clouds, to an overloaded cloud.

As clouds may be utilized to distribute content, a tussle of illegal content (re-)distribution arises, where cloud customers share copyrighted data. Content owners may therefore demand cloud or information providers (depending on the implementation), to review data shared via a cloud, or if the data is publicly shared, to track users distributing their content. This tussle may be very relevant for RESERVOIR as a solution must be found, that makes users accountable but at the same time protects user privacy on a reasonable level.

Also a tussle is encountered, when two cloud providers A, B agree to cooperate in case of congestion. If A's cloud is congested he has to outsource workload to B's cloud. B may decide to assign the tasks received from A low priority or push them to slow cloud nodes, in order to keep his cloud prepared for sudden workload peaks. This policy is obviously not in A's interest, who relies on B's dedicated computing power.

A further tussle may emerge in relation to the use of clouds from multiple cloud providers: cloud providers might have an interest in accessing and exploiting data of a user even after service usage is completed. Questions like who is enabled to erase data and whether/for whom/for how long/for which purposes data remains accessible are important to be looked at in this context.

Another tussle may be encountered when an user cannot reach certain nodes of a cloud because the users edge provider shapes traffic roaming to other ISPs. Thereby a user may only get access to parts of a cloud that offer less quality of experience.

C.8 Socio-economic Profile for RESUMENET

- Project acronym: **ResumeNet**
- Project name: Resilience and Survivability for Future Networking: Framework, Mechanisms, and Experimental Evaluation
- Duration: From 2008-09-01 to 2011-08-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=87023
- Project website: http://www.resumenet.eu/

C.8.1 Project Focus and Relevance to SESERV

ResumeNet proposes a new architectural approach to Internet resilience that is multilevel, systemic, and systematic. At the same time, interoperability with legacy network components is maximized. ResumeNet is relevant for SESERV since it shows constraints of the tussle analysis proposed by SESERV. In particular, ResumeNet investigates network failures caused by arbitrary events. These events cannot be aggregated in a direct manner to stakeholders and therefore the utility of a tussle analysis is limited.

C.8.2 Socio-economic Priorities for ResumeNet

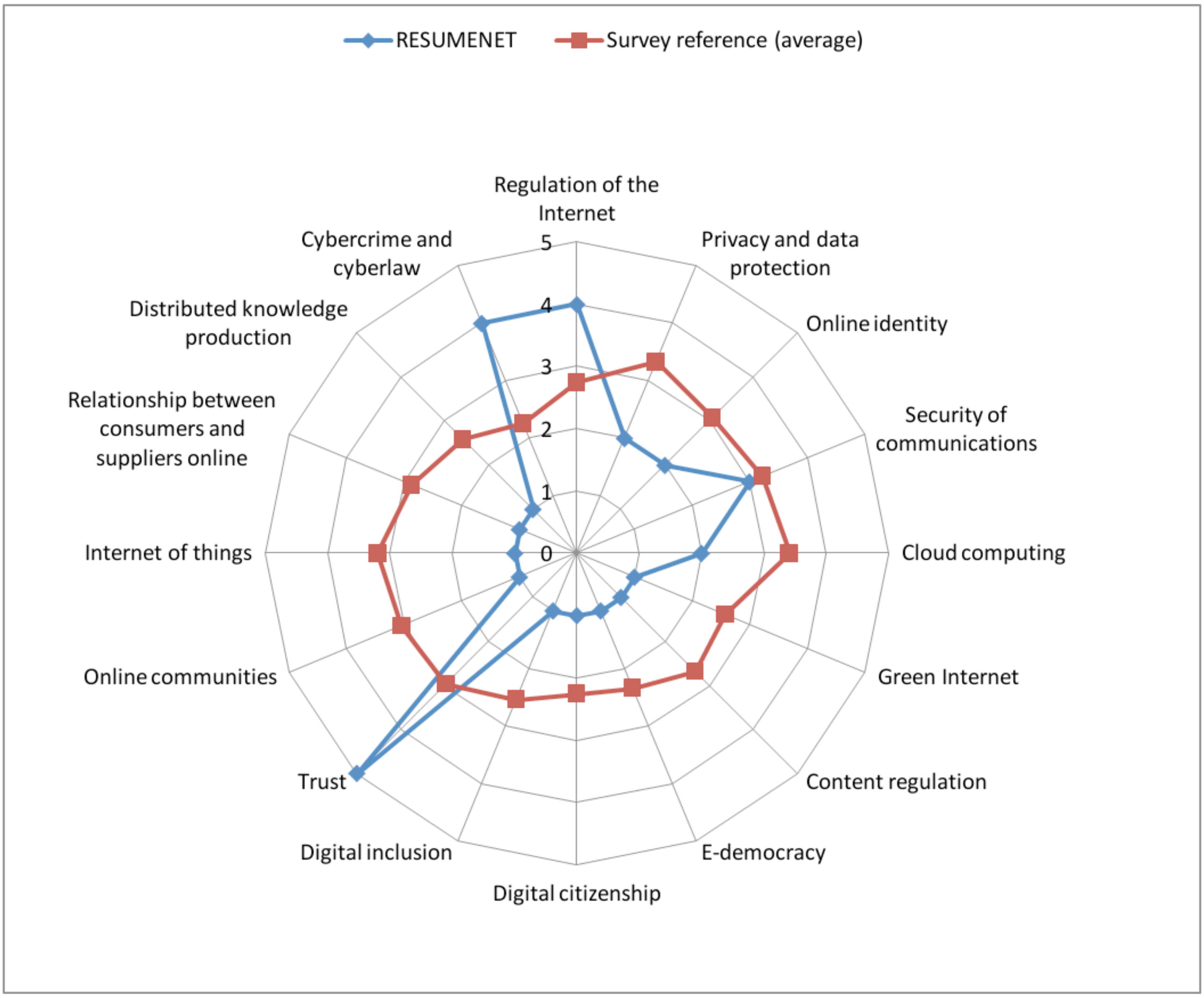

Figure 37: Socio-economic Profile for ResumeNet in Comparison with Survey Reference

When comparing ResumeNet's socio-economic profile with the average socio-economic profile determined from 92 participants in the SESERV survey, ResumeNet is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 37):

- Trust
- Cybercrime and cyberlaw
- Regulation of the internet

These priorities are founded in ResumeNet's goal to deliver mechanism for Internet resilience. Since trust includes risk drivers, actors at risk, and risk management, which are crucial for resilience mechanisms, trust is a key feature for ResumeNet. Cybercrime includes hacker attacks and cyberterrorism, which constitute a serious threat to network operability. Therefore cybercrime is also of great interest for ResumeNet. Because Internet failures may arise in adverse interactions of different Internet components and resilience mechanisms need to be implemented in very basic protocol layers, regulatory aspects of the Internet are important to ResumeNet, as well.

C.8.3 ResumeNet Stakeholders

ResumeNet investigates different scenarios where resilience of the Internet might be threatened. Since these threats, *e.g.,* a disastrous event causing a black out or an attack by a malicious user, arise mostly from accidental impacts, the stakeholder model cannot be applied directly for most cases. However, the two stakeholders that appear constantly may be outlined.

- The Connectivity Provider in terms of an instance of an Edge ISP or a Transit ISP, who offers physical connectivity and intends to keep its infrastructure operational in order to comply with SLAs.
- A member of the user meta-stakeholder, thus an end-user or an organization on behalf of many single individuals, who demands connectivity optionally in combination with certain qualities of experience. Furthermore, a distinction is made to malicious and trustworthy users.

C.8.4 ResumeNet Tussles

As mentioned above, many scenarios considered by the ResumeNet project do not allow for an appropriate identification of stakeholders. Therefore the identification of tussles is also problematic. To be precise, the problem is that ResumeNet considers threats to network functionality, which can arise for manifold reasons, *e.g.,* component faults, hardware destruction for example caused by natural disasters, human mistakes, and cyber attacks. Although the latter can be clearly drawn to malicious human behaviour, ResumeNet is more interested in ways to deal with the resulting network failure than in analysing interactions between involved entities. All other considered threats have in common that they do not have a predictable behaviour or goals and do not comply with any restrictions. Therefore, they cannot even be modelled by a more abstract concept of stakeholders. This poor performance of tussle analysis for the scenarios considered by ResumeNet is not surprising though, as tussle analysis was proposed to predict socio-economic interactions between individuals and enterprises.

Nonetheless, ResumeNet pointed us to a scenario where the protection of publish-subscribe systems is investigated. Here, the publish-subscribe system is the resource, provided by the application service provider – a stakeholder. Malicious opponents wish to *repurpose* this resource, for example, in order to illegally capitalize the information it stores. The provider could counter this attack by changing access control policies to the publish-subscribe system. This could be considered an example of the provider temporarily restricting the capabilities of the resource to mitigate the attacker.

Another example, we were pointed to, is selfish node behaviour, *i.e.*, non-forwarding behaviour, is in wireless mesh and opportunistic networks. In this potential tussle, peers – the stakeholders – send and receive traffic and have the dual roles of consumers and providers. Buffer is the resource under contention. Since nodes are considered purely as technical entities they lack intentions, wherefore a tussle analysis may prove to be out of place.

C.9 Socio-economic Profile for SAIL

- Project acronym: **SAIL**
- Project name: **Scalable and Adaptable Internet Solutions**
- Duration: From 2010-08-01 to 2013-01-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&DOC=33&CAT=PROJ&QUERY=013155eff689:4248:229b398e&RCN=95447
- Project website: http://www.sail-project.eu/

C.9.1 Project Focus and Relevance to SESERV

SAIL leverages state of the art architectures and technologies, extends them as needed, and integrates them using experimentally driven research, producing interoperable prototypes to demonstrate utility for a set of concrete use-cases.

SAIL aims to improve application support via an information-centric paradigm, replacing the old host-centric one, and develop concrete mechanisms and protocols to realize the benefits of a Network of Information (*NetInf*). This is a competing solution to traditional CDNs, where the cache ownership, the re-directing intelligence and cache selection are controlled by a single stakeholder, *i.e.*, the CDN provider. In the NetInf CDN, the aforementioned responsibilities are shared between more stakeholders. Cache servers may be owned by Cloud Operators, such as data centres, however, here it is assumed that they are owned by the Edge ISPs which allows the content to be served as close as possible to the end-users. The intelligence and cache selection is performed by a new stakeholder, the NetInf CDN provider who acts as a Broker.

SAIL embraces heterogeneous media from fiber backbones to wireless access networks, developing new signaling and control interfaces, able to control multiple technologies across multiple aggregation stages, implementing Open Connectivity Services (*OConS*). For example in cases where connectivity between certain nodes no longer holds, several heterogeneous wireless nodes can build a multi-hop network in order to provide the end-users with the connectivity between them and towards a fixed Internet infrastructure. Traffic is relayed towards an Edge ISP (called Network Operator) either by end-users themselves (forming an ad-hoc network) or by providers (called Community Infrastructure Providers) operating for instance wireless access points (forming a mesh-network). A Broker (called Community Operator) defines and enforces the set of policies that promote cooperation.

Furthermore, SAIL enables the co-existence of legacy and new networks via virtualization of resources and self-management, fully integrating networking with cloud computing to produce Cloud Networking (*CloNe*).

SAIL is highly relevant to SESERV since it specifically addresses socio-economics issues, and network migration, driving new markets, business roles and models, and increasing opportunities for both competition and cooperation.

Bellow, in sections C.9.3 and C.9.4, we present the stakeholders and tussle analysis as they have been derived based on the business analysis performed for the respective use cases identified by SAIL (see [18]).

C.9.2 Socio-economic Priorities for SAIL

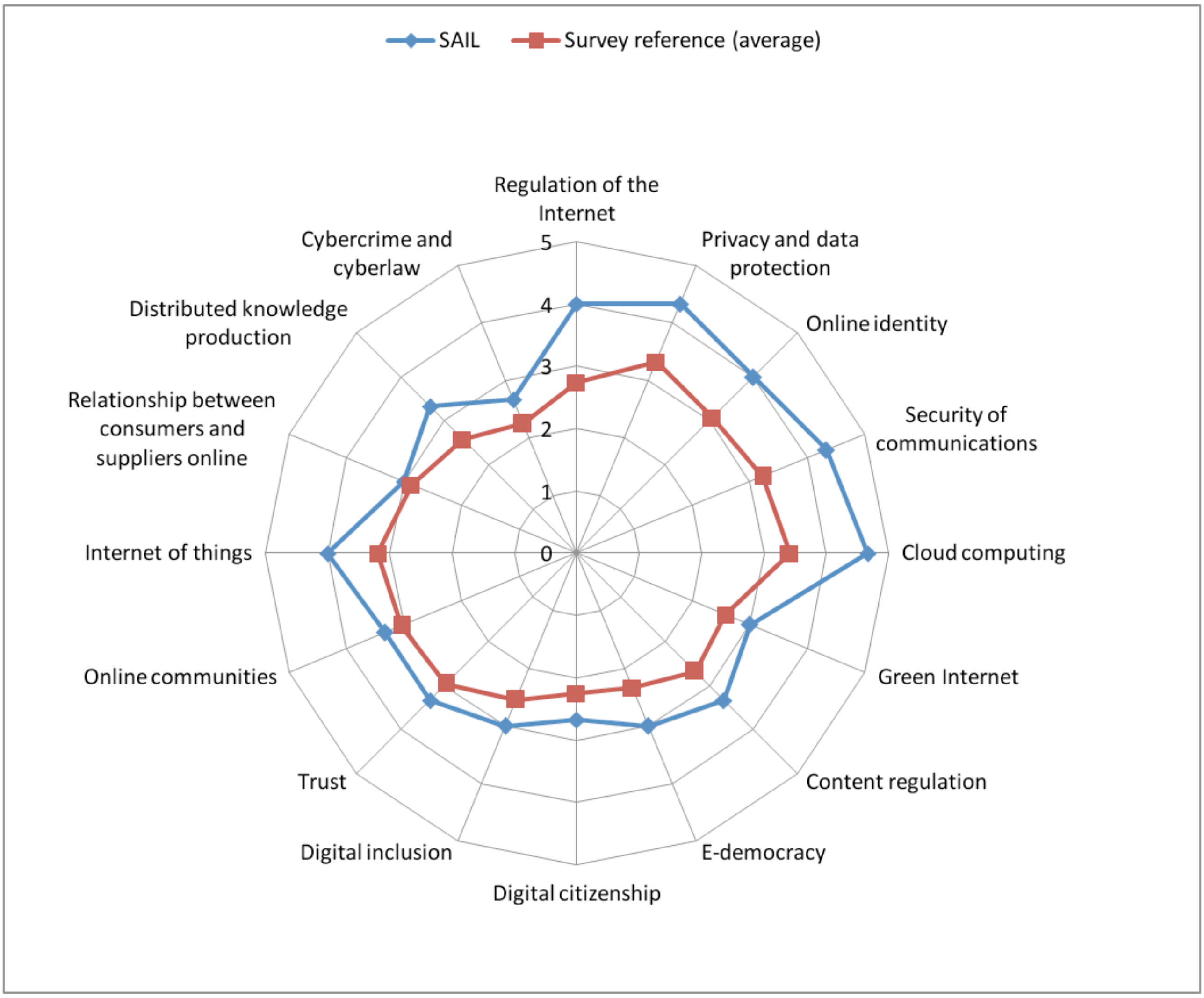

Figure 38: Socio-economic Profile for SAIL in Comparison with Survey Reference

When comparing SAIL's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, SAIL is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 38):

- Relationship between consumers and suppliers online
- Privacy and data protection
- Cloud computing
- Internet of Things

The first two topics are consequences of the base and the extended base scenarios investigated within the SAIL project which includes content providers (CPs) uploading video content to a repository provided by their service provider (SP) and making it available for future use by any possible consumer interested in this content.

The latter two topics are derived by the fact that instead of serving all the traffic generated by the aforementioned activity from a single server farm as would be common today, *CloNe*, *OConS* and *NetInf* will work hand in hand to cache and to transform the content at suitable places in the network, such that these flows can be served at optimal user experience and minimal use of network and transport resources.

C.9.3 SAIL Stakeholders

The set of actors and their roles are presented bellow.

- End-users who access the Internet via Edge ISP to gain access to content and other services, or even relay other users' traffic towards its ultimate destination.
- Members of the Connectivity meta-stakeholder:
  - Edge ISPs who provide mobile and/or fixed (wireless and wireline) Internet access to end-users (customers), install and operate cache servers for video content caching,
  - Transit ISPs (national, international) who offer global Internet connectivity,
- Content Distribution Network Providers (CDN Providers) that as an instance of the Information Provider meta-stakeholder preserve and operate NetInf cache servers, or follow the traditional service model (e.g. that of Akamai),
- Content Owners (CO) who provide the content item requested by the end-user,
- Brokers such as NetInf CDN Providers and Community Operators. In the former case they aggregate, index and secure the content, act as a single point of contact for the Content Owners, resolve the nearest location of the content, resolve the NetInf ID of the content. In the latter case they provide supporting services in order to build and sustain collaboration across the members of the community.
- Network Component Providers (called Network Infrastructure Providers) that own and manage the access and core infrastructure resources to Edge and Transit ISPs.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.9.4 SAIL Tussles

Below, tussles that may arise between the stakeholders identified by SAIL are briefly discussed:

- The localization of traffic due to the use of NetInf caches affects the volume exchanged between Edge ISPs as well as Edge ISPs and Transit ISPs. This though implies that existing interconnection agreements may not be justifiable. For example an Edge ISP operating NetInf caches having a peering arrangement with an Edge ISP may break this agreement seeking to provide transit service to the latter one. Similarly, a Transit ISP who sees its revenues being reduced may decide to adjust transit prices or enter the content delivery market by acting as a NetInf CDN provider.
- A NetInf CDN provider collaborates with multiple Edge ISPs (cache owners). If the NetInf CDN provider neglects to use the cache servers of an Edge ISP and re-directs end-users' requests to distant caches, then the inter-connection cost of the "neglected" Edge ISP will be increased due to the limited use of its cache servers and the significant increase of its inter-domain traffic. This tussle may occur if the NetInf CDN

provider is controlled by a third party or a Transit ISP who would experience revenues decrease due to the localization of traffic (see previous tussle).

- A NetInf CDN Provider collaborates with multiple Edge ISPs (cache owners). If though the content item requested by an end-user is served by the caches of another Edge ISP, then the NetInf CDN provider that receives the request may not serve it (walled garden case). This tussle between the NetInf CDN provider, the other Edge ISP and the end-user may occur if the NetInf CDN provider is controlled by an Edge ISP.
- A Content Owner may provide corrupted or malicious content, or, in general, it may not offer the requested content with the pre-agreed quality. This may lead a NetInf Provider to controlling which Content Owners will operate in the market. Thus this tussle arises primarily between the Content Owner and the NetInf CDN provider.
- An Edge ISP which is also the cache owner, may decide to hide critical information or provide inaccurate information about its network, servers, *etc*. in order to affect the content delivery, fearing that such sensitive information will be used for espionage. For instance, the Edge ISP may want to promote the content delivery by an overloaded server due to lower cost, which though would imply degraded QoE for the end-users. Thus this tussle involves primarily the Edge ISP and the NetInf CDN provider.

- A tussle arises between an End-user (or a Community Infrastructure Provider) relaying traffic of another End-User and a Community Operator (a type of broker), if the former one does not follow the policies established by the latter, *e.g.*, routing policies or traffic prioritization.
- A tussle arises between a Network Component Provider and a member of the Connectivity Provider meta-stakeholder, if the former does not provide accurate network information to the latter.
- A tussle arises among a Network Operator, a Content Owner and a CDN provider, if the last one does not offer the agreed content/service, or when the Network Operator/Network Infrastructure Provider in purpose degrade the performance of the CDN service in order to other traffic.

C.10 Socio-economic Profile for STRONGEST

- Project acronym: **STRONGEST**
- Project name: **Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport**
- Duration: From 2010-01-01 to 2012-12-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=93780
- Project website: http://www.ict-strongest.eu/

C.10.1 Project Focus and Relevance to SESERV

The STRONGEST project follows an evolutionary approach for the Future Internet, aiming to design and demonstrate a hybrid transport network that combines optical and packet network nodes, being orchestrated by a multi-technology control plane that allows provision of advanced network services across vendors, domains and carriers. With the growing size of transport networks and their dynamic label switched path management, automatic provisioning coupled with traffic engineering is considered essential to operate them cost-efficiently. In such as distributed environment procedures for service management, fault management and performance monitoring play a noteworthy role in providing end-to-end telecommunication services. Thus STRONGEST project is relevant to SESERV, even though it focuses on the single carrier case (where multiple administrative domains can co-exist) without however excluding the multi-carrier context.

C.10.2Socio-economic Priorities for STRONGEST

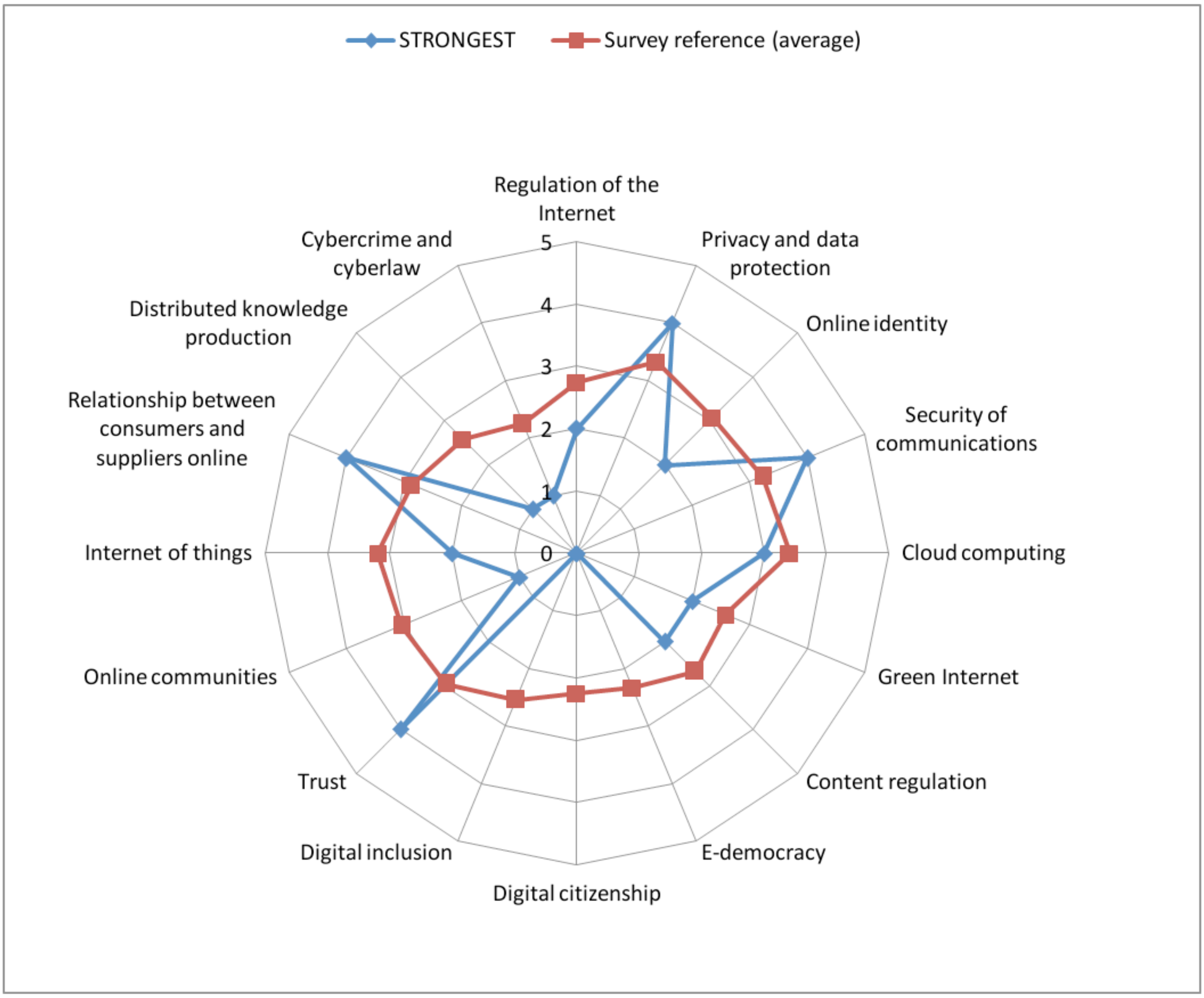

Figure 39: Socio-economic Profile for STRONGEST in Comparison with Survey Reference

When comparing STRONGEST's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, STRONGEST is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 39):

- Relationship between consumers and suppliers online
- Security of communications

- Regulation of the Internet
- Trust

C.10.3 STRONGEST Stakeholders

The set of stakeholders interested in STRONGEST [25] includes:

- Connectivity Providers such as Edge ISPs, Transit ISPs who provide Internet connectivity services. Each Connectivity Provider may operate several domains, which are network elements of compatible technology (for instance optical switches), possibly managed by separate administrative authorities and following different policies.
- Information Providers: Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Market Place Providers and Internet Retailers who need Internet connectivity in order to offer their services.
- End-users and Consumers who demand Internet connectivity perhaps with differentiated quality of service.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.10.4 STRONGEST Tussles

A tussle exists among ISPs for not allowing full visibility of their own topology, available resources and selected policies (such as overbooking ratio). Reasons for this tussle include prevention of business secrets leakage for avoiding customer stealing by competing ISPs or prevention of security-related attacks to sensitive infrastructure. We should note that such behaviour could be performed by non-neighbouring ISPs that gather the necessary information through intermediary ISPs. STRONGEST investigates approaches towards Traffic Engineering information exchange between domains/carriers that respect confidentiality restrictions posed by party. One such option is when each domain can apply its internal policies and strategies, so that the summarized information can be obtained according to heterogeneous criteria, methods and algorithms.

A tussle exists among ISPs for responsibility in case of SLA violation. Indeed, in case of failure or out-of-SLA service delivery, the violative carrier should be identified in order to compute each ISP’s contribution to the compensation towards other carriers or the end customer. For this reason, mechanisms must be in place allowing carriers to agree on the root cause, even when multiple technologies are used for fulfilling a customer request.

A tussle can appear among domains or ISPs over network resources that will be used for creating an end-to-end path towards a destination. In case the most suitable intra domain path for a service request is unavailable, a domain could select to serve that particular customer using a backup path composed of more expensive resources (for instance a higher capacity virtual intra-domain path called lower valued Label-Switched Path used for more demanding traffic types). If the backup path is also critically loaded then new requests from demanding applications may experience quality-related issues. This tussle may arise in the inter-domain level, as well. If a path was computed on demand, a selfish ISP could setup a less costly path even though the customers’ requirements may not be satisfied. If a path was pre-computed, a selfish ISP could send biased advertisements in order to favour the crossing of some domains/ISPs.

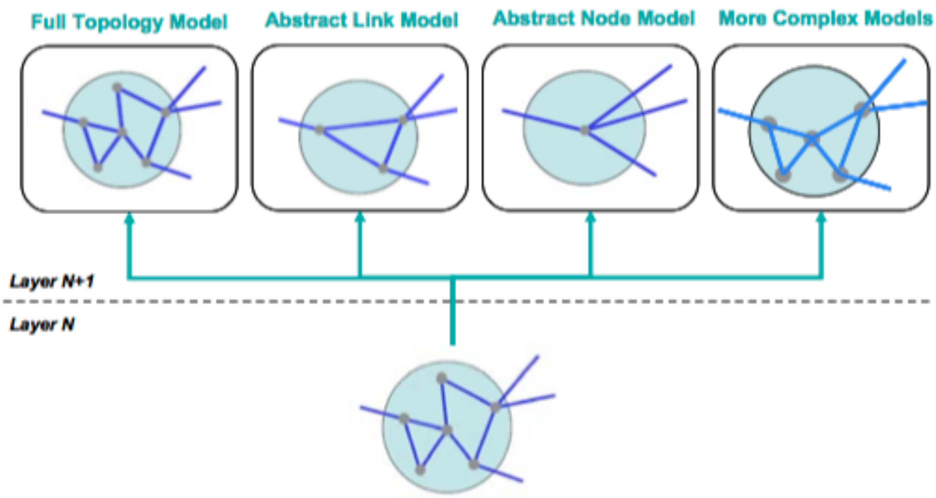

Figure 40: Topology Summarization Techniques Investigated by STRONGEST for Achieving Topology Abstraction between Different, Hierarchically-organized Domains/ISPs

C.11 Socio-economic Profile for TRILOGY

- Project acronym: **TRILOGY**
- Project name: **Re-Architecting the Internet. An hourglass control architecture for the Internet, supporting extremes of commercial, social and technical control**
- Duration: From 2008-01-01 to 2011-03-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=85449
- Project website: http://www.trilogy-project.org/

C.11.1Project Focus and Relevance to SESERV

The TRILOGY project follows an evolutionary approach for the Future Internet aiming to redesign the control functions of the Internet. The project focuses on the routing and the resource control functionalities, trying to develop and evaluate performance as well as the socio-economic impact of new technical solutions.

TRILOGY is highly relevant to SESERV for studying the socio-economic issues arising when introducing new Internet technologies.

C.11.2 Socio-economic Priorities for TRILOGY

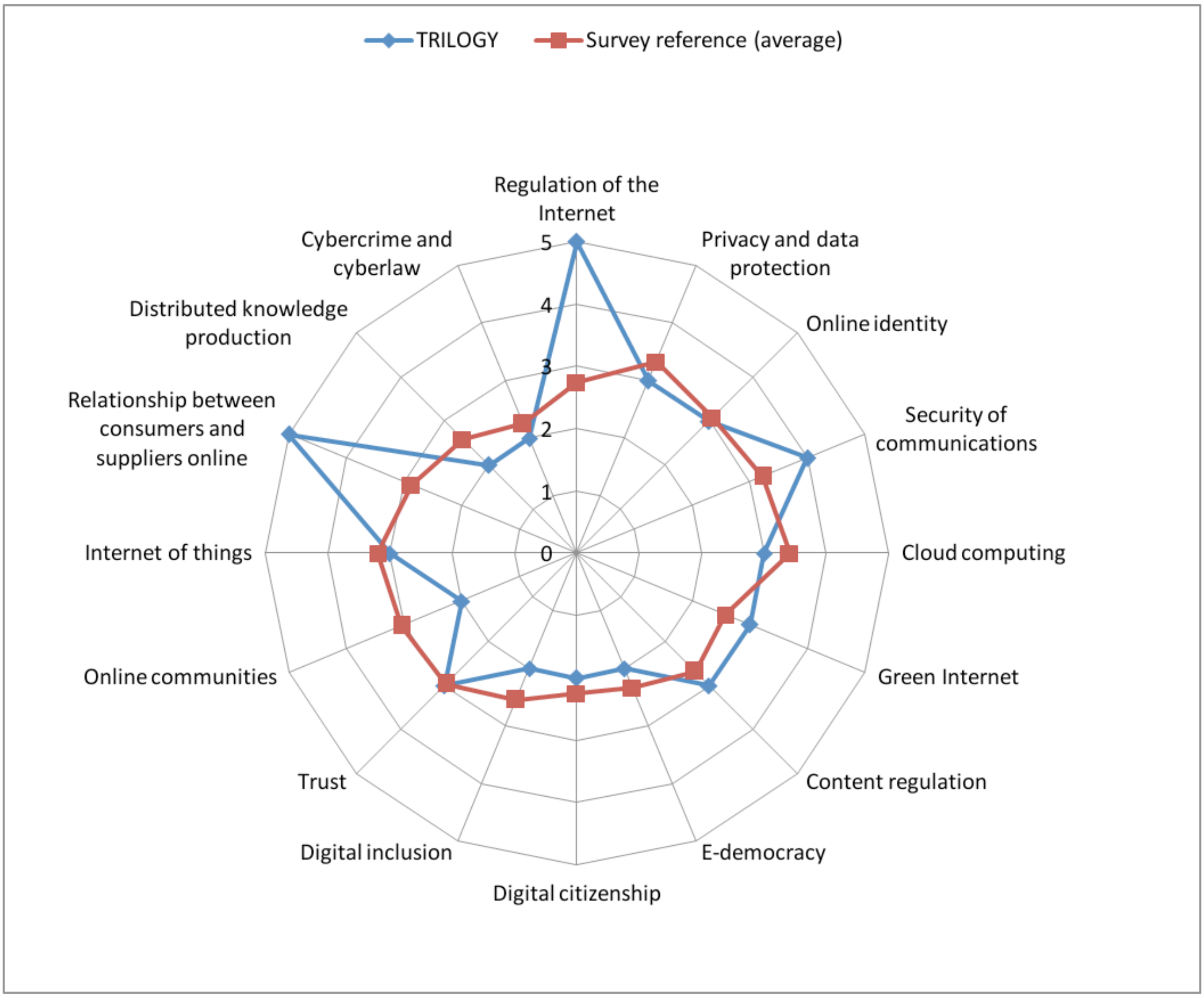

Figure 41: Socio-economic Profile for TRILOGY in Comparison with Survey Reference

When comparing TRILOGY's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, TRILOGY is found to *emphasize the following socio-economic topics beyond average* (*cf.* Figure 41):

- Relationship between consumers and suppliers online
- Regulation of the Internet
- Security of communications
- Green Internet
- Content Regulation

C.11.3 TRILOGY Stakeholders

The set of stakeholders interested in TRILOGY [26] includes:

- Connectivity Providers and specifically Edge ISPs, Transit ISPs who provide Internet connectivity services.

- Information Providers like Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Market Place Providers and Internet Retailers who need Internet connectivity in order to offer their services.
- Members of the Users meta-stakeholder which includes residential and business (small, medium, and large) customers who buy connectivity to Internet and End-users who use a consumer's Internet connection to meet their communication needs.
- Policy makers such as Regulators, Security agencies who set competition policy and pose privacy, security constraints, as well as Administration Authorities that control how the Internet operates, *e.g.,* global IP address allocation.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.11.4 TRILOGY Tussles

The Trilogy project studied extensively bandwidth contention among End-users, as well as, amongst an ISP and its Customers, due to the aggressive behaviour of popular file-sharing applications. The Re-ECN and MPTCP (Multi-Path TCP) protocols were proposed and a novel congestion control algorithm for the latter that give the right incentives to users of bandwidth intensive applications.

A tussle can arise among Edge ISPs for attracting customers by adopting different pricing schemes (such as based on traffic volume and congestion volume).

A tussle may arise among Connectivity Providers, who can exploit multi-path transport (MPTCP) in a multi-homed Internet to achieve their economic goals. More specifically, such goals are the following:

- Avoid traffic bursts and thus cost (due to 95^{th} %tile pricing scheme among ISPs).
- Increase profit by promoting more profitable routes.
- Increase the transit cost to potential peers, making peering more attractive.

The idea is that ISPs can selectively drop packets that belong to users of MPTCP because such traffic will automatically shift to other paths (due to the associated congestion control suggested) without affecting significantly users' experience. In the example of the following figure, given that the two users Host I and Host II can communicate using up to 4 different paths concurrently (at different transmission rates), if ISP B drops packets on the path "2" then the rest will be expected to increase their rates. In this way ISP B can avoid transit costs paid to ISP A.

The Trilogy project also studied the social tussles surrounding "phishing", the attempt to acquire sensitive personal data of end-users by masquerading as a trustworthy entity, as a tussle among two website owners. The tussle is being played out in the routing domain: the fraudulent one advertises more specific BGP prefixes so that ISPs update the entries in their routing tables and route end-user requests to the fake website instead of the real one. This situation has been shown to be a real problem due to the incentives of ISPs to increase their revenues by attracting traffic, but no mechanism has been suggested to deal with this security problem and the fears that it raises among end-users. Policy makers may intervene in order to protect vulnerable end-users.

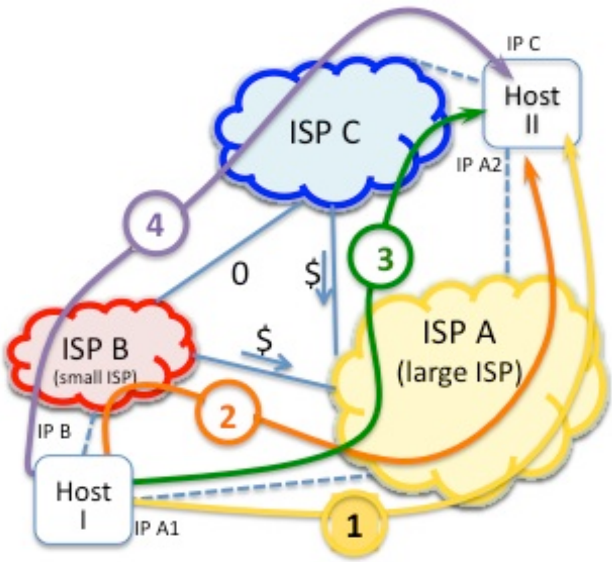

Figure 42: Using Multi-path Transport (MPTCP) in a Multi-homed Internet

C.12 Socio-economic Profile for UNIVERSELF

- Project acronym: **UNIVERSELF**
- Project name: **UNIVERSELF**
- Duration: From 2010-09-01 to 2013-08-31
- CORDIS information: http://cordis.europa.eu/fetch?CALLER=PROJ_ICT&ACTION=D&CAT=PROJ&RCN=95900
- Project website: http://www.univerself-project.eu/

C.12.1Project Focus and Relevance to SESERV

The UNIVERSELF project follows an evolutionary approach for the Future Internet, aiming to introduce self-management techniques that allow convergence of different technologies (at the vertical level or “across layers”) and cooperation among different ISPs (at the horizontal level or “across players”). This requires flexible control and service management planes as well as standardized and technology-agnostic interfaces for federated service provision. Furthermore, carefully designed processes must be in place for building confidence and trust among the participants.

UNIVERSELF is highly relevant to SESERV for studying the socio-economic issues arising in such a federated environment, where parts of the network infrastructure are assumed to be cognitive and others can be configured to apply the provider’s policy on-demand. The efficiency introduced, the level of trust achieved and the ability of the proposed mechanisms to capture the stakeholders’ interests are expected to drive their adoption.

C.12.2 Socio-economic Priorities for UNIVERSELF

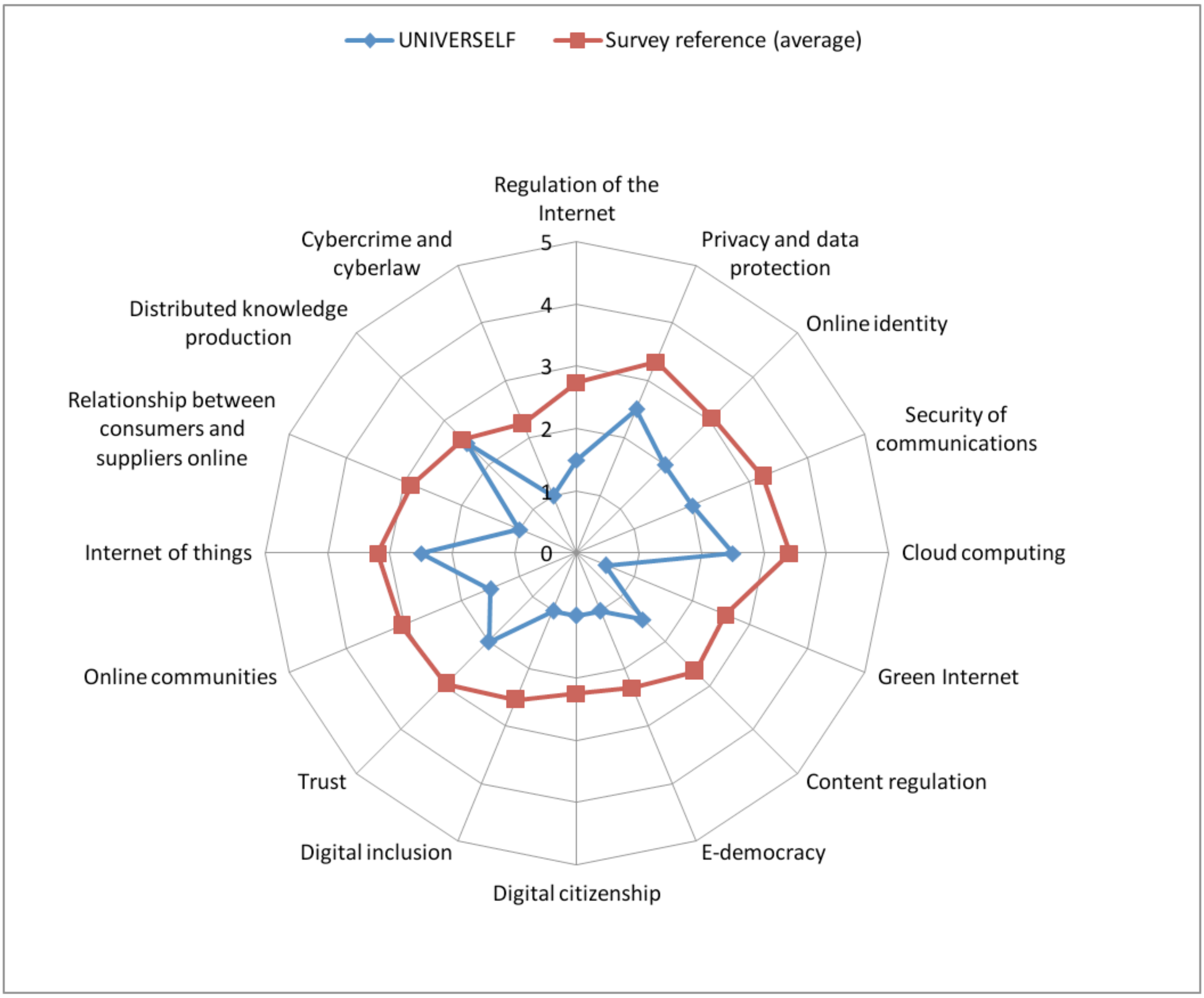

Figure 43: Socio-economic Profile for UNIVERSELF in Comparison with Survey Reference

When comparing UNIVERSELF's socio-economic profile with the average socio-economic profile extracted from 92 participants in the SESERV survey, UNIVERSELF is found to *emphasize the Distributed knowledge production socio-economic topic beyond average* (*cf.* Figure 43).

C.12.3 UNIVERSELF Stakeholders

The set of stakeholders interested in UNIVERSELF includes:

- Connectivity Providers such as Edge ISPs (including 3G and 4G operators), Transit ISPs who provide Internet connectivity services.
- Information Providers including Application Service Providers, Content Distribution Networks, Communication Providers, Gaming Providers, Market Place Providers and Internet Retailers who need Internet connectivity in order to offer their services.
- Members of the Users meta-stakeholder, which includes residential and business customers who buy connectivity to Internet, as well as End-users who use a consumer's Internet connection to meet their communication needs.

- Infrastructure Providers such as a Network Component Provider and in particular an Access network provider.
- Policy makers: Regulators, Security agencies who set competition policy and pose privacy, security constraints.

Note that for each of the dedicated tussles being discussed below, a variety of single or multiple instances of these stakeholders may exist and that they are in these different cases in charge of various positions and benefits/drawbacks.

C.12.4 UNIVERSELF Tussles

A tussle exists between the involved ISPs if a set of infected end-users performs a Distributed Denial of Service (DDoS) attack to a targeted end-user by sending unsolicited traffic. Internet is sender-driven which means that the traffic destination has limited control over incoming traffic. Existing technologies that mitigate the effects on the receiver, such as firewalls and NAT servers, cannot avoid the waste of significant network resources. This is especially true for the Destination Edge ISP (the ISP who serves the targeted end-user) that receives all this traffic. Thus each Destination Edge ISP wants to block malicious incoming traffic at the entrance point, but the rest ISPs on the path may not have the incentive to do this at their entrance point. The reason is that a Source Edge ISP wants to forward its customers' traffic and Transit ISPs usually charge their customer ISPs based on the volume of traffic. Using a reputation system for end-users to prioritize traffic to/from trusted users in case of network overload, for example, could allow ISPs to mitigate the effects of a DDoS attack. Such a reputation system (as shown in the figure below) could be based on valuation reports of user behaviour (based on their application context, *e.g.,* successful data streaming, failed login, ... that are generated, collected and distributed among the ISPs. In this way, Edge ISPs can collaborate in fighting DDoS attacks and collectively gain by providing better services to their customers and block traffic as soon as possible.

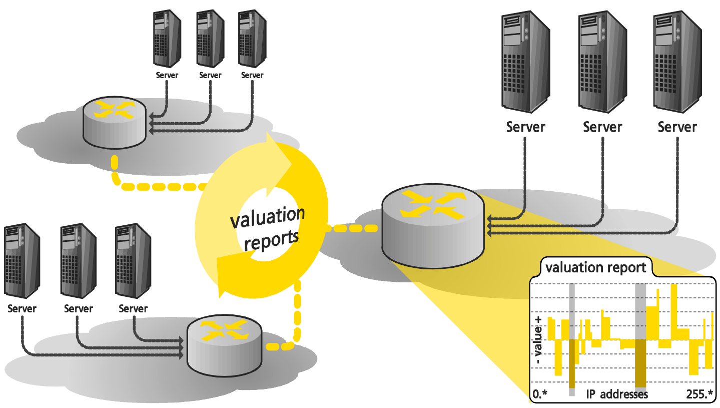

Figure 44: The UNIVERSELF Reputation System for Preventing DDoS Attacks

A tussle can arise amongst a Connectivity Provider who wants to optimize resource usage and users forced to handover to another access-point, consuming more energy or suffering from congestion.

A tussle may appear between an Information Provider, an Edge ISP that hosts a service competing with the Information Provider and subscribers who have a preference on the service origin. In this case the technology can give an Edge ISP significant control over the provider of complementary services (a situation known as “walled-garden”).

A tussle can arise amongst an ISP who wants to offload its LTE-based 4G network and an Infrastructure Provider who prefers to save energy by turning-off under-utilized 3G cells.

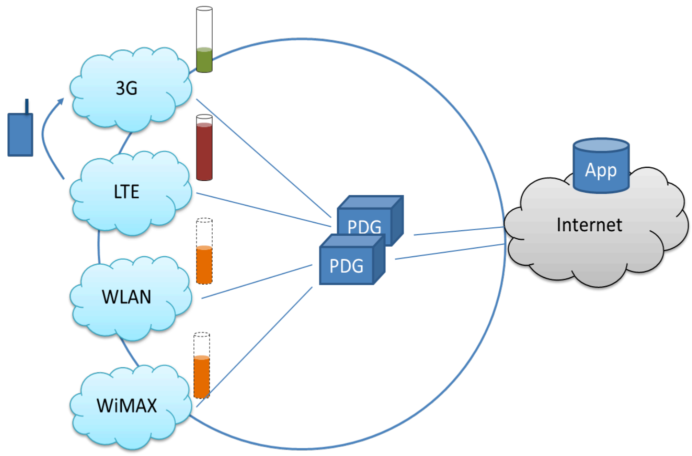

Figure 45: Offloading an LTE-based 4G Network Using an Under-utilized 3G Cell