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Executive summary

One objective of the SAIL project is to analyse the socio-economic impact of the new, Future Internet related technical concepts. This work has been divided into several stages. In the first stage, the high-level business analysis of the new technical concepts was carried out and recorded in the deliverable 'Business analysis for use case scenarios' (D.A.1). In this second stage, the deeper analysis of the three socio-economic aspects of the Future Internet, i.e. the Intangible Aspects, Business Aspects, and Regulatory Aspects, is carried out. The results of this of work have been recorded in this document.

With respect to the **Intangible Aspects** (Section 2), work focuses on the analysis of major impact that internet can create on the society as a whole, due to the externalities it produces. The externality is something that, while it does not monetarily affect the producer of a good, does influence the standard of living and welfare of the society as a whole. The analysis highlights a selection of a few major externalities and proposes an economic method to evaluate them; this method has been applied to an exploratory example to swiftly evaluate the model's usefulness for the SAIL context.

With respect to the **Business Aspects**, work is divided into three focus areas according to the SAIL technical concepts:

- In Section 3, the global content delivery scenario "NetInfTV" is analysed by studying value networks of information-centric networking (ICN). First, key trends and uncertainties of ICN have been identified. The main finding here is that the current content delivery trends could be well supported by information-centric paradigms. Then, in the value network configurations (VNC) analysis, solutions competing with NetInf are compared by drawing an analogy between content delivery models that provide the same piece of content from multiple locations (cache servers) around the Internet. To challenge currently dominating VNCs, novel architectures, such as Netinf, need to allow feasible revenue sharing between actors. And third, two interesting business models for NetInf were analysed. Both models seem promising, but more in-depth study is needed to validate their feasibility.
- In Section 4, a business analysis of the Open Connectivity (OConS) Use Case "Creating and Sustaining the Connectivity in Wireless Challenged Networks" is carried out. Market scenarios have been developed for the metropolitan and rural areas identifying the key actors and their roles, and presenting a SWOT analysis for the most important actors.
- In Section 5, the most relevant dimensions of the cloud networking service adoption on the enterprise market were identified. A number of interviews with clients and sector professionals have been conducted; the qualitative analysis shows that corporations are likely to adopt the service more extensively than SMEs do. Also, it seems that the network operators can competitively offer cloud-based turnkey systems to their enterprise customers.

With respect to the **Regulatory Aspects** (Section 6), the main target in this stage is the identification of the potential regulatory issues related to the new SAIL concepts. The work focuses on the direct impact of the new technologies on regulation, and has been made from the perspectives of Interconnection, Privacy and Trust, Charging, and other regulatory issues. The analysis has revealed several issues that need to be resolved to widely exploit the SAIL concepts.

1 Introduction

1.1 Motivation and objective of document

The SAIL (Scalable and Adaptive Internet Solutions) project will broaden the range of application models that can be supported in the Internet by making it easier to develop, deploy, and securely run complex networks. This will increase business opportunities for a wide range of players, ensure the economic viability of the future Internet, and foster the creation of new products, services, and markets.

The SAIL project focuses on three main technical work areas and will provide a working solution for these areas, i.e., a Network of Information and Cloud Networking with Open Connectivity Services. In addition, the socio-economic assessment of the above mentioned technical concepts is made from the following three perspectives: Intangible Aspects, Business Aspects and Regulatory Aspects.

To keep the socio-economic work well structured and to ensure clear cycles of innovation, we have split the work into several stages.

In the **first stage**, the high-level business analysis of the new technical concepts was carried out based on the scenarios and use cases which were created in different Work Packages of the project. The scenarios, use cases, and the results of this business analysis were recorded in the deliverable ‘Business analysis for use case scenarios’ (D.A.1). That deliverable and the proposed methodology created the foundation for a deeper analysis of the three socio-economic aspects of the Future Internet. The results of this **second stage** of work have been recorded in this document.

In the **third stage**, when the final versions of the scenarios and technical concepts have been further developed and have stabilised, the socio-economic analysis will be refined and broadened, resulting in the final evaluation of the SAIL concepts from the socio-economic perspective (deliverable D.A.8). In the course of our technical development, the socio-economic aspects-related research will be kept consistent with technical work. In close cooperation between the Work Packages, the business and regulatory recommendations will be iteratively extended.

1.2 Structure of document

After the introduction given in this section, the document is structured as follows. In Section 2 the Intangible Aspects of the new scenarios and use cases emerging from the new SAIL concepts are discussed.

In Sections 3, 4 and 5, the Business Aspects are discussed separately from the points of view of each SAIL concept. Each section analyses one WP scenario identified in D.A.1 deliverable. Section 3 uses value network configuration methodology introduced in D.A.1 to study different value network configurations of information-centric content delivery focusing especially to those that are of interest of NetInf; Section 4 studies OConS wireless mesh networks using experiences of earlier studies, SWOT analysis and value network analysis; and Section 5 uses stakeholder interviews to study the chances of offering IT/IS solutions on the cloud with CloNe. Even though the research methods vary between the sections, they all share an overarching goal to evaluate the feasibility of SAIL concepts by studying the resulting value networks and industry architectures.

Section 6 focuses on the Regulatory Aspects of each concept, and finally Section 7 concludes and gives guidelines for the next stage of work.

2 Intangible Aspects

For technicians a new technology is successful if it has interesting technical characteristics and provides new technical opportunities, while the market success of a new technology, although excellent, depends strongly on the customers viewpoint and on the capability to satisfy current or potential user needs in a sustainable way.

Up to the recent past there was the tendency to handle separately technical and non-technical topics, addressing to the latter only after technologies had been developed; but in a global networked society this tendency may prevent the take-off and success of new technologies in the areas of the Future Internet ecosystem. **The final users heavily impact on the spreading of new technologies, as they have the buying power**: therefore their point of view, as well as all what can influence it and their willingness to buy new service, must be studied and evaluated.

Starting from the question: ‘How will users (humans or machines) benefit from the technology advances in SAIL?’, the intangible aspects researches address potential impacts that SAIL technologies can have on the end-customers, their consumption behaviour, new trends in their lifestyle and on society-at-large dependability on the future internet infrastructures and services.

The target of the intangible aspects section is to link the technology with the customers and their needs and requirements, analysing before the SAIL technologies are designed what are the possible benefits that they could enable or provide (sections 2.2, 2.3, 2.4, 2.5 and 2.6). But there are also potential negative effects that must be investigated: attention should be paid to potential network-based criminal activities and to, a lot of questions about privacy, security, access control and identity stealing that can arise and create new worries to private persons and businesses (section 2.7). These negative outcomes must be faced as they could hamper significantly further evolution of SAIL innovative technologies. In addition, users do not change their behaviour suddenly, but an adoption period is needed and a detailed understanding of how customers will likely adopt and use services is required. Moreover, new models are needed to give an economic value to the intangible aspects (sections 2.8 and 2.9). Therefore a proposal to identify a model and measure the intangible aspects is approached in the SAIL environment with an exploratory example use.

2.1 Physical and non-physical assets

Intangibles are non-physical assets, opposed to physical ones. But not all assets lacking substance are classified as intangible assets. Money owed or an account receivable, for instance, is considered a current account, even though it has no substance. Furthermore, expenditure can be qualified as intangible asset only in case a company expects benefits from it in the following years and that expectation is supported by evidence.

The intangible aspects may vary a lot according to the issues they are related to; therefore a unique definition or list of them cannot be found in literature. Although they lack physical substance, intangible assets—also called intangible property in the financial context —may represent a substantial or major portion of a business total asset. It must be noted that these assets are considered “intangible” not only because they are non-physical assets, but also because it is quite difficult to assign them a proper financial value, in spite of being recognized as valuable by the stakeholders.

The business literature in the last decades is of interest because it clearly differentiates between tangible resources, which it refers to as financial capital, and intangible resources, which it refers to as intellectual capital. The interesting aspect is that in literature is a proven economic fact that tangible assets are only part of a company capital, while almost seventy-five percent of a company’s value is located in intangible assets ([1]). What’s more is that these assets, although not in physical form, can be utilized as **a source of value and real revenue for a company**.

Revenues enabled by the internet cannot be only thought of as money flows coming from equipments selling, from applications and services usage and subscriptions, from the internet-enabled businesses, and from the even growing advertising-based business models: that is, from the concrete, or tangible, aspects of the current internet. But a lot of different money flows are directly or indirectly enabled by the internet, not coming from direct buying or selling of goods: they derive from the so-called intangible aspects, as internet has proven to be the root engine for the *knowledge economy* era.

The intellectual property refers to a number of distinct types of creations of the mind for which property rights are recognized and protected with the corresponding groups of law. The intellectual property has become such an important factor behind companies' competitive strength, and in the internet 2.0&more society this statement is true also for private individuals and small groups.

It is quite common, in fact, that personal knowledge or abilities or competencies (collectively known as “contents”) are sold or made available through the network to other persons or even to large companies and potential customers can be found all over the world. As revenues enabled by the intangible clusters may derive from many aspects, it is not easy to make clear what all the potential money flows are.

All these intangibles can create a quite large impact on the society as a whole, due to externalities created by the internet. In the economics language the externality is something that, while it does not monetarily affect the producer of a good, does influence the standard of living and welfare of society as a whole. A good definition of the phenomenon is that an externality is an effect of a purchase or use decision by one set of parties on others who did not have a choice and whose interests were not taken into account ([2]). Two types of externalities can be recognized:

- A **positive externality** is something that gives benefits to the society, but in such a way that the producer cannot fully profit from the gains made. Examples are environmental clean-up and research: a cleaner environment certainly benefits society, but does not increase profits for the company responsible for it, as well as research and new technological developments create gains on which the company responsible for them cannot fully capitalize.
- A **negative externality** is something that costs the producer nothing, but is costly to society in general. Examples are much more common: pollution is a very common negative externality; a company that pollutes loses no money in doing so, maybe even it saves a lot of money, but society in the whole must pay heavily to take care of the problem pollution caused.

The above mentioned examples are related to the economics and business world, but externalities are very often relevant in many other society situations. For instance, crime is an externality of the drug market, as well as hydrogenated vegetable fats market downsizing is an externality of the World Health Organisation (WHO) researches.

As to the internet world, a lot of externalities can be recognised, if we compare the present life and lifestyles in the developed world with the life and lifestyles which belonged to generations not so far from the teens or the so called “digital native generation”.

A selection of a few externalities will be described, detailing issues such as importance, meaning, impact on society, perspective on societal changes they make viable, etc. A more detailed discussion on intangible aspects related to internet and on externalities can be found in the SAIL deliverable D.A.1 ([3]). This section includes:

- Focus on the intangible aspects lists those intangibles that will be deepened
- Success for community-based Internet: discussion on the first aspect with a positive impact on the society

- Bridging the digital and education divide: besides traditional conditions that could limit internet and internet based services adoption, there are new specific external influences that today should be faced to promote the development of an innovative, always connected society
- Internet democracy: the possibility offered by the internet to spread information of any type everywhere and immediately in the world to anybody has opened new scenarios where the word ‘democracy’ is enlarging its meaning
- Early lessons to think over presents some relevant intangibles, previously discussed, that are already covered by SAIL researches in the technical WPs
- Internet abuse section focuses on the fact that abuse often comes from the difficulty to settle a clear and sharp border line between convenient usage of internet and misuse and highlights negative externalities that may result from that
- The economic evaluation of the intangible aspects presents a proposal to identify and measure the intangible aspects, given that it is always a matter related with the subjective individual's point of view at a given moment in time and under a given socioeconomic context
- An exploratory example use of the Technology Acceptance Model (TAM model) in the SAIL context section presents an example to swiftly evaluate the TAM model usefulness for the SAIL context
- The Conclusions section lists major findings in the Intangible Aspects area.

2.2 Focus on few high value intangibles

Among all the **intangible aspects**, few of them can be assumed to have a **higher social and / or economic value, due to the externalities they produce**. Many recent examples in the world have shown how intangibles can have a potential disruptive impact on the end-customers, their lifestyle and on the society-at-large.

In the following sections four externalities will be addressed, giving an example on how they can impact on / take advantage from technology and connecting them with proper technical aspects developed in SAIL. Valuable positive externalities can be found in:

- *Community satisfaction and community participation* (in Human experience cluster) are the variables that explain success in community-based Internet for information-centric networking better than demographic variables
- *Bridging digital / education divide* (in Human & Organisational clusters) with ease of access and continuous help provided with cloud networking
- *Internet democracy*, from the experience of these days with North Africa protests: Algeria, Morocco, Egypt, Iran and all the other countries lying along the Mediterranean Sea are experiencing the importance of a network of information that helps people staying in touch and configures itself according fast changing needs.

An example of negative externality will be also discussed:

- *Internet abuse* can have a negative impact on personal feelings and personality, an excess of connectivity could become “addiction”. An example of vicious circle, how can it start and develop, referring to the always on – any device connected society
- *Internet dependency* can have a negative impact on personal self-sufficiency and everyday creativity. Examples are plenty in the younger generation that rely on internet to solve their daily affairs not developing their own reasoning based on their previous experience.

2.3 Success for community-based Internet

The influence of the internet in community life is a research area that impacts, of course, on the digital divide gap. But in the current research issue, in an ‘internet-for-all’ future perspective, we are focussing on the relationship between the internet and the community outcomes. The investigation will be mainly on the participation of individuals in their communities and their satisfaction with community life.

Up to now, the demography of internet access shows that there is a strong correlation between education, income and internet access. Individuals with greater education and income are also the ones that typically have greater access to the internet than their less educated and lower income counterparts. This outcome is true in all the developed countries, as can be seen in each national statistical institute researches on telecommunications usage.

According social researchers who spent time on it, the pivotal question to be answered is: do individuals who have access to new media differ from those individuals who do not have access to new media in the context of community involvement and community satisfaction? The reasons for which this research question is important are that it helps us better capture the relationship between the internet and the community, beyond the traditional displacement-based framework, and it informs pragmatic decisions about creating technology access points in communities.

According to Dutta-Bergman ([4], [5]). The internet is a facilitator of economic, professional, and social success of individuals and communities by providing access to valuable information. Therefore, **community internet access** is an empowering tool in the production of positive community outcomes. This fact is especially true to **enable social inclusion** for the elderly, for differently-abled people, for chronic or temporary invalids, for mothers or families with babies and, in short, for anybody who has any (temporary) reason which forbids her/him to live a normal life, as access to the internet empowers people by connecting them with information and helps them connect with community and society. Non-access, on the other hand, creates social isolation and perceived non-existence.

Another possible hypothesis is that individuals that choose to be active in their communities also perhaps choose healthier communities to live in that provide access to a wide variety of resources, including access to new technology. Community satisfaction, similar to the role of internet access in the domain of community participation, shows a positive relationship with community internet access. The internet is an enabler that opens up doors for individuals to a plethora of resources. Therefore, individuals that live in communities that provide them with access to the internet are more likely to be satisfied with these communities, compared to individuals living in communities without access to the internet.

2.4 Bridging the digital and education divide

It is not easy to estimate the social (intangible) value that internet has to bridge the digital divide. A possibility comes from some aspects of the service adoption theories, specifically the separation of behavioural intention from behaviour. The service adoption theories have the aim to predict consumer intentions and behaviour as well as a relatively simple basis for identifying where and how to target consumers' behavioural change attempts.

The *strength* in the models is essentially the fact that the behavioural intention is separated from the actual behaviour. So this model can be helpful to understand consumers' personal value ranking on services or goods, highlighting where the value has sign 'plus'. Besides, it explains the individual's social behaviour introducing the "social norm" as an important variable.

The *traditional limiting conditions*, that have value sign 'minus' and can have a strong influence on the final outcome, are: social pressure, compliance with social group behaviour and subjective beliefs on others' expectations. Examples are:

- I don't feel comfortable with new uneasy-to-use devices, but I must buy them to feel inside my friends group
- I would go to the theatre, but my family expects that I take photos at the school family day

- My intention is to learn how to use a new cell phone, but I become angry with difficulties and throw it away

Besides traditional conditions that could limit service adoption, there are new, specific external influences that produce intangibles with a ‘minus’ value, as they prevent the development of an innovative, always connected society.

2.4.1 Limiting conditions: technology divide

There are **limiting conditions** that arise directly from the technology itself, but much more arise **from personal perspectives and feelings about new technologies**. An example in the first area comes from the fact that teens are ‘digital native’, while people who are over 30 are ‘digital immigrants’. There is a language gap that is difficult to bridge: e.g. social media spreads information horizontally, while analogical media spreads information vertically, usually in a top-down solution. Older people are often even more uneasy and unwilling to start using new services (I don’t feel comfortable with new stuff; I just want to use devices I’ve always been accustomed to). Also older people have physical limitations that can impair their service adoption tentative, as for example less eyesight capabilities, less finger flexibility and also less conceptual flexibility that make difficult a high rate of adoption of technological innovations among older people if these factors are not accounted for.

One of the main concerns of the technology developers should be in bridging the technology divide between successive technologies incremental developments. On one hand the technologies and services human interfaces must be adapted to the end-user previous experiences in order to favour their initial experiments with the new technologies and services. On the other hand the interfaces should be as self-explanatory and intuitive as possible to shift the mental effort of the adopters from how to use the technologies and services into perceiving how to apprehend some type of added value by the adoption. Simplicity, low effort and added value are the key words to consider in respect to new services being offered: all together they could change the social value for this intangible aspect from ‘minus’ to ‘plus’.

2.4.2 Limiting conditions: educational divide

A second, and most important, area of limiting conditions is **the educational divide.** In the following section there are some sentences showing how large this area can be. These sentences are examples of feelings belonging to people who are not in digital divide, but don’t want to have access to internet: “I don’t know how to …”, “In case of problems I don’t know what to do”, “I don’t want to interact with machines instead of humans”, “I’m not interested in…”, “I feel afraid of making mistakes”, “I don’t want to show others that I’m not on a proper level of competence”, etc. The different situations could be gathered in a bulleted list as follows, pointing out what aspects seem to specifically struggle against the building of a “knowledge society”, and wide opening a digital and educational divide:

- There are people who think internet is **not important or useful,** or that it is only a waste of time, or that advertised services are not interesting for them
- Others would like to use internet, but they **feel inadequate** to use it. This is especially true with the elderly with no skilled persons to help, or in case of people who started with internet, but feel that it is a hard job for them every time they switch their pc on as they are afraid of making mistakes
- Some people think that internet = games & chat & movie. People in this group are usually young, they are in the “digital native” area, but they only have a **limited experience** on it. They possibly spend a lot of time on their PCs, but neither have a satisfactory real social life, nor have many interests alternative to gaming and entertainment
- The last group includes people who are **afraid of internet**, as their feeling is internet = danger. People in this group think that security is impossible on the networks, as internet is crowded with people chasing for the opportunity to fraud or steal money or

sensitive data. Possibly they are the same people who don't want to use credit cards and online banking, and try to avoid any type of online exchange of sensitive data.

These issues underline that in the developed world there is a tendency to build a "knowledge society", but a kind of "**mental gerontocracy**" still live in some strata of the society, not due to age, but mainly to a conservative behaviour. The gerontocracy behaviour opens a wide gap among traditional behaviour and innovation, old schemata and new tendencies, but it is not only due to the physical age: it is more the result of a backward-looking cultural behaviour that often is typical of education deprived both old and young people.

Another important gap has been opened among generations: a linguistic gap that is tightly linked to the **knowledge and experience of the digital world**. People aged in the 'baby boomer' and 'X' generations have a different approach to the digital world than the 'digital native' and the 'Facebook' generations. The youngest generations use digital media in an innovative way to discuss, participate, communicate and meet together in a different way respect to the paper and tangible media. The traditional way to communicate is unidirectional, slow, in a top-down, from-one-to-many way. The Facebook communication is changing social relationships as it reaches people in a peer-to-peer, fast, immediate, networked way. Opinion leadership is not the privilege of well-known persons, but is a fast changing attribute of persons who participate to discussions and prove to be solid and reliable in what they say and witness. Opinions are shared among billion people every day, therefore internet access has become a unique opportunity to teach, learn, participate, communicate and build a knowledge base (either local knowledge, either global knowledge) ubiquitous accessible.

The educational divide is another important intangible whose value in social terms could be changed by internet from 'minus' to 'plus' sign. In fact the educational divide opens a wide gap between people who are going along the path of the Facebook communication societal changes and people who are tied to traditional communication ways and between developed and developing countries. Should it be overcome, all strata of population could enter the political and social arena and the poorest countries could enter the developed world arena ([6]).

2.4.3 Limiting conditions: Psychological and privacy concerns

Human behaviour is acquired and conditioned by human interaction and behaviour imitation. The social internet current paradigm can be seen as a social bridge and a social value diffusion tool within widespread communities thus contributing to a global cohesive view of social knowledge and subjective norms worldwide. Psychological social distance and disregard of social norms (negative intangibles) seem to grow in the population either in urban or rural areas due to social isolation. But it can be broken by social networks supported by the internet, producing a positive intangible value.

Internet social networks are considered by many digital immigrants as a privacy invasive tool that brings more causes to worry than added value to their lives, therefore a common behaviour of those that are not digital natives is to have a high degree of psychological distance towards social network services.

The gap between the social network early adopters and early majority class (usually digital natives) and the laggards class (digital immigrants or older people) might not ever be bridged causing these two segments to be ever far apart in their social understanding of the world and on the subjective norms that they obey, eventually causing a generation disruptive social gap.

2.5 Internet democracy

The possibility offered by the internet to spread information of any type everywhere and immediately in the world to anybody (positive intangible value) has opened new scenarios where the word 'democracy' is enlarging its meaning. Given that information is power, today everyone is potentially enabled to share the decision power and new, unpredictable ways of information distribution sprang into our world. A recent example of this intangible is the spreading of Wikileaks (Annex 3): reactions and possible impact of this quite new way to use the internet are analysed below.

2.5.1 Reactions to Wikileaks

A CBS TV poll (Figure 1) shows that 60 percent of Americans think that Wikileaks' publication of secret files will have a negative impact on relationships between USA and other countries. In the same poll, 73% of interviewed persons agree that public opinion should not be entitled to know secrets related to national security, while 25% of people think the opposite and the remaining 2% have no opinion ([7]).

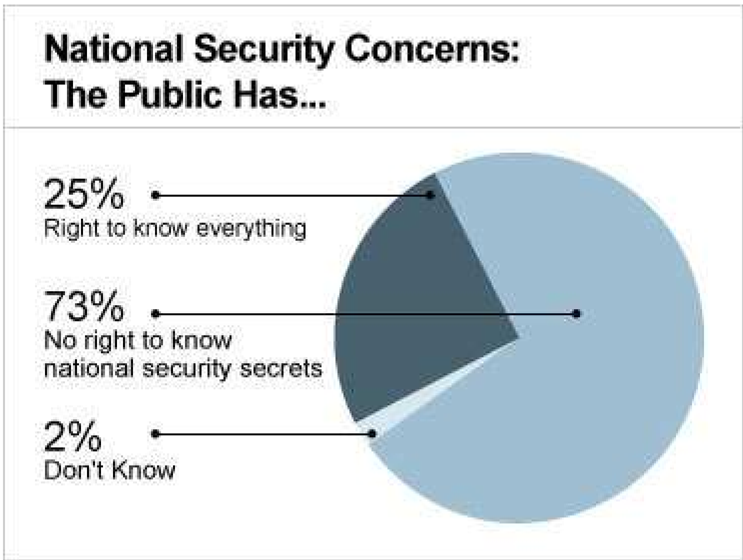

Figure 1. CBS News Poll: Americans Concerned WikiLeaks Dump will Hurt the U.S. (source: [7])

Bradley E. Manning, the USA soldier who was arrested in May 2010 on suspicion of having passed restricted material to Assange, is prosecuted for "help to the enemy" ([8]). The Pentagon says that the publication of reserved documents Julian Assange's site Afghanistan and Iraqi wars first, and then the publication of the diplomatic cables sent by USA Ambassadors, put in danger USA military troops and civil residents.

The American Central Intelligence Agency (CIA) has created the Wikileaks Task Force to evaluate the possible impact that Julian Assange's revelations will have, especially on the relationships among the American government and informers. In fact one of the worst possible impacts is that the American government could pass a sense of unreliability, thus reducing or destroying its possibility to be the recipient of important, secret and 'hot' information from the informers: secrets will not be revealed to whom who are not able to keep them safely.

Other reactions come from governments all over the world and from organisations (such as the above mentioned CIA) involved in all cables and files Wikileaks published. Wikileaks files gave start to significant changes in governments relationships, due to the unveiling of hidden reports and links they have among them and with other organisations.

2.5.2 Possible impact from Wikileaks' secret cables publication

Wikileaks has published such a great deal of governments' secret files that never in history happened to be unveiled and this fact could impact heavily on future societal life.

Reactions are really different: in general people are sceptical and react with sufficiency as to the real importance and impact the cables could have on the current political arena. The general feeling is that "everybody knows that CIA spies on UNO" or that "Berlusconi is obsequious with Putin", therefore almost nobody cares about the so-called 'Wikileaks revelations'. But it is difficult to agree with the feeling that nothing interesting, new, or important will come out from the Wikileaks cables, as only a small percentage of the half million documents were analysed up to now. Then, it is quite different to suspect or to be definitely certain and the Wikileaks cables are evidences, as almost nothing has ever been contradicted.

Another important consequence is that whistle blowing could become a normal practice inside companies and governments, forcing government leaders and top managers to an ethical and transparent behaviour with the support of innovative technology. This issue shows off that Wikileaks could be a viable instrument to change relationships among political classes and supporters or voters and in the end between Politics and Society.

Impacting evidence is also that traditional media are fast losing their power, while the “blogosphere” influence is fast improving its weight. People appear to be more concerned about transparency, as recent riots in North Africa and the nuclear disaster in Japan are showing. The demand for a clear, plain objective and frank information on any situation is rapidly growing, as more and more people get used to deepen news from different viewpoints.

As an example, Al Jazeera has dramatically changed the way to inform in the Arab countries. It shows facts in the meantime they are happening and comments are given from different viewpoints. It looks more like a blog, than an official voice of governments.

Another example: the Government official information on the Japanese disaster has showed in short time to be “accommodated”, while webzines, blogs, TVs and online newspapers all over the world were giving large relevance to the nuclear hazard and possible consequences. Japan’s Prime Minister has been seen all around the world when, interviewed by NHK (Japanese public TV), answered in a shy and hesitant way to journalists tough questions on the nuclear plant and related danger; then he was pressed to answer in a loud voice: a really new approach by Japanese journalists who were asking for transparency and not for formality ([9] on Japanese Government facing criticisms for the government’s handling of the nuclear crisis, for giving no transparency to N-meltdown and for being aware of possibility of reactor core's meltdown before quake).

Here the really interesting point is reached: **Wikileaks cables** are not seen as really dangerous because they unveil crimes or wrong doings of world Governments in the past, but because they **force world Governments from now on to behave truly democratically and be transparent**. This conclusion unveils how large and valuable the impact of innovative technology like SAIL can be on the societal life, as detailed in the section below on few significant example.

2.6 Early lessons to think over

If we look at the recent events in the world from the SAIL viewpoint, some lessons could be learnt. In the comments below some recommendations that SAIL technology should take into account are in bold.

2.6.1 Flash crowd

[…] At no period in human culture have men understood the psychic mechanisms involved in invention and technology. […] ([10]). About 40 years ago Marshall McLuhan presented a view that is still a pillar when forecast are needed on technology spreading. In the developed world discussions are focussed on deploying next generation networks to give access to everybody and in any situation to bridge the digital divide in an ‘old fashioned’ style.

In the meantime, in the developing world both youngsters and older people are bridging the digital divide in an unconventional way: aimed to **exchange as many information as possible** in the fastest way and **in the widest possible range**, people are **using any media** they have **building temporary networks** including mobile phones and any type of portable devices.

SAIL impact

This aspect of interactions and data exchange is innovative for the current internet, but sounds quite familiar for SAIL WPB – NetInf and WPC – OconS. One of the proposed scenarios ([3]) in fact is specifically devoted to support flash crowd, both to support efficient information exchange and connectivity needs. In WPB the aim is to provide access to contents in a fast and effective way without relying on centralised servers. In WPC the aim is to face a fast change in the network connectivity management due to a flash crowd, i.e., a large group of people with mobile devices in a location where there is an increased demand for communications and services in case of an expected or unexpected event.

2.6.2 Liquid technology to improve democracy

The old discussion whether technology is able to change the world or if mankind is the only subject able to make changes is proving to be old-fashioned. It is quite obvious that technologies are not able to make revolutions, whereas people are. But insurrections in North Africa are proving that **new technologies and media are social enablers** for those situations. In fact they enable people **to get information, discuss, stay in touch, communicate and orchestrate events**, becoming so long an undistinguishable part of the process itself. The internet has grown up as an effective instrument to gather people together and to improve democracy.

Technology has become *liquid* respect to people's life: it is part of people's experience and can be separated from people no more than dresses or food could be. An example: on January 25 and 26, 2011, Twitter and Facebook were blocked in Egypt during the recent Egyptian riots. On January 27, various reports claimed that access to the Internet in the entire country had been shut down and the responsible authorities achieved this by shutting down the country's official Domain Name System, in an attempt to stop mobilisation for anti-government protests ([11]). Major ISPs across the country had to explain to users that their servers were also taken down, though a few ISPs remained available.

But during the nation's internet ban, continued for a full week till February 2, a growing number of citizens found new ways to communicate without direct access. Some users turned to dial-up modems to connect to modem pools located in other parts of the region outside of Egypt, while other users found other ways to access the internet ([12]).

SAIL impact

In unexpected events like those, SAIL technology could be useful. Both WPB – NetInf and WPC – OconS are involved in this scenario (see [3]). The current cellular networks should evolve into mobile data services and networks architecture should evolve from a centralized and static model into a more distributed and dynamic one, also enabling mobile devices to connect each other using several access technologies with multiple interfaces.

The use case – Event with large crowd – specifically fits: it deals with a large crowd in a geographic location being interested in the same content, such as live broadcasts of the event itself and/or related information. Especially when such events cannot be planned in advance, it is difficult to provide the requested content using the existing network infrastructure. Flash crowd 'consumer services' may be offered by local self-organized community networks or be supported by service providers with a global presence in the internet. From a provider/business-to-business view, flash crowd connectivity service providers will have the need for special edge-to-edge communication across the core networks as well. WPC – OconS may provide a solution, with the OConS provider in the role of a network operator or operator of a sub-network/domain. Among the others, the following challenges need to be addressed:

- Allocating resources dynamically and in an application-independent way.

- Provide content and services to users, Virtual operators, service providers, OTT service providers or any other parties. Avoid bottleneck in both access and core networks
- Address cooperation, self-organization and opportunism in various types of networks, from infrastructure to spontaneous ad-hoc and wireless mesh, even to share content locally, e.g., over WiFi / Bluetooth - after it has been received over the mobile communication infrastructure
- Use virtualization and dynamic allocation of resources in order to provide bandwidth isolation and support for services with stringent requirements
- Enable network operators to provide services to Over-The-Top (OTT) service providers, such as Cloud Networking (CloNe) and Network of Information (NetInf), and their customers in an optimized way. This may include connectivity and transport services between the (edge-)domains (represented by service or data centres): e.g. video creation, production and distribution
- Controlling how users/customers are authenticated and to what extent their authorization is sufficient for network attachment, service discovery and network domain usage. From an end users point of view it is specifically demanding to ensure privacy of information that is gathered to support the mobility management processes, while from the network operator side the main overarching security objectives are network availability and control integrity.

An information-centric network, like the architecture developed in WPB – NetInf, could provide the basic functionality for user-provided caching and possibility to retrieve information from multiple interfaces, while some resource management function would be needed to organise local redistribution of content over WiFi / Bluetooth.

Among all the opportunities an important question stands up: who has, or could have, the power over the internet? This is food for thought especially for the regulatory part of Sail.

2.6.3 Traditional media and technology cannot be cancelled by innovation

Some people tend to overstate the importance of the role that internet played in fuelling the revolution in the Mediterranean area: the right perspective seems to be that Arab people used well the tools they had at hand. The rapidity and resilience of internet-based communication can be admired. Additionally, it should be noticed how **the younger generation is shifting to new uses for the internet and new ways to share information**. Also the role of the social web must be acknowledged.

But also traditional media like Al Jazeera and older enabling technologies (i.e. mobile phones and digital cameras) were equally important in sharing the riots with the rest of the world and supporting the physical actions of people who were protesting (see [13]). The aim is to well integrate traditional and new media.

SAIL impact

A goal for SAIL could be to enable collaboration between traditional and disrupting media / technologies.

SAIL WPB – NetInf (see [3]) can be helpful for this scope, as it is addressed to the opportunity to have information accessed, used, stored and forwarded in an endless run according to the (fast) changing locations where needs of reaching information arise. The location for temporary storage of information can have social and regulatory impact. Social impact may happen in case the contents accessed undergo different policies in the accessing user country and in the storage server country. An example could be a content that is supposed to be free by the user, while the server country's laws/contracts/subscriptions envisage a payment. Another example is the case of a content that is public somewhere and is restricted in another location.

SAIL WPC – OConS (see [3]) could be involved in extending the variety of access technologies, as this WP is working to settle distributed mobility functions to provide the agility and the efficiency when moving between heterogeneous connectivity, while benefiting of the best (or most fitted) networking resources and optimal data path for each traffic flow. A number of problems should be faced to produce new devices, equipped with multiple interfaces, and to enable them to benefit from multi-homing and multi-path routing. Among the others, the following issues are closely related to the current aspect:

- Complexity to have fixed/mobile networks convergence work, to deploy existing protocols in a (flat) distributed network architecture and to support different types of fixed/nomadic/mobile on a single network architecture
- Per flow mobility anchor selection and activation, depending on communication context (type of application, user preferences, terminal capabilities, radio environment...)
- Managing connectivity requests for virtual resources over physical clusters of heterogeneous wireless systems (TDMA, CDMA, OFDM and OFDMA based systems). When a request for connectivity in a specific area served by a cluster of heterogeneous radio access technologies (RATs) is issued, the decision process should allocate the most adequate resources
- A coherent approach to carefully treat and manage identities and location related information. The need for coherent naming and related resolution schemes involves tight work with WPB.

2.6.4 Collaborative, up-to-date, real-time information

Innovative ways to share information involve also credibility. In the Japanese nuclear disaster the Government started transmitting continuous updates through the public TV service NHK. But social networking websites such as Twitter and Facebook have been invaluable in the aftermath of the Japan's earthquake as phone lines went down. Even local governments sent updates via Twitter when their servers went down and their web sites became inaccessible. Even TEPCO, the operator of the quake-damaged Fukushima atomic power plant, has a Twitter profile, but has been very slow to issue tweets. They started only about one week since the disaster, thus earning lots of criticism (see [14])

In such an unexpected and dramatic event the opportunity to have immaterial data and immaterial software running on servers could be really important and thus exhibit great intangible value to society in general. But also in the everyday life this is an increasing need: immaterial data (online accessible such as in Google docs), immaterial software (e.g. Picasa, Google docs, YouTube) and the only material thing is the device and its interfaces, so that we could be free from a lot of problems. The youngsters already feel that features like **automatic synchronism, real-time collaboration, and instantaneous storage access** are unavoidable, as well as to have locally the last updated version of documents, collaborative chatting and editing, real-time co-working.

SAIL impact

SAIL WPD – CloNe (see [3]) can help in this vision with the introduction of cloud networking in enterprise and private life. Cloud networking provides an enterprise with more flexibility in its operations and the way it does business. So far cloud computing has demonstrated the ability to flexibly scale services to provide on-demand and pay-per-use IT. With flash network slices, cloud networking introduces dynamic geographical distribution and flexible network provisioning into the equation.

The dynamic geographical distribution capabilities can be a valuable feature in catastrophe scenarios like in Japan possibly acting as a dynamic storage backup of information and recourse availability thus preserving knowledge and immediate working capabilities in the eventual presence of catastrophic infrastructural damages, either at enterprise or individual level.

Also people's private life could take advantage from this capability offer. In the virtual desktop use case, for instance, the enterprise could be substituted by a network or cloud provider and the employers could be seen as private persons. In this way maintenance and software provisioning are not in charge of private users, who can take advantage of having always a seamless access to every software and data, avoiding maintenance problems. In the same time resources are tailored according to instant usage:

- When browser/email is used, only low CPU/low memory configuration and connectivity to the Internet are provided
- If a student in Engineering has to develop a project for University, eventually using a heavy simulation program, a virtual machine with multiple CPU/GPU (Graphic Processing Unit) cores and large memory, with a high bandwidth access is required
- If an Architect has to present a project showing how a public park will be after innovative intervention, a 3D rendering software has to be used which requires virtual machines with access to high-end CPU/GPU s
- In the evening the whole family sits down in front of the TV set to watch the last 3D-all surround movie and also for them a high bandwidth access in real time must be provided

2.7 Internet abuse

Internet abuse is a negative outcome of the internet accessibility. It often comes from the **difficulty to settle a clear and sharp border line between convenient usage of it and misuse**. It is not up to this study say whether internet use is convenient or not, but there are some aspects, that could originate improper use, which must be known. Legislators and psychologists should pay specific attention to sensitive areas to make internet a positive experience for all. Also the SAIL project is involved in the issues listed below, as they can have a negative impact on the society and the willingness people have to use technology. Recommendations to bridge these issues can be found in the Regulation sections and in the Security Theme work.

2.7.1 Be aware of what profiles show

A first remark is that people should be always aware that **while surfing the web they (potentially) show the entire world what they are doing**. So they not only make available information on what they are doing, but they often become vulnerable beyond their awareness. Therefore everybody should pay attention to take advantage of the web as much as possible and in the meantime to be careful to protect him/her from 'being fished'. Therefore the following issues are linked with the security issues being discussed in the Security Theme of the SAIL project.

A first aspect is that the existing communication capabilities provided by the internet may be used across the boundaries of different legal frameworks to distribute or share data definitively not legal (e.g. terroristic information, child pornography, politically offending messages, etc.). Another aspect involves the need to protect ourselves and our sensitive data from Identity Theft while surfing or accessing sites that are not properly protected. Identity Theft is related to the stealing of a noun and of a person's financial information, especially credit cards, online bank accounts, Social Security number for USA and UK, and any other type of sensitive data with the intention of using that data to commit fraud and create a phony persona. A recent example is about Mio Sony customers, who were stolen of their user profile data (partially including also credit card details).

2.7.2 Educate ourselves

A really important issue is the need for everybody to educate his/herself about the net. The goal is to **be familiar with World Wide Web**, especially in case of families with children, otherwise it is impossible to keep under control their activity on the web and show them how dangerous contacts or relationships can be recognised and forbidden.

2.7.3 Preventing identity thefts

Knowledge, monitoring and forbidden access is also important even to protect ourselves and our sensitive data while surfing or accessing not properly protected sites. An Identity Theft is the stealing of a noun and of a person's financial information, especially credit cards, online bank accounts, Social Security number for USA and UK, and any other type of sensitive data with the intention of using that data to commit fraud and create a phony persona.

Another important thing that is often underestimated is the standard **internet safety**, including very basic rules that unfortunately even experienced users don't care about enough, as:

- Strong firewall and antivirus software and secure passwords are at the core of everyone's attempts to protect against identity theft
- Individuals must take measures to secure their information (generally online) or dispose of their unwanted documents carefully (offline)
- Under no circumstance give anyone own name, address or telephone number
- Pay much attention before meeting anyone in person met on the Internet

2.7.4 Real life vs. virtual life

Another quite new issue, featuring as a consequence of the "anywhere seamless access" concept, is the need to monitor ourselves to prevent possible damage from living both real and virtual life in the same time. Examples of effects due to this can be easily found surfing on the web. According to news sites ([15]), in February 2011 a young driver in Chicago has been accused of attempting to update her Facebook page on her cell phone when she allegedly struck and killed another driver. As more and more cases where the accident was caused by a driver using a cell phone, new rules for lawyers are being settled. "Texting and driving is now becoming an all-too-common situation that we see with many of our auto accident litigation cases. […] Just looking at my cases so far, we calculate a 1 in 9 chance (11%) that the negligent driver was using a cell phone at the time of the accident. I believe this percentage will likely continue to rise." ([16]).

2.8 The economic evaluation of the intangible aspects: a proposal

The intangible aspects identification and measurement on business, or in any other subject in life, is always a matter related with the subjective individual's point of view at a given moment in time and under a given socioeconomic context. In spite of these high degrees of freedom it is possible to achieve some consensus around some intangible aspects derived from business activities and their valuation.

Evaluation for intangibles can be done only if:

- There is an activity
- The activity can be clearly identified
- The activity is not a direct money flow
- The activity is not physical.

As previously described (see 2.1) the *activity* can be thought of as intangible asset if it is a resource under control of the activity producer. In case of the internet intangibles stakeholders and actors for the activity producer role can be (as per the definition on D.A.1) enterprises, cloud operators, network operators, content providers, business partners and even the end-users.

A constraint is that the resource must be produced by past events and that in the future it is expected that the activity producer will be rewarded with economic benefits. While "being under control" means that the activity producer has the opportunity to take advantage of benefits related to intangibles and to make them “exclusive”, while could be able to exclude others from using them: but this is different from ownership.

The *economic value* produced by the activity could be:

- Gains from product selling
- Savings on production cost
- Any other economic benefit
- The value can be separable from other economic benefits
- The production cost can be clearly identified.

Being not easy to evaluate all the mentioned aspects for intangibles involved in businesses, far more difficult is to identify and evaluate them for the intangibles involved with internet. This is why lateral thinking techniques had to be used to start solving the problem. A promising approach seems to be the application of innovative service adoption models.

2.8.1 A short description of Technology Acceptance Model

In the past decades several models have been proposed to relate the concepts of real and intended service adoption and usage. Its importance is due to the fact that it can be a guide for the development teams to better specify, adapt and develop new technologies and services tailored on consumer’s expectations and needs, thus enabling a higher adoption rate and a higher service usage rate and trying to guarantee a high degree of commercial success.

Among the others, combining the following classes of service adoption models look particularly fitting the intangible aspects area:

- The theory of reasoned action (TRA)
- Its evolution into the theory of planned behaviour (TPB)
- The technology acceptance model (TAM), which is a further improvement mainly from the first theory.

For a deeper discussion of the above mentioned theories, see [17], as here only the last one will be discussed.

The technology acceptance model (TAM – see Figure 2) is an extension of the TRA and TPB models aimed to modelling what are most important factors influencing users’ acceptance and willingness to use a new technology. According to TAM theory, attitude measures that are used in TRA are replaced by two major factors:

- **Perceived usefulness** (PU), defined as "the degree to which a person believes that using a particular system would enhance his or her job performance".
- **Perceived ease-of-use** (PEOU), defined as "the degree to which a person believes that using a particular system would be free from effort".

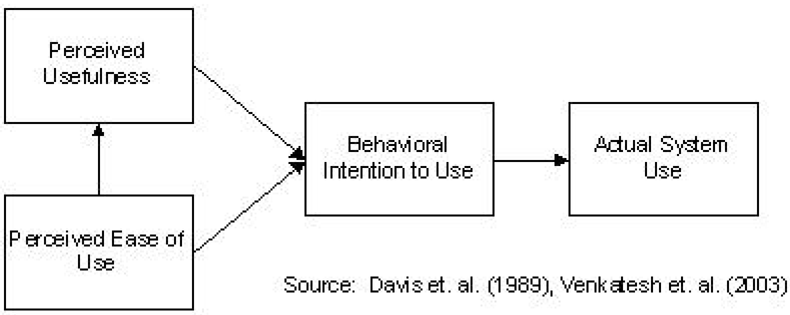

Figure 2. TAM model (see [20])

This model has captured the interest of researchers on the diffusion of innovations, thanks to the prominent role given to the perceived ease of use and to the simplicity and ease of use in empiric studies, becoming over the years one of the most used models of technology research and was used in several studies ([17], [18], [19] and [20]).

In spite of some other more recent modelling proposals for technology adoption the TAM model is still one of the models that deliver a very appropriate effort/prediction ratio due to its simplicity and high predictive power.

2.8.2 Strength and weakness of the model

The **strength** is that the TAM is able to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes based on past living and social experiences. In other words, it helps to identify the environmental aspects that impact on the users' acceptance and usage of a technology.

Perceived usefulness is also seen as being directly impacted by perceived ease of use. Besides, TAM recognizes an influence that social norms have on users. All these aspects are eligible for the present intended scenario evaluation of SAIL.

Weakness in the original TAM theory presented by Davis ([18]) ignored the aspect of social influence related to adopting and utilizing a new technology. Improvements on this aspect have been introduced by later studies (among others [20])

Another weakness is that the perceived ease of use and usefulness of technologies are investigated without analysing whether users are experienced in use of technology or not. In either case the perception of ease of use and usefulness can dramatically vary, but for innovative services this apparent drawback can actually be a good point because the purpose of the experiment will be to capture intention of behaviour towards a concept idea to test or a prototype service to test to actually help in the service development phase.

The **proposed approach** consists in applying a TAM model revised to the SAIL environment. The starting point is to see that TAM has strong behavioural elements, but no limits have been taken into account. The assumption that when someone forms an intention to act, then he will be free to do exactly what was planned without limitation can be only theoretical. In practice, constraints such as limited ability, time and environmental, educational or organisational limits will modify the freedom to act. Besides, there are unconscious habits that work against that freedom: personal attitudes and skills, the habit to behave in a traditional way, the 'educational divide' that prevents the elderly from a quick and fast usage of innovation, etc., as was discussed in previous sections.

The model should be developed to find out what intangibles will be helpful to bridge the gaps and enable a fast adoption of innovation and how the bridging value could be measured for each intangible discussed.

2.9 An exploratory example use of the TAM model in the SAIL context

In order to swiftly evaluate the TAM model's usefulness for the SAIL context, we resorted to 5 (five) structured interviews, supported on a guide script following the TAM model, to 5 Portuguese SME managers to assess the "Enterprise in the Cloud" scenario defined in D.A.1.

Usually the TAM model is supported by extensive questionnaires for statistical purposes, but as the purpose of this experiment is just to evaluate the applicability of the model and also to identify the main determinants that could later be used to complement the model for a real broader experiment, we decided to opt for a small set of structured interviews and not to use a broader questionnaire approach at this stage.

A guide script was produced with the description of the "Enterprise in the Cloud" service scenario that was explained to the participants at the beginning of the interviews. Then a set of five open questions were made, referred to the TAM model and the participants were encouraged to give their own views and opinions regarding the questions and also to make some philosophic considerations that they considered appropriate. They first answered the questions in a pragmatic manner and later they were allowed to deviate into philosophic opinions about the subject that was being assessed and the usefulness of the TAM model dimensions, in an attempt to explore new possible adoption determinants to be studied in a later phase of the project with a broader conceptual model.

Researcher interviewed (in Portuguese) the top managers of the SMEs that accepted the interview invitation and the answers were transcript into paper for posterior analysis. The reason for the choice of SMEs instead of large corporations in this stage of the investigation has to do with the fact that large corporations usually have their full-fledged IT departments and large IT resources available. Therefore, the incentive to change to a Cloud Computing scenario in large corporations should account for the reutilization factor of all of the staff and deployed infrastructures related issues that could bias the replies that we were looking for at this stage more focused on the intangible aspects of the service adoption.

The main findings of the interviews were the following:

1) All of the interviewees replied "Yes" to the question "Do you consider the "Enterprise in the Cloud" service useful for you and for your company?"

   Clearly all considered the usefulness of such a service to be a valid dimension influencing their adoption decision in a positive correlated manner, but all also mentioned security and cost benefit analysis to directly impact on their decision and on the perceived usefulness evaluation, thus from this question answers we extract that security and cost are also concepts related with, and that must be assessed with, the service usefulness concept. Another finding is that *à priori* all interviewees considered the service to be useful, thus giving a very good indication of high service adoption rates if the service will be able to technically deliver on its performance promises and exhibit a cost effective value proposition in comparison to local on-site installation hosting.

2) To the question "Do you consider that the service daily management and utilization could be difficult for you to use?" all interviewees replied "No".

   All of them expressed their expectation that using a service in the cloud should be as difficult, or as easy, as to use a local on-site similar service, as long as the network performance could permit a similar user experience in terms of waiting times and service availability. Form this question answers we can extract that ease of use is a valid dimension influencing the service adoption decision in a positive correlated manner, none the less this dimension user evaluation is dependent on the network technology that must assure similar user experience between Cloud Services and local on-site hosted services, therefore network broadband performance and network availability are relevant variables to consider when evaluating this dimension.

3) To the question "In case the service was offered to you today, would your intention be to adopt it?" None of the interviewees gave a definitive favourable answer. All of them stated that at the moment, and based only on the service description, they could not make an informed decision indication. Generically all of them said that it would depend upon the following variables to be assessed at the moment of decision: Cost comparison with current on-site solution, security features and capabilities available, service availability, easiness of the migration from current on-site solutions to the cloud networked solution, and intangible trust on the service provider to fulfil its promises and commitments. From the answers to this question it is clearly visible that service experimentation prior to adoption and robust SLA agreements are also variables with direct impact on the service adoption decision. Therefore Perceived Usefulness and Perceived Ease of Use seem to be insufficient dimensions to fully capture the Intention to Use this service, in spite of being important in the adoption intent explanation.

4) To the question "Have you ever used a service supported in a similar concept as Cloud Computing Service?" Four of the five interviewees replied "Yes" and one replied

"No". Almost all of the people that replied favourably stated that their experience was very much network dependent and on cases the network performed well the experience was rewarding and very useful, on the other hand on cases where the network exhibit delays, long latency periods or even crashed the experience was very bad, including the loss of data and unsaved work, which supported the conclusions extracted from the previous analysis. The general feeling of all of the interviewees was: I'm willing to try and then will I make my mind as to adopt or not the service.

5) Finally it was asked to all of the interviewees to enumerate the perceived advantages and the perceived disadvantages of the "Enterprise in the Cloud" service.
   a. Advantages reported:
      i. Presumably lower costs on CAPEX and OPEX;
      ii. Fast corrective maintenance actions by the provider;
      iii. Pay-as-you-go is considered a fair commercial model;
      iv. Ubiquity on the service access is an advantage;
      v. Ease of use of IT complex infrastructure resources;
      vi. Resource optimization;
      vii. Synergies of scale;
   b. Disadvantages reported:
      i. Security;
      ii. Privacy;
      iii. Intrusion risk (by hackers);
      iv. Network dependency;
      v. Service provider dependency;
      vi. Need for contingency plan when network is not available;
      vii. Learning curve for the service management;

From this above reported research exercise it is clearly evident that the TAM model, in spite of being a good starting base to capture the relevant dimensions of the service adoption, must be complemented with additional dimensions in order to try to better explain the adoption intent of the service and thus the actual service adoption.

Nevertheless the research exercise pointed to some of the additional relevant variables to consider in the revised model to be used for a more comprehensive evaluation of the adoption dimensions for the services supported on the SAIL technology, namely it seems that Service Availability, Relative Advantage (cost related), Security Aspects, Service Provider Dependency and Experimentation are some of the dimensions that should be evaluated in further studies.

2.10 Conclusions

In section 2 the focus is on the Intangible Aspects area. The intangible aspects address to how the final users can impact on the spreading of new technologies, as they have the buying power and decide or prevent the take-off and success of new technologies.

Starting from the question: ‘How will users (humans or machines) benefit from the technology advances in SAIL?’, the intangible aspects researches address potential impacts that SAIL technologies can have on the end-customers, their consumption behaviour, new trends in their lifestyle and on society-at-large dependability on the future internet infrastructures and services.

The section starts with a short introduction to what intangibles are in section 2.1. The target of the section is to link the technology with the customers and their needs and requirements, analysing before the SAIL technologies are designed what are the possible benefits that they could enable or provide (sections 2.2, 2.3, 2.4, 2.5 and 2.6). But there are also potential negative effects that must be investigated: attention should be paid to potential network-based criminal activities and to, a lot of questions about privacy, security, access control and identity stealing that can arise and create new worries to private persons and businesses (section 2.7). These negative outcomes must be faced as they could hamper significantly further evolution of SAIL innovative technologies. In addition, users do not change their behaviour suddenly, but an adoption period is needed and a detailed understanding of how customers will likely adopt and use services is required. Moreover, new models are needed to give an economic value to the intangible aspects (sections 2.8 and 2.9). Therefore a proposal to identify a model and measure the intangible aspects is approached in the SAIL environment with an exploratory example use.

Recommendations to SAIL are:

- Attention to evaluate possible benefits and potential negative effects of the SAIL technologies before they are designed.
- Attention to enlarge the social value of the internet, due to the externalities (e.g.: social inclusion, bridging the educational divide, bridging the lack of knowledge and experience of the digital world that some social groups have, etc.)
- Attention to users' needs for technology: to enable people to exchange as many information as possible in the fastest way and in the widest possible range, using any media, building temporary networks including any type of portable devices.
- Attention to users' needs for societal opportunities: new technologies and media are social enablers for people to get information, discuss, stay in touch, communicate, orchestrate events, and enlarge democracy and transparency by Governments, Organisations and Companies.
- Attention to privacy, regulation and security issues, to understand and prevent concerns about internet frauds and abuse.

3 Value network configurations and business models of NetInf

This section analyses value network configurations and business models of the Networking of Information (NetInf) concept which is being designed in WP-B of the SAIL project. Generally speaking, NetInf concerns information-centric networking and data addressing like in content delivery, and could be useful in cases where content is more important than its location or owner. Multiple scenarios and use cases have been identified in an earlier D.A.1 deliverable [3], but in this phase of the project we chose to analyse the global content delivery scenario (NetInfTV) where the widest-scale deployment is expected. In this scenario, the principal customer is a content provider who needs to deliver content to content consumers. The content provider chooses its content delivery method based on, for example, cost, performance, coverage, and controllability.

NetInf could possibly be used in multiple existing information-centric content delivery models, such as proprietary CDNs and P2P networks, but we focus here on two specific business models that compete with these existing models: 1) Access Network Provider (ANP)-provided Content Delivery Network (CDN) model (see Section 3.3.1), and 2) Virtual CDN model (see Section 3.3.2). Additionally, the possibility to use NetInf in ANP's internal network is discussed briefly, even though that model does not directly apply to our content provider-driven thinking. The reason to include this model is that an ANP could use NetInf with its own managed services before starting to provide CDN services to content providers with the same infrastructure.

The rest of this section is organized as follows: In Section 3.1 we identify the most important trends and uncertainties in information-centric content delivery and by analysing their implications for NetInf. Then, Section 3.2 describes eight competing value network configurations (VNCs), including three NetInf-specific configurations and compares them based on value distribution between actors, network openness, and level of available Quality of Service (QoS) guarantees. This analysis identifies the most important challenges NetInf will face on the market. In Section 3.3, we focus on the aforementioned two NetInf-specific business models and briefly discuss their value propositions and value flows. Finally, Section 3.4 introduces a future research topic of content cacheability, and Section 3.5 concludes our findings.

3.1 Trends and uncertainties in information-centric content delivery

Information-centric networking should not be developed in void but both technical and business environments need to be taken into account. Large-scale content delivery is namely a huge business nowadays with multiple existing actors and business models. Information-centric networking is potentially a disruptive technology that may change the value networks of content delivery.

In this section, we identify both key trends and uncertainties related to information-centric content delivery and analyse their impact on NetInf. The analysis is based on the high-level trends and uncertainties presented in D.A.1 [3], but now the focus is specifically on NetInf. Some of the trends actually justify the importance of NetInf research whereas others direct the research to the most relevant topics. Uncertainties, for one, allow us to prepare for multiple possible futures and thus explain the existence of different kinds of research activities.

3.1.1 Trends

The most important content delivery trends identified in earlier studies [21], [22] are listed in Table 1 with their implications to the global content delivery scenario of NetInf (NetInfTV) and information-centric content delivery in general.

Table 1. Content delivery trends and their implications for NetInf

Trend	Implications to global content delivery scenario of NetInf
Focus moves from connectivity to content	This trend is the basis for the whole information-centric paradigm. From the market perspective, the key finding is that basic transport services are commoditizing and the revenue possibilities are increasingly in higher value services, like VPNs [21]. ISPs and mobile network operators want to avoid becoming only bit pipes. Therefore they try to expand their value proposition and ensure new revenues through vertical integration.
Extreme competition between Internet services promotes usability	Due to minimal cost of switching content provider, end users can easily switch from one to another. Because content providers' revenue depends on the size of their customer base, they are willing to pay for being able to offer better than best effort content delivery to end-users. A good example of content providers' need for better quality is Google, who tries to improve the end-user experience (mainly decreasing latency) of their services by improving the response times of their data centres, bringing content closer to customer, offering an optimized web browser and even trying to optimize transport protocols in a proprietary way.
Content consolidates	Most content is migrating to a relatively small number of large hosting, clouds, and content providers due to significant economies of scale and network effects. As a result, the power of these players increases and they may consider building their own, proprietary transport networks.
Importance of video traffic increases	Internet is used increasingly to deliver video. Cisco forecasts that by 2012 close to 90% of consumer traffic in the Internet is video [23]. This suits well to NetInf since video traffic, especially on-demand video, represents an easy content type due to its static nature.
Globalization continues while also local content becomes more important	In general, entertainment industry is global and a large part of the most popular content is consumed all over the world. On the other hand, also local content gains importance when people share their personal content with their fellows. Color [24] is an interesting example of this type of application that shares the content with people in one's proximity. This dualistic trend brings challenges to NetInf since it needs to scale both for global and local content distribution needs. In this deliverable, however, we focus on the challenges of global content delivery.
Direct peering increases and new economic models emerge	This indicates that both ISPs and content providers tolerate high transaction costs of more complicated interconnectivity environment [25] if they can achieve cost savings. NetInf may be able to decrease the need for complex interconnection agreements if transparent caching proves to be a success story. However, NetInf may also shake up the current interconnectivity ecosystem, which is discussed in more detail in Section 6.4. The business models we study here are still based on the assumption that the interconnectivity ecosystem does not change dramatically.
Content creation will be more user-driven	This trend lends credibility especially to the user-generated content use case described in D.A.1. In our global content delivery scenario, it is irrelevant who creates the content as long as the content is provided by content providers (*e.g.*, user-generated videos provided by YouTube).
Everyone wants continuous access to Internet content	People are no longer accepting limitations in the access to their content. Storing content on hard disks becomes a less viable option if it is not synced to the web. NetInf may improve availability of content by copying the content to multiple locations.

3.1.2 Uncertainties

The key uncertainties (U1-U7) related to information-centric content delivery are listed in Table 2 and explained briefly in the text below. Addition to the uncertainty itself, the table also shows the opposing ends of the uncertainty.

Table 2. Key uncertainties in information-centric content delivery

U1: Do content providers require guaranteed (and differentiated) Quality of Service?		
Yes	o o o o o	No
U2: How open will content networks be to content providers and end-users?		
Open	o o o o o	Closed
U3: Will caching be transparent or based on business agreements?		
Transparent caching	o o o o o	Agreement-based caching
U4: How will the price ratio between storage and transmission evolve		
Storage becomes relatively cheaper	o o o o o	Transmission becomes relatively cheaper
U5: Where will the caching be done?		
In the end points / edges	o o o o o	In the network
U6: Will the regulator allow caching?		
Yes	o o o o o	No
U7: What is the level of standardization in ICN?		
Standards	o o o o o	Proprietary solutions

U1: Do content providers require guaranteed and differentiated quality of service?

One significant reason for the success of CDNs has been the demand for means to deliver guaranteed quality of service. On the other hand, P2P networks have shown that information-centric networking can succeed also without guaranteed QoS. Demand for guaranteed and differentiated QoS is clearly a question that depends on application (or use case) and content provider (and end-user) preferences. In any case, the capability of NetInf to provide QoS seems to be important, especially if the goal is to challenge the proprietary CDN model.

U2: How open will content networks be to content providers and end-users?

Openness of content networks and cache servers is another interesting question. Some content networks (P2P networks, web caching) serve content of every interested content provider whereas others (*e.g.*, CDNs) limit the access to a subset of content providers. On the other hand, some content networks, such as closed BitTorrent communities, serve the content only to limited audience. The level of agreement required (U3) is crucial for the openness of content networks.

U3: Will caching be transparent or based on business agreements?

This uncertainty is pretty close to both U1 and U2 since both level of differentiated QoS and level of openness depend on the (non-)existence of business agreements. Engineers designing ICN seem to focus foremost on transparent caching even though the widely deployed ICN model, content delivery networks, depends heavily on business agreements. Another important dimension of this question is who makes the caching decision, Internet access provider or content provider? Especially in transparent caching, this question is unclear and if the proper technical solutions to allow multiparty-control over caching decisions are not available, the tussle over control may prevent deployment.

U4: How will the price ratio between storage and transmission evolve?

The common myth inside the industry seems to be that price of storage has dropped and will drop faster than price of transmission. This may be true but reliable evidence based on real price information and cost comparison has not been shown. An unpublished study conducted by Aalto, which was based on pricing data collection, did not support the hypothesis. Furthermore, comparing storage and transmission pricing is hard because purchased storage capacity can be used multiple times (product-like investment) but the transmission is typically a pay-per-use service (service-like investment). Also OPEX for power consumption is different for storage and transmission. Thus, when the storage and transmission prices and costs are compared, avoiding apples vs. oranges type of comparison is a real challenge.

U5: Where will the caching de done?

Caching can be done either in the network (in routers, cache servers) or in the communication end-points (end devices) and both solutions exist already nowadays in the market. Ownership of cache locations affects which actor pays for and benefits from caching. The same question can be asked in relation to the communication path; some ICN solutions assume on-path caching (CCN [26]) whereas NetInf also allows off-path caching.

U6: Will the regulator allow caching?

A regulator may get interested in caching if it is in conflict with consumers' interests. It may be that some content is too sensitive for caching or the parties that are caching the content have to be qualified to store (even temporarily) that kind of data. This question and other areas possibly requiring legislation are discussed in more depth in Section 6.6.

U7: What is the level of standardization in ICN?

Interoperability of information-centric networks has not been on a very high level. CDNs are controlled by a single stakeholder and typically use proprietary technologies. The same is true also for P2P networks. However, interest in improving interoperability is increasing as demonstrated by recent IETF activities on standardizing in-network caching (DECADE WG) [27] or CDN interconnection (BoF in IETF-80) [28]. What makes this topic interesting is that it seems to be ISPs who are driving standardization while CDN providers seem to be happy with their proprietary solutions that are the basis for their market power.

A more distant question is interoperability between novel ICN proposals like CCN [26], NetInf [29], and PSIRP [30]. This may not be relevant in the short term because all the proposals are currently examining the potential of the information-centric paradigm. However, in the long term some standardization activity in IETF or in other standardization forums may be needed.

3.2 Value network configurations in information-centric networking

Global content delivery with information-centric networking (ICN) and with guaranteed quality of service has been chosen as the service to be analysed in this section. The service uses information-centric networking technology for scalable and efficient content delivery in the Internet. The reachability of the service is global and is not restricted to any single domain or scope. In addition, QoS guarantees are available due to business contracts and agreements. In this section, the most important roles in providing this service are identified and, based on the key roles, different value network configurations of information-centric networking are constructed.

3.2.1 Role analysis

Twelve key roles with high demand and low interchangeability have been identified based on a thorough deconstruction of activities and functionalities related to the information-centric content delivery. The role descriptions and drivers increasing/decreasing role importance are listed in Table 3.

Any content delivery ecosystem is driven by two roles: 1) content consumption, which brings money to the ecosystem either directly through access and content payments or indirectly through advertisement; and 2) content provisioning, which satisfies content consumption needs. The extent of content provisioning varies from distributing a single information object to aggregating content of multiple content creators, but the overarching attribute is that the content provider (CP) chooses the content delivery model for the content it provides.

Table 3. Key roles in information-centric content delivery

Role	Description	Drivers for role importance
Content consumption	Using a device to request content and possibly paying for it.	+ brings money to ecosystem; chooses content she consumes – restrictions on content choices
Content provisioning	Publishing and managing content and operating the origin server	+ value is in content services; customer relationship with content consumers; selection of content delivery model – decreased content control
Content access management	Authentication, Authorization, and Accounting (AAA) related to content usage	+ controls the access to content revenues – ad-based model does not necessarily need AAA; AAA integrators
Access network operation	Providing Internet access to both content consumers and content providers	+ local monopoly to consumers; consumer relationship – virtual operators, regulation, multihoming
Interconnectivity provisioning	Providing connectivity between access networks	+ large part of content is located off-net – direct peering between access network providers and content providers; caching
Cache management	Controlling (and owning) cache servers, including content selection and cache updating	+ critical for content availability and content freshness; pays for the investment – content network management may take control
Cache location ownership	Controlling the locations where cache servers are to be installed	+ caching should be done close to consumers (limits locations) – ubiquitous caching
Content network management	Routing, managing QoS, accounting of content delivery	+ demand for QoS; need to minimize the number of actors a CP has to contact – resource redundancy
Name resolution	Controlling content directory and resolving content names to location(s)	+ cost and QoS implications of location decisions; – role not necessary in all architectures (*e.g.,* CCN does not include this role)
Device & software provisioning	Delivering and configuring devices + software for consumers	+ proprietary software/OS, managed devices, relationship with content consumers – open platforms, standards
Content creation	Creating the content to be delivered by CPs	+ availability to means for content creation increases – increasing amount of content reduces importance of a single piece of content
Network equipment provisioning	Providing network equipment (*e.g.*, routers and cache servers)	+ demand for technical improvements and changes; lock-in to proprietary technologies – open technologies

The content access management role is valuable because it controls access to content revenues by authenticating and authorizing content consumers. Information about content usage is relevant not only in the subscription model but also advertisers value this information.

Providing Internet access to content consumers and content providers is an important role that enables the content distribution and often collects a major share of money used for content consumption in the form of access fees. Access operator's local monopoly to its customers increases the role's importance, which on the other hand diminishes if multihoming increases. Global scope of content delivery requires interconnection between access networks, even though the in-network caching inherent to ICN as well as direct peering between CPs and ANPs cause large part of traffic to bypass interconnection networks.

Caching is a fundamental property of ICN. An entity controlling and managing cache servers has its word to say about content selection and lifetime in the cache. Due to cost considerations, the content freshness may be questioned which may lead to a tussle between those who manage caches and those who provide content. Additionally, the location of cache servers is crucial for both performance and cost reasons. Proximity to content consumers is often desirable, which restricts the possible locations and may lead to a situation where cache servers are managed by a different actor than cache locations.

Origin and cache servers constitute a content network that is often realized as an overlay to the basic IP network with its own routing mechanism for content requests and data. Even though content routing is the only mandatory activity of content network management, business considerations, like content providers' demand for controlled QoS and cache owners' interest in monetizing their investment, lead to a need for managing QoS and accounting of usage of content network's resources. From a technical perspective, distributed solutions are possible, but the miserable history of distributed QoS mechanisms and the need to minimize the number of actors with whom a content provider has to make a contract speak for centralized QoS management.

Name resolution is separated from routing and forwarding activities included in the content network management role because of its strategic importance. Even though ICN focuses on the IOs instead of on a specific location where they are retrieved from, the content is still served from somewhere and the decision from where to serve has significant cost and performance implications. For example, P2P applications often deliver content from suboptimal locations, which increases latencies and access providers' costs. Location decisions can also be used as a tool to support the role holder's strategic traffic engineering goals.

Providing devices and applications to content consumers is another important role since hardware and software capabilities affect the content selection, consider for example the impact of P2P file sharing applications. In addition, providing network equipment such as routers and servers to the access and interconnectivity networks is crucial for the functionality of the basic IP network. Lastly, the content provisioning role does not necessarily mean content ownership, which is represented by the content creation role.

Figure 3 presents a generic role configuration that is constructed based on the identified key roles. Roles that do not directly participate in content delivery but significantly affect the VNCs and technology choices by supplying hardware, software, and content to the ecosystem are presented in this generic configuration with blue arrows; they are left out of the more specific configurations presented in Section 3.2.2.

The technical interfaces connect the technical components to each other via protocols. They are shown in the general role configuration because regardless of the competing technical solution, the technical interfaces in each specific value network configurations should not change, at least much.

On the other hand, business interfaces are not shown in Figure 3 because they connect the actors in the value network and the actors that control the roles depend on the value network configurations of different competing solutions. The generic role configuration assigns only those roles to actors that are controlled by the same actor regardless of the technical solution; *i.e.* the content provisioning and management, content consuming, access network operation, and interconnectivity provisioning roles. The rest of the actors are shown in the specific value network configurations in the following section.

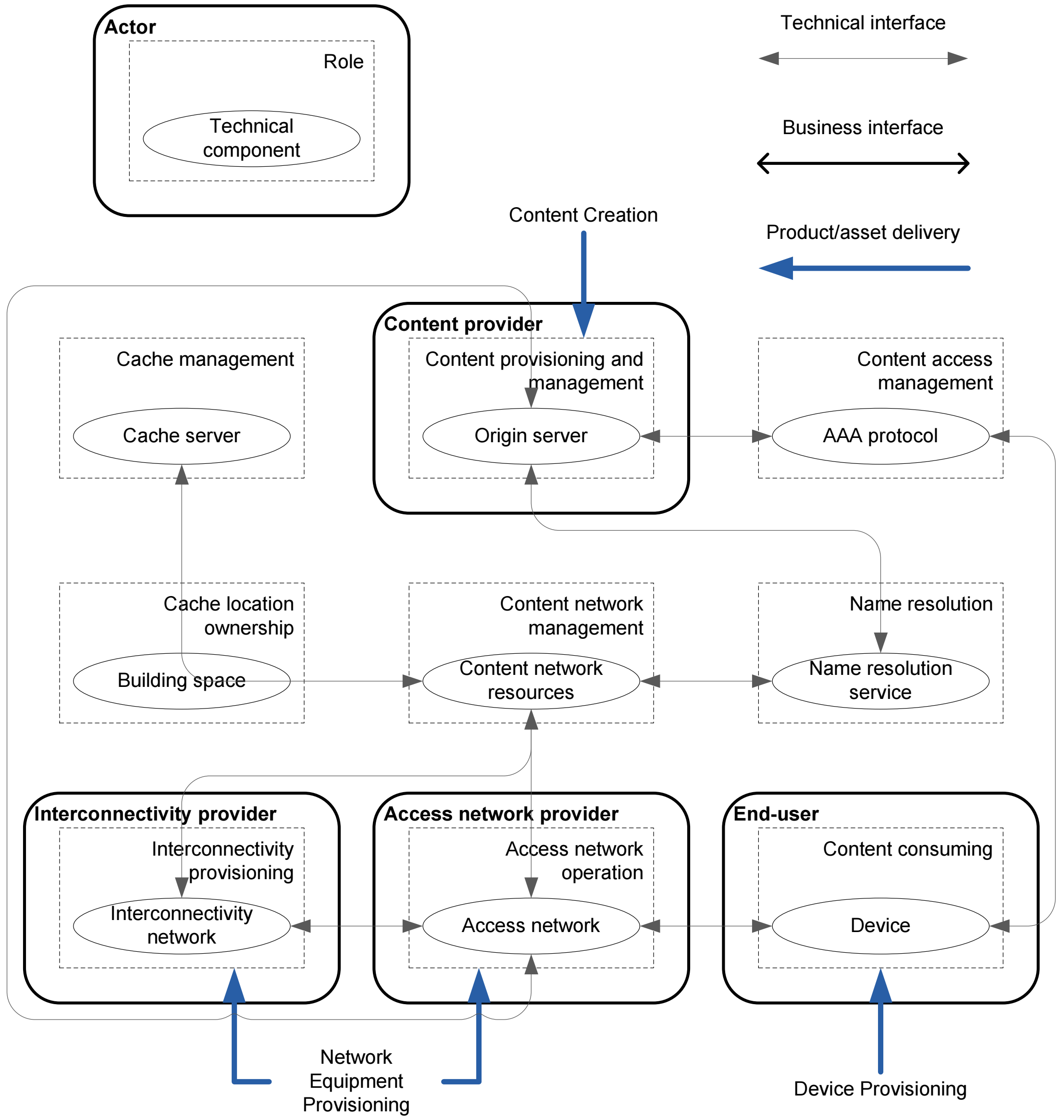

Figure 3. Generic role configuration

3.2.2 Value network configurations

After the role analysis we identified altogether eight possible value network configurations (VNCs) for information-centric content delivery that are presented in this section. The summary of these VNCs are shown in Table 4.

The two first VNCs, 1) the pure ICN VNC, and 2) the virtual CDN VNC, are considered especially interesting for NetInf. The other VNCs are competing solutions for them, from which direct competition includes the different CDN setups. In addition, networking of information used in ANP's internal services is presented at the end of this section, though it does not fit into the scope of the discussion since it is limited to services within each ANP and does not have a global reach.

Table 4. Summary of identified VNCs.

Name	Lead actor	Description	Example
Pure ICN VNC	Access network provider	ANP offers transparent caching and controls the major content network elements.	-
Virtual CDN VNC	Virtual CDN provider	A virtual CDN provider offers CDN services but relies on ANP's caches.	-
Pure-play CDN VNC	CDN provider	A CDN provider provides content delivery services for content providers and has own cache servers.	Akamai [31]
Interconnectivity provider CDN VNC (INP CDN)	Interconnectivity network provider	An interconnectivity network provider builds its own CDN service, and thus controls most of the roles in the VNC.	AT&T's CDN service [33]
Content provider CDN VNC (CP CDN)	Content provider	A content provider decides to build its own CDN for delivering its own content, and thus controls most of the roles in the VNC.	Google Global Cache [34]
Peer-to-Peer VNC (P2P)	End-users	A peer acts as both the content provider and the end-user.	BitTorrent [35]
Content Provider Peer-to-Peer VNC (CP P2P)	Content provider	A content provider can use the peer-to-peer network for distributing its content but it retains control over the content.	Voddler [37]
ANP Internal Services VNC (ANP ICN)	Access network provider	An ANP can use ICN to improve the services it offers its own subscribers.	Comcast's XFINITY Triple Play [38]

Even though these VNCs compete and can substitute each other, they may also coexist; *e.g.*, an end-user can access content both using peer-to-peer networking and downloading it directly from the origin server. The difference between each VNC lies essentially between which actors control the content network, *i.e.*, the cache controlling, content network management, name resolution, and content access management roles. In addition, control over what content is delivered and QoS issues play critical roles.

Pure ICN VNC

Figure 4 presents the typically suggested VNC of NetInf. Here the access network provider (ANP) plays a major role as it controls the content network apart from the content access management role, which is controlled by the CP.

No real-life deployments of a pure ICN network exist yet. Two possible deployments are: (1) as a purely transparent caching network similar to web caches or (2) as an ANP-driven CDN. When the transparent caching network model is used, no content delivery-related agreements exist between the CP and the ANP, whereas in the ANP-driven CDN, the CP has to sign content delivery contracts with all ANPs whose cache servers it wants to use. Due to this reason, a business interface may or may not exist between the CP and the ANP (and thus is not drawn in the figure).

The strength of NetInf compared to some other information-centric designs lies with the unrestricted in-network caching as compared to proprietary caching done by, *e.g.*, CDNs.

Therefore, both the CP and the end-user benefit from this configuration. However, in the ANP driven CDN model, the CP has to sign contracts with several ANPs to have the same reach of customers as in the Pure-play CDN case (see Figure 6). On the other hand, when no business agreements exist between the ANP and CP, no QoS guarantees need to be made by the ANP to the CP, thus the ANP-driven CDN model is at the focus of the later business model analysis.

The ANP itself also benefits from this VNC as less inter-domain traffic is generated. In addition, as the ANP takes both the cache location ownership and cache management roles, no conflict of interest between these roles can arise.

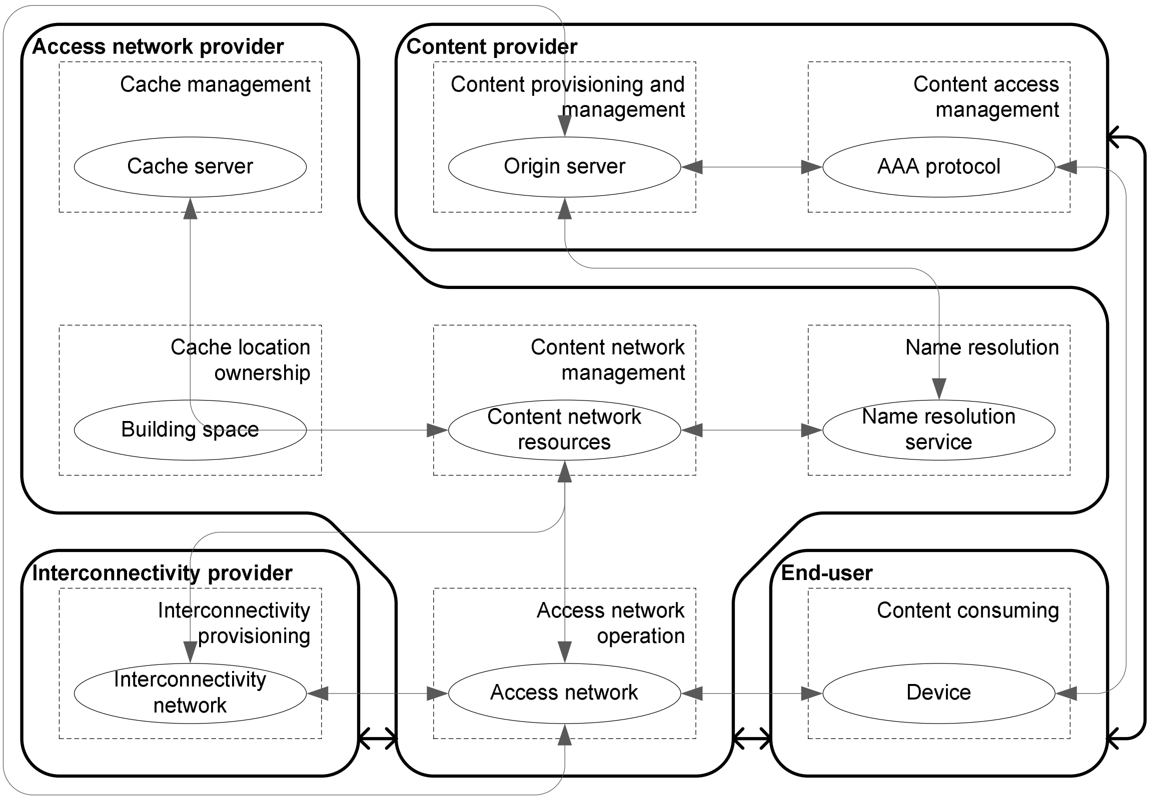

Figure 4. Pure ICN VNC

Virtual CDN VNC

One potential use case for NetInf is as a distributed CDN. Here, a virtual CDN provider controls customer relations with CPs. The cache servers are managed by multiple ANPs instead of the CDN provider and thus the CDN provider has a business relationship with each ANP. In this VNC, the content network management, cache management, and name resolution roles are controlled by the CDN provider, who as a consequence has the strategic position to offer content delivery services with guaranteed QoS to CPs; shown as a business interface in Figure 5. However, the Internet access-related business interface between the CP and the ANP is not illustrated because only specific content delivery agreements of CPs are shown in the VNCs.

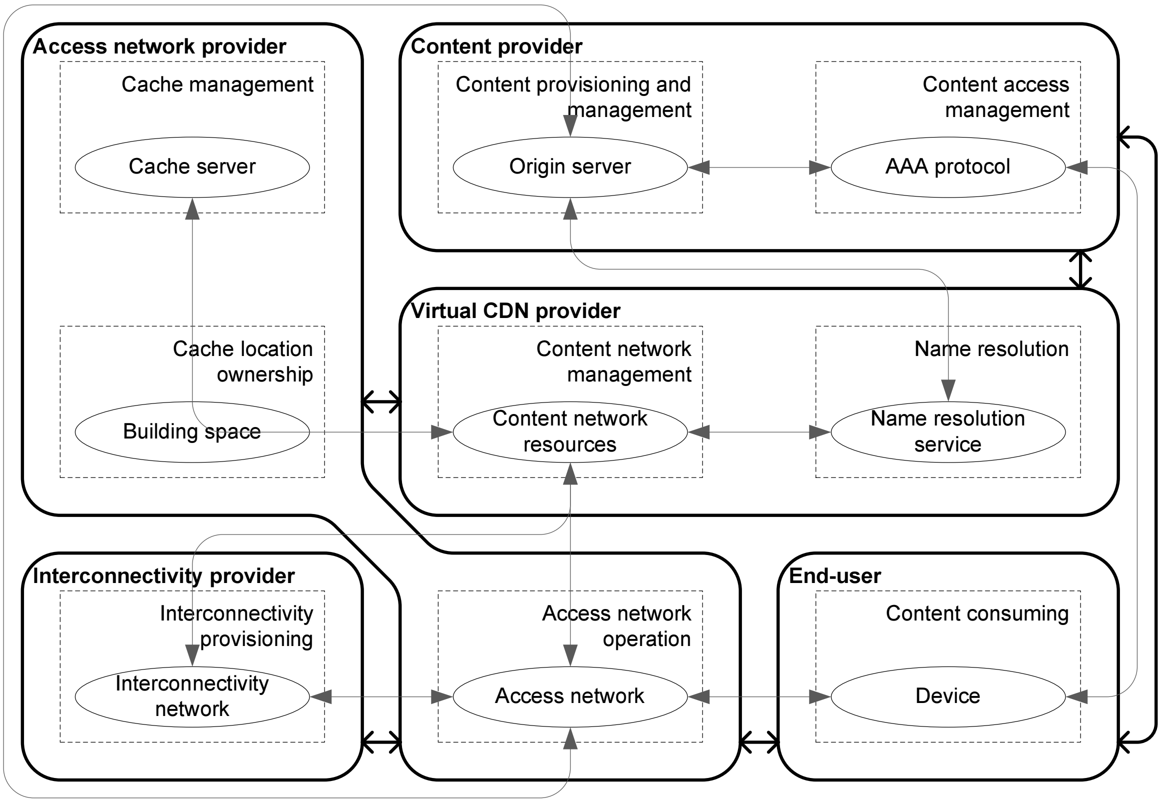

Figure 5. Virtual CDN VNC

This VNC is comparable to and can be considered as a direct competitor to the pure-play CDN. The virtual CDN operator solves the Pure ICN VNC's inconvenience of CPs having to sign several contracts with hundreds of ANPs and instead only one contract with the virtual CDN operator is enough. Thus the revenue logic lies in the virtual CDN provider charging CPs for the guaranteed QoS.

In the pure CDN case, the ANP owns the cache location and the CDN owns cache servers. However, as the cache location owner controls who can place cache servers in its premises, the ANP may not wish to enter into agreements with the CDN if the ANP considers the CDN as a competitor for its own content. Thus, the virtual CDN configuration has an advantage compared to the Pure-play CDN VNC because ANP owns both the cache management and cache location ownership roles, and so no conflict of interest between these roles can arise. However, this also poses the main challenge in this configuration, as the virtual CDN provider relies on the ANPs to cache the content, which may affect the degree of guaranteed QoS.

Pure-play CDN VNC

In the Pure-play CDN VNC, the only difference compared to the virtual CDN is the cache management role, which is now taken by the CDN provider and not the ANP as is shown in Figure 6. Thus the CDN provider has a business relationship with the ANP because the caches are installed into ANPs' premises. The CP manages the content access and customer relations in this VNC and has a business relationship with both the end-user and the ANP.

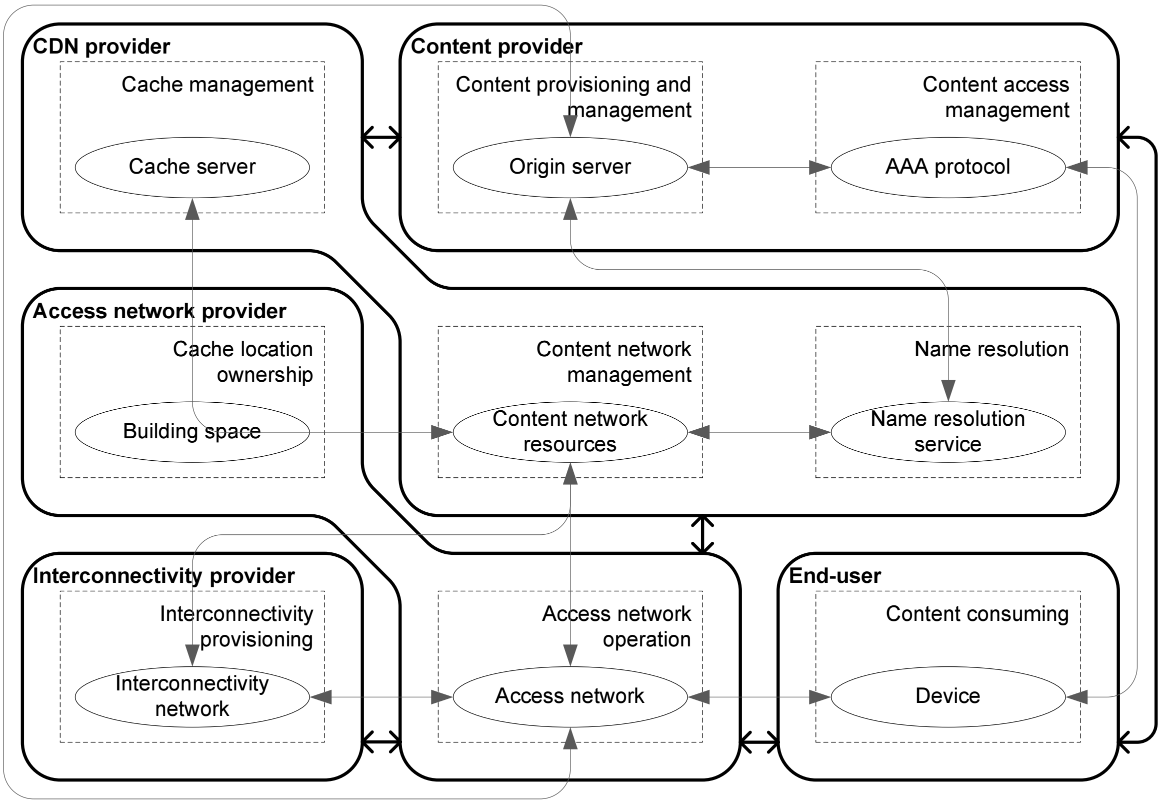

Figure 6. Pure-play CDN VNC

In the pure-play CDN business one company (*e.g.*, Akamai [31]) operates the content network as an overlay on the basic Internet. The CDN provider provides content delivery services and guarantees QoS to the CPs, thus the revenue logic is based on CPs paying the CDN provider. On the other hand, also ANPs may profit from this arrangement as CDNs offer ANPs free peering points to their networks and less traffic goes through the interconnectivity network resulting in savings in transit costs [32].

As mentioned in the virtual CDN description, the cache location ownership role is important in this configuration because the ANP has the power to select who can place cache servers in their network. Thus if the ANP considers the CDN as a competitor for its own content, it may not wish to enter into agreements with the CDN. In this case, the CDN provider has to place the cache servers into their own network but this may impair the delivered QoS.

Interconnectivity provider CDN VNC (INP CDN)

A CDN provider needs extensive network connection and a large CDN provider usually builds its own interconnectivity network for content delivery. On the other hand, it is also possible for the interconnectivity provider to start offering CDN services to CPs as shown in this configuration (Figure 7). The interconnectivity provider manages the content network and name resolution as well as the caches in this configuration. Thus, the content provider has a direct business relationship with the interconnectivity provider instead of the access network provider. However, it is assumed that the actual content traffic will still move through the access network.

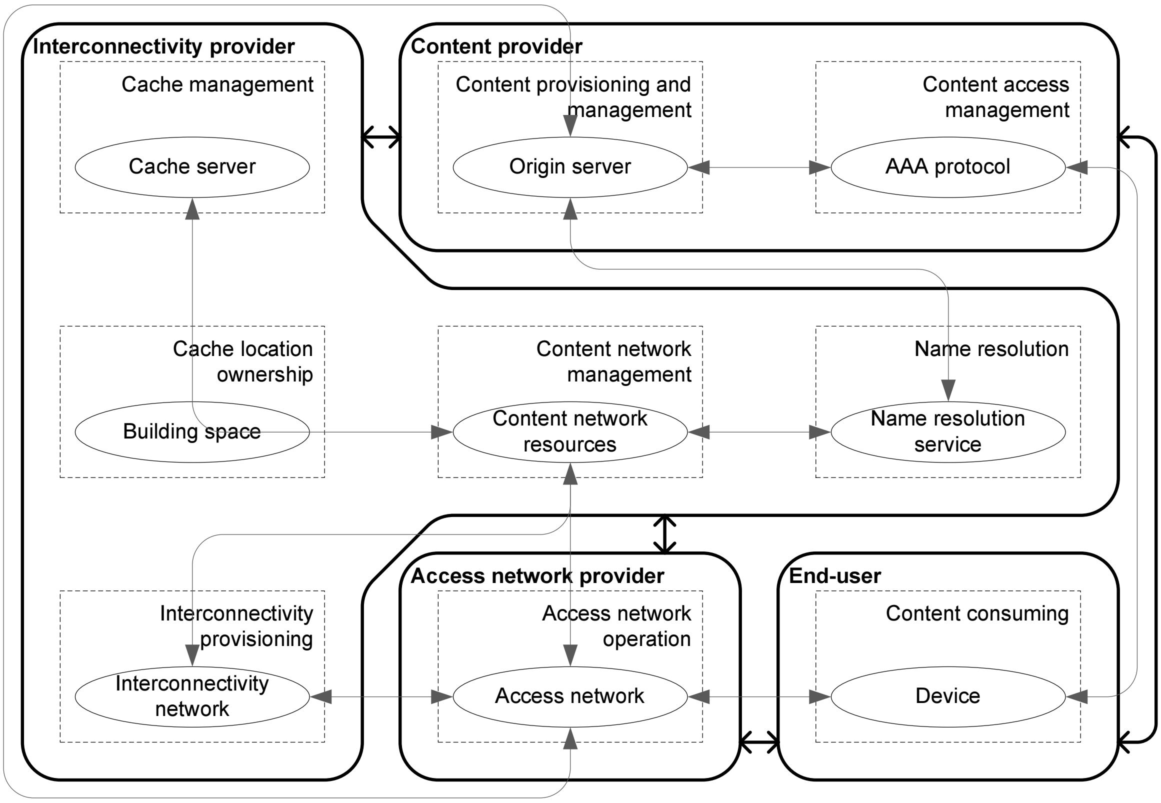

Figure 7. Interconnectivity provider CDN VNC

AT&T's CDN service [33] is an example of an interconnectivity provider's CDN offering. In this configuration, the interconnectivity provider already has a global connectivity through its own network or settlement-free peering with other interconnectivity providers. The value logic thus comes from the interconnectivity provider using the existing connection to offer value added services to existing and new enterprise customers. As the interconnectivity provider owns both the cache servers and the content network, the access to which is gained only through agreements with the interconnectivity provider, the situation where the caches do not wish to store certain content cannot arise.

In this configuration, the cache servers are placed in the interconnectivity network, which is farther away from the end-users. From this perspective, this VNC is less efficient than the VNCs where the caches are located near end-users, for example, in the access network.

Content Provider CDN VNC (CP CDN)

In this configuration (Figure 8), the CP builds its own content delivery network for meeting its own QoS requirements. Through controlling both the content provisioning and the content network, the CP manages the customer relations to end-users. A business relationship with the ANP exists because cache locations are still owned by ANPs.

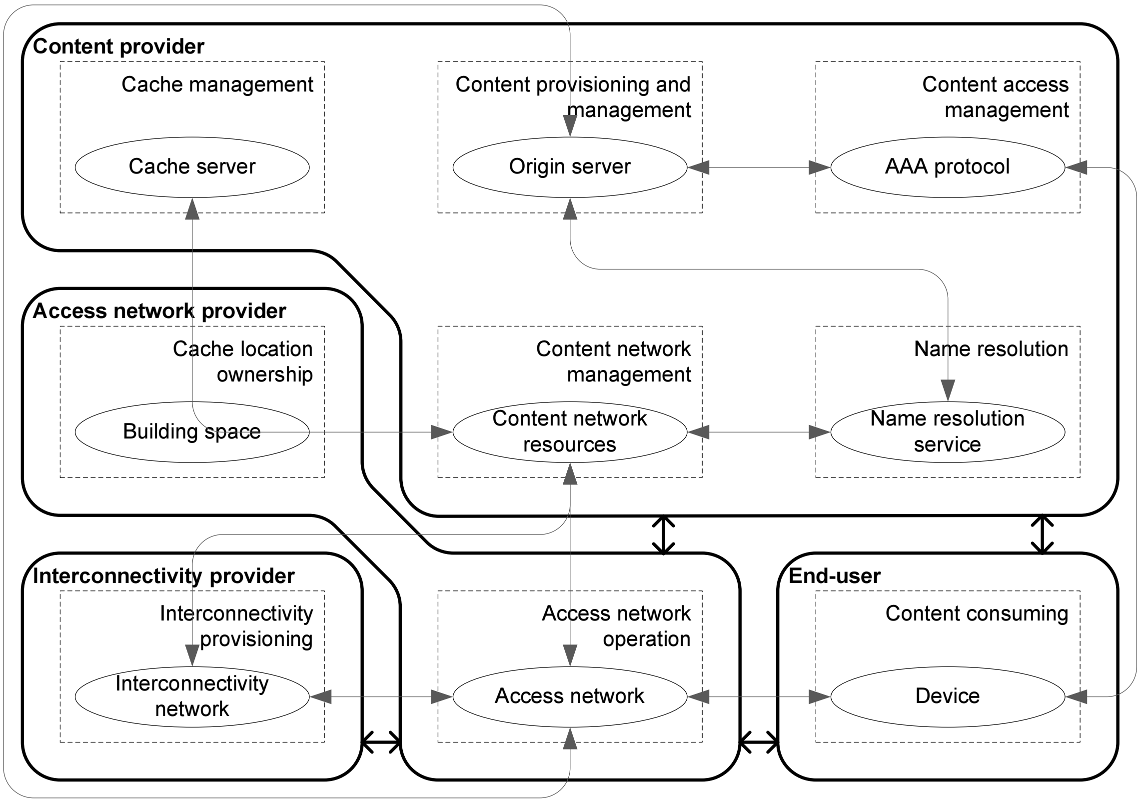

Figure 8. Content provider CDN VNC

Google's Global Cache (GGC) [34] is an example of a CP CDN, where Google both owns the content and the CDN. The value logic in this configuration comes from Google being a large CP with extensive traffic volume and thus its own CDN gives almost full control of the content delivery while enabling cost-efficient performance optimization.

Because of the huge initial investments and high level of expertise needed, this VNC is suitable only for the content giants. Similarly to the CDN case, because the ANP owns the cache locations, conflict of interest between the CP CDN and ANP may be a challenge. Additionally, competition regulators may take actions against the big CP CDN players if they possess monopolistic market power.

Peer-to-Peer VNC (P2P)

The end-user plays an important role in this configuration as both content provisioning and consuming is done by the end-user. In addition, the end-user manages the content network and controls caches as the caches are located on each user's devices. A tracker and index provider emerges into the market to control the content access management and name resolution roles as is shown in Figure 9. If the tracker and index provider offers closed network service, login or payment information are required; this is shown as a business interface between the end-user and the tracker and index provider

An example of this VNC is the BitTorrent [35] file sharing network, where a third party manages and provides a registry of content indices and tracker information. Since the end-user acts as both a content provider and content consumer, the cost of offering content is paid by the end-user and thus usually no revenue logic is involved in this case, which is also the main strength of the P2P technology from the end-user's perspective. In addition, a P2P network is very scalable due to vast number of content sources, which can be chosen freely and used simultaneously.

A major challenge with the P2P network is control over what content is shared. As has been seen with the BitTorrent network, a lot of copyrighted content is being shared illegally. In addition, P2P traffic imposes great strain on the access network and large costs for the ANP but the ALTO WG in IETF is trying to solve this problem [36].

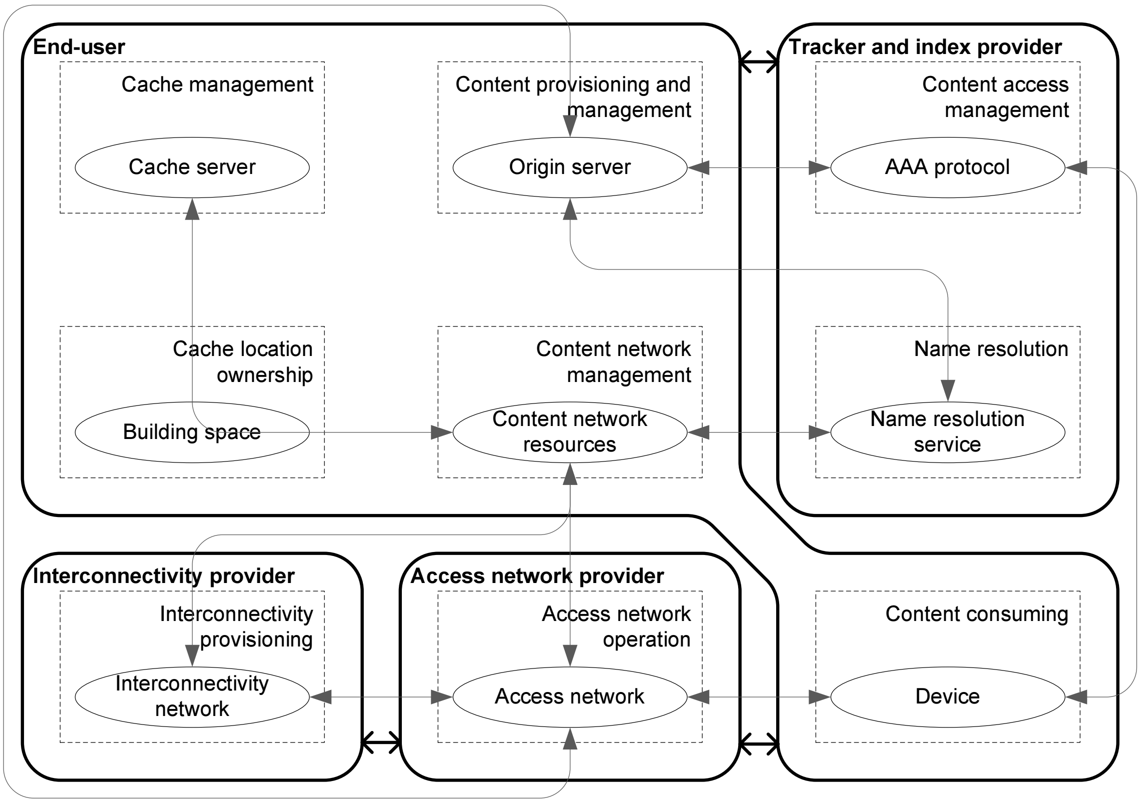

Figure 9. Peer-to-peer VNC

Content Provider Peer-to-Peer VNC (CP P2P)

Peer-to-peer technology can also be utilized directly by the content provider by offering content through a P2P network. In this configuration (Figure 10), the content provider also manages the content network and origin server in addition to the name resolution and content access. The end-users act as cache servers as they cache content on their devices and upload them to other end-users.

The Swedish online film service Voddler [37] is an example of a content provider peer-to-peer network, where legal films and TV series are offered to end-users on an on-demand basis. Once the end-user has downloaded the copyrighted content, it can be shared with others users in the Voddler service. From the operator’s and content provider’s point of view, using the P2P network lessens the strain around the origin server. The value logic of this configuration lies in the convenience of getting everything online, when you want it, where you want, for only a small fee or even for free if you are willing to watch some advertisements. However, this small fee might still be too much for some users or the advertisements may affect the user experience and cheaper and ad-free alternatives such as the BitTorrent network might be preferred.

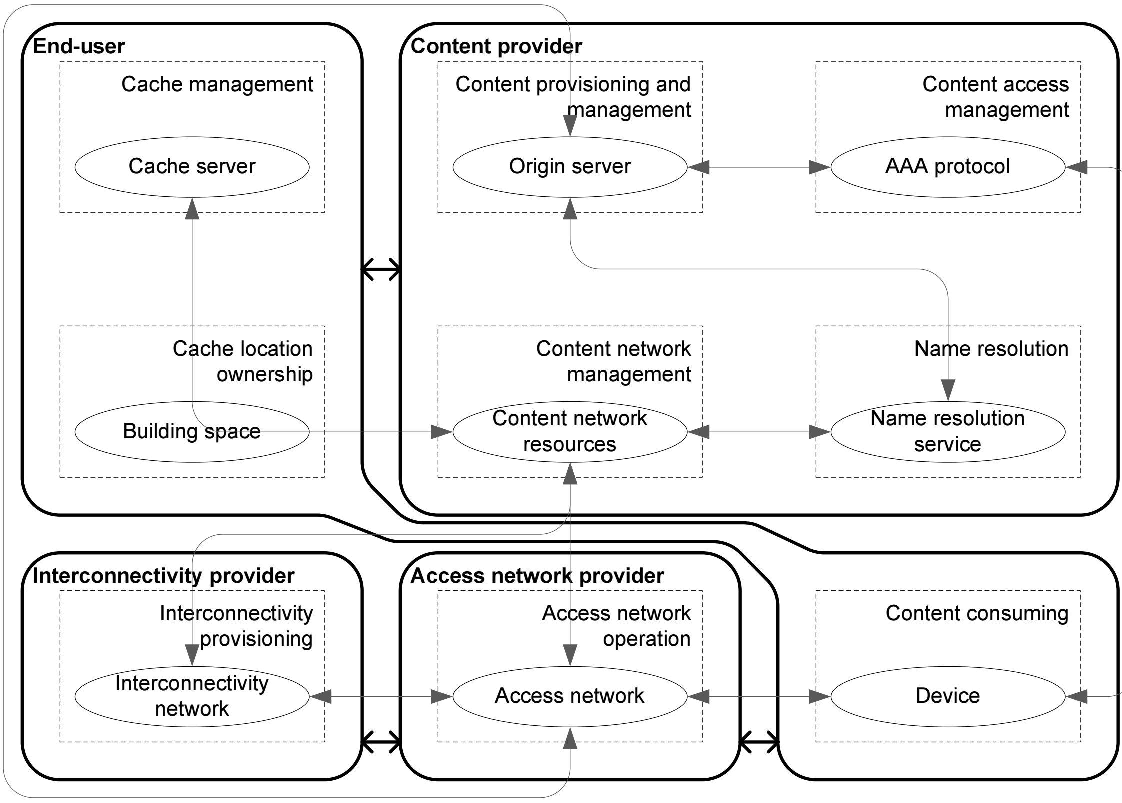

Figure 10. Content provider peer-to-peer VNC

ANP Internal Services VNC (ANP ICN)

Another potential use case for NetInf involves an ANP's internal network, where NetInf can be used to optimize content delivery to ANP's own customers. In this VNC (Figure 11), the technical implementation is the same as in the Pure ICN VNC, but the business model is different. The ANP plays a strategic role in this configuration as the model is about its internal as opposed to global content delivery. ANP also makes the initiative towards the CP regarding content delivery. The ANP controls the whole content delivery network, and also provides and manages content to be consumed by the end-users, even though the content may not originate from the ANP. As a consequence of content delivery being only local, the interconnectivity network is not used and thus the role is not included in the VNC.

An example of this setup is Comcast's XFINITY Triple Play [38], where Comcast buys content from content creators, such as movie studios or TV channels, and offers this content to registered users as live or on-demand services with the possibility to record for viewing later. Thus the revenue logic comes from registered users paying Comcast for the content as well as the delivery. In addition, as XFINITY Triple Play is a value added service for Comcast, more customers may switch to the Comcast's bundle for basic connectivity. A clear benefit for using ICN in the ANPs internal network is the increased network performance, especially when it comes to popular on-demand content.

From the end-user's perspective, this solution is a convenient way to get on-demand content as well as an easy option to access services that the end-user is ready to pay for. On the other hand, the necessity of registering and paying for the content may become an obstacle as price sensitive end-users may prefer a cheaper alternative with no registration, such as the P2P file sharing system. In addition, as this VNC does not have global reach, it cannot be considered as direct competition to the above described VNCs.

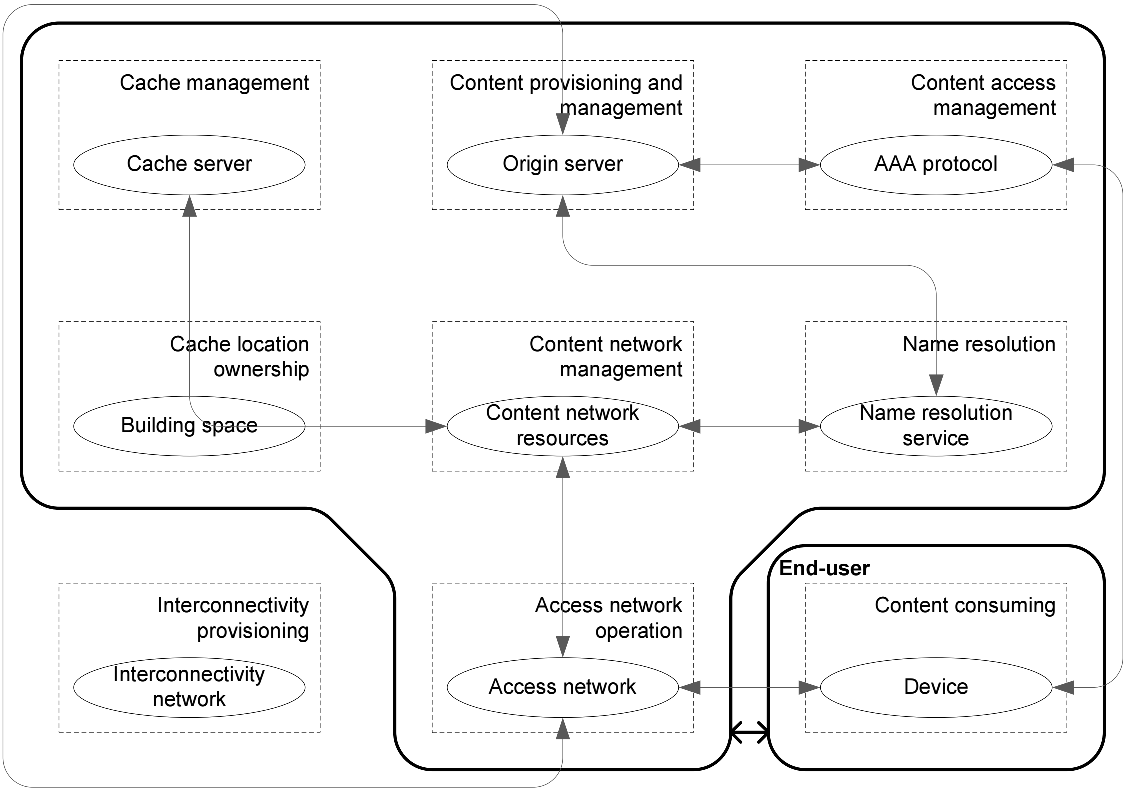

Figure 11. ANP Internal Services VNC

3.2.3 Value distribution in VNCs

Control of the critical roles and the level of competition define the value distribution between actors in each VNC. Figure 12 inspired by Christensen et al. [39], illustrates in a simplified manner into which actor's pockets the profits are flowing. The presentation is qualitative and thus only the ratio of coins within and between the VNCs should be examined. For a quantitative analysis of the content provider's costs in some of the identified VNCs, please see Bill Norton's analysis concerning video distribution [40].

In most of the VNCs, caching reduces ANPs' transit traffic costs and thereby decreases interconnectivity providers' revenue. Interconnectivity provider CDN VCN is an exception, because caching is done on interconnectivity provider's network and therefore the transit traffic revenues remain at the same level and also content provider's content delivery payments flow to interconnectivity provider. Also P2P VNCs are exceptions since current P2P applications do not optimize the cache selection based on location of caches. The most profitable VNCs for ANPs are those where they get additional revenue either from content delivery (Pure ICN VNC and Virtual CDN VNC) or content provisioning (ANP-internal services VNC).

Profit-maximizing content providers, for one, may prefer Pure ICN VNC without QoS guarantees, if they judge the attainable QoS sufficient for their needs. If the CP is big enough, building one's own CDN may also be an attractive option. This content provider CDN VNC maximizes content providers' control over content delivery and still delivers reasonable profit margin. Content provider P2P VCN on the other hand is really cost-efficient solution. Both content provider CDN and P2P VCNs require (for the CP) more technical expertise than other VNCs, which limits their usage to technology-savvy content providers. On the other hand, profits related to content provisioning are smallest in the P2P VNC, which leaves content creators empty-handed due to copyright infringements. Additionally, specialized CDN providers take their share of content delivery profits and thus reduce both ANPs' and CPs' profits.

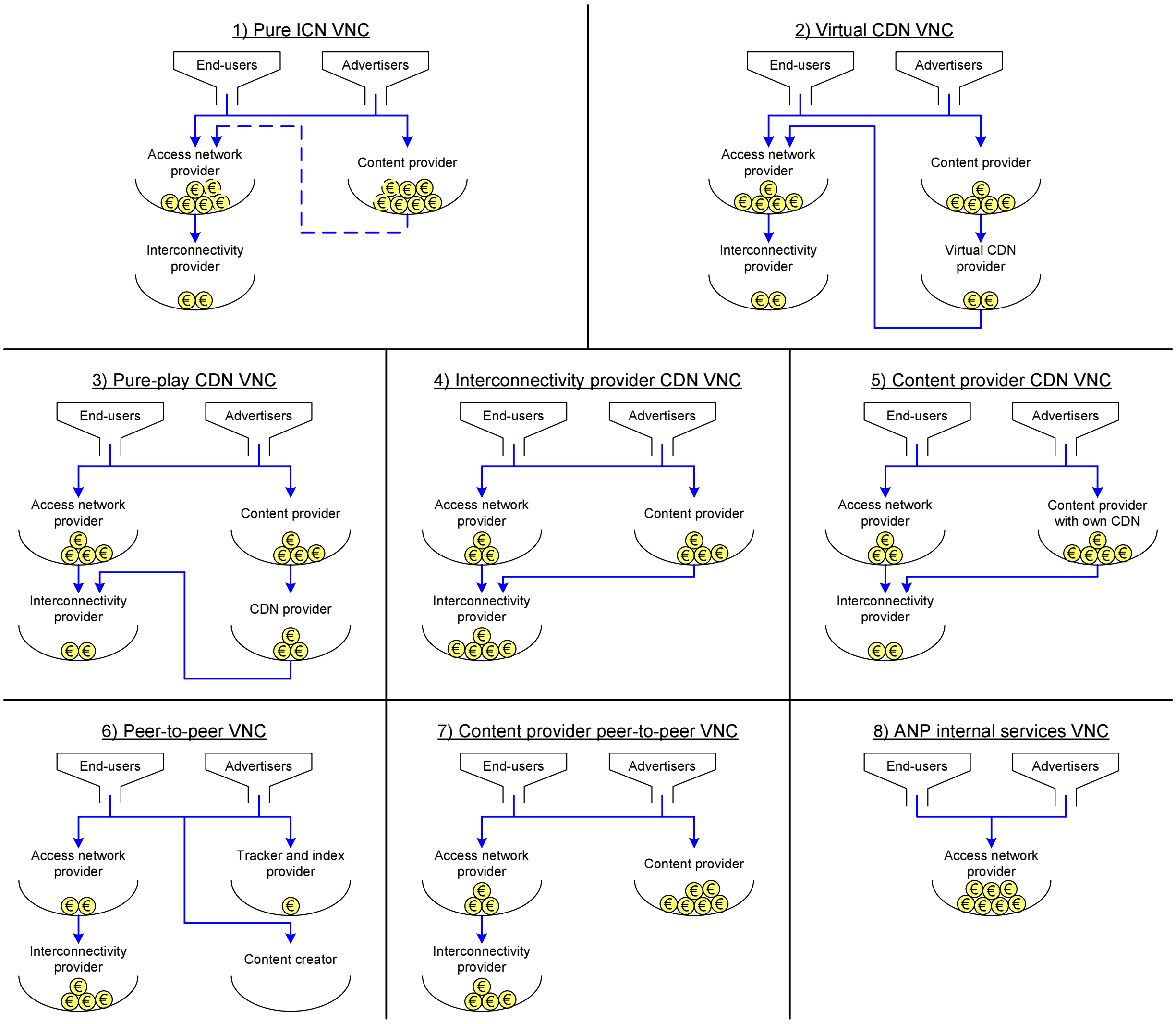

Figure 12. Profit distribution in the identified value network configurations for information-centric content delivery

3.2.4 Comparison of VNCs based on network openness and QoS guarantees

The identified VNCs are diverse and range from open networks that any CP and end-user can access to closed networks, where CPs and end-users are allowed into the network based on some given criteria. The main difference in the constructed VNCs relates to the control of certain critical content delivery roles, such as the cache management, cache location ownership, content network management, name resolution and content access management. In addition, the VNCs differ in their capability to deliver guaranteed QoS to the CPs. These findings can be summarised by the matrix presented in Figure 13. The chosen parameters – the possibility of guaranteed QoS and the openness of content networks – are of our interest because it is in these dimensions that the VNCs differ from each other from a CP's point of view. The CP perspective, for one, is crucial because CPs decide which content delivery architectures are to be used.

The area that each VNC occupies in Figure 13 indicates the extent to which they can vary in both dimensions. For example, the Pure ICN presents the possibility of being fully open to all CPs or having content delivery agreements between CPs and ANPs, which limits the openness of the network. On the other hand, when no contracts exist between CPs and ANPs, QoS cannot be guaranteed whereas with contracts, QoS can be guaranteed to some extent but not fully due to the nature of the VNC. These variations are shown in Figure 13 as the box named Pure ICN.

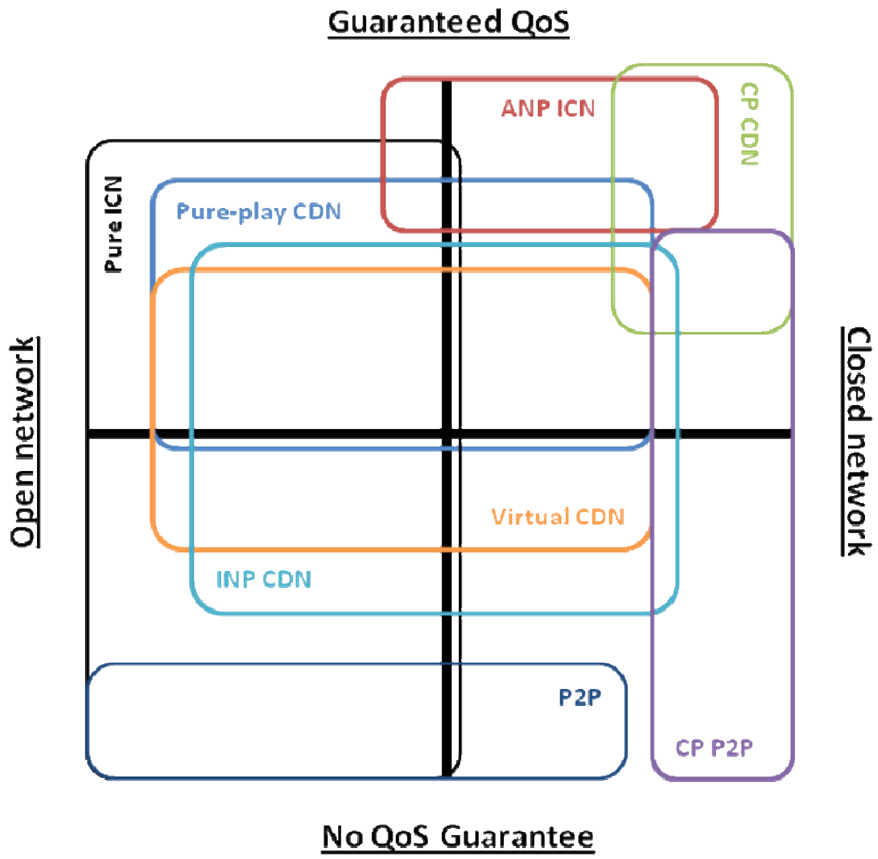

Figure 13. Comparison of identified VNCs in terms of scale of operation and possibilities to deliver guaranteed QoS

3.3 Business models for NetInf

From the eight value network configurations, two business models – the ANP driven business model from the Pure ICN VNC, and the Virtual CDN business model – and their service value proposition are discussed in more detail in this section. These two models are chosen because they are new and no ready business model or examples exist for them, thus more research needs to be done on them. In addition, the value networks in terms of monetary, service and intangible benefit flows between each stakeholder are presented and explained to better formulate the two business models.

The analysis done in this section is part of the STOF business model design process [41], where issues from the service, technology, organisation, and finance domains are considered in designing a viable and feasible business model. The STOF method has four steps starting from the quick scan, where the domains are first examined and critical design issues such as targeting, security, partner selection, and pricing are defined. The analysis continues with the evaluation of critical design issues and critical success factors related to creating customer value and network value.

In this deliverable only the service and finance domain analysis of the quick scan step is done because the VNCs constructed in the previous section explain the organisation domain adequately. The rest of the STOF analysis may be used later when one business model is chosen for the discussion.

3.3.1 Service value proposition for ANP-driven Pure ICN

As mentioned before, the studied service is global content delivery with QoS guarantees by using information-centric networking technologies. In the following two sections, a more detailed description of the intended service with two different NetInf business models is given; including the targeting, value proposition and other service offering-related issues. The service provider in the ANP-driven business model is the access network provider; thus, the analysis is done from their perspective although the benefits for several other stakeholders are also discussed. A summary of the service value proposition is shown in Table 5.

The service in this business model is offered by large network operators who are capable of building their own content network for content distribution. The target group of the service include content providers, who wish to provide content to access network operator's content consumers and who value quality of service guarantees in the content delivery. The benefit for the content providers of selecting an ANP with QoS offerings is then the ability to guarantee service quality to the content consumers. In addition, the access network provider might collect usage statistics and offer this information to the content provider as an intangible benefit, which also serves as a means for customer retention.

As caching is used, the benefit for the content consumers is the quick service and lower network latency as the content is located near the consumers. In addition, as the content providers have the ability to offer QoS guarantees, the content consumers may enjoy good service quality.

Table 5. Service value proposition for ANP driven Pure ICN

CDI	Description
Targeting	• Content providers who value QoS • Content providers in turn target ANP's consumer subscribers
Benefit for access network provider	• Less traffic going through the interconnectivity network due to caching • As a consequence dependency on transit provider is decreased • New business opportunities leveraging the proximity to end-users
Benefit for content provider	• Can offer guaranteed QoS to consumers • Usage statistics from the access network provider as intangible benefits
Benefit for content consumers	• Less latency due to in-network caching • Guaranteed QoS
Branding	• High quality service through in-network caching

Caching also benefits the access network operator as less inter-domain traffic is generated and the ANP needs to pay less to the interconnectivity provider. As a consequence, access network providers are less dependent on the interconnectivity provider, which increases their market negotiation power. The close proximity of cache servers to the end-users may induce new business opportunities for the ANP such as dynamic content and application acceleration. In addition, as in-network caching reduces latency of content delivery, the ANP offering ICN content delivery may gain a good reputation for its high quality service, which can be used to build the brand name.

3.3.2 Service value proposition for Virtual CDN

The service value proposition for the virtual CDN business model is similar to the value proposition of an ANP-driven, pure ICN business model. However, a few differences exist. First, the virtual CDN provider is the service provider, thus the analysis is done from its perspective keeping in mind the benefits for several other stakeholders. A summary of the value propositions can be found from Table 6.

This business model is targeted at smaller network operators, who cannot build their own content networks but who still wish to offer QoS-guaranteed content delivery service to their subscribers. The benefit of this business model to the ANP is the ability to offer QoS to content providers. In addition, due to caching, less traffic going through the interconnectivity network is generated.

The benefit for the content provider and content consumers are the same ones as in the ANP-driven, pure ICN business model. In addition, branding is also based on providing high quality services to the consumers.

Table 6. Service value proposition for Virtual CDN

CDI	Description
Targeting	• Small network operators that are not capable of building own content networks • Content providers who value QoS • Content providers in turn target any content consumer
Benefit for access network provider	• Less traffic going through the interconnectivity network due to caching • Revenues or subsidization of cache servers from the virtual CDN provider
Benefit for content provider	• Can offer guaranteed QoS to consumers • Usage statistics from the virtual CDN provider as intangible benefits
Benefit for content consumers	• Less latency due to in-network caching • Guaranteed QoS
Branding	• High quality service through in-network caching

3.3.3 Financial arrangements

This section illustrates the value flows between stakeholders in the two chosen business models. The value flow diagrams illustrate the payment or monetary flows, the transfer of services and products, and the intangible benefits. The intangible benefits, as Allee [42] defined them, are value and benefit that are not included in the service and cannot be accounted for in monetary terms, such as customer loyalty, image enhancement, and human competence in terms of information.

The stakeholders in the figures correspond to the actors in the corresponding value network configurations. In addition, the supporting roles are expressed as the content creator, device provider, and network equipment provider. The payment or monetary exchanges are shown with black arrows, the service and products with blue arrows and the intangible benefits with red arrows.

In the ANP-driven business model, altogether seven stakeholders are identified. The access network operator is the service provider and both the content provider and the end-user pay it for the content delivery. The access network operator besides offering content delivery services collects usage statistics and offers this information as an intangible benefit to the content provider. It is also possible for the access network operator to include the usage information collection in the service provision agreement, in which case it is not an intangible benefit but included in the service flow. The full value flow diagram is shown in Figure 14.

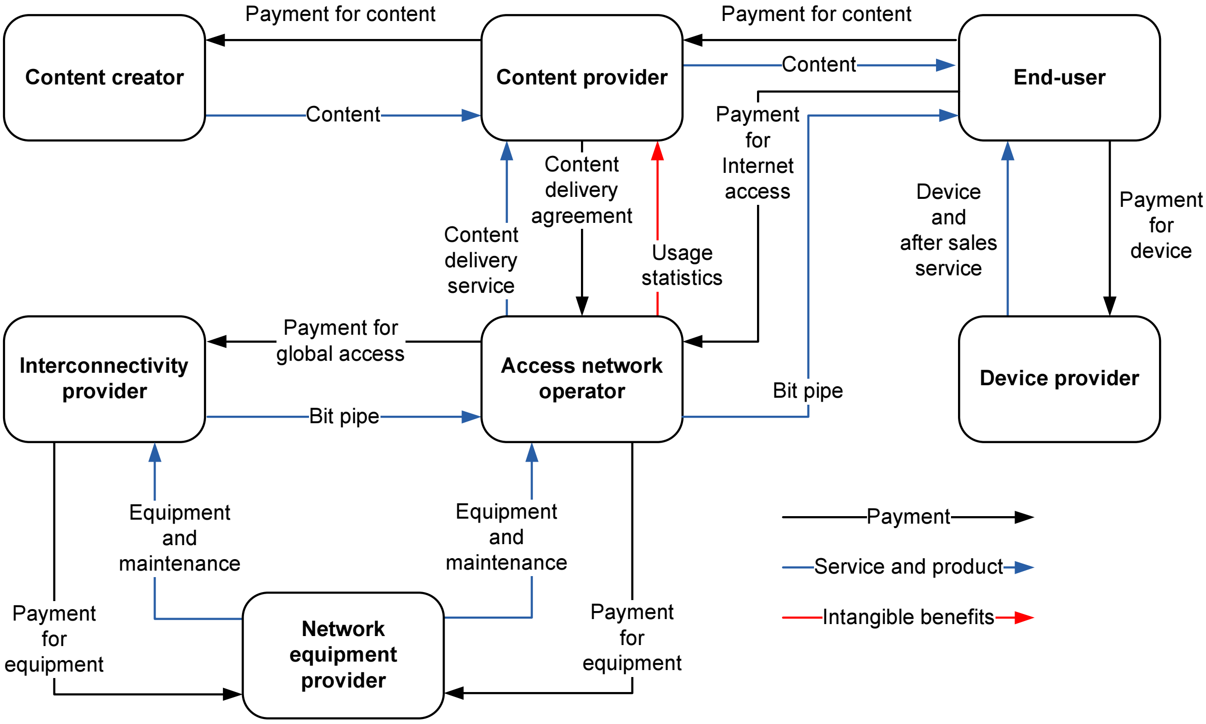

Figure 14. Each stakeholder's value flow of the ANP driven business model

In the virtual CDN business model, eight stakeholders are identified with a virtual CDN provider offering the content delivery service. The content provider in this business model pays the virtual CDN provider for content delivery, whereas the end-user still pays the access network operator for the content delivery. Instead of the access network operator, now the virtual CDN provider collects usage statistics for the content provider as an intangible benefit. In addition, the virtual CDN provider pays the access network operator for using their cache servers. The full value flow illustration is shown in Figure 15.

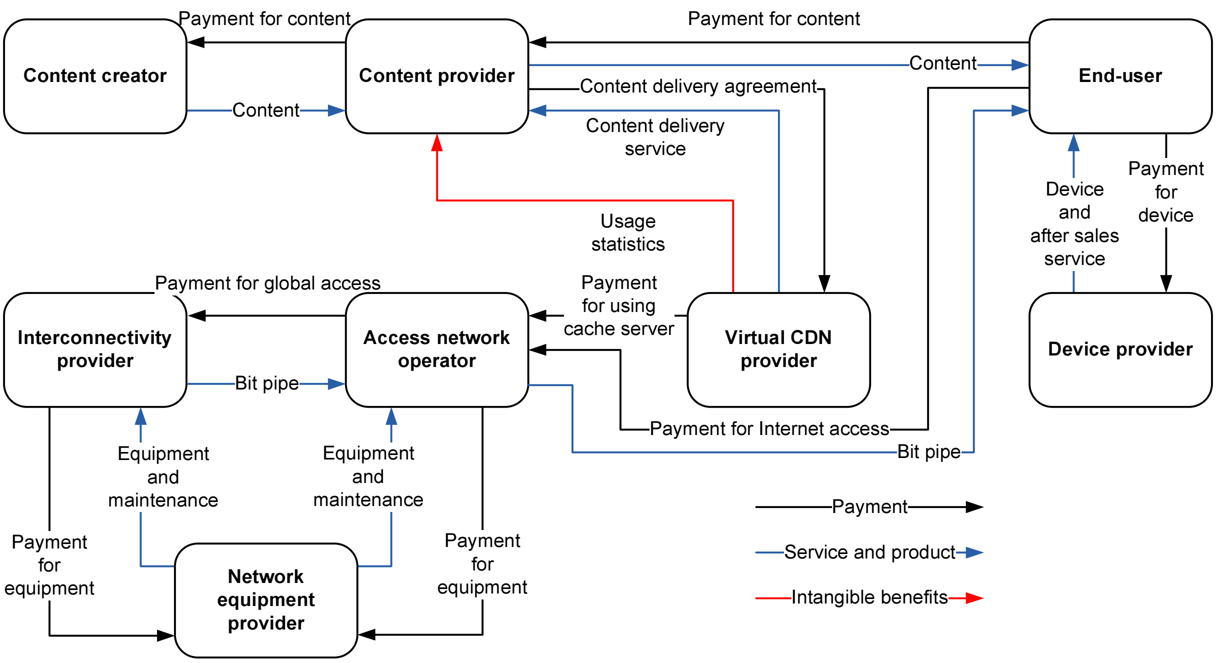

Figure 15. Each stakeholder's value flows of the virtual CDN business model

3.4 Future research topic: Content cacheability

The fundamental idea of ICN is in-network caching at locations near the end-users, thus it is important to discuss the feasibility of caching. The feasibility can be divided into two main research topics; one dealing with the potentiality of caching in the Internet (*i.e.*, what proportion of Internet content/traffic is cacheable from technical and regulative perspectives), and the other with the economic feasibility of caching for different stakeholders.

As a next step, the potential of caching will be investigated and the main question is *how much of the content in the Internet can be cached*. This investigation can be done from several different perspectives, which are listed below.

- What does caching mean in ICN and how does that differ from web caching?
- What is the redundancy of Internet traffic [43]?
- How does the Zipf-like distribution [44] of content affect the cacheability of content?
- What proportion of the content is dynamic (vs. static) and (how) can it be cached?
- How often is content updated and how does content update rate affect its cacheability?
- What content can be cached from a regulative perspective?
- Who is allowed to cache content?
- How is content access control handled in ICN?
- Why did the web caching hype at the end of the 1990s end?

The methodologies to be used in this research may include but are not limited to the following:

- Literature review
- Expert interviews
- Traffic data analysis

The aim of the above investigation is to provide a solid background for the economic feasibility analysis of in-network caching. For example, the following topics and questions may be studied in more detail after the potential of caching has been determined.

- What is the price ratio between content storage (memory) and content transmission (bandwidth) and how does that affect feasibility of caching?
- What is the value of the enhanced performance (*e.g.,* time and cost savings) for end-users?
- Techno-economic modelling of stakeholder costs.
- Game theoretic analysis on stakeholders' utility and willingness to deploy ICN.

3.5 Conclusions

In this Section 3, we focused on the global content delivery scenario of NetInf (NetInfTV scenario in D.A.1) by studying value networks of information-centric networking (ICN) on a high level. First in Section 3.1, we identified key trends and uncertainties of ICN and analysed their implications for the scenario. The key finding from this environmental study was that current content delivery trends could be well supported by information-centric paradigms. However, it remains uncertain if the novel ICN architectures need to be able to deliver guaranteed and differentiated QoS and, consequently, if caching will be transparent or based on business agreements.

During the value network configuration analysis done in Section 3.2 we were able to compare the competing solutions to NetInf by drawing an analogy between different content delivery models that provide the same piece of content (an information object, IO) from multiple locations (cache servers) around the Internet, such as proprietary CDN, P2P, or NetInf-specific models. This was done by identifying the functional roles of ICN and illustrating eight alternative value network configurations (VNCs). The difference between each VNC lies essentially between which actors control the cache servers, manage the content network and access to information objects, and content access management roles. In addition, control over what content is delivered and QoS issues play critical roles. As the growing traffic volumes rapidly increase the demand for ICN architectures, it is likely that the competition but also co-operation between these different VNCs become more intense. To leverage ICN infrastructure optimally, initiatives that support, for example, application-independent in-network caching [27] or CDN interconnectivity [28] may be needed. Additionally, being able to challenge currently dominating VNCs, novel ICN architectures, such as NetInf, need to enable feasible revenue sharing between actors.

In Section 3.3, we analysed two interesting business models for NetInf: 1) the Access network provider-driven business model from the Pure ICN VNC, and 2) the Virtual CDN business model. The analysis describing the value proposition and value flows was done mostly from the ISP (especially access network provider) perspective. Both business models seem promising, but a more thorough study is needed to validate their feasibility.

Finally, true potential and feasibility of caching is an interesting question that has not been widely studied from the socio-economic perspective. Therefore in Section 3.4, we described the research questions and methodologies that are to be used to study this content cacheability question during the next phase of the project.

Recommendations to SAIL project

- Discuss actively with content providers who are the primary customers of NetInf services.
- To make NetInf-based content delivery services more interesting to content providers, NetInf should to be able to deliver guaranteed quality to content providers.
- Make sure that transparent caching does not lead to conflicts between stakeholders with different goals, or at least make sure that there are technical means to solve possible conflicts related, e.g., to content control in caches.
- To foster deployment of NetInf, make sure that the costs and benefits are aligned.

4 Business Aspects of Open Connectivity Services

4.1 Introductory Considerations

WP-C has several different use-cases, but for this deliverable the idea was to choose a representative one, although not fully considering all the aspects taken into account by the others, looking at it from a business perspective. Use-Case 1 “Creating and Sustaining the Connectivity in Wireless Challenged Networks” was chosen due to the fact that it analyses some very challenging concepts, like Wireless Mesh Networks (WMNs), ad-hoc, or Delay Tolerant Networks (DTNs), and WMNs concepts and ideas are very interesting from a business perspective. WMNs have the ability to provide connection to the Internet in areas with difficult or limited access to the network, via the ability to connect several devices together, which can revolutionize mobile networks technology and network architectures as they exist today in our global marketplace. The total availability of wireless connections will also promote the full use of Internet services in rural areas, and end the digital divide still existing in regions with low purchasing power, as well as in specific focus areas in regions of a city with special needs. These two scenarios (rural and urban ones) are developed ahead in this chapter.

With this new generation of wireless infrastructure, it is possible to rapidly deploy a low-cost network providing Internet connectivity to end-users. This infrastructure can be easily implemented on college campuses, community neighbourhoods, enterprise environments, or isolated villages without network infrastructures. Based on mesh routing technology from traditional suppliers, like Motorola and Cisco, as well as a number of start-ups, WMNs are competing with traditional cellular macro-cellular networks on the price/performance ratio in the market for wireless broadband, and in metropolitan area network connectivity [45]. Additionally, IEEE has been working towards the standardization of mesh networks, in 802.11.s [46].

Mesh networks address two key issues, when trying to implement new wireless networks: they can provide coverage over an area substantially greater (relative to conventional Wi-Fi) than any given single access point, without the need of a fixed infrastructure, and they can provide very cost effective solutions. This technology is especially used for outdoor deployments in areas with poor coverage. WMNs extend the typical Wi-Fi networks by using multiple low cost 802.11 radios as routing nodes, which pass data between themselves and require much less fixed core network connections. While using this architecture for wireless meshing, wireless access points work as broadcasters that provide connectivity within walking distance to other connection points, being centred on free Wi-Fi networks.

The first generation of mesh networks implemented in several cities have shown that they are impractical to provide network access in perfect conditions. The experience gained with these early business models showed that there is a very small limit on the throughput that the network can provide to the user, and that there is much unfairness in the network overall, as well as constant degradation of multiple access communication. As an aggravating factor in the specific case of San Francisco, CA, USA, the access to this service was indeed bleak. For all these reasons, the obtained results were well below investor expectations, as they got the attention of a very limited number of users [47]. Still, the situation has changed since then, and new opportunities may arise.

Nowadays, wireless networks are everywhere, although they are only used in a “traditional way”, just to provide wireless access to the network directly through every access point. Mesh concepts are not widely used (although some examples of studies on WMNs can be given, such as [48] and [49]), but this entire infrastructure can easily be used to do so. One just needs to create a viable business model that takes the real costs into account, in terms of both technical and economic viabilities. Due to this, one believes that this is the perfect timing to look once again to WMNs. One starts the business modelling by evaluating whether the current status of technical development and the broad availability of wireless networks can be really beneficial, profitable and efficient. A key question is whether technical specifications and algorithms can live up to expectations and visions of mesh networking?

Now, and in the coming years, one will be challenged to create a new generation of WMNs. At a technical level, the OConS WP is involved in finding ways to scale networks, and upgrade all networks with a combination of improvements in hardware and specialized algorithms specifically created for this purpose. One also presents some scenarios, in order to have some common references for the comparison of technologies, [45], so that a viable business model is established. WMNs must find and establish a viable position between what exists today and the future offerings the market will provide, concerning infrastructured and non-infrastructured networks. Another question that needs to be solved is whether WMNs can continue to use unlicensed spectrum, as they use currently, or if licensed spectrum is required in some situations to deploy this kind of networks (as it is studied by OConS).

Throughout the remainder of this chapter, one will address technical challenges, as well as economic and social differences, related to this new generation of networks.

4.2 Objectives of Wireless Mesh Networks

The main idea behind WMNs is to enable wireless networks' users to overcome the limitations of hotspots, and to offer a broadband service in areas with limited access to the Internet. The potential market of WMNs is still in a very early stage, but a couple of ideas can be put forward, showing that a viable business model behind the concept can be created, especially in new markets. Such networks can provide a platform for multiple opportunities for new technologies, and for innovative service models to exist without a large scale deployment (both in technical and financial terms) [50], [51]. Therefore, there is indeed an opportunity to experiment and test new business models with new ideas regarding pricing systems. To some extent, these models can evolve, and these tests may be adopted and expanded to more mature markets, targeting to complement existing offerings. Currently, WMNs are in a very experimental stage, being a reflection of existing technologies and their development cycle. There are several start-up companies working on WMNs using unlicensed spectrum, and as the technology matures, the ideas behind them will be promoted by established suppliers, and will be applied also to licensed bands. Already nowadays some players, *e.g.*, Google, Earthlink, and a number of small regional providers, operate on the mesh network markets, but they lack market strategy and future direction [52].

Usually, the major providers of mobile services are not considering WMNs, because these networks have not yet a proven business model. Many major mobile operators, such as T-Mobile USA [53], have invested in the distribution of medium-scale WLAN hotspots; thus, they could use their already deployed hotspots to start the WMN deployment. Again, this raises the question of the unlicensed spectrum currently associated with WLANs, thus, with lack of quality of service guarantees.

The ideas on the usage of WMNs will increase the overall usage of mobile services [50]. The largest mobile operators, especially in the European market where the number of customers is almost stagnant, are looking for very specific business models that cannot be easily addressed by any other player in the market. These specific services are targeting specifically public services at municipalities, like surveillance, public safety, and road monitoring. Certainly, suppliers and new regional companies that serve very specific rural areas will also appear, as well as in university campuses. Still, community networks deployable in either urban environments or rural scenarios are the new showcase enabled by the SAIL.

WMNs focus on specific applications that are typically custom-built for each use case; hence, designing a single solution for all types of customers is not necessary. However, networks can and should be designed to take advantage of the installed technologies, and be able to incorporate emerging technologies, such as WiMAX or LTE [54]. Business models must also evolve, because the existing low-cost municipal networks are evolving to more advanced and costly ones as more users are brought into the network.

4.3 Requirements of Wireless Mesh Networks

WMN solutions require a service infrastructure that ensures the following:

- Efficient network management, so that network performance should be given top priority.
- Sufficient security with authentication and authorization steps.
- Roaming and network wholesale enabled capabilities.
- Back-office transaction operations including billing for different user groups, subscriber management, pre- and post-paid billing systems as well as credit card paying options (predominantly to support expatriate subscribers), one-time password, scratch cards, and e-voucher solutions.
- Portal infrastructure for self-service and service lifecycle management, roaming, clearing house and settlement functions [55].

4.4 Adding Connectivity

The selected OConS use-case is focusing on the construction of a network system that can provide connectivity over several wireless nodes (*e.g.*, WMNs) that are willing to connect each other simultaneously, in order to provide all nodes with multiple options of connection to the network resources [3]. This leads to a constantly moving network with endless possibilities. In order to deploy WMNs, several aspects need to be addressed and analysed [56]:

- Technology – Which are the rules for network usage?
- Cooperation at different layers – How do the different layers interact?
- Incentive mechanisms and the human perspective – How does it work?
- User participation – Who are the participants, and how can they be satisfied?
- Network creation – How can a network be created, and what are its main purposes?
- Cooperation and resource provisioning – How to cooperate and provide resources for QoS guarantees?

The Open Broadband Access Network (OBAN) model deals with these different areas, focusing on the relationship between Wi-Fi technological developments, user acceptance, and business scenarios, where both users and the capability of network creation are tested. The OBAN concept is described as an open broadband access network, where public users can share the network capacity of the paid fixed access lines [57].

Nowadays, the capacity of residential users' fixed access lines is not fully used, generating huge amounts of network capacity that is wasted. This "wasted" capacity, that no one else is authorized to use, can be part of the solution of the traffic volume over the network that WMNs will be requiring. The design of the OBAN concept contains technological solutions to provide connectivity to public users through privately owned access lines. This means that other users that want to enter and use these kinds of networks are able to use the capacity left unused in the currently installed broadband accesses.

WMN solutions are already used as a cost-effective solution by several wireless communities, such as municipalities, campuses, enterprises, and public safety organizations. An example of a success story is a start-up company based in California (Tropos Networks) [48], which delivers firmware via Wi-Fi network providing a simple solution that interconnects several peers with a small flat rate. Other examples using a more aggressive method are companies that offer Wi-Fi equipment to several users to deploy them on rooftops, and users receive free Internet connection in exchange (BelAir, PacketHop, SkyPilot, Strix Systems and RoamAD) [58].

At the beginning of large scale WMN's deployment, both "fixed" network already existing in the market and "*on-going*" ones, which can be created on the move, may co-exist. Other attempts were made by several companies to achieve a good performance WMN, like an open-mesh form of connection. WMNs in spontaneous form can only work effectively if the different layers of connection can operate between them with specific incentives, creating value for the different players. In this area, one is witnessing the creation of a multitude of networks based on communities of both social and professional nature [56].

The main issue in WMNs is the sharing of physical resources in the backhaul network between users, creating incentives to the users, in order to create the network and provide connectivity for all. The work on business modelling for this scenario needs to take this issue into account. With these new types of relationships, users can create a relation that enables a win-win situation. In order to conceptualize the business model, the work must start by the analysis and identification of the main trade-offs [56] at the core choices, among alternative digital business models, followed by a comparison in terms of competitiveness and efficiency [59].

4.5 Technical Issues

Other aspects that need to be taken into account concern the networks themselves. Issues like network constraints, communication delays, unstable/unpredictable links, non-existent end-to-end paths, very low data rates, node constraints, and computational and storage resources are “trouble makers” for an effective construction of WMNs. In order to address these issues, some matters need to be resolved [60]:

- adaptive network architectures,
- application protocol design,
- new transport paradigms,
- suitable operating systems support and network APIs.

Despite the cited examples, the business model concept [61] of WMNs is not widely studied. For instance, one can think that selling the right to use assets is more profitable and more highly valued by the market than selling the ownership of these assets [62].

The main issues under consideration are the sharing of resources between users, and the possible incentives that must be given to them in order to do so [63], [64]. How is a user rewarded by forwarding traffic from others? How can this be fair? What knowledge about the neighbour must one have in order to make the network to work? How can this be made to work? Technically, this also raises some challenges, like security or privacy issues, that must be addressed. These issues may have an impact on how networks can be developed, thus, affecting possible business opportunities [65]. All this must be as transparent as possible to users, *i.e.*, there must be some kind of software to act as an interface for users, and to perform the connection between network points [56]. Other issues, already partially addressed, are the lack of information concerning the types and preferences of individual peers, which is required for the computation of the optimal allocation of costs and resources in a peer-to-peer system [64].

The network creation process has to start with an agreement settled by all players, in which any individual player sets his/her own rules, which can be negotiated in between the players. Issues to be defined include, *e.g.*, traffic volume, payment conditions, and reputation. One example is the neighbourhood community that relies on trust (reputation) between the players to provide its services. In this case, network construction is treated as an inherent part of the community’s activity, the creation of a link corresponds to a community “join”, being subject to the doctrine (previous made agreements) set by each community [55].

After this process of “certification”, the incentive part of the process begins. Several kinds of incentives were studied, but one particular incentive may be highlighted. In a peer-to-peer system, as well as in virtual communities, end-users are allowed to exchange resources (*e.g.*, content and bandwidth), expertise, and presence. In each of these cases, networks allow for a variety of applications in an efficient way, taking advantage of the small contributions from a very large number of users. For the implementation of an incentive mechanism, rules need to be established for participating agents, which will lead these agents to behave in a certain manner, rewarding or punishing them according to their actions [66]. In order to a WMN be successful, players need to be rewarded for altruistic behaviour, so aspects like influence, level of importance, status, and number of connections can be of high importance.

One of the assumptions of a WMN is that it should be spontaneous. But even being spontaneous, these self-organized communities have the purpose of establishing suitable cross-layer social incentive mechanisms, so that users have some kind of QoS guarantees. An example of work in this subject is the CARMEN project [67]: WMNs are differentiated by adding “carrier-grade” requirements that improve the network in an adaptive, flexible, reliable, easy to manage, and intelligent self-configuring way. An important aspect of this specific project is that it fosters the capability to be commercially feasible.

4.6 Traffic and Usage Aspects in Mobile Networks

The WMNs being considered in SAIL can be defined as a set of infrastructures constituted by specific nodes that are equipped with at least one wireless card, *i.e.*, each node has at least one radio access technology [3]. Some of these nodes are connected to Internet, but it is not required that all are, because they can access the Internet via hops in the WMN. Then, the usefulness of interchanges can be divided into two distinct parts: one that provides connectivity to all registered users of each node, and another to transmit data to and from the nodes of the mesh through a backhaul mesh network.

One of the main advantages of WMNs has always been the low cost of implementation [55]. However, all experiments carried out up to now have proven that low cost itself is not enough to change user behaviour and the modes of operation that one considers usual.

The main advantage to be explored is the combination of high speed networks with the terrestrial mobile network coverage. In order to exploit this advantage, one must look at WMNs from a perspective of consumer/customer; if they are seen only from a supplier's perspective, they will tend to lose value, turning the advantage into disadvantage. It is from this perspective that SAIL addresses a new business model, because traditional WMN implementations may not offer sufficient benefits to justify any additional expenditure on connectivity. A case of failure occurred in San Francisco in 2007, where the network supplier lost about thirty million dollars, while gaining only 2 000 users on the network, [47]; additionally, the network also had problems with privacy issues.

Still, one of the big question marks always arising around the idea of mesh networks is their traffic capacity. How will they scale up when the number of nodes or the traffic generated by each node increases?

Even if one develops good business models for WMNs, they will be (widely) used only if the end-user experience is good enough. This means good and fast access to information, which makes the analysis of traffic aspects in these kinds of networks even more important. The first step is, obviously, to look at the traffic generated by users themselves. For such, one needs to explore the current Internet usage patterns of mobile users, which will be the users of mesh networks.

Starting by looking at the global number of mobile users, the natural trend is the continuous growth of the number of mobile subscriptions in both developed and developing nations, although the growth is faster in the latter ones. As Figure 16 shows, the number of subscriptions just passed 5 billion [68], and 6 billion is right around the corner [69]. This means double digit growths, even if the overall growth is steadily decreasing, as indicated by ITU, Figure 17, [69]. These are very large numbers, and operators need to almost continuously upgrade their networks to keep up with the demand. Therefore, research and new ideas on femto-cells [70] or mesh networks [71] are very hot topics.

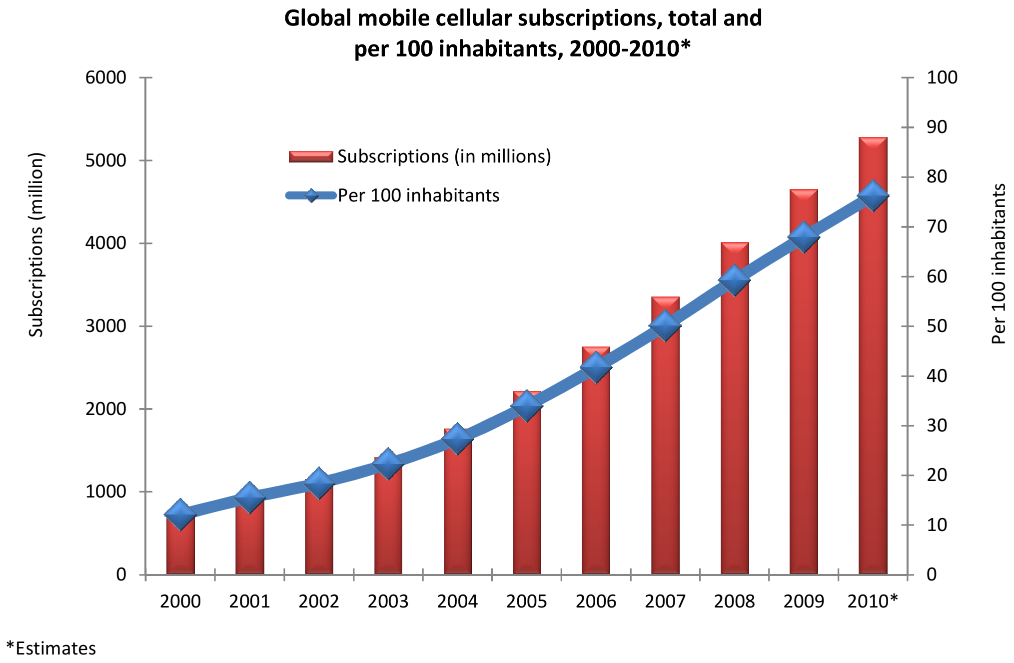

Figure 16. Evolution on the number of mobile phone subscriptions (extracted from [72]).

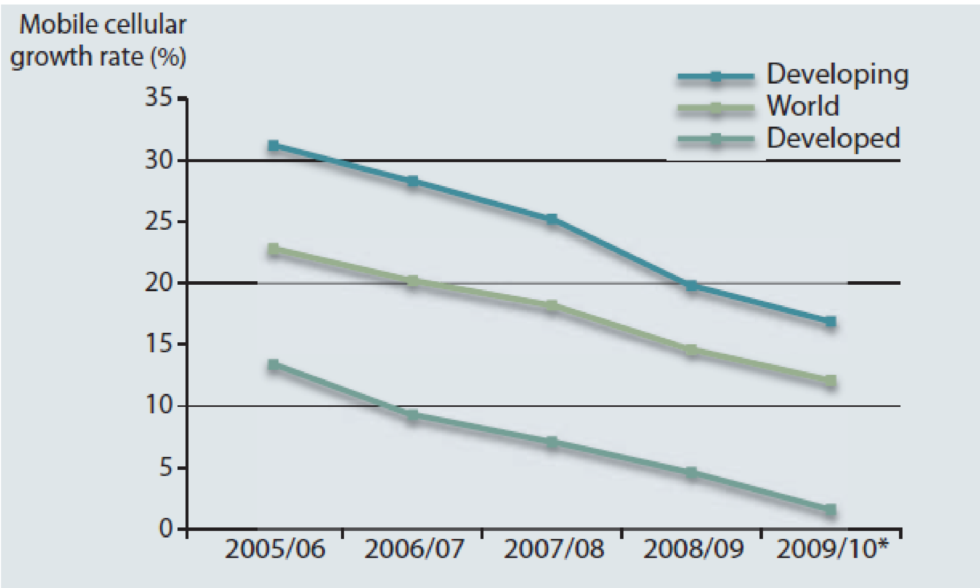

Figure 17. Mobile cellular growth rates (extracted from [72]).

However, the major challenge for operators does not come from the evolution of the number of users, but from the huge growth in the traffic generated by each user. The average monthly traffic by a single mobile user is still quite moderate, but with the explosion of the number of smartphones and laptops, these numbers are growing very fast. A regular mobile phone generates about 3.3 MB/month, but a smartphone does almost 80 MB/month (24 times more), and a laptop more than 1 GB/month (around 500 times more) [73]. In 2010, smartphones represented just 13% of the number of terminals, but accounted for 78% of the traffic; both these figures are expected to grow even more, as the importance of video grows, and the number of tablets increases sharply in the coming years [73], [74], and [75]. Other “high-end” devices have a similar behaviour, Figure 18.

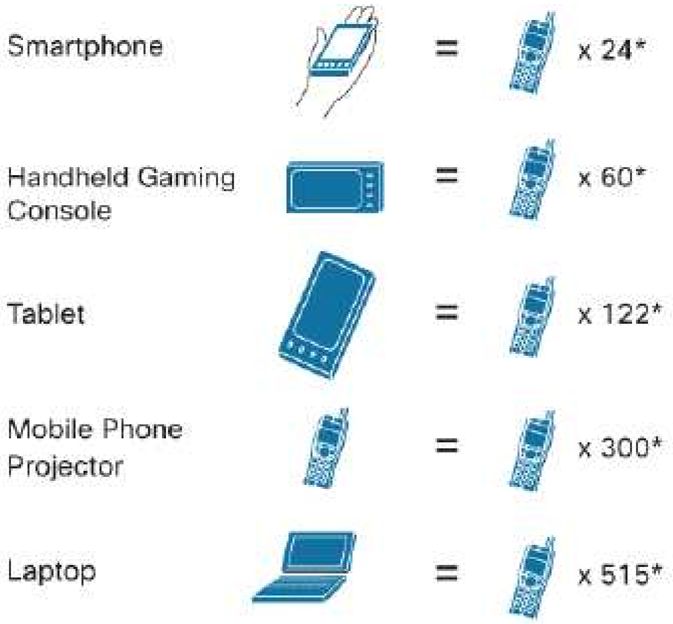

Figure 18. Traffic volume of high-end devices compared to traffic volume of a basic phone (extracted from [73]).

As stated in [73], Figure 19, these numbers are expected to grow. Mobile traffic is increasing by a factor of 26 until 2015 (it grew 2.6-fold just in 2010, well over what was estimated in the previous year). Of course, the impact of this growth is somewhat, but not entirely, reduced by the increase in the connections speeds, as the average connection speeds are expected to increase "just" 10-fold by 2015.

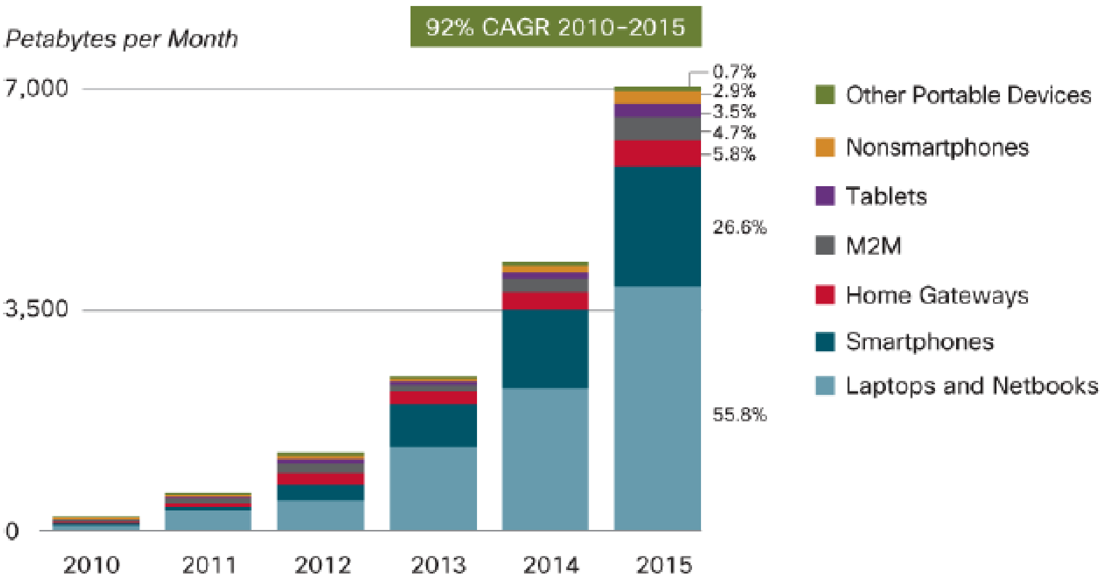

Figure 19. Traffic growth for mobile terminals (extracted from [73]).

With a 26-fold increase in the average traffic volume, the average traffic volume per smartphone user exceeds 2 or 3 GB/month in 2015. A simple community mesh network with just a few tens of nodes will reach traffic volumes of the order of 200 to 500 GB/month. The growth rate is more important than absolute values, because this traffic growth can cause trouble to WMNs, therefore, the design, implementation, and business models must take the scalability issues into account. One extrapolated these data until 2020, in order to make some predictions. Since the growth is decreasing from exponential to almost linear, one can make a trend line over the current 2015 predictions, and get the data presented in Figure 20. Considering the estimated growth and the numbers from Figure 18, one estimates that in 2020 the traffic volumes from tablets can reach 2 GB/month.

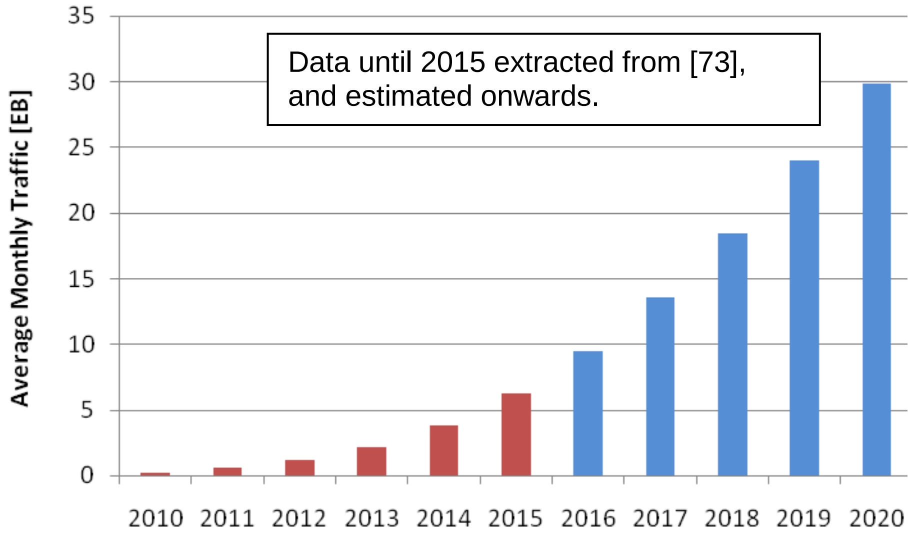

Figure 20. Growth in mobile traffic volume until 2020

4.7 Current Market Performance

Currently, the main problem all around the Europe is a policy of scarcity. Financial markets are hesitant concerning new investments in the telecommunications sector. The stakeholders that deal normally with this market fear that operators' cash flows will decline significantly.

The revenues in the telecom market are declining on a yearly basis, and European service revenues are decreasing at an estimated rate of 3%. Some details that characterize the current European telecoms market are:

- Voice traffic growth is decreasing to +3%, instead of an average of +7% in the last years, due to market maturity combined with economic recession (impact on B2B and roaming).
- Due to regulation and competition, the average price per minute declined on average by 11% in the last few years.
- Fear for large CAPEX increases due to market uncertainties.
- Traffic congestion (*e.g.*, at AT&T in the USA and O2 in the United Kingdom) [76].

Another aspect is that the mobile Internet growth leads to a traffic explosion. In order to characterize the mobile traffic explosion, one looks to the smartphone penetration acceleration, which was around 20-25% of handsets sold in 2009, and 30-40% sold in 2010-2011, and above 50% onward, Figure 21. This means consumer-pull and an operator-push is happening in the market. The big trend is that users are using data for real, hence, being ready to pay for a data bundle.

With the expectation of a continuous traffic growth, the new WMN technologies must enter the market with special characteristics, which should present real innovation over the currently available solutions. The niche market that must be occupied by WMNs is the one described in Figure 22, within the red ellipsis, especially in the personal space/home environment/neighbourhood.

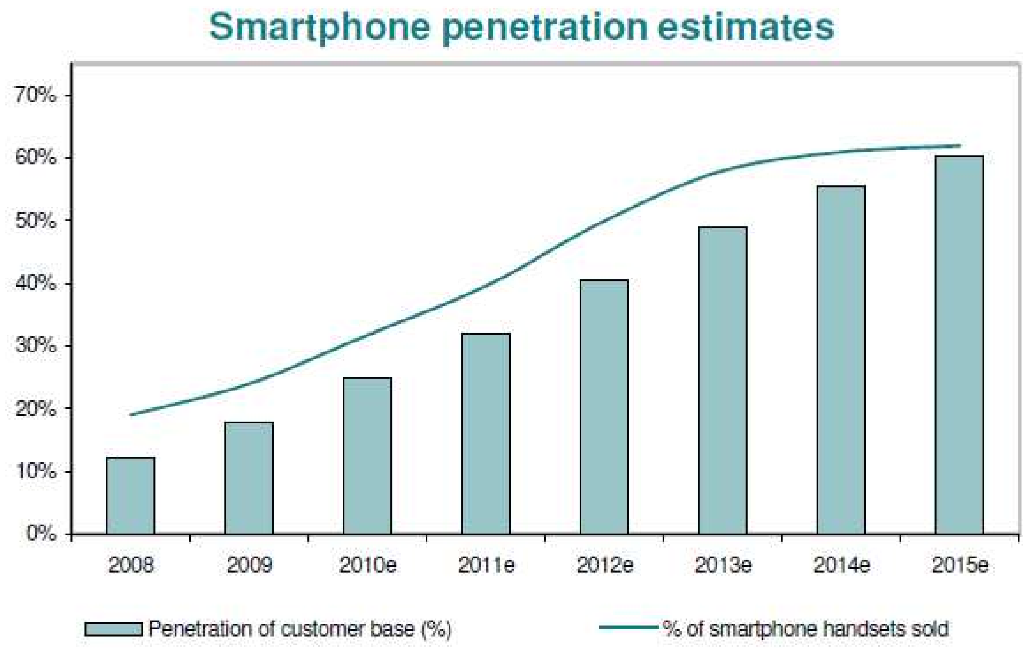

Figure 21. Smartphone penetration estimates in 2008-2015 (extracted from [77]).

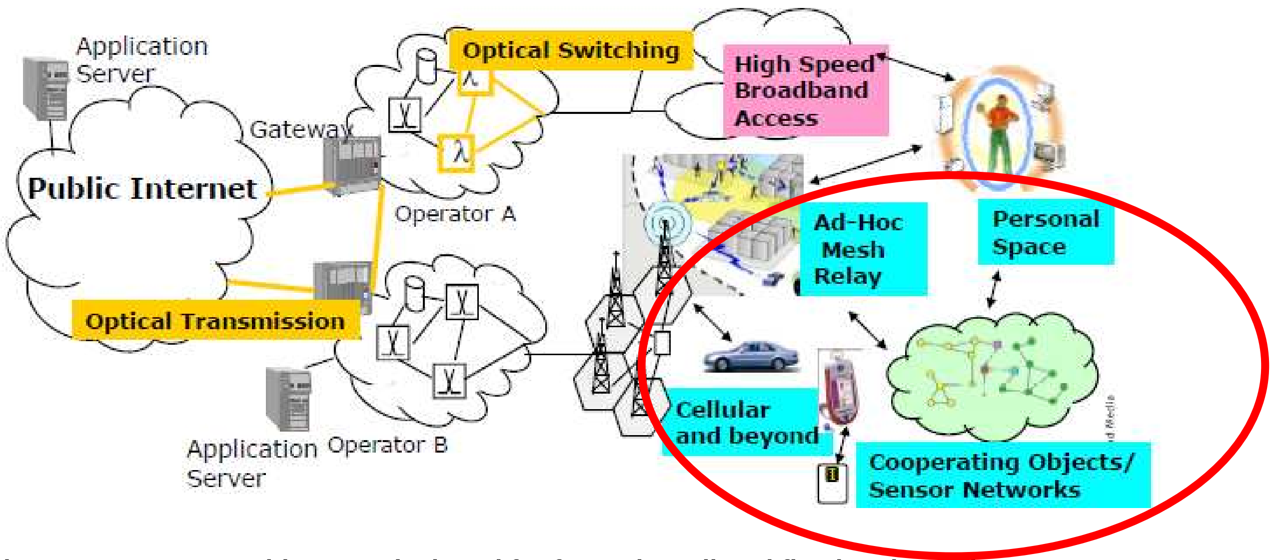

Figure 22. Internet architecture designed for future broadband fixed and mobile access (extracted from [78]).

The WMN market has already some players, such as Cisco, which has given new credibility to WMNs. Cisco's position in this area is to build and implement WMNs within a larger unified networking architecture. This should include indoor and outdoor WLANs infrastructures, together with security and services integration [78].

Currently, one can find already operating in the market a more focused Mesh Network, rather than a general market solution. A WMN cannot be sold as an independent service, but rather as an integrated service of a package solution [49], although it may work for community access where users will tolerate best effort quality. Still, a mesh network can be established without any operator, but an underlying business model needs to exist. The solutions proposed by OConS are directed primarily for communities, and so they are a possible answer for this, hence, WMNs can and should be designed to take advantage of installed technologies and be able to incorporate emerging ones.

From a competitive view point, SAIL, and especially the OConS Scenario, should continue to evolve and optimize the mesh technology with modular architectures, ensuring flexibility and easy addition of all devices increasing the scalability and upgradability of the network. So as advantages and leading points, OconS must [77]:

- Give preferences to dual or multi-radio interface implementations, because of the increased robustness that WMNs need.
- Ensure support for multi-user groups, with prioritization based on user class or traffic type.
- Support a range of services across different user segments, with QoS that will become critical as multi-service business models evolve.
- Build best-of-breed partnerships with strategic players in the value chain, such as big players in the market. WMNs will not stand alone, rather they have to be combined with other technologies, because of the general network dependency that they have.
- Recognize the impact of value chain complexities on the ability to implement innovative solutions. The support and the coordination across the entire value chain is very important for the success of the project.
- Anticipate the role of large established networking players, build a strong position in a niche market (such as public safety), or to position itself as acquisition target by continuing to evolve and attract customers.
- Recognize that advanced network management systems will be a key differentiator.

4.8 Market Scenarios

4.8.1 Setting the scene

Not all attempts to implement WMNs have been successful. The reason for the failure has been that the market was not ready to deal with the community, sharing and cooperation aspects that WMNs are promoting. Another reason was that the business models of these implementations were not properly explained to the several players and stakeholders.

But one may consider that now the market is already mature to support a technology such as WMNs, and users are ready to understand the proper usage of this technology. Nonetheless, there are still some aspects that must be fulfilled in order to WMNs to be successful:

- **Price** – This is one of the key elements for the success of this technology. Although the expressed benefits that exist by using WMNs can be put forward, the price is key to the users to join and to cooperate.
- **Capacity requirements** – WMNs are a response to users that are not heavy Internet users, but want only a good enough connection for browsing or email.
- **Security and mobility concerns of mesh algorithms** – Mesh implementation may introduce some security concerns from users, which must be addressed by the mesh algorithms. Also, mesh algorithms must handle mobility, and always have the key goal of minimizing both intra- and inter-node latency [79].

The OConS architecture benefits from the efficiency with which it transports subscriber traffic from a certain point over a number of hops to either the destination within the mesh or to a point that interconnects to the backhaul. With more efficient networks fewer backhaul connections are needed, which reduces costs.

There are a number of additional architectural attributes that are also important:

- **Centralized management (only in wide areas)** – There is a need in medium- and especially large-scale WMNs to centralize the provisioning of resources [79].
- **Multiple classes of service** – As noted above, it is important to be able to provide multiple classes of service (and classes of users) within a single mesh network. Each of these classes may require different traffic prioritization levels, and security and pricing

profiles. This capability can have a profound impact on both cost minimization and potential revenue opportunities.

- **Upgrade capabilities** – While WMN nodes tend to be inexpensive, they become much more cost-effective when they can be provisioned with multiple radio interfaces, and especially when these additional radios can be added in already existing networks. This excludes the growth needs for the WMN, and helps to minimize CAPEX.
- **Security** – Security must be addressed in the whole network, not being just an OConS concern. Security issues relating with a cooperative technology as WMN have to be well preserved in order to provide satisfaction and comfort to users.
- **High mobility** – Applications involving moving vehicles will become much more important over time. The key element here is the capability to process an inter-node handover for rapidly-moving clients. In addition, the capability to maintain session connectivity at high speeds is essential for commuter rail applications [79].

4.8.2 Establishing Scenarios

Two scenarios are taken for WMNs, Metropolis and Rural, where actors behave differently. These scenarios are useful to highlight the main aspects of this WMNs business analysis. In Figure 23, an overview of a generic WMN scenario is presented, where the interaction between players can be seen. Some fundamental relationships need to be maintained in all WMN scenarios, identifying, for instance, values flows between players. Also, in this section, the WMNs are positioned as an alternative to the current offerings (*e.g.*, fixed access or mobile networks).

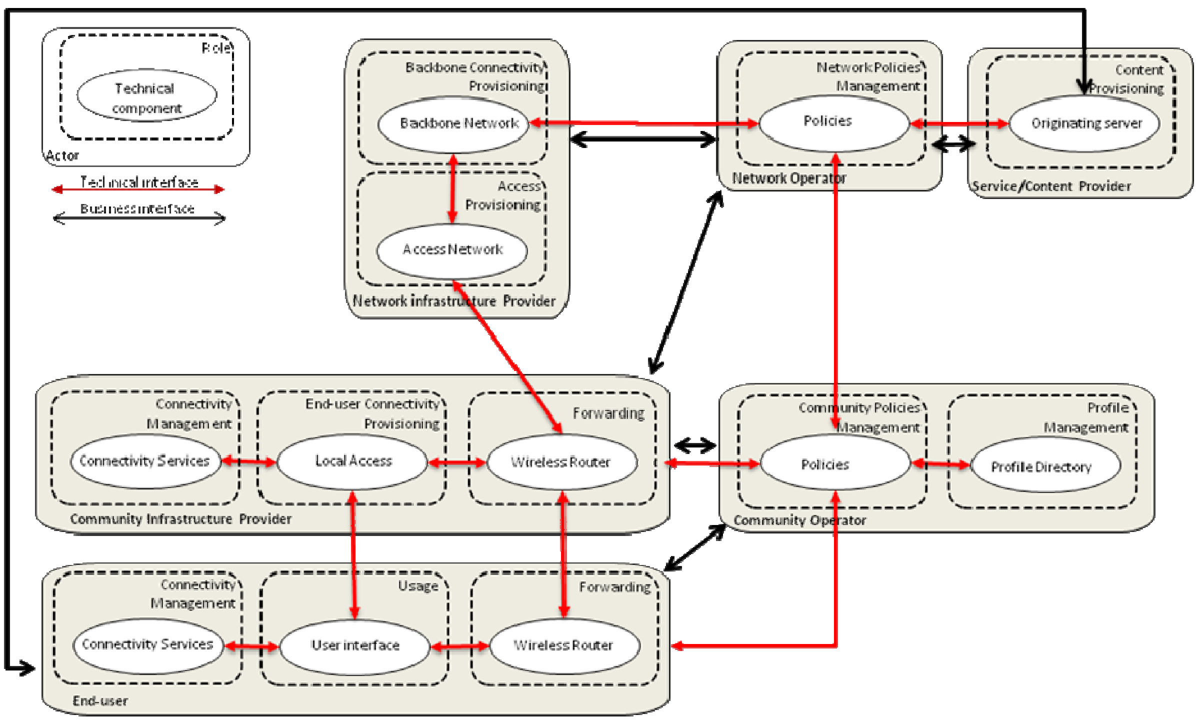

Figure 23. Generic value network configuration of Wireless Mesh Network (extracted from [3]).

Figure 23 presents six different players and the roles that the different actors as to follow for each relation:

- **Community Operator** – This player authorizes and manages the community's infrastructural resources. It defines a set of policies, based on which the community builds a spontaneous and self-organized network. It encourages end-users nodes to share their resources and cooperate by giving incentives, rewards or even a cash payment. Community operator works together with the Community Infrastructure Provider in order to capture more end users to join the network for a progressive effectiveness of the network. The idea is that a community operator has to aggregate community infrastructure providers in order to have relevance in the market. The more partners (community infrastructure providers) a community operator has, the more value the network delivers to an associated end user.

- **Community Infrastructure Provider (CIP)** (neighbours, old buildings, universities, hospitals, sports arenas, hotels and airports) – CIPs are responsible for building the spontaneous and self-organized wireless network communities of cooperating nodes. In these cases, ad-hoc network will be created, enabling a reduction in CAPEX, considering that the infrastructure already exists. A community infrastructure provider is basically composed of end-user nodes with forwarding capabilities that generate traffic. In the case of a WMN, mesh nodes forward traffic mostly towards gateways to the Internet (mesh nodes with gateway connectivity to the Internet).
- **End-user** – The end-user has multiple alternatives to access Internet. In order to choose a WMN as the preferred access there needs to be some kind of incentive (price building mostly). This incentive is delivered to the end user in two ways: first the usage of a WMN must be cheaper than any other private connection; second he/she must receive some compensation for routing traffic of other users. With these two options, a dramatic cost reduction to access the Internet must occur. This actor is a nomadic user that only wants to get access to Internet and does not route other users' traffic.
- **Network Infrastructure Provider** – Owns and uses the access and core infrastructure resources to provide global network connectivity. It exchanges traffic with the WMN through gateway mesh nodes.
- **Network Operator** – Authorizes and manages the access network.
- **Content/Service Provider** – Provides services, applications and content.

The black arrows in Figure 23 represent how Cash Flows work between players and how the business can perform in a generic model, and the red arrows are the network/infrastructure connection between players. For example, the End-user pays to the Service/Content provider for the usage of the content that the Service/Content Provider delivers to the End-user over the network without affecting other relations. Other relation is the one where End-user pays for the connection delivered by the Community Operator and after that the community operator pays to the community infrastructure provider the usage of infrastructure that was given to the End-user, creating like this a cycle of payments and usages very important for both Metropolis and Rural Scenarios. The value flows for both scenarios are presented in more detail in the corresponding sections.

In order to better understand the usage of WMNs in a market scenario context, one describes how they work in the two different business cases mentioned above, "The Metropolis Scenario" and "The Rural Scenario". In both scenarios, the interconnecting points are almost always wireless, concerning both clients (subscribers) and infrastructure nodes. The natural configuration options in wireless meshes are greater than in any other wireless architectures. Potentially, very large areas can be covered with minimal effort, without the need for costly licensed spectrum, and backhaul capability can increase as subscriber traffic demands grows.

In order to position WMNs in the current market, one needs to look at the other options that a given user has to get Internet connection. Table 7 shows, in a very simplified way, the most usual Internet connections that a given end users has, in comparison to WMNs, in terms of price, and connection access (availability in a given area).

As it can be seem, WMNs can be positioned as an offer with low prices, and wide and scalable availability, when compared to the other usual Internet connections available to the end user. For such, a viable business model must be identified and studied.

Table 7. Level of Price/Connectivity offer to an End-user.

Connection Form	Fixed Access	Free Wifi	Mobile Networks	Mesh Community
Price (Scale from 0-5, Free to Expensive)	3	0	5	1
Connection Access	Restrict	Limited to a small surrounding area	Global	Wide and Scalable

4.8.3 Scenarios Applications

The scenarios applications presented are only focused in the three main players:

- End-user
- Community Operator
- Community Infrastructure Provider

The other players perform have no relevance for the application and creation of the WMN's in this business analysis.

4.8.3.1 The Metropolis Scenario

This scenario is defined based on the assumption that with the increasing living costs for the period of 2009-2013 that the world (especially Europe and the USA) is facing, consumers will respond with a lower capability to pay for an internet connection and will look for cheaper ways to have it, as shown in Table 7.

Some existing business models can be used as the starting point for our business model work. FON [49] has a business model where each End-user pays a fee to the network provider and works as a provider in his/her house to the peers that are nearby so that a user outside his/her own house can use someone else's network. This has some similarities with the scenario under analysis, but for WMNs there are additional specific issues, and so, several changes must be done in order to create a viable business model [56]. Some other examples are Belair Networks [80] and Seattle Wireless [81]; in these cases, the network is provided as a public service that covers a city, with few nodes that everyone can use. The main questions over the possibilities of creating a municipal WMN are the large scale and the high stakes that a project like this can demand, compared to a company that can create the network with just its own clients.

In a mature Internet market with extensive broadband coverage, as the current market in Europe, WMNs will have to find the proper market share and start from there. For a WMN service to prevail, it has to be included in a multi-service Internet service package. At present, in some countries, one can access the Internet everywhere with a mobile terminal. With a smartphone, the offering is at the extreme – access everywhere, but the prices offered are usually standard to all operators in a country, and high for the effective usage for a common user. This aspect can be the key element for the effective usage of WMN. One pays for a capacity that he/she is not effectively using, and WMNs are a solution to share this capacity with others, and split the cost of the Internet access. This is more visible in a residential area, where one has always-on Internet connection, which is not being used most of the time. Thus cooperation and sharing must be put in the user's agenda.

The deployment of WMNs in the Metropolis scenario makes sense for residential areas, where neighbours share the usage and capability of an Internet connection, or in a campus environment – old buildings, universities, hospitals, sports arenas, hotels and airports - where it is expensive, impractical or impossible to open ceilings, floors and walls to install data cables. WMNs in a residential area are explained in Figure 24, showing five mesh access points that perform a viable connectivity model for a WMN.

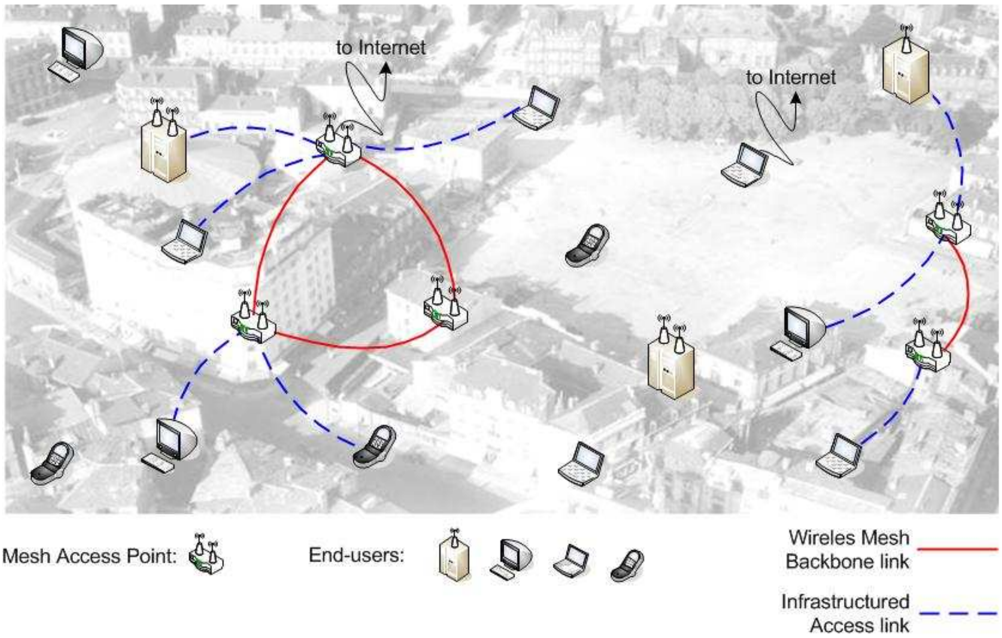

Figure 24. Spontaneous network with limited connectivity.

User's expectations for OConS WMNs can be very high, being likely to increase further with its innovative techniques that can progressively be extended to others communities that have the same aspects. The need to support both current and emerging applications requiring greater throughput and time-bounded performance motivates an increased attention on the architecture and management of the products that are used to build such networks. Figure 25 exemplifies how cooperating nodes can provide a different range of scalability to the network. An end user makes part of the solution, becoming a bridge to perform connectivity between other end users and the mesh access point.

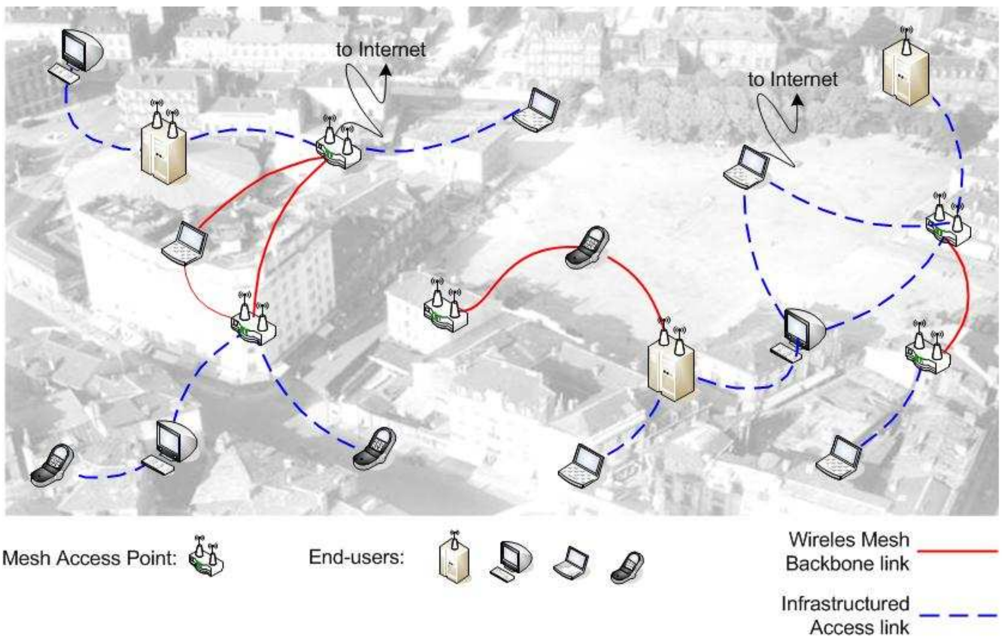

Figure 25. Spontaneous network after optimization of connectivity using innovative techniques.

Dealing with the capacity problems is an issue that can make differentiate between success and failure. This includes the capability to handle large amounts of data, including video traffic potentially for many simultaneous users and applications at any given location, and also the capability to grow and scale economically.

The value flows between actors of the Metropolis Scenario are presented in Figure 26, in a simplified way.

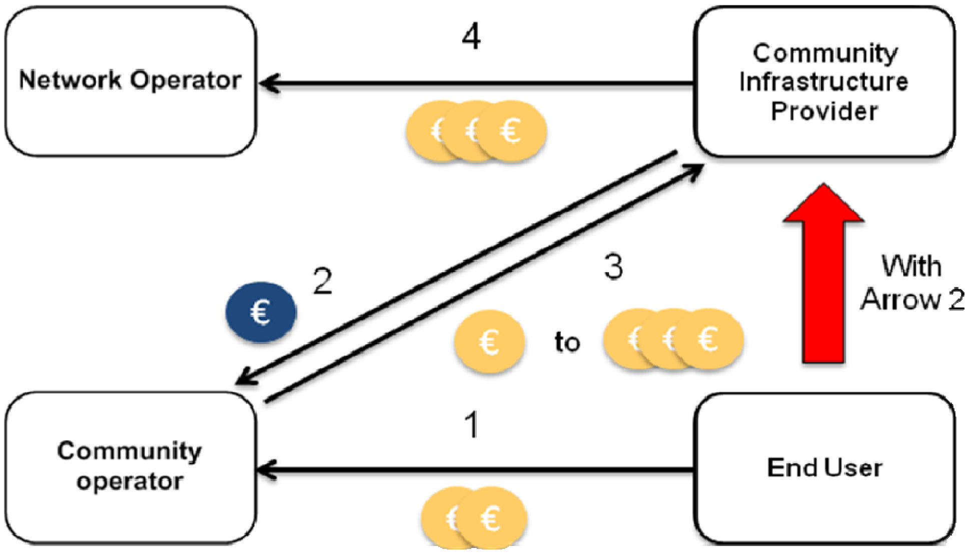

Figure 26. Value flows between actors on the Metropolis scenario.

Basically, a given End User of the community must pay to the Community Operator (Arrow 1), in order to become a member of the community, or simply pay to have network access for a given period of time (*e.g.*, a roaming user just passing by). Arrow 2 and 3 are the flows of an investment made by the End User for this to become a Community Infrastructure Provider, Arrow 2 and Red Arrow. From this investment, the End User transformed into a CIP can perform as a network facilitator and, because of his proximity to other End User that does not have connection, he/she can perform it by a certain price (Arrow 3). The value of the return of investment will depend fundamentally from the usage that the gateway will have by the others End Users.

The Community Infrastructure Provider, in turn, must pay to the Network Operator for the Physical access to the network (Arrow4). It should be noted that, any given user can play all of the above roles at once, thus, he/she can be an End User and a Provider at the same time.

The end users can be:

- End User and member,
- End User not member of the community,
- End User and Community Infrastructure Provider,
- End User and Community Infrastructure Provider with connection to the Network Infrastructure Provider.

All value flows involved may not only be money, but (and this is very important in WMNs) be incentives and rewards, as a way to lead users to become part of the community and/or share their resources.

There are special relations that should be put in evidence in this scenario. The relationship between the Community Infrastructure Providers and the Community Operator is crucial for the latter, because it has to have a minimum number of clients in order to be successfully implemented. The tighter this relation is, the more benefits in terms of price per usage can be delivered to the end user. On the other hand, the success of a Community Infrastructure Provider depends on how many End Users it can bring into the network. Additionally, the End User has also an interest in expanding the network, because this lowers the interconnection costs. The Community Infrastructure Provider should have a perceived method that can benefit both players: the more End Users it gets, the lower costs they have, and the more End Users collected the more it wins also, because the network expands more.

SWOT Analysis

A SWOT analysis is given for the most important actors that were identified, *e.g.,* End Users Community Infrastructure Providers and Community Operators.

In Figure 27, one finds that the advantages to the End Users of the implementation of a WMN are the low cost connection that he/she will pay and the possibility to be connected with a multi-hop protocol all over a specific location - Metropolis. The downside of a WMN is the capacity that the connection can deliver, and the low quality of some connections that can be offer by a certain number of End Users.

Strenghts

• The capability to be connected in a cheaper way, by using capacity that was wasted in the network.
• The capability to be connected all over the network, without being limited to an access point coverage area.

Weaknesses

• The connection capability of the network can influence the type of usage of an End-User compared to other solutions.
• The End-User may be in an area without mesh connectivity.
• The available capacity may limit the operation of certain services.

Opportunities

• The price to be paid to the community infrastructure can be lowered by adding links to other End-Users.
• The service can become nomadic in by having an extended agreement with the community operator

Threats

• The network can be easily obstructed if security is not provided.
• The low quality of mesh routers interconnections can influence the overall network performance.

Figure 27. SWOT Analysis for End Users in the Metropolis Scenario.

The player for whom the WMN brings more advantages is when an End User becomes a CIP. With this junction of players, an End User can also benefits of the resource sharing that passes by his network, in addition also benefits of a cost reduction of his direct connection to the network operator. The WMN Community Infrastructure Provider, if it is established to collect revenues of the network, will also have to be pro-active in the form of connection that it can deliver. The capacity of its connection to the network operator (physical connection) will influence the success of its connection node. Figure 28 can easily show these conditions.

Strenghts

- The aggregation of clients' needs in a specific area.
- The control of the network and of users choices in terms of value.
- The sharing of resources, enabling the provision of resources to other nodes.
- The extension of service coverage.
- The easiness in capacity increase.

Weaknesses

- The possibility that the business model is easily overruled by others in a liberalized market.
- The very competitive market.
- The sharing of capacity.

Opportunities

- The collection of an important number of loyal clients, in order to have an important argument when negotiating with the Community Operator

Threats

- The problems associated to network security.
- The competition coming from other companies.
- The low negotiation power with the Community Operator.

Figure 28. SWOT Analysis for Community Infrastructure Provider in the Metropolis Scenario.

The Community Operators are the ones that can influence the market to join the network, and also to build the network. For such, one will have to act in the market with a strong capacity to react when a specific location does not have the sufficient capacity in a network that can bring a good QoS to the End-user. The Community Operator, as demonstrated in Figure 29, has the capability to adapt the model costs and margins whenever it wants, and for that it is in a good position to be successful. With the WMN, it can deliver a Win-Win situation to all the players presented in this scenario.

With these SWOT analyses, one identifies some of the strengths and opportunities to be considered when developing and delivering the technology solutions of OConS in a WMN perspective. The weaknesses and threats must be taken into account when the negotiation between players occurs, because the market is always trying to develop new innovative solutions.

4.8.3.2 The Rural Scenario

In this scenario, the Internet access is currently provided by cable, as ADSL is limited with the distance. A mobile Internet connection may also be available, but with costs that are usually higher to the end user. In this case, the provision of a mesh solution could be of great interest to the inhabitants of these rural areas, and users are not as demanding as those in the Metropolis Scenario, as their primary request is basic connectivity with a low cost.

A WMN can offer a solution to both operators and users by becoming the cheapest solution in rural areas. The starting point of the deployment is negotiation between network operator and a Community Infrastructure Provider that should act as a lead user. Also, the actual coverage requirements, both in terms of the number of nodes, and the distances between them, need to be evaluated. The extra nodes that are delivered by users should work as an increment of capacity and speed of the network, working in parallel with the network nodes.

Strenghts

- The limited number of operators in each market.
- The capability to select the best Internet options for both End-Users and CIP.
- The possibility that a good market offer is usually adopt by every CIP.
- The fact that “Community” is a keyword in the future Internet
- The aggregation of available resources, shared within a community.
- The communitarian model, sharing costs.

Weaknesses

- The low profit margins.
- The possibility that the network is often congested, if the communities have many users and there is not enough capacity.

Opportunities

- The many new market areas to explore.
- The adding of a new market to the company’s portfolio.
- The easiness to implement.
- The flexibility associated to the model.
- The capability to negotiate interesting prices/conditions with network operators that provide access to the core network.
- The opportunity to negotiate services for the community with content/service providers.

Threats

- The lack of capability to negotiate prices.

Figure 29. SWOT Analysis for Community Operators in the Metropolis Scenario.

Capability, security, performance and management are also important in a scenario like this, but they are not the decisive attributes to perform the choice between cable connectivity, mobile or WMN. The key point after price is the extra coverage to regions where Internet access is not available, thus, decreasing the number of users that would like to have access but were denied by reasons of costs or distance to connectivity points.

A WMN solution similar to one presented in this scenario was already tested in a rural area of Scotland [82]. In this case, the solution proved to be very useful, but it had two problems that should be answered and revised by OConS: (1) the long distance between nodes may create coverage problems, and (2) the energy consumption of access points need to be much lower than current values, or then alternative energy sources to solar energy must be available.

However, the value flows between actors of the Rural Scenario, Figure 30, show that because of the isolated areas that are common in rural areas, more Mesh Access Points will be needed in order for the community operator to deliver connectivity to all of his clients (End-users). The Community Operator must take into account the size of the community. This CAPEX investment is a risk for the success of this scenario. Also the incentives/payments made by the Community Operator to the Community Infrastructure Provider are one of the soft points of this scenario – the incentive must be high for the End-user become a Community Infrastructure Provider and prevent the Community Operator of large investment costs (Arrow 2 Flow).

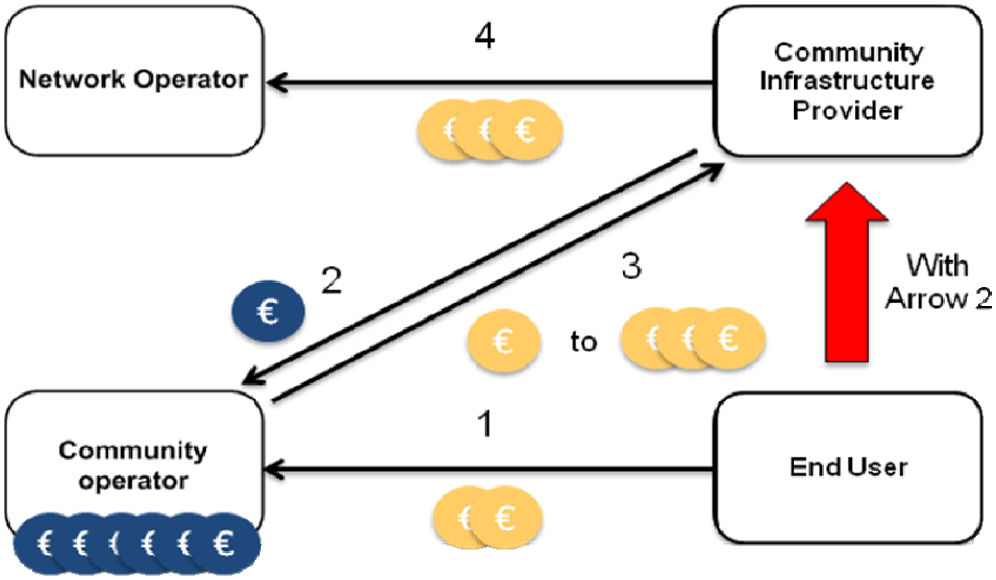

Figure 30. Value flows between actors on the rural scenario.

SWOT Analysis

A SWOT analysis is given for the most important actors that were identified, *e.g.,* End Users Community Infrastructure Providers and Community Operators, as already done in the Metropolis Scenario.

In Figure 31, one presents the SWOT analysis for an End User. In this case, the big advantage is to have a connection, but the price for having it, even though in a low cost way, is the capacity to have coverage in wide areas.

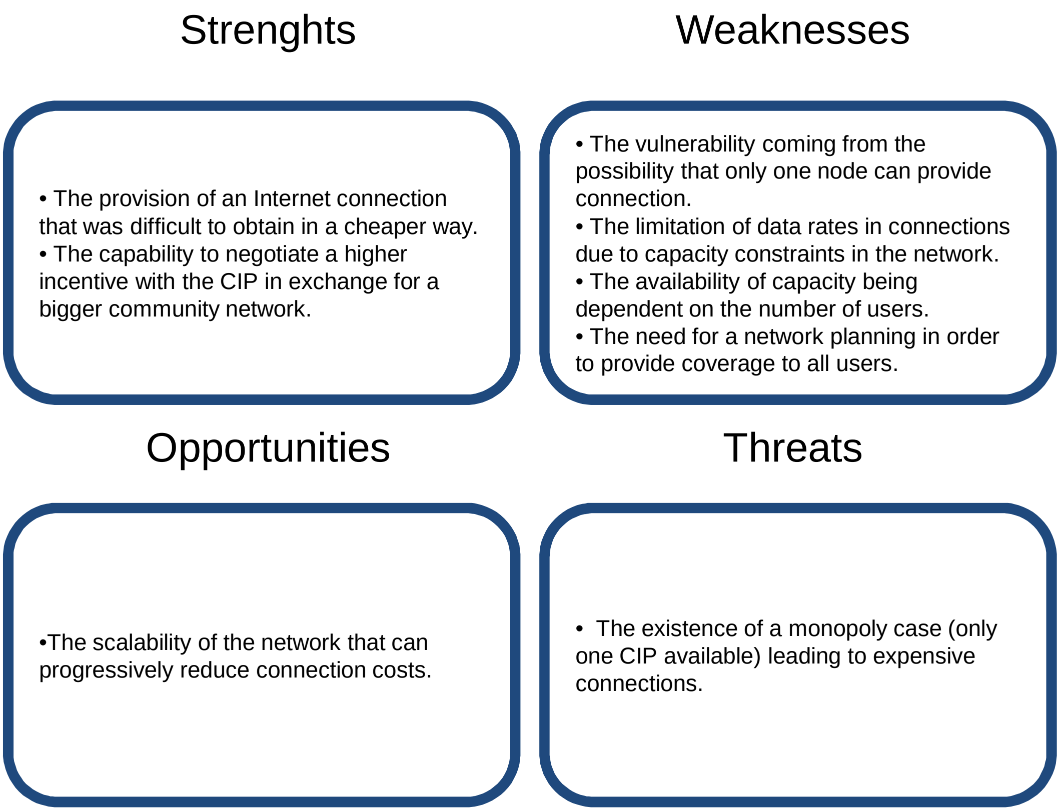

Figure 31. SWOT Analysis for End-Users.

The Community Infrastructure Provider will have the responsibility for the success of this model. Through it will pass the interconnection nodes that deliver connection to all the users that subscribed the service. If End Users only subscribe this service, it will have a complete dependency of the CIP and will only pay for the service if this works well and the QoS needs are satisfied. As presented in Figure 32, the Strengths and Opportunities are very appealing for this model perform well.

Strenghts

- The cheap, fast, easy and self-organized deployment, not needing to use expensive fixed communication infrastructures.
- The quality of service presented to End-Users.
- The definition of incentives to End-Users.
- The sharing of resources, enabling the provision of resources to other nodes.
- The extension of service coverage.
- The easiness in capacity increase.

Weaknesses

- The dependence of the communitarian network on the cooperation of individual members for its efficient operation.
- The lack of sustainability of the network, if there is a low capability to aggregate End-Users.

Opportunities

- The increased robustness of the network when more End-Users join it.
- The delivery of premium services to End-Users.
- The progressive increase of capacity coming from the scalability and the connection of more mesh routers to the core network.

Threats

- The lack of capability to have all clients satisfied concerning QoS vs. Price.
- The lack of capacity of the network.

Figure 32. SWOT Analysis for Community Infrastructure Provider.

For the Communities Operators, this is the perfect market where a network operator does not have interests nowadays, because of the implementation costs of technology. In this case, the Network Operator can give these market shares to a Community Operator that can collects CIP, and develop his business model with a lower cost than a Network Operator. The difference between the Network Operator to a Community Operator is that the first will not destroy value to his network by delivering a low cost connection. The Community Operator only offers low cost connection, and Figure 33 describes what can be obtained by becoming a Community Operator.

Contrary to the Metropolis scenario, in the Rural Scenario the actors that run networks can increase their customer base by getting into areas that previously had no value for them. Also, End Users can establish new ways of connection at more affordable prices. The key to a successful scenario, especially in this case, is the cooperation between end users by sharing their available resources.

Strenghts

- The reduction of the infrastructure marginal costs by adding new clients.
- The provision of a social benefit to distant locations.
- The sharing of the costs enabled by the Communitarian Model.
- The flexibility allowed by the model.

Weaknesses

- The low profit margins.
- The possible high implementation costs compared to the low return on investment.
- The dependence of a community on its users to stay in the market.

Opportunities

- The large number of new market areas to explore.
- The adding of a new market to the company's portfolio.
- The capability to negotiate interesting prices/conditions with network operators that provide access to the core network.
- The opportunity to negotiate services for the community with content/service providers.

Threats

- The large cost to deploy the network in a given location.
- The possible reputation problem if QoS is not good enough.

Figure 33. SWOT Analysis for Community Operators.

4.9 Conclusions

A business analysis of OConS' Use-Case 1 is made. This business analysis focuses on the Wireless Mesh Networks component of this use-case, since WMNs are considered to be a viable example in terms of business. The general objectives of these types of networks are addressed, and their requirements are identified, *e.g.*: efficient network management, sufficient security, roaming and network wholesale enabled capabilities, and back-office transaction operations, including billing for different user groups, subscriber management, pre- and post-paid billing systems.

A brief analysis of these kinds of networks is made, looking at previous examples already implemented, and, most importantly, looking at their negative aspects, so that lessons can be learned. Traffic and usage aspects are addressed as well. A forecast of the average traffic volume per smartphone user shows a value above 2 or 3 GB/month in 2015. A simple community mesh network with just a few tens of nodes will reach volumes of the order of 200 to 500 GB/month. The growth rate is very high, hence, this traffic growth can pose problems to WMNs.

From a competitive viewpoint, SAIL, and especially concerning the OConS Scenario, should continue to evolve and optimize the mesh technology with modular architectures, ensuring flexibility and easy addition of all devices, increasing the scalability and upgradability of the network. So as advantages and leading points, OconS ideas on WMNs must be placed as:

- giving preference to dual or multi-radio interface implementations;
- ensuring the support for multi-user groups, with prioritization based on user class or traffic type;

- supporting a range of services across different user segments, with QoS that will become critical as multi-service business models evolve;
- building best-of-breed partnerships with strategic players in the value chain, such as big players in the market, since WMNs will not operate as standalone;
- recognizing the impact of value chain complexities on the ability to implement innovative solutions;
- needing to anticipate the role of large established networking players, building a strong position in a niche market;
- recognizing that advanced network management systems will be a key differentiator.

Market scenarios are developed for Metropolitan and Rural areas, identifying the key actors and their roles, and presenting a SWOT analysis for the most important actors. The actors are: End-Users, Community Infrastructure Provider, Community Operator, Network Infrastructure Provider, Network Operator, and Content/Service Provider. Strengths include the sharing of resources, enabling the provision of resources to other nodes, the extension of service coverage, and the easiness in capacity increase. Weaknesses encompass the low profit margins, the possibility that the network is often congested, if the communities have many users and there is not enough capacity, and the availability of capacity being dependent on the number of users. Opportunities are associated to the many new market areas to explore, and the progressive increase of capacity coming from the scalability and the connection of more mesh routers to the core network. Several threats are listed, among which one has the problems associated to network security, and the lack of capacity of the network.

5 Business aspects of Cloud Networking

The development of a complete and flexible architecture for Cloud Networking (CloNe), as proposed by SAIL's WP-D, with flash network slice capabilities, almost certainly will set in motion the deployment of complex applications and services over heterogeneous virtualized networks. Additionally, it most likely will foster commercial offering of network-hosted services in SaaS, PaaS and IaaS models, both for the residential and for the enterprise ICT markets, as D.A.1 investigation suggests [3].

The business analysis will help to better understand the engineering implications derived from the market environment by trying to understand market response and to improve market success for the proposed CloNe SAIL technology.

In this pursuit of improved market adequacy for the CloNe SAIL technology, two scenarios each with its own use cases were defined in D.A.1: 1) the "Dynamic Enterprise (Enterprise in the Cloud)" scenario, and 2) the "Elastic Video Distribution on the Cloud" scenario. Furthermore, a preliminary business analysis was performed for the scenarios on D.A.1 and overall generic conclusions were drawn. For this subsequent phase of the project an alternative business analysis will be performed on the global Dynamic Enterprise (Enterprise in the Cloud) scenario focusing on the real SAIL technology clients – the enterprise customer client segment – complemented by the network operator perspective.

The Dynamic Enterprise (Enterprise in the Cloud) scenario refers to the provisioning of IT/IS solutions from the cloud computing ecosystem complemented with cloud networking services to the enterprise market. This scenario was chosen for further business analysis due to its broad scope of real world applicability, potential for high degree of process and product innovativeness and most of all due to its high importance for the network operator business.

In reality an effective and efficient offering and usage of IT/IS solutions in cloud computing paradigm, either in SaaS, PaaS, or IaaS model for the enterprise market, complemented with cloud networking services, will possibly act as a strategic efficiency factor for the productive and economic processes of corporations and SMEs. These services hypothetically will allow for more IT/IS systems flexibility, scalability, cost rationalization, a shift from fixed costs to variable costs, increased product dynamics from the IT/IS supplier and ultimately better bottom-line values for companies. The enterprise customers will be freed to refocus in their core business activities and leave the IT/IS support systems and solutions to specialized 3rd parties partners that work for the cloud computing ecosystem and that will benefit from scale factors and focused specialized technical skills that will reflect on their market offerings.

With Sail technology on the equation network operators will be able to offer dynamic, flexible and self-provisioned connection services (i.e. cloud networking services) to complement their cloud computing offer and thus increase market value for the enterprise final customers.

On the other hand, enterprise market segment is already very relevant for the network operators' business. With the current paradigm shift to cloud computing, its importance will surely increase within the scope of activities of the network operators, or so the market believes as identified below.

In this section we will analyse the adoption determinants of the cloud networking service in the light of the perceived service perspective from the enterprise client and the network operator actors. We chose a qualitative approach for this study and conducted a series of interviews with enterprise clients and network operators' sales force in the pursuit of answers to the adoption determinants of the cloud networking service.

The major findings of these interviews are described below in three sections: (i) Section 5.1 describes the traditional value network configurations (VNC), (ii) Section 5.2 describes the methodology used in the study to evaluate SAIL CloNe VNC. It introduces the identified major trends, uncertainties and relevant service adoption dimensions for SAIL VNC. (iii) Section 5.3

describes one anticipated future market configuration based on the combination of the current market trends and the relevant service adoption dimensions identified in the first section.

5.1 Value network configurations of Dynamic enterprise scenario

In this section we analyse the options and limitations of the traditional IT/IS system VNCs.

5.1.1 Actors in the Dynamic enterprise scenario

Supported by D.A.1 work, and in an attempt to frame the market scenario for the qualitative study framework to be executed, we define the most relevant actors as described below:

- **Enterprise** – an enterprise is a company organised for commercial purposes. There are no restrictions on the enterprise activity, which can range from a factory to a services consulting business. Some requirements of an enterprise are shared by other types of organisations, but an enterprise typically has more stringent security and regulatory constraints to protect its intellectual property, information privacy, and to ensure legal compliance. In the scope of this global generic scenario, we consider an enterprise to be an organization ranging from a large corporation with hundreds or thousands of employees and with its own IT infrastructure and global presence. An SME, for one, has only a few employees and without any type of IT infrastructure.
- **Business partner** – a business partner is another company, customer, or supplier that is involved with the enterprise in the course of its business. A business partner may be given access to some infrastructure and services of an enterprise to support the business relationship between the partner and the enterprise.
- **Cloud site operator** – a cloud site operator is an organisation that manages a cluster of processing and storage infrastructure that implements a public infrastructure service. The cloud site operator offers public cloud computing services to client organizations.
- **Application provider** – an application provider is an organisation that develops, implements, and deploys the applications on the distributed cloud or makes direct deployments of the applications on the client's own infrastructure. In the scope of this global generic scenario, the application provider business model can be either 1) to sell the applications directly to the enterprise client, or 2) to sell services jointly with the cloud site operator in a SaaS model.
- **Network operator** – a network operator is an organisation that manages a network (with flash network slices) that implements communication services between the offices and remote infrastructures of an enterprise and other cloud computing sites. In the scope of this global generic scenario, the network operator can also perform the functions of cloud site operator and eventually application provider. In this scenario the cloud may be distributed over the network, with computing and storage deployed in the network of the network operator.

For this qualitative study, the definition of applications/IT/IS systems can be any IT/IS system ranging from simple services, as for example voice/VoIP or fax servers, web servers, and mail servers, to large complex systems, as for example manufacturing industry and production MRP systems, ERP systems and shared logistics platforms.

5.1.2 Traditional value network configurations

Traditionally (i.e., before SAIL technology introduction) the usual simplified value network configuration (VNC) of this scenario can be depicted by Figure 34. The enterprise clients (either corporations or SMEs) can choose *(i)* to acquire the applications/IT/IS systems and install them in their own infrastructure (which they will have to assure and manage), or *(ii)* adopt a cloud computing offering from one cloud site provider, be it the network operator or an independent cloud provider. In this second choice the enterprise client can dynamically manage and scale its cloud resources (namely storage and computing) via a self-service portal within a couple of hours' timeframe.

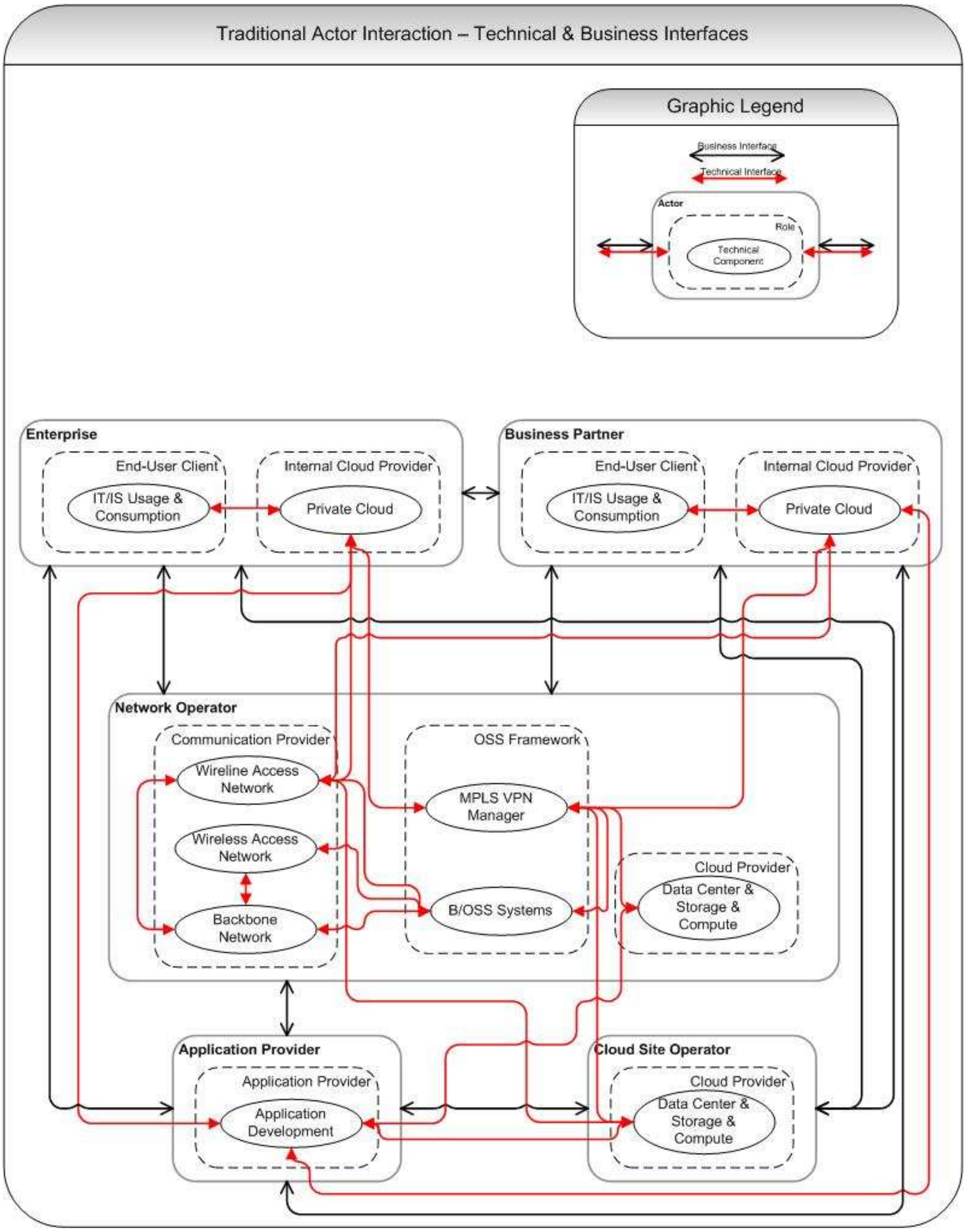

Figure 34. Generic VNC for the Enterprise in the Cloud scenario.

For this scenario the enterprise client will have different business relations depending upon the business model chosen:

- **Option 1: Collocation VNC** – To acquire the applications/IT/IS systems and install them into enterprise client's own infrastructure, which it will have to manage and operate.
- **Option 2: Network operator hosting VNC** – To adopt a cloud computing offering from network operator's own cloud provider.
- **Option 3: Cloud site operator hosting VNC** - To adopt a cloud computing offering from an independent cloud site operator

Collocation VNC

In this option the application provider delivers the application to the enterprise client and the enterprise client uses the network operator to access, and to give access to, its systems through L2/VPN or MPLS/VPN connection services, Figure 35.

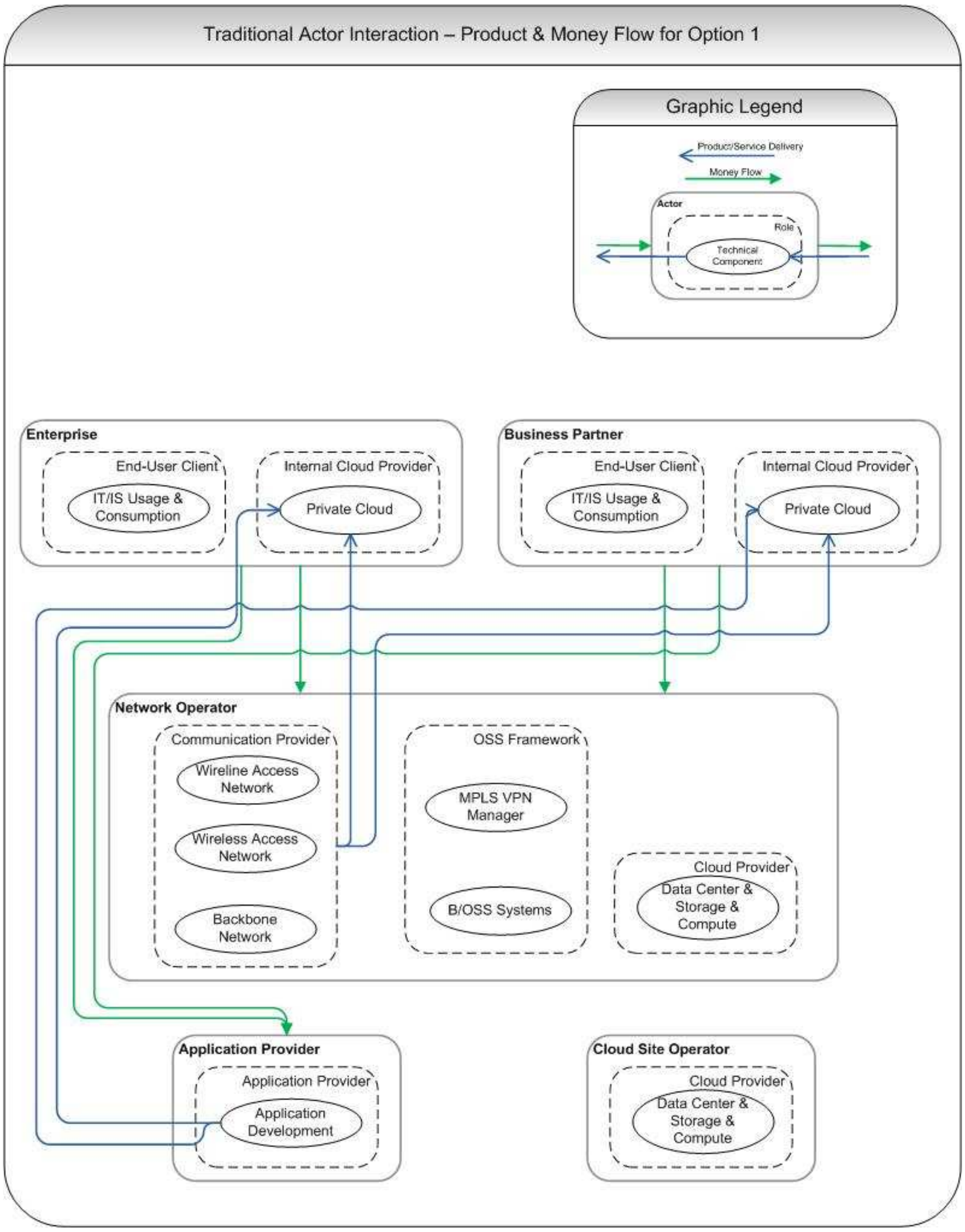

Figure 35. Collocation VNC

Network operator hosting VNC

In this scenario the application provider delivers the application to the network operator's internal cloud provider, which in turn offers the service (SaaS or PaaS or IaaS + connection L2/VPN or MPLS/VPN services) to the enterprise client, Figure 36.

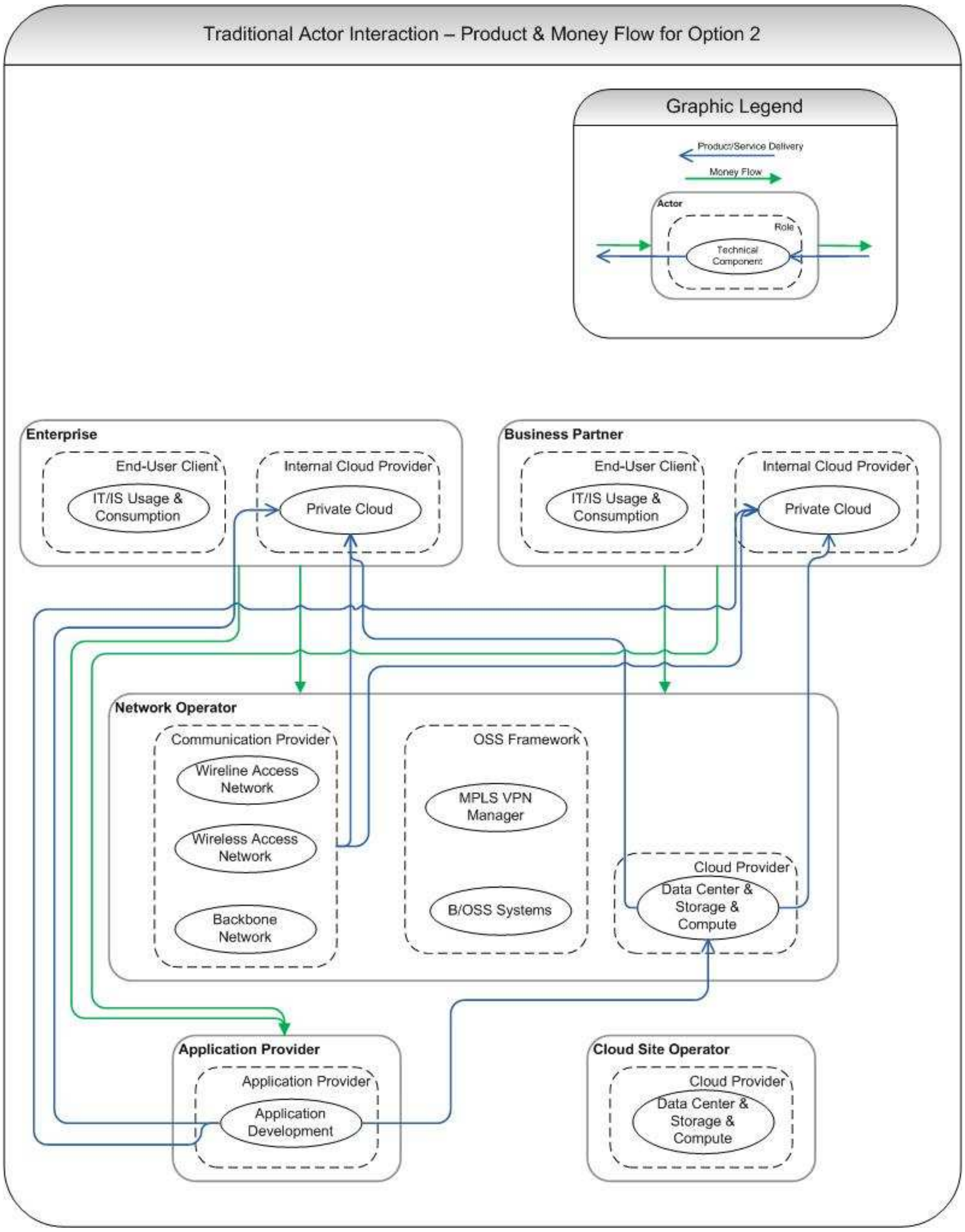

Figure 36. Network operator hosting VNC

Cloud site operator hosting VNC

In this scenario the application provider delivers the application to the cloud site operator, which delivers the SaaS, PaaS or IaaS service to the enterprise client. To be able to access the IT/IS systems the enterprise client will have to engage with the network operator to acquire the L2/VPN or MPLS/VPN services to access, and give access to, the IT/IS Systems, Figure 37.

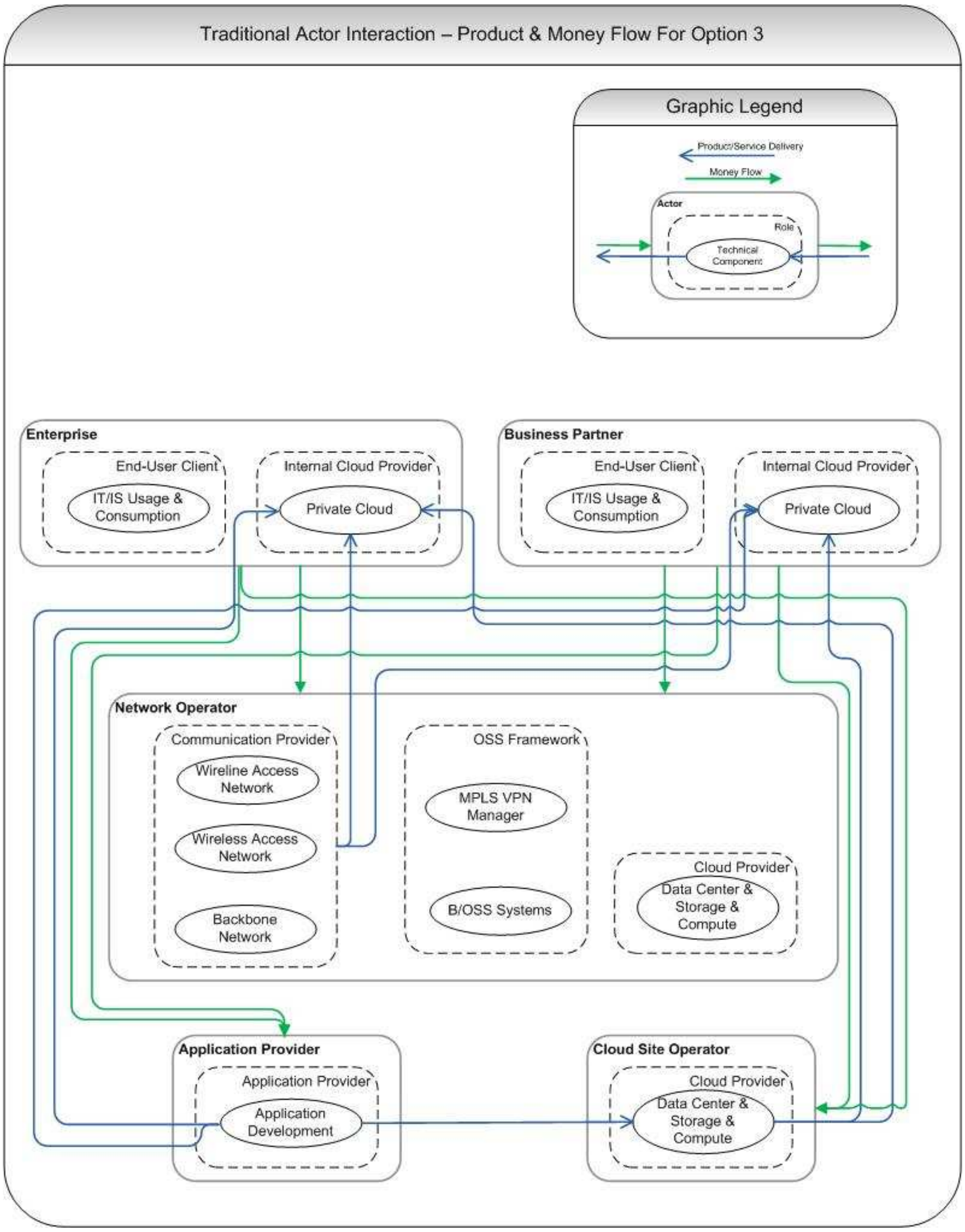

Figure 37. Cloud site operator hosting VNC

5.1.3 Limitations of traditional VNCs

The traditional VNCs presented in the previous section exhibit some limitations from the business perspective both to the network operator and to the enterprise client, which can be seen as the starting point for higher value propositions for this segment.

The network operator relies on L2/VPN or MPLS/VPN connection services to support its commercial offering and is unable to add value to it via the offering of dynamic, flexible and self-provisioned L2/VPN or MPLS/VPN connection services. Due to limitations on the combination of network technology and B/OSS provision processes involved, the network operator is unable to offer L2/VPN or MPLS/VPN connection services for client self-provision. Current commercial offers require a two, or more, hours' lengthy provisioning process (compared to the "On-the-Fly" alternative) to establish L2/VPN or MPLS/VPN connection services between the enterprise clients and data centres of the cloud site provider. Furthermore, the VPNs offered are static, meaning that network operators cannot offer VPN service options to enterprise clients that comprise pay-as-you-go models or self-provisioned bandwidth elasticity "On-the-Fly". Once the VPN connection is established, its intrinsic characteristics are fixed on for the contract period and can only be altered after renegotiations between the enterprise client and the network operator.

Sail Technology will permit the offering of dynamic, flexible and self-provisioned L2/VPN or MPLS/VPN connection services thus overcoming some of these limitations.

From the value network figures above an additional topic emerges regarding the network operator's position in the overall value network. In two of the three options the role of the network operator is reduced to the traditional "bit pipe" role. Network operators can try to challenge this role by engaging in vertical integration processes, like in Option 2, where the network operator would take also the cloud provider role.

This vertical integration would allow the network operators to offer a better value proposition to their customers via *(i)* single supplier business model, and *(ii)* improved end-user experience due to increased performance from the distributed cloud architecture. The improved customer loyalty presumably obtained from the vertical integration would help maintaining the network operator's market share in the enterprise segment. The vertical integration of the network operator would also bring new dynamics and competitiveness to the market, which at the end of the day would benefit the entire ecosystem of stakeholders.

From the enterprise client perspective the current commercial offering exhibits several relevant gaps that enterprise managers would like to see bridged and SAIL Technology could help bridging some of those gaps. Note that the enterprise business landscape for IT/IS systems can be divided into two main groups, the corporate market segment and the SME market segment, which differ both in requirements and available resources.

5.2 Expert interviews

In this section we report on the investigation conducted to understand SAIL CloNe adoption determinants.

5.2.1 Methodology

To understand the adoption determinants of the cloud networking service we conducted a limited series of interviews with Portuguese top managers from enterprises and with professionals from the enterprise sales force from one Portuguese network operator. We divided the enterprise market into two segments: 1) the corporate segment and 2) the SME segment. We conducted five interviews to top SME managers, three interviews to CIOs from medium to large corporations, and four interviews to professionals from the enterprise sales force from one convergent Portuguese network operator.

Despite the very limited number of interviews carried out for this investigation, which obviously limits the generalization of the conclusions drawn from this work, we believe that the overall conclusions reported in this section provide valuable inputs for engineers at WP-D. It also provides guidelines for future research on CloNe business aspects.

We started all interviews by introducing the cloud computing concepts and business offerings to the interviewee. This phase was followed by the introduction of the cloud networking service concept. Then we posed a series of open questions regarding this hypothetical service, for example about the easiness of comprehension of the service concept, the foreseen advantages and disadvantages of the service in comparison with the present L2/VPN and MPLS/VPN connection service offering, the perceived usefulness of the service and the perceived market potential for the service in Portugal.

5.2.2 SME client perspective

We explained the concept of cloud networking by first anchoring on the well-known concept of cloud computing, and then building on top of it the new concept of cloud networking. This approach proved to be a very effective way of explaining cloud networking to the interviewees.

Therefore all of the respondents understood effortlessly the concept of the cloud networking service by comparison with the cloud computing service. This means that the concept of the cloud networking service is perceived as a natural evolution of the cloud computing technology and is compatible with people's natural views of the technological environment in which they live.

Nonetheless, almost all of the respondents started straight away to talk about network security issues, network availability issues, high technology dependency, SLA importance, etc., which indicates that the uncertainties of the cloud computing model are inherited by the cloud networking service.

The perceived usefulness of the cloud networking service was high for the corporate market segment but low for the SME market segment due to a number of factors, such as:

- lack of perceived need;
- lack of in-house know-how to manage the process;
- lack of know-how to fully understand and compare alternative offerings;
- lack of know-how to identify the relative advantage of the service;
- lack of trust in the network provider's SLA; and
- high network dependency associated with the lack of a contingency solution in case of network fault.

In general, the managers of the SMEs thought that the service was only of interest for the corporate segment or possibly for multi-site SMEs, which was not the case of any of the five SME companies with whom we talked to.

Also the professionals interviewed from the enterprise sales force of the convergent network operator brought up the same thought. Their assessment was that many SMEs do not have the motivation to go into cloud computing paradigm, and therefore do not feel the need for cloud networking services. The sales professionals' broad comment was that in the SME segment managers still overvalue ownership of their systems and solutions. Therefore, if they can bear the costs, they do not move into cloud computing models, and no real incentive to adopt cloud networking services exists.

5.2.3 Corporate enterprise client perspective

On the other hand, from corporate enterprise clients' perspective, the service seemed interesting to the CIOs, especially for video-conferencing applications with on-demand increase/decrease of bandwidth and for specific events like workshops, trade fairs and shows, LAN parties, and temporary projects with business partners abroad.

Interestingly one person pointed out that to use a self-service portal to manage the cloud networking service, the portal would have to work based on use-case choice[1], otherwise the company's IT professionals would reserve more network resources than necessary due to lack of in-depth knowledge of the bandwidth required by the systems. From this comment it is suggested that cloud networking service interface should hide the service complexity from the end-user as much as possible, even for end-user administration purposes.

[1] Something along the lines of: "if you want to interconnect two HD video-conference points chose this option"

This CIO also suggested that the service should have two flavours: 1) An on-demand self-service portal for service management with human interaction for occasional needs, and 2) a B/OSS system that constantly monitors the circuits from his company to the cloud. When the circuits would reach 90% (or 60%) of the average bandwidth usage, the system would automatically increase (or decrease) the bandwidth of the circuits so that average usage of 80% of the available bandwidth would be achieved. He added that with this second flavour the operator should also offer him differentiated rating and charging along with the pay-as-you-go capability to enable cost optimization.

From interviews of the CIOs and the enterprise sales force professionals we were also able to conclude that corporate market segment prefers turnkey solutions from a single vendor (SaaS + connection circuits) to engaging in negotiations with several vendors, including application providers. Additionally, all CIOs expressed more interest in acquiring applications, computing, storage and connections from a single network operator than acquiring several separate components from separate vendors and then manage their solutions themselves.

5.2.4 Generic enterprise segment conclusions

Generically both segments from the enterprise client market exhibit no difference in most of the requirements which were identified based on both cloud computing and cloud networking services, namely:

- for enterprises whose core business it not IT/IS, the IT/IS systems are considered support systems;
- it is expected that the IT/IS systems exhibit very high (99.999%) availability;
- it is expected that the IT/IS systems exhibit high security, privacy, redundancy and ubiquitous access;
- it is expected that the IT/IS systems are adequate for the everyday operations of the enterprise;
- it is expected that the IT/IS systems can evolve and be customized for specific needs of each enterprise;
- it is expected that the administration of IT/IS systems can be done effortlessly by the enterprise (either directly on a self-service tool or via HelpDesk in SaaS model);
- it is preferable that the cost and dimensioning of the IT/IS systems varies according to the enterprise's timely requirements, instead of acquiring an over-dimensioned solution to meet expected future requirements as the current common practice is;
- it is more preferable to acquire a turnkey IT/IS solution from a single supplier and develop and engage in a business relation with a single (or few) supplier than to have high transaction costs and relate with several partial suppliers;
- it is easier to hold a single entity than several entities responsible for any occurrence in the IT/IS solution; and
- it is preferable to manage a single invoice for the IT/IS systems than several invoices.

5.2.5 Network operator perspective

Finally from the network operator perspective we conclude that at least in Portugal, the network operators are not recognized as natural IT/IS suppliers and thus some marketing effort should be undertaken to diminish this service adoption barrier and to generate client awareness and recognition of network operators as natural IT/IS suppliers. The Portuguese enterprise market segment seems to be very sensitive to the offered marketing mix and SLAs, and does not seem very receptive to the cloud computing and potential cloud networking service offerings at this moment of time.

On the other hand, the professionals from the network operator's enterprise sales force stated that usually clients from this market segment resort to over-dimensioning of their permanent connected network circuits and resources in order to guarantee peak traffic network availability, which means that the core network usually exhibits under-utilization. With the cloud networking service operators could reduce the over-dimensioning (or under-utilization) of the core network and transfer those cost reductions to their clients by offering differentiated charging and rating models according to time of day. One of the examples suggested was to offer a lower network fee for the core network utilization during the night in order to try to increase the overnight traffic over the core network with the corresponding circuit release during the working day time. Thus adoption of cloud networking services would promote a smoother, evenly and overall more efficient average usage of the core network resources.

Finally some reserves were pointed out also by the convergent Portuguese network operator professionals regarding the financial impact of the cloud networking service offering on the network operator’s balance sheet. All of the interviewees were unanimous that a thorough economic and financial study should be performed in order to identify the long term impact of the introduction of CloNe SAIL technology and services into the network operator’s business ecosystem.

5.3 SAIL CloNe VNC – Anticipated market configuration

In this section we characterize the anticipated SAIL CloNe market configuration supported by the above findings.

From the above contextual study we can conclude that a number of factors should be taken into account on the marketing mix when designing market offerings that are supported on the subjacent cloud networking service and CloNe SAIL technology. Furthermore, an effort should be undertaken to produce service offerings that can captivate not only the corporate market segment, but also the SME market segment.

A recurrent question on the interviews from the clients, either corporate or SME clients was: "How does this cloud networking service concept relate to the access network, namely to mobility scenarios?" The clients in both segments expressed large interest in the service concept if it could be applied also to their 3G/LTE wireless access solutions. Combining mobility needs and technological trends of high bandwidth wireless solutions such as LTE, most of the interviewed clients asked if they could use the cloud networking service to access their IT/IS resources (either in premises private cloud computing resources or public could computing resources) when they are on the move.

This mobility trend combined with

- the turn-key solution preferences,
- the single focal contact point preferences, and
- the preferences for the availability of IT/IS specific customization capability from the supplier side, along with other market trends such as
- network operators going into Cloud Computing providers space, and
- network operators going into the M2M (machine-to-machine) solution provider space, suggests that in the future the network operators will evolve into complex and all-inclusive solutions provider through vertical integration as depicted in Figure 38.

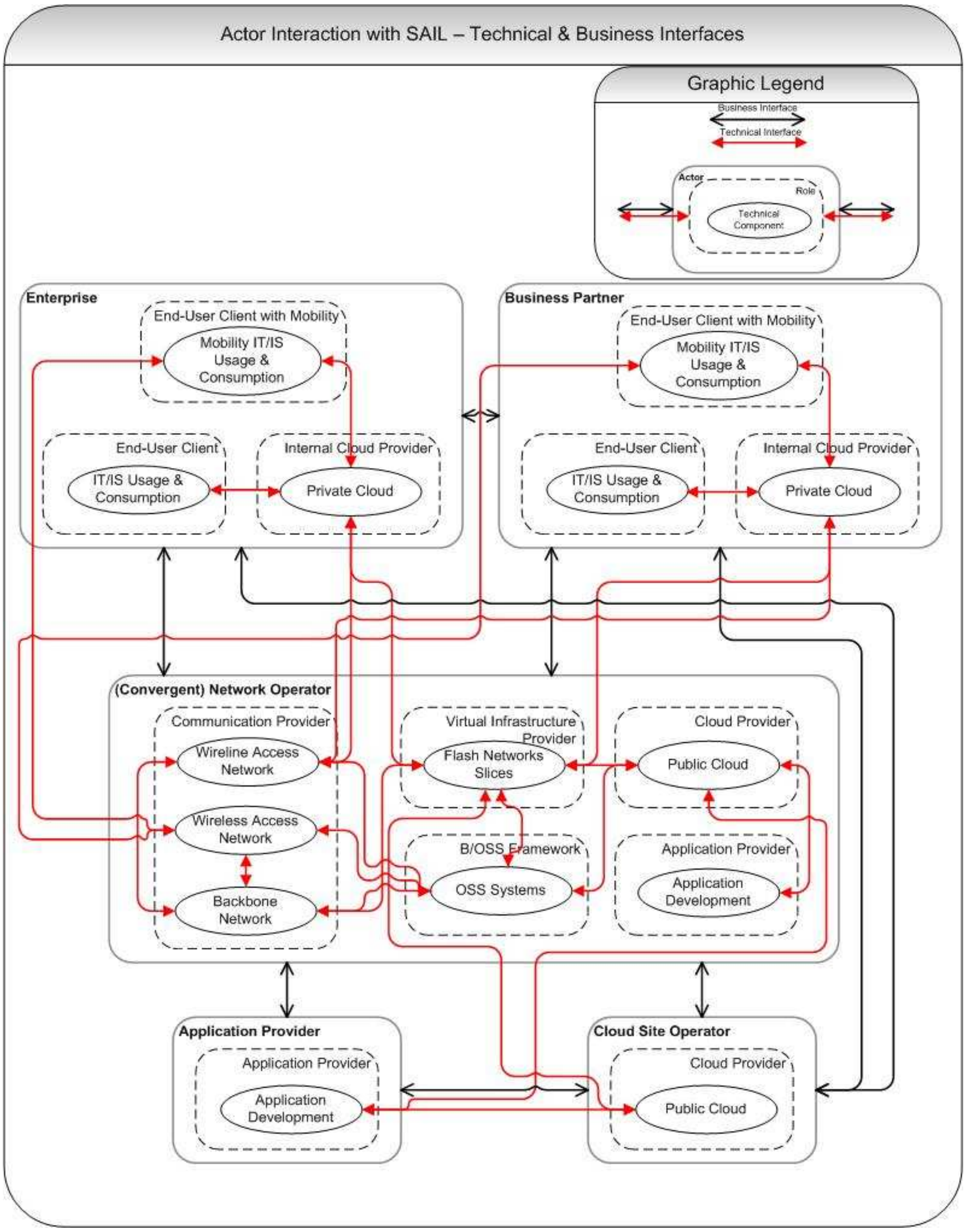

Figure 38. Vertically integrated VNC – technical and business interfaces

This futuristic, vertically integrated VNC scenario will not only imply the use of CloNe SAIL technology at the network layer, but will also imply further developments on the OSS layer framework to support the required management and control functionalities and interfaces on the existing IT/IS telco ecosystem, as well as extensive developments on the BSS layer framework to manage, control and make effective the business model from the network operator's perspective, Figure 39.

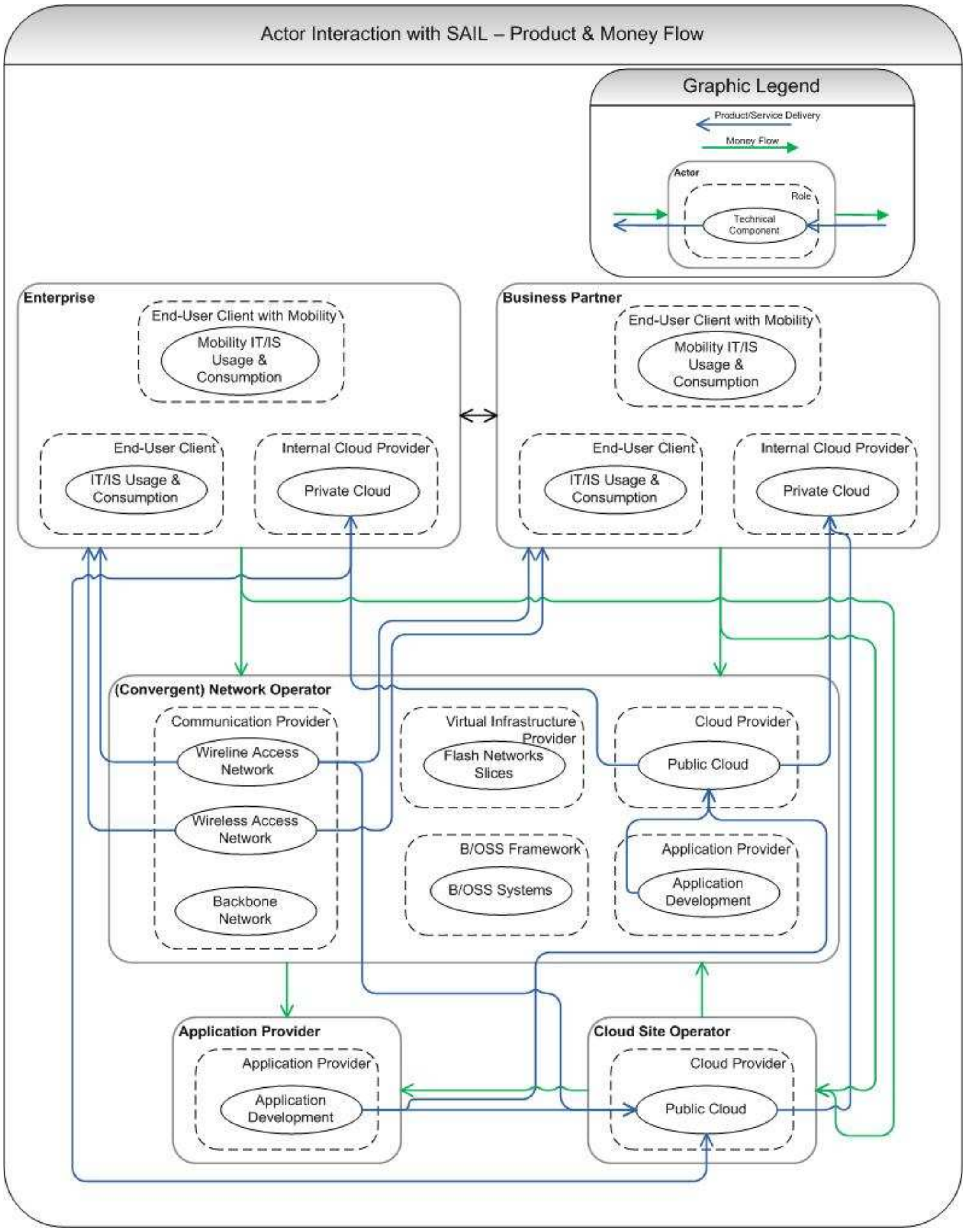

Figure 39. Vertically integrated VNC – product & money flows

Ultimately in this future scenario the enterprise clients of all segments could relate regularly only with one single actor to fulfil their IT/IS and network business needs. This single actor – the network operator – could provide a full pay-as-you-go model for both IT/IS systems and network connection requirements. SAIL CloNe technology will also allow service self-provision between network operators for eventual sporadic traffic overload or timely specific solutions.

5.4 Conclusions

In this section we identified the most relevant dimensions of the cloud networking service adoption on the enterprise market. We conducted a number of interviews to clients and sector professionals, and we qualitatively concluded that the cloud networking service adoption rate will probably be higher amongst corporations than SMEs. Nevertheless, if the service concept could be outstretched to the broadband wireless access networks, the SME segment could also be motivated into a fast adoption of the service. This finding could be of interest to the technical developing teams of WP-D.

Supported on the combination of market trends and the findings from the investigation, it seems plausible that the future market configuration could exhibit large vertical integration on the part of the network operators. This would qualify them to offer cloud-based turnkey IT/IS systems with cloud networking connectivity to their enterprise customers.

It should be mentioned that the small sample used in this study does not support generalization of the results. The reported results should be interpreted as plausible guidelines to support research questions to be developed and tested in later work.

6 Regulatory Aspects

6.1 Introduction

Regulation is affected by the technological development in three different ways [83]. **First**, there is a direct impact: New technologies lead to the development of new services and modes of delivery unforeseen by the existing regulation. Use of IP telephony, for instance, raises new issues with regard to numbering and emergency services. **Second**, new technologies affect the overall market structure and the level of competition by changing conditions for supply, which again affect the need for regulation. An example is the facility-based competition enabled by using cable broadcasting networks to access the Internet. **Third**, new technological opportunities create a demand for new types of services, which again affect the overall market structure. The two most prominent examples are the introduction of mobile services and the introduction of the World Wide Web. The demand for mobile services has created an entirely new market and has enabled a number of new entrants providing their services in competition with the incumbent operators. The Internet has been the driving force behind the growing demand for broadband connections, and this has made it more attractive for alternative network providers, such as cable and electricity companies, to enter the telecom business.

It is, however, often difficult to draw a sharp distinction between these three different kinds of impact, as the same technology may affect market structure and regulatory needs in several different ways simultaneously, Figure 40.

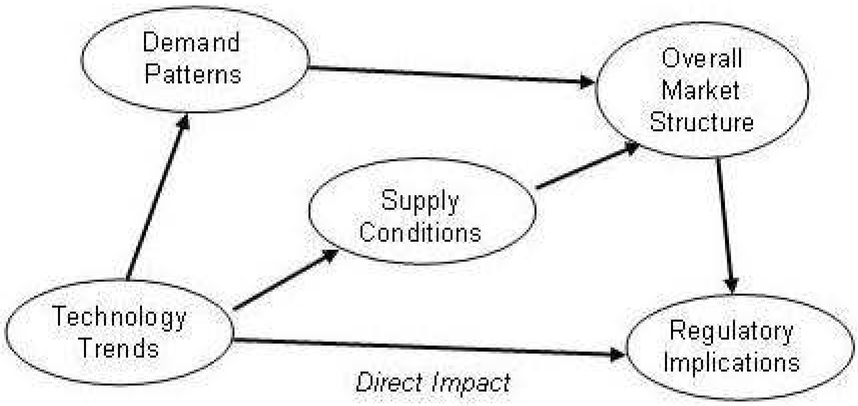

Figure 40. Direct and indirect regulatory implications [83].

With respect to the Regulation Aspects, the main target of this document is to identify the potential regulatory issues in the SAIL concepts and technologies, and analyse their importance. Regarding the three different kinds of impact above, the focus is on the direct impact of the SAIL concepts and technologies on regulation.

In the following sections the identification of and discussion on the potential regulatory issues are based on the technical and industry architectures, as outlined in Deliverable D.A.1. The assessment of those issues is made keeping in mind the consumer welfare (CW) and general regulatory objectives introduced in Section 6.2 and on the importance of the SAIL concepts and technologies for the different stakeholders as introduced in Section 6.3. First, interconnection-related regulatory issues are discussed in Section 6.4. Then, the Security and Privacy related regulatory issues in the Network of Information concept are discussed in Section 6.5 and the potential new regulatory issues in Section 6.6. Charging models in the Network of Information concept are discussed in Section 6.7.

6.2 Consumer Welfare and general regulatory objectives

Today, the following target for a regulatory intervention is commonly accepted [84]: Increasing/ensuring consumer welfare, which is ultimately determined by the structure and level of the retail prices paid by end consumers. The preconditions for reaching this target are the economic efficiency, rapid **innovation,** and **efficient and timely investment**.

The general regulatory objectives derived from the targets mentioned above are listed as follows [85], [86], [87], [88]:

1) Encourage and attract stakeholders to **invest** in cost-efficient information infrastructure and technologies.
2) Ensure that through **competition** the telecom services are offered to customers in a cost-efficient way.
3) Ensure availability of the essential requirements and mechanisms to facilitate **market entries** of new entrants in an adequate competitive environment (e.g. interconnection), thus improving services and reducing charges.
4) Ensure right infrastructure is made available to customers in such a way that will continue to expand the scope and increase the value of telecommunication services offered to them (service and network **innovations**).
5) Support operators to satisfy customers' needs and demands for affordable and high quality telecom services that enhance and improve customers' living and **efficiencies** and productivity, with applications covering social developments, home environment, health care, education, government agencies, security, etc.
6) Since the future networks are critical infrastructures for the business and societal interactions, it is clear that ensuring **security, privacy and confidentiality** will be one of the key objectives when designing the new information sharing systems.
7) Encourage operators to provide suitable and affordable telecom services to communities in non-profitable localities (**Universal Services**/**Universal Access**).
8) Ensure **justice** and efficiency for utilizing National Scarce Resources (e.g. Frequency Spectrum, Numbering).
9) Increase **national competitiveness** through use of ICTs.

6.3 Importance of SAIL concepts

The different SAIL scenarios and use cases have been presented in deliverable D.A.1 (Project scenarios and use cases) [3]. The importance of the new concepts in increasing the consumer welfare can be understood by reviewing their pros and cons for the different actors of the markets. Those pros and cons, which resulted from the business analysis of the concept-specific use cases, have been listed in Annex 1. It is quite clear that the new technologies will allow new and more efficient ways to provide services for end-users, enterprises and other communities. The deployment of those technologies will also enable new market structures, which will thus provide new business opportunities for the existing and new players in the value chains. The consumer welfare will be increased provided that the rules for running the systems and business are fair and encourage investments in the systems and entry to the market.

6.4 Interconnection

Interconnection is defined in different ways in the different regulatory and policy regimes that deal with it. A good definition is included in the 12 July 2000 proposed European Commission Directive on Access and Interconnection: *Interconnection means the physical and logical linking of public electronic communications networks used by the same or a different undertaking in order to allow the users of one undertaking to communicate with users of the same or another undertaking, or to access services provided by another undertaking. Services may be provided by the parties involved or other parties who have access to the network* [85].

In the context of the SAIL concepts, Interconnection means the availability of resources for interconnecting, via the technical interfaces, the elements of those concepts, which elements are located on the different administrative domains.

6.4.1 Approach

The regulatory implications of the new SAIL Concepts on Interconnection regulation, i.e. the potential regulatory issues, have been identified by following the procedure below:

1. The generic regulatory objectives and the criteria for consumer welfare have been discussed in section 6.2. This discussion has been complemented with discussions on the regulatory objectives for Interconnection in section 6.4.2 and on the existing regimes for Interconnection in section 6.4.3.
2. The SAIL Concepts have been analysed from Interconnection perspectives in sections 6.4.4 – 6.4.6. This analysis is based on the deliverable D.A.1 "Project Scenarios and Use Cases". This has resulted in the identification of Interconnection needs in each scenario and use case.
3. The importance of Interconnection in the SAIL concepts in increasing the consumer welfare is analysed in section 6.4.7.
4. The potential technology implications on Interconnection Regulation are discussed in section 6.4.8.

This procedure is illustrated in Figure 41 below.

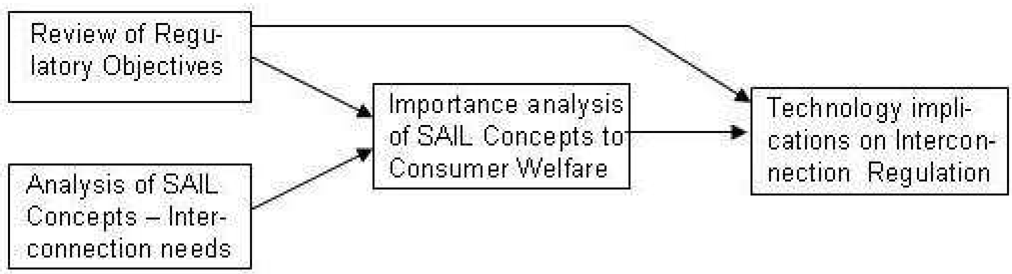

Figure 41. Approach for the identification of Interconnection issues

6.4.2 Regulatory objectives for interconnection

According to ITU's surveys [85], **Interconnection-related issues are ranked in many countries as the most important problem in the development of a competitive marketplace for telecommunications services**. The purpose of an Interconnection regime is to benefit users by encouraging competition that will lower the price and improve the scope and quality of services. For competition to be successful at maximizing consumer benefits and innovation in telecommunications market, carriers must have the opportunity to access all customers, even those customers connected to networks of their competitors.

Interconnection is not a new issue, as it was necessary to interconnect the various national networks, each of them operated by national monopolies for enabling international communication. However, the liberalization of national telecom markets added a new dimension, as both supplementary and competitive networks now have to be interconnected. Even though new technologies enable the creation of new alternative communication networks, the regulation of interconnection will still be an important tool for the facilitation of competition in both services and facilities.

Most regulators maintain that interconnection agreements are commercial agreements between the operators involved. It is therefore not the task of the regulator to draft the agreement, but only to ensure that agreements made are following the guidelines prepared by the regulator [83].

6.4.3 Existing regimes for interconnection

In the context of the transition from monopoly to competition Interconnection becomes more than just the linking of networks. An incumbent telecommunications provider has a vastly superior market position and strategic interest to keep out or minimize competitors in its market area which means that it has an incentive to limit Interconnection. If the incumbent, with the vast majority of customers, does not interconnect with new entrants, the new entrants will have little chance of attracting customers of their own. If promoting competition is an important goal, then Interconnection regimes need to be carefully designed to ease the way for firms to enter the telecommunications service industry. Thus, Interconnection regimes should be designed in the interest of promoting liberalization of the telecommunications sector and competition among providers [85].

The current regimes for interconnection of Internet services and for interconnection of telephony services are very different [83] (Module 7, Section 2.4.3). A number of remedies may be used in order to facilitate the development of a competitive market, including: **transparency**, **non-discrimination**, **accounting separation**, **access obligation**, **price control** and **cost accounting**. The choice of remedies depends on the level of competition on the markets for each interconnection product.

The switched interconnection products are usually priced on a per minute basis. Prices are in most countries regulated and cost-based. Cost-based prices can be determined in many different ways, and regulation can be either proactive or reactive. Reactive price regulation implies that the regulator assesses prices available on the market and intervenes only if prices are deemed to be above cost-based prices. Proactive price setting implies that the regulator announces price ceilings at regular time intervals.

European ISPs are in principle entitled to interconnect at cost-based prices, when negotiating with a provider with a strong market position, but regulatory intervention has in practice been very limited when it comes to interconnection of packet switched networks. **Important differences between interconnection of telephony services and Internet services**, which affect how settlements can be determined, and how they can be regulated, are:

- Single-Service vs. Multi-Service networks,
- Network Transaction Unit – Calls and packets,
- Reliable and Unreliable Network Services, and
- Symmetric and Asymmetric Network Paths.

Different cost models may be applied. Both the US and the EU use forward-looking cost models [83], [89], [90] to determine the charges for major switched interconnection products, but historic cost accounting (fully distributed costs) or price minus (end user prices reduced by a certain percentage) are used as well. Forward-looking cost models are considered to be the most relevant method for price setting, but this method is very resource demanding and is based on cost estimates for hypothetical networks, and is thus subject to uncertainty.

The EU framework is in principle technology neutral and obligations for interconnection apply to telephone operators as well as ISPs if they are infrastructure based (virtual ISPs – VISPs are not included). However, there are important differences in how national regulators intervene in interconnection agreements. Interconnection agreements are in principle commercial agreements. Only if disputes arise, the regulator may intervene.

In the current Internet, Interconnection has been normally implemented on voluntary agreements between IP Service Providers. These freely negotiated arrangements have resulted in a richly interconnected Internet and have not depended on regulatory obligations. The Future Internet, which will be more complex having several different technical and administrative domains (e.g. virtual networks) and carrying new types of traffic, make concerns rise whether the old approaches are sufficient in the future [85].

6.4.4 Interconnection needs in the Network of Information concepts (WP-B)

For the Network of Information (NetInf) concept, Deliverable D.A.1 includes the technical and industry architecture descriptions for 2 scenarios and 8 use cases. These scenarios and use cases are discussed in the following from the Interconnection needs' point of view.

Scenario: NetInfTV

This scenario represents a heavy content distribution perspective of NetInf and focuses on video distribution even though NetInf itself is not content-type specific.

The variety of video delivery applications involves a wide range of actors and business relationships. Video delivery also means a significant cost to these actors because of need for large storage capacity and high bandwidth.

NetInf can offer alternative sources for video distribution and utilise in-network caching to lower network load, while enhancing end-users' quality-of-experience (QoE).

Use Case: NetInf as decentralized CDN

This use case presents a competing solution for legacy CDNs (Content Delivery Networks) where the cache ownership, intelligence for redirecting requests (*e.g.*, DNS), and cache selection are typically centralised, *i.e.*, controlled by single stakeholder. In the NetInf CDN, the cache servers are not owned and operated by a single stakeholder but the responsibility is shared between multiple actors.

From a business perspective, using NetInf to build a decentralised CDN seems a promising application area because of a chance to save in transport costs if the content is delivered close from the end-user. Note that cache servers are application independent.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) End-user device – Access Network, over which the content is delivered to the End-user device
b) Originating server of a Content Provider – Cache server of an Internet Access Provider (IAP)
c) Cache server of an Internet Access Provider – Directory of content -server of a NetInf CDN Provider
d) Resolution server of an Internet Access Provider – Cache server of an Internet Access Provider
e) Cache server of an Internet Access Provider – Access Network of an Internet Access Provider
f) Resolution server of an Internet Access Provider – Access Network of an Internet Access Provider

The following industry actors play a role in this use case: End-user, Internet Service Provider (Internet Access Provider IAP, Internet Backbone Provider IBP), CDN Provider, Content Provider, and NetInf CDN Provider. The new actor, NetInf CDN provider, acts as a single point of contact for content providers who want their content to be distributed using a NetInf CDN. Its content management role is not completely necessary, but it dispenses content providers from separate negotiations with all the NetInf cache owners. The IAP caches the content for which the content provider has paid to be cached and controls the resolution server which defines the best location to serve the requests of an End-user.

Since industry actors can play several roles, and since several actors can play the same role, NetInf concept related interconnections are needed across different administrative domains:

A. between Internet Access Providers
B. Internet Access Provider – NetInf CDN Provider
C. Internet Access Provider – Content Provider (if NetInf CDN Provider not used)

D. Internet Access Provider – Internet Backbone Provider (who may also run a Cache server)
E. NetInf CDN Provider – Content Provider

Scenario: Next generation mobile networks

The current cellular networks are evolving from a centralised and static architecture into a more distributed and dynamic one. Moreover, the mobile entities get more advanced and have the possibility to connect through different access technologies with multiple interfaces.

To optimise the user experience, the content and services may need to be adapted to the user terminals, access networks and to the variations of the geographical user population. This allows more efficient usage of the network resources and higher QoE for the users. The mobile operators may use their knowledge of the network state and user locations to dynamically move services and content.

Use Case: Video with added local information

In this use case a video is distributed from a central server to a number of mobile users. The video is enriched with some information that is generated locally, close to the users receiving the video. The ability of the service delivery to adapt to changes in the user locations and service demands requires handling of large amounts of state information to optimise the placement of the services in the network.

A solution to realise such a service is to have locations in the network that provide **processing units** capable of integrating the locally generated information with the centrally originated video and place the respective service components at the locations that are beneficial for execution. It could be done in the home network of an end-user, or in the visited network in a roaming case, but also external service providers can provide that service in their own servers.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) End-user device – Access Network (home, visited)
b) Access Network (home, visited) – Content Processing server
c) HSS (location information) – Content Processing server
d) Content Processing server – Content Generation server
e) Content Processing server – Broadcast server

The following industry actors play a role in this use case: End-user, Mobile Network Operator (home, visited), Local Information Provider, Broadcast Content Provider, and (external) Service Provider.

The NetInf concept related interconnections are needed across the following administrative domains:

A. Home Network Provider – Visited Network Provider
B. Network Provider (home, visited) – Local Information Provider
C. Network Provider (home, visited) – (external) Service Provider
D. Network Provider (home, visited) – Broadcast Content Provider

Use Case: *Mobility and multihoming*

Mobile users today typically have multiple access networks to choose from, and for a given access technology potentially multiple networks exist, which are operated by different operators. The set of available networks can change according to user mobility, but also according to operator decisions.

As a user moves, previously available access opportunities disappear while new opportunities emerge. The different available networks at a time may provide different characteristics with respect to the fundamental communication services, performance, current utilisation and costs. An additional characteristic may be content availability as not all content may be available in all networks.

It is not clear at the moment what the interconnection requirements for a NetInf system are with respect to seamless connectivity and hand-over. To be studied further.

Use Case: *User-generated content*

In this use case a user generates and publishes new content, which will become available via the global NetInf name resolution service. The content is originally located in the user's device, but when the content's popularity increases, the content is replicated in a network storage of the local domain. The local NetInf name resolution information is updated accordingly. When the content becomes even more popular, another operator decides to replicate the content in its own cache servers. This means that the content is published again in this new operator's domain. The content created by a user can be aggregated and further distributed by a Service Provider.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) End-user device – Access Network, for retrieving content stored in a device
b) between name resolution servers of different Access Networks

The following industry actors play a role in this use case: End-user, Internet Service Provider (Internet Access Provider IAP, Internet Backbone Provider IBP), and Service Provider.

Interconnections are needed across the following administrative domains:

A. End-user (i.e. the creator and owner of content) – Internet Service Provider
B. between Internet Service Providers
C. Internet Service Provider – Service Provider (i.e. the aggregator and distributor of the user-created content)

Scenario: Developing regions

There are big differences between the real possibilities for using the Internet in different parts of the world and between different social groups. As more and more of our daily activities move online, this discrepancy risks increasing the digital divide rather than reducing it.

In many developing countries, the problems are the non-availability of the broadband connectivity, the high costs if the connectivity is available, and the reliability of the service. This is even more apparent in many regions where the power supply is very unreliable. The cellular network coverage is becoming better in many developing countries but this still has problems of reliability, capacity, and coverage areas.

NetInf is expected to provide a better, more robust and efficient solution to the communication needs of these communities than the existing Internet protocols. The information-centric approach and the inherent caching features as well as its improved resilience to disruptions make it a good option here.

Use Case: Community ISP

In areas where it is not economically attractive for larger Network Operators to deploy infrastructure, or where the services provided by them are not attractive or sufficient (not enough capacity, bad coverage, or too expensive for a large portion of the population), it should be possible for a local company, non-profit organization or co-op group to set up a NetInf network and offer services to the local population. It should be possible to set up a NetInf network with only two NetInf devices, and then be able to grow to a global network. As the network grows (or if parts of it are lost due to partitions or other outages), there will be a need for dynamic election procedures to elect certain nodes to perform network functions, for example name resolution service (NRS) and storage.

Much information in these regions is highly local, but the community ISP should purchase a bit pipe to the outside world. However, these are often very costly and unreliable in the developing world, so it will be crucial to use NetInf in order to use the bandwidth as efficiently as possible and at a more affordable rate.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) Between the Name Resolution Servers (NRS) of the local and remote networks
b) Name Resolution Server – Cache server (local, remote)
c) Access Network (local, remote) – Cache server (local, remote)
d) Access Network (local) – Backbone Network

The following industry actors play a role in this use case: End-user, Local Community ISP, Traditional Fixed ISP, Traditional Cellular Operator, Transport company (taxi/bus), and Global NetInf network.

Interconnections are needed across different administrative domains listed below:

A. Local Community ISP – Traditional Fixed ISP (backbone provider)
B. Local Community ISP – Traditional Cellular Operator (to allow access to local services by all local users)
C. Local Community ISP – Global NetInf network

6.4.5 Interconnection needs in the Open connectivity system (OconS) scenarios (WP-C)

The Interconnection needs in the OConS concept have been identified using Deliverable D.A.1 as the main source of information. For this concept it includes the descriptions for 1 scenario and 4 use cases. Only those use cases, which were elaborated to the technical and industry architecture levels in D.A.1, have been discussed in the following from the Interconnection needs' point of view.

Scenario: Supporting Flash Crowd Connectivity Needs

The flash crowd is a large group of people with mobile devices in a location where there is an unexpected and increased demand for communications and services. People wish to communicate, either with people who are on-site or outside of the flash crowd area.

The available access networks may include different technologies and access points, and a self-organised community mesh network could complement the available communication networks. The nature of the flash crowd creates requirements for either server based or user generated content. These will likely require higher bandwidth than what may be available for both access and core networks.

The flash crowd connectivity service providers will have the need for special edge-to-edge communication across the core networks as well. The *OConS* user in this case is a complete network, e.g. a data-centre cloud or service cloud.

In this scenario it is important to optimize the use of available capacity (Including access, network and services) to provide the right level of Quality of Experience, and to enable operators to provide services to Over The Top (OTT) OTT service providers in an optimised way. This may be achieved by, *e.g.*, moving the (cloud) services and the networking services closer to users for a period of time.

Use Case: Creating and sustaining the Connectivity in Wireless Challenged Networks

In this use case several wireless nodes within a Flash Crowd are willing to build a multi-hop network in order to provide the end-users with the connectivity between them and towards a fixed Internet infrastructure.

The Community Operator (CO) provides and manages the community infrastructure resources of the Community Infrastructure Provider (CIP) to build up a self-organized wireless network community of cooperating nodes. It can be an ad hoc or a wireless mesh community network. In the case of an ad hoc network, it is composed by end-user nodes with forwarding capabilities that generate traffic and forward it between them. In the case of a wireless mesh network, mesh nodes forward traffic mostly towards gateways to the Internet (mesh nodes with gateway connectivity to the Internet). Mesh nodes may be end-users that also generate traffic (as ad hoc nodes) or may be mesh access points that provide infrastructure wireless connectivity to end-users.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) Wireless Router of a Community Infrastructure Provider – Access Network of a Network Infrastructure Provider
b) Wireless Router of a Community Infrastructure Provider – Wireless Router of an End-user

The following industry actors play a role in this use case: End-user, Community Infrastructure Provider, Community Operator, Network Infrastructure Provider, Network Operator, and Content/Service Provider.

Interconnections are needed across the following administrative domains:

A. Community Infrastructure Provider – Network Infrastructure Provider
B. Community Infrastructure Provider – Network Operator (an incumbent running also network infrastructure)
C. Community Operator – Network Operator

Use Case: Optimizing the QoE for End-users with adequate management of the Cloud/Network services

Different services are provided to the Flash-crowd end-users through several available networks. Possibilities for connectivity are also through the access provided by a self-organised community (i.e. mesh network) in a public location, or ad-hoc networks (e.g. using Wi-Fi Direct), and a technology failure or power shortage may sometimes disable one or more technologies or devices. Obviously, these access alternatives might be operated by different entities, with which the End-user could (or does not) have an agreement.

The decision-making mechanisms are needed to "optimally" choose the interfaces, the access networks, or the paths in order to achieve the highest possible quality-of-experience (QoE) for an end-user. Also the mobility (of the users and, more generally, of any "mobile entity") should be provided in a seamless and transparent way, whatever is the used access network(s).

All the actors should be able to optimally manage the connectivity services. This requires that end-users, operators and other actors can dynamically configure the network and the devices to customise services and related QoE.

The implementation requires collecting information from several sources, storage of information (distributed, centralised), privacy and security of collected information, defining and measuring QoE, definition of the decision-making entity and availability of protocols for cooperative decision-making, enabling and controlling the distribution of traffic load among different networks.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) End-user device – different Access Networks
b) between different Access Networks
c) between the connectivity and load management systems of different networks and operator systems

The following industry actors play a role in this use case: End-user, Infrastructure/Resource Provider, Network Provider, Network Operator, and Content/Service Provider. For simplicity and harmonisation with other use cases, we assume that Network Provider represents also Infrastructure/Resource Provider.

Interconnections are needed across different administrative domains as follows:

A. End-user (incl. also mesh and ad-hoc networks) – different Network Operators
B. between Network Providers
C. between Network Operators
D. Network Operator – Content/Service Provider

6.4.6 Interconnection needs in the Cloud Networking (CloNe) scenarios (WP-D)

The Interconnection needs in the CloNe concept have been identified using Deliverable D.A.1 as the main source of information. For this concept it includes the technical and industry architecture descriptions for 2 scenarios and 8 use cases. Those scenarios and use cases have been discussed in the following from the Interconnection needs' point of view.

Scenario: Dynamic Enterprise

The introduction of cloud networking offerings to the enterprise means additional flexibility in its operations and in the way it does business.

With flash network slice capabilities, an enterprise will be able to dynamically adapt its IT services to include new remote locations, added functionalities and new entities.

In this scenario, multiple cloud sites, implementing virtual processing and storage infrastructure, are connected by an operator's network. Some of these sites may belong to the enterprise and some may be external public cloud providers.

Because the dynamic enterprise is a scenario of global extent, numerous inter-domain networking questions are likely to exist. A question is how the overall virtualised networks composed of individually provided networks can be constructed. For instance, from which (virtual) network providers will the network slices be constructed? Likely, there will not be a single (virtual) network provider, but rather multiple providers that collaborate for providing global virtualisation.

Use Case: Media Production

In this use-case a TV channel sub-contracts programme production to specialised domestic and international production companies. In the past, the channel would have expected the sub-contractor to provide its own infrastructure and software, delivering only video content to the TV channel. Now, the TV channel has moved to using cloud networking for its IT services and in so doing has the opportunity to extend its own production facilities for use by the sub-contractors.

In order to reduce the costs and risk for its sub-contractors, TV channel acts as the service provider, infrastructure provider and system administrator to create the media production service used to perform the commissions.

The media production service is data intensive and interactive. In order to optimise communication costs and to provide a service of reasonable quality worldwide the TV channel engages cloud site operators to provide locations to run the service near the media producers, and network operators to provide secure dynamic connectivity services between the TV channel, the cloud sites and the producers.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) between different clouds (private, public)
b) Flash Network Slices (of Network Operator) – Cloud (private, public)

The following industry actors play a role in this use case: Enterprise (e.g. a TV Channel), Business partner (of an Enterprise, e.g. a Media Production Company), Cloud Site Operator, Network Operator.

Interconnections are needed across the following administrative domains:

A. Network Operator – Cloud Site Operator
B. between Cloud Site Operators (private, public)
C. Enterprise – Cloud Site Operator
D. Enterprise – Network Operator

Use Case: Virtual Desktop

In this use case the company has multiple offices across the globe and buys cloud services from multiple cloud providers, in order to ensure that virtual desktops are provisioned close to its employees. It also actively changes cloud providers depending on current pricing.

Scenario: Elastic Video in the cloud

This scenario presents the offering of video and similar services from a cloud network ecosystem to the retail market with user perceived enhanced QoE, leveraged on distributed computational resources at the edge of the network architecture.

The scenario represents a framework of distributed resources in a cloud model, meaning that cloud resources are geographically scattered inside the operator network in a more *fine-grained* fashion than traditional centralized data centre clouds. The driver for such a distributed deployment is to leverage on the closeness to the final users to offer enhanced QoE.

This type of deployment will allow multiple content providers to share the same distribution and computing infrastructure in cloud model.

Use Case: Elastic Live Video Distribution

In this use case the scaling of the application is automatically provisioned by the distributed cloud according to the behaviour of the users. The scaling is controlled by the constraints set by the application provider.

From a business perspective the network operator will offer a paid service to the content provider. The network operator will also benefit as it will experience better usage of its network/computing resources. The end-user will experience faster response times especially under heavy usage peak periods. The content provider does not need to build a massive server farm for video distribution or to have a specialized IT department to deal with it. The content provider can focus on media content production while the network operator will focus on scaling of the distribution network. This opens up new business opportunities for small independent content providers.

This use case has the following technical interfaces, where the protocol interoperability has to be ensured:

a) end user device – network infrastructure, over which the content is delivered to the end user device;
b) content provider streaming server – application deployment service (cloud), to distribute the content
c) cloud network internal processes.

Three main industry actors in this use case, (i) the End-user, (ii) the Content Provider and the (iii) Network Operator, play several roles. The content provider is the owner of the content and makes it available in its streaming server to the other actors. The network operator provides the connectivity service that allows the end user to access the content. The content provider also has a business interface with the network operator for delivering its content over the network in a scalable manner using the cloud network service provisioning. The cloud service could also be operated by a Cloud Operator, who would like to deploy its servers in a distributed manner in a Network Operator's network.

Interconnections are needed across different administrative domains as follows:

A. between Network Operators
B. Network Operator – Content Provider
C. Network Operator – Cloud Operator
D. Content Provider – Cloud Operator.

6.4.7 Importance of Interconnection in SAIL concepts

The different SAIL scenarios and use cases presented in D.A.1 (Project scenarios and use cases) were briefly introduced in the previous sections, and the Interconnection needs were identified.

All scenarios discussed in the previous sections have introduced several new technical interfaces, new actors for running the business (a part of a value chain) and new roles for the existing and new actors. A key prerequisite for the deployment of the new technologies and for running the business is that the interoperability across the technical interfaces and fair Service Level Agreements (SLAs) across the involved parties are ensured. However, this may not happen without any guidance from the regulatory authorities. Also, running the business across countries and regions requires that the rules are harmonised between them. This, in turn, requires that the regulatory authorities in different countries and regions have to cooperate.

One can see from the table in Annex 1 that there is a lot of direct and indirect potential to increase consumer welfare with the new concepts, and their exploitation should be supported. Lack of Interconnection between the technical entities, and across administrative domains, would be a key obstacle to prevent the deployment of the new concepts to the maximum extent.

6.4.8 Technology implications on Interconnection regulation

Interconnection needs and their importance in the new SAIL concepts were discussed in the previous sections. Also, a lot of potential to increase consumer welfare with the concepts was identified. The implications of these concepts on Interconnection regulation have been listed in Annex 2 according to the following categories [85]: Framework and procedural issues, Commercial issues, and Technical and operational issues. The main issues from that Annex have been summarised in the following:

- availability, capacity and quality of Interconnection between the systems (old, new)
- the level and structure of Interconnection charges
- non-discriminatory and equal access to systems and services
- availability of open standards for interoperability across technical interfaces
- need for global rules for interconnecting systems across countries and regions.

The importance of these issues have been assessed in the following using the regulatory objectives in section 6.2 as the main criteria for assessment. The aim of the assessment is to understand what would happen to the regulatory objectives, if the Interconnection related issues of the new SAIL concepts are not addressed by the regulators. Based on this assessment, the importance of each issue is summarised in Table 8 below.

Availability, capacity and quality of Interconnection between the systems

The new SAIL concepts will improve the service delivery in many ways. For competition to be successful at maximizing consumer benefits and innovation in telecommunications market, the Service Providers (Network Operators, etc.) must have the opportunity to access all customers, even those customers connected to networks of their competitors [85]. Without any obligation to provide Interconnection by the incumbent service providers, there would be less competition from new entrants and less investments on new, better systems. Regulation on the availability, capacity and quality of Interconnection between new systems would have high effect on the regulatory goals 1) - 5) and 7), and medium effect on goal 9) (see section 6.2).

Level and structure of Interconnection charges

Interconnection charges are payments between operators to compensate each other for traffic exchanged between their networks. In the context of the new SAIL systems, compensations would be needed, not only for the traffic exchange, but also for the usage of the new system functions (cache, directory, etc.) of another Service Provider.

According to [85], there are various reasons for specifying that interconnection charges should approximate costs. Serious problems can result from a dominant firm charging competitors interconnection prices that are significantly above cost. First, it deters market entry and the development of competition. Second, customers of the competitors will ultimately have to pay for these excessive charges. Third, the excessive prices can provide a pool of revenues that the dominant firm can use to subsidize losses, for example losses incurred as a result of predatory pricing action taken by the dominant firm to drive competitors out of a market.

Regulation on the level and structure of Interconnection charges would have important effect on the regulatory goals 1) - 5) and medium effect on goal 7) and low effect on goals 8) – 9) (see section 6.2).

Non-discriminatory and equal access to systems and services

Avoidance of discrimination is a central objective of most interconnection policies [85]. It should be noted that interconnection arrangements may vary from one competitor to another without being ‘unduly’ or ‘unjustly’ discriminatory. Two competitors may have voluntarily agreed to different agreements, for example, to suit their different operating conditions. A specific type of discrimination, which can be fatal to the prospects of competition, involves providing insufficient network capacity to interconnecting operators as compared to an incumbent’s own services.

Regulation on the non-discriminatory and equal access to systems and services would have important effect on the regulatory goals 2), 3) and 7), medium effect on goals 4) and 9), and low effect on goals 1), 5) – 6) and 8) (see section 6.2).

Availability of open standards for interoperability across technical interfaces

The Future Internet will comprise many new players partly being rivals in business, partly cooperating in their offer to the customer. Additionally, the Future Internet will remain split into many administrative and legal domains. This is true also with respect to the new SAIL concepts. Both aspects demand for widely accepted standards for interfaces and rules for interoperability. Open standards are a route to interoperability. They shall be robust in terms of completeness (complete technical disclosure of APIs, protocols and formats), control (fair and transparent multilateral governance), cost (fair, reasonable and non-discriminatory licensing of essential IPR) and compliance (adherence to standards and industry specifications).

In the SAIL concepts, the protocols have to be specified between the different system components for enabling the interoperability within an administrative domain, or between the domains. Regulation on the availability of open standards would have important effect on the regulatory goals 2) – 4) and 7), medium effect on goals 1) and 9), and low effect on goals 5) – 6) and 8) – 9) (see section 6.2).

Need for global rules for interconnecting systems across countries and regions

Since the Future Internet will be a combination of thousands of networks, and a single network may span across country and regional borders, global approaches will be needed in the regulation. Regulators who impose uniquely local regulatory burdens, or more costly requirements than other regulators do, can handicap players in their national markets. The world from this perspective, however, is very fragmented: we have 148 (in 2007) national regulatory agencies world-wide, and we have a number of regional organisations, which are trying to harmonise the rules on that certain regional area. This means that to agree on the joint, global approaches on the regulatory issues will be very challenging.

With respect to the new SAIL concepts, the global approaches would take the following regulatory goals forward: 1) – 5) and 7), and would have low effect on goals 6) and 8) – 9) (see section 6.2).

The assessment above has been summarised in Table 8 below.

Table 8. Assessment of importance of Interconnection

Issue / Criteria	Availability, capacity and quality of IC	IC charges	Non-discr. and equal access	Open Standards for IC	Global rules for IC
1) Investments	High	High	Low	Medium	High
2) Competition	High	High	High	High	High
3) Market entry	High	High	High	High	High
4) Innovation	High	High	Medium	High	High
5) Efficiency	High	High	Low	Low	High
6) Security	Low	Low	Low	Low	Low
7) Universal access	High	Medium	High	High	High
8) Justice w.r.t. Scarce Resources	Low	Low	Low	Low	Low
9) National competitiveness	Medium	Low	Medium	Medium	Low

6.5 Security and Privacy in Network of Information

The dominant use of the Internet today is as a media distribution network. It was designed for interconnecting network nodes, not to be used for mass distribution of information. To make it more efficient for information distribution a number of technologies have been developed, for example, the web, CDN and P2P networks.

NetInf is about identifying data by name as a core principle, thus decoupling data from location and enabling in-network caching and replication. By introducing NetInf technology into the core design of the Internet there will be better support for functions such as caching, multi-access and p2p distribution which are key to any efficient media distribution network.

NetInf will also change, and require changes to, the business, legal and regulatory landscape. Examples include changes to how peering agreements are made in a network that heavily relies on caching. Compensation schemes for user nodes contributing cache space, bandwidth and/or battery for participating in delivery of objects to third parties. The caching of objects also have implications on how the legal framework deals with caching objects, in transit, that would mean copyright and/or other legal violations if they were regarded as being in your possession.

It is quite clear that regulations made with traditional networking in mind could limit the possibility to introduce new technology that make use of specific techniques, e.g., caching, in a way that was not foreseen. It is therefore important that there is a dialogue between policy makers, business stakeholders, and the research community to create a mutual understanding of the issues. This could provide guidance when trade-offs needs to be made between different technical solutions. It could also initiate regulatory reforms needed to make the introduction of new more efficient technology possible.

This section focuses on the security and privacy aspects in this context

6.5.1 Regulatory objectives of security and privacy

The European Commission says in its press release[2] related to the Telecoms Council, Brussels, 31 March 2009, that '*ICT systems, services, networks and infrastructures form a vital part of European economy and society, either by providing essential goods and services or by constituting the underpinning platform of other critical infrastructures. They are often called Critical Information Infrastructures as their disruption or destruction would have a serious impact on vital societal functions*'

The above-mentioned statement makes it clear that ensuring security, privacy and confidentiality will be one of the key objectives when designing the new information sharing concepts of the Future Internet. Therefore NetInf security should be designed to allow for different levels of security demands from a regulatory perspective. To be able to adhere to different regulatory environments the security functionality of NetInf should be configurable using policies.

To which level NetInf supports privacy is also an issue that can be determined by regulators by setting policies for NetInf operations. NetInf as a technology can support fully anonymous communication as well as offering a full-blown Orwellian [91] communication system.

To fulfil the regulatory requirements it will not be enough with technical security mechanisms, there will also be a need for laws that prohibit certain actions that would be impossible to find technical solutions to enforce. An example is how long an Information Object (IO) can be cached. After the time-to-live (TTL) for a cached IO has expired it should be deleted from a cache, there is no technical solution envisioned enforcing this requirement, so the only feasible way to deal with this is to make it illegal not to delete the IO when the TTL has expired.

6.5.2 Existing regulation for security and privacy

As a background we here provide some basic concepts for this discussion. This description of concepts are taken from the 4WARD deliverable *D-1.2 Project-wide Evaluation of Business Use Cases* [92], where also a more detailed discussion of the concepts can be found.

Key Concepts

According to [93], the concept of **privacy** is a fundamental motivation for security. Privacy is commonly understood as the right of individuals to control what information related to them may be collected and stored and by whom and to whom that information may be disclosed. By extension, privacy is also associated with certain technical means (e.g., cryptography) to

[2] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/139&format=HTML&aged=0&language=EN&guiLanguage=en/

ensure that this information is not disclosed to any other than the intended parties, so that only the explicitly authorised parties can interpret the content exchanged among them.

Most commonly, privacy and **confidentiality** are used as the same term, but it should be noted that differentiation between privacy and data confidentiality exists [94], the former relating to the protection of the association of the identity of users and the activities performed by them (such as online purchase habits), and the latter relating to the protection against unauthorised access to data content. Encryption, access control lists, and file permissions are methods often used to provide data confidentiality.

Information security is related with the requirement that the use of electronic communications networks to store information or to gain access to information stored in the terminal equipment of a subscriber or user is only allowed on condition that the subscriber or user concerned is provided with clear and comprehensive information on this (e.g., in accordance with EC Directive 95/46/EC), inter alia about the purposes of the processing and the subscriber is offered the right to refuse such processing by the data controller.

Network security is related with the requirement to protect sensitive data from unauthorised access or accidental disclosure. The network security problem is typically divided into integrity and confidentiality. The integrity problem affects public information (e.g., stock information) and can be addressed by signatures and checksums *that need to be verified*, while confidentiality requires encryption. The more problematic aspect of trust in a network is related to authentication, access control and authorisation, when the first question to be checked is whether you are connected to the entity you intended, with no malicious middlemen.

The **communication security** dimension is a new dimension defined in [94] that ensures that information flows only between authorised end points. This dimension deals with measures to control network traffic flows to prevent traffic diversion and interception.

Data integrity is the property that data have not been altered in an unauthorised manner. By extension, data integrity also ensures that information is protected against unauthorised modification, deletion, creation, and replication and provides an indication of these unauthorised activities.

The **availability security** dimension ensures that there is no denial of authorised access to network elements, stored information, information flows, services and applications due to network interruption. Network restoration and disaster recovery solutions are included in this category.

Authentication is the provision of proof that the claimed identity of an entity is true. Entities here include not only humans, but also devices, services and applications. There are two kinds of authentication: data origin authentication and peer entity authentication.

Lawful interception is the interception of telecommunications by law enforcement agencies (LEA's) and intelligence services, in accordance with local law and after following due process and receiving proper authorisation from competent authorities.

Whilst the detailed requirements for lawful interception differ from one jurisdiction to another, the general requirements are the same. The Council of the European Union notes that the requirements of the member states to enable them to conduct the lawful interception of the telecommunications constitute an important summary of the needs of the competent authorities for the technical implementation of legally authorised interception in modern telecommunications systems.

Network dependability summarises that without reliable communication networks and services, public welfare is endangered, economic stability is susceptible, other critical sectors are exposed, and state security is threatened. The long-term benefits of reliable communication networks are incomparable. The people of Europe stand to greatly benefit from the anticipated economic efficiency, citizen connectivity, functional flexibility and speed.

6.5.3 Security and privacy needs in the new technical and industry architectures for Network of Information

The current regulation for security and privacy still lags when it comes to being adapted to the current Internet. When regulation is adapted to be in line with current Internet technologies it would be of great value if also future Internet technologies, like NetInf, were taken into account. This is of course a challenge, but would provide a more stable regulatory environment if accomplished.

Issues to be considered include:

- How to protect private information in caches, especially in peer caches
    - Giving the owner of IOs control over the resolution service for the IOs he/she owns could be one way of providing fine-grained privacy control. An owner controlled resolution service could also be part of a key distribution infrastructure that is needed for ensuring confidentiality of information.
- Large caches (both of requests and responses) make it easy to check what information a certain individual is requesting. How is access to caches protected?
- When someone caches content that is in transit from the content provider to the content consumer, if the content is illegal, can the cache provider be accountable in any way?
- How can the binding between some type of human understandable name and a NetInf ID be made secure?

6.5.4 Location of legal disputes

When a criminal offense has happened there is an issue which legislation should apply. There are, at least, three possible locations to choose from, that of the victim, that of the offender or that of the service provider.

The location of the victim seems a good way of protecting people’s personal interest. That means that a provider must know what regulation applies to their customers. This might on the other hand make service provisioning overly complicated which might hamper the evolution of new services and markets.

Using the jurisdiction of the offender seems to be an obviously bad idea. This would provide an opportunity for ‘scam havens’ where remote stealing and fraud is legalized, similar to how tax havens have made business on providing an opportunity for people to avoid taxation.

The jurisdiction of the service provider might be a solution as that can provide sort of a neutral ground into which both the offender and the victim has to enter before contact can be made. The entering of the legal zone might be made either by explicit acceptance before connectivity can be established or it could be implicit as part of the service agreement with the service provider.

6.6 New regulatory issues in Network of Information

Developing new technologies raises new issues and some of these issues require regulation as a solution. Networking of Information is no different in this aspect. Most of the regulatory issues introduced by Networking of Information relate to the caching functionality as caching poses security and privacy threats. This section will briefly explain these new regulatory issues and assess their importance based on several criteria listed below.

The regulatory issues raised by the Networking of Information are as follows:

- Sensitive data protection
- Access control
- Net neutrality
- Standardisation

Each issue is assessed with criteria, which cover the most important Internet regulative objectives (see section 6.2) such as to:

1. attract investments into markets using the Internet
2. increase competition in the markets using the Internet
3. lower market entry barriers for offering services in the Internet
4. increase service innovation and network innovation in the Internet
5. guarantee economic efficiency of businesses relying on the Internet
6. guarantee security and privacy of the Internet
7. guarantee universal access

The aim of the assessment is to determine what will happen to the regulatory objectives if the new regulatory issues are not addressed by the regulators. Based on this analysis, the importance of each issue is summarised in Table 9 with the scale high, medium or low, where high means the issue will have a high impact on the given criterion and low means little impact.

6.6.1 Sensitive data protection

The main issue dealing with the caching of content is user privacy. Because the caches can cache anything, including users' private information, it is important for the regulators to address which content can be cached and which not. If everything can be cached, users' private information such as e-mail addresses, private messages or even passwords may be compromised from the cache servers.

This issue is especially important, because data and user privacy is problematic even without caching. For example, many lawsuits against Google on the matter of privacy have been filed such as the Gordon Ray Parker case, where he sued Google for eleven different violations including invasion of privacy and copyright infringement [95]. Privacy International has published a report on the privacy issues of some large companies such as Google, Microsoft and Amazon and the report's conclusion is that most of the evaluated companies pose privacy threats [96]. To protect the end-users' rights, the end-users can advance a privacy lawsuit if the service provider loses collected personal data [86]. However, this is only a measure to compensate for the lost personal data and does not stop the data from being compromised. In addition, concerns about the caching of search data by Google has been raised by both end-users and organisations, especially since under the Patriot Act, Google has to provide such information to the U.S. government [87]. Thus it is essential for the survival of caching related technology that private data is protected properly.

Regulation on user privacy should not have much effect on the first five regulatory goals. However, the level of guaranteed security and privacy in the Internet will be affected since the regulation of user privacy deals directly with the security issues of the Internet. For example, the regulators can make some security technology compulsory to Internet service providers or even content providers, such as the Australian legislation that mandates ISPs to offer content filtering software to its subscribers [84]. In the case where government mandates security technology provisioning, as a consequence to meet these requirements, service and network innovation might increase.

Caching in general will affect universal access as content can be accessed faster and closer to the end-users. However, if some content is not allowed to be cached due to privacy concerns, the accessibility of this content drops back to the level of before caching was introduced. Thus, regulation on sensitive data protection might affect universal access but does not make it worse from the level of before caching.

6.6.2 Access control

How to manage access control in a network where content is being cached locally in the network elements and distributed from these network elements is a major regulatory challenge. This is especially true for copyrighted material since it is harder to check each user's credentials when accessing content from cache servers.

Legislation on copyright infringements caused by web caching exist and for example, the U.S. Code frees Internet service providers from liability for monetary relief for infringement of copyright by caching material in the network operated by the ISP if the material is not uploaded by the ISP [97]. However, this legislation only removed the blame from ISPs but does not solve the problem. Thus, if caching is to expand from being simply web caches, a means for protecting copyrights has to be developed and regulation may help in this.

Similar to regulation of sensitive data protection, if some copyrighted content is not allowed to be cached, universal access is worse compared to when all content is cached. However, this has no major impact. In addition, the point of regulating copyright is to guarantee the content makers what belongs to them and thus is a form of enhancing privacy in the Internet.

If access control is not done properly, piracy such as copyrighted material sharing through P2P networks is possible and thus decreases the content maker's revenue. This in turn decreases the content makers' incentive to create new content. Thus service and network innovation decreases as a consequence of failure in protecting copyrights.

Imposing copyrights is a means of reducing competition from other content makers. In addition, if one service provider has access to certain copyrighted content and another does not, their mutual competition is unbalanced and copyright protection can be seen as a market entry barrier. Thus regulation on access control in a minor affect decreases competition and increases market entry barriers.

6.6.3 Net neutrality

Net neutrality issues refer to the rights of subscribers to have the same level of connectivity when paying for the same level of service as well as to no limitations from the access operators and regulators. The U.S Federal Communications Commission has adopted three rules to preserve the openness of the network [98]. These rules include transparency of the network and no blocking of content. In addition, no unreasonable discrimination of content or applications is allowed, where paying more for priority service is unlikely to satisfy this rule.

However, some users or applications, especially in content delivery, require Quality of Service (QoS) guarantees and data discrimination. Thus guaranteeing QoS and prioritisation of traffic in Networking of Information without violating privacy and other net neutrality concerns is a challenge faced by the Network of Information developers as well as regulators.

Regulation on net neutrality should not affect the amount of investments, innovations or economic efficiency. However, QoS requirements might act as a market entry barrier to certain markets, if the content providers require QoS but the ISP does not have the means of providing it. As a consequence, competition in that market might be lowered. These effects should be quite small since the current legislation in some, if not all, countries already prohibits unreasonable discrimination of content.

Net neutrality deals directly with network access issues, thus the effect on universal access is high. For example, if regulation on network openness does not exist, some content will be discriminated against and access to that content is significantly lowered. In addition, if QoS requirements include privacy guarantees, it will improve the security and privacy of the service.

6.6.4 Standardisation

In the technology development phase, the standardisation of protocols and network equipments should be considered. However, if no common standards exist, the regulators should take command to ensure compatibility between networks and network equipments.

Standardization from one perspective is beneficial for most stakeholders because it guarantees system compatibility and thus universal access. Also from a financial perspective, standardization could be beneficial. For example, in the Blu-Ray vs. HD DVD war [99] over the next generation DVD format, both camps invested a lot into the technology and both formats were sold in the market. When Sony's Blu-Ray format finally won, all the investments of Toshiba into HD DVD were for nothing and consumers were left with obsolete devices.

On the other hand, standardization reduces competition in the market in the short run as all will produce products with the same technology and the competing technology's supporters are forced to leave the market. In the long run, however, standardized technology lowers market entry barriers and thus increases competition when users can choose from any of the producers of a product or service.

When technology is standardized, it may decrease service innovation and network innovation in a market because no competition on the technology exists anymore. On the other hand, it may also increase innovation when players cannot compete with the technology anymore and thus have to differentiate their product somehow.

6.6.5 Summary

The assessment and discussions from the previous sections are summarised in Table 9. As a conclusion it can be said, that none of the regulatory issues has much impact on the level of investments done in the market. In addition, in general all regulation affects economic efficiency in a sense that regulation intervenes with the natural flow of market dynamics and thus makes it less efficient. However, none of the discussed regulatory issues affects efficiency specifically.

Table 9. Assessment of importance of new regulatory issues.

Issue / Criteria	Sensitive data protection	Access control	Net neutrality	Standardization
1) Investments	Low	Low	Low	Low
2) Competition	Low	Low	Low	High
3) Market entry	Low	Low	Medium	High
4) Innovation	Low	Medium	Low	Medium
5) Efficiency	Low	Low	Low	Low
6) Security	High	Medium	Medium	Low
7) Universal access	Medium	Medium	High	High

6.7 Charging models in Network of Information

In ICN networks, there are strong reasons to keep compensation for content and transport totally independent. Transport will rely heavily on caching, also in nodes controlled by end-users. For them to be willing to contribute network, storage and battery resources compensation scheme is needed. Giving credit every time someone is delivering an information object from a cache can provide this. But the cache provider delivering the data is normally the one that should receive compensation for the content that the data is instantiating. To funnel compensation from someone renting a movie to the movie rental service through an end-user seems very complicated. Compensation for content is therefore better dealt with at the service level. One way of doing this would be that you get a decryption key when you rent the movie.

Compensation for delivering information objects could, for example, be done as follows:

- For each object you deliver you get one credit to retrieve another object

- More credits to retrieve objects can be bought from a broker service or comes with your subscription
- Credits can be cashed at the broker service

6.8 Workshops

To further advance the discussion on regulatory issues the SAIL project will arrange national regulatory workshops during 2011. So far two workshops are planned, one in Sweden and one in Finland. Based on the results from these national workshops the SAIL project will arrange a European workshop during 2012.

The issues that will be discussed during these workshops include:

- legal border between packet buffering (as in today's routers) and in-network caching for a little longer time
- difference between caching in
  - network provider equipment
  - end-user equipment
  - service provider equipment
  - CDNs
- efficient distribution of encrypted content
- what limitations does today's regulation/legislation put on ICN technology
- what changes to regulation would be beneficial for ICN technology
- privacy vs. legal intercept
- border between licensed and unlicensed operation
- the need for regulating peering agreements to ensure the feasibility of entry of small new players
- Digital divide issues

6.9 Conclusions

The main target of the analysis in Section 6 was the identification of the potential regulatory issues related to the new SAIL concepts. The work focused on the direct impact of the new technologies on regulation (see section 6.1), and was based on the investigation of the business aspects of the different SAIL concepts recorded in the deliverable D.A.1 'Project Scenarios and Use Cases'. The assessment was made at first from the perspectives of Interconnection, Privacy and Trust, and Charging, and then also a number of other regulatory issues were discussed. The identification of potential issues was in all cases made keeping in mind the generic objectives for regulation and consumer welfare.

The analysis has shown that there is a lot of direct and indirect potential to increase consumer welfare with the new technical concepts, and their wide exploitation should be supported. Lack of Interconnection between the technical entities, and across the administrative domains, would be a key obstacle to prevent the deployment of the new concepts to the maximum extent. It is essential for extending the scope and efficiency of the telecom network, and is especially important for new operators entering the market who normally use the existing facilities of another operator for providing their services. It therefore is fundamental to a competitive market structure.

With respect to the Security and Privacy needs in the Network of Information concept, the following issues, or questions, can be highlighted:

- How to protect private information in caches, especially in peer caches?
- How should the access to caches be protected in order to maintain the privacy of the individuals' actions?

- Who (content provider or content consumer) is accountable for the illegal content transmitted via the caches?
- How can the binding between some type of human understandable name and a NetInf ID be made secure?

With respect to the potential other, new regulatory issues (sensitive data protection, access control, net neutrality and standardisation) related to the NetInf concept, a conclusion is that none of them has much impact on the level of investments done in the market. In addition, all regulation affects economic efficiency in a sense that regulation intervenes with the natural flow of market dynamics and thus makes it less efficient. However, none of the discussed regulatory issues affects efficiency specifically.

With respect to charging, there are strong reasons to keep compensation for content and transport separated. Also, the money flows from consumers to Service Providers have to be clear and simple.

7 Final conclusions

The Socio-economic work in the SAIL project has been divided into several stages. In the first stage of work, the high-level business analysis of the new technical concepts was carried out and recorded in the deliverable ‘Business analysis for use case scenarios’ (D.A.1). In this second stage of work, the deeper analysis of the three socio-economic aspects of the Future Internet has been carried out. The results of this of work have been recorded in this document.

In Section 2, the Intangible Aspects of the Future Internet have been elaborated. Work focused on the impacts that final users can have on the spreading of new technologies, as they have the buying power. The analysis of major impacts that internet can create on the society as a whole has been developed studying the externalities it produces. The externality is something that, while it does not monetarily affect the producer of a good, does influence the standard of living and welfare of the society as a whole. The target of the study was to investigate how the technology can be linked with the customers and the society-at-large to enlarge the social value of the internet, evaluate societal opportunities to enlarge democracy, understand concerns about internet frauds and abuse, identify possible benefits and potential negative effects of the SAIL technologies before they are designed. The section ends with the proposal of an economic method to evaluate the intangibles and an exploratory example to swiftly evaluate the model usefulness for the SAIL context.

With respect to the Business Aspects, work was divided into three focus areas according to the SAIL technical concepts. In section 3, the global content delivery scenario of NetInfTV scenario was analysed by studying value networks of information-centric networking (ICN). The key trends and uncertainties of ICN were identified. The main finding here was that the current content delivery trends could be well supported by information-centric paradigms. In the value network configurations (VNC) analysis competing solutions to NetInf were compared by drawing an analogy between content delivery models that provide the same piece of content. It seems that being able to challenge the currently dominating VNCs, novel architectures, such as Netinf, need to enable feasible revenue sharing between actors. Finally, two interesting business models for NetInf were analysed. Both models seem promising, but more in-depth study is needed to validate their feasibility. More generally, SAIL should discuss actively with content providers who are the primary customers of NetInf services. To make NetInf-based content delivery services more interesting to content providers, NetInf should to be able to deliver guaranteed quality to content providers. Additionally, transparent caching may lead to conflicts related to content control in caches between stakeholders with different goals, so technical means to solve these possible conflicts need to be introduced in NetInf.

In section 4, a business analysis of the Open Connectivity (OConS) Use Case “Creating and Sustaining the Connectivity in Wireless Challenged Networks” was carried out. The Use Case is based on wireless mesh networks, and so, current examples of mesh network implementations were considered and analysed. Market scenarios were developed for metropolitan and rural areas identifying the key actors and their roles. The values flows were analysed in more detail, and also, a SWOT analysis for the most important actors was presented. Basically, the main idea for the technical development of wireless mesh networks is to have a lot of flexibility, so that this technology can compete with the other options available in the market.

In section 5, the most relevant dimensions of the cloud networking service adoption on the enterprise market were identified. A number of interviews to clients and sector professionals were conducted, and the qualitative analysis resulted in that the service adoption rate will probably be higher amongst corporations than SMEs. Nevertheless, if the service concept could be outstretched to the broadband wireless access networks, the SME segment could also be motivated into a fast adoption of the service. This finding could be of interest to the technical developing teams of WP-D. Also, it seems that the network operators can competitively offer cloud-based turnkey systems to their enterprise customers. The small sample used in this study does not support generalization of the results, however. The reported results should be interpreted as plausible guidelines to support research questions to be developed and tested in later work.

In Section 6, the Regulatory Aspects of the SAIL concepts were analysed. The main target was the identification of the potential regulatory issues related to the new SAIL concepts. The work was focused on the direct impact of the new technologies on regulation, and was made from the perspectives of Interconnection, Privacy and Trust, Charging, and other regulatory issues. The analysis has shown that there is a lot of direct and indirect potential to increase consumer welfare with the new technical concepts, and their wide exploitation should be supported. For instance, lack of Interconnection between the technical entities, and across the administrative domains, would be a key obstacle to prevent the deployment of the new concepts to the maximum extent. The selected issues from this document will be further elaborated in the 3rd stage of the SAIL socio-economic work. Discussions with the Regulatory Authorities are also needed in order to get their opinions on which of the issues could be included in their agendas as well.

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ANNEX 1: Importance of SAIL concepts to different Stakeholders – Pros and Cons

The Pros and Cons of the SAIL concepts for different stakeholders are presented in Table 10.

Table 10. Pros and Cons of the SAIL concepts for different stakeholders.

SAIL Concept	Stakeholders	Pros / Cons
Network of Information (NetInf)	End-users	improved quality of end-user experience, because of lower latency and lower risk of bottlenecks; better robustness; improved battery life-time by offloading processing from the terminal to processing nodes in the network; installation a piece of software into a device may be needed
	Network Operators, Internet Access & Backbone Providers	cost savings in transit traffic; new business opportunities e.g. as a NetInf CDN provider; more competition e.g. in business with Content Providers; easier for someone to deploy a local network and provide services to a community; lower usage of network resources; less transit revenues for IBPs; risk of investment
	Content providers	better service delivery when services are closer to end-users; cheaper service delivery due to competition and standardization; worse control over the content than in traditional models; more detailed SLAs needed with the Network Operators
Open Connectivity (OConS)	End-users	extended End-user connectivity; lower access costs because of Wireless Mesh Network; potential for incentive benefits when contributing with resources to network creation; users may participate in the communitarian WMN business model; transparent and access-agnostic connectivity to services; better QoE (performance, price, power consumption) because of the most appropriate access alternative all the time; QoS depends on the intensity of the WMN usage; increased energy consumption with several interfaces
	Network Providers and Operators, Community Infrastructure Providers and Community Providers	more robust and adaptive network with self-healing and self-configuration properties; cheaper and faster deployment of systems; new business opportunities for new types of operators; better usage of Internet access resources lowers the price per community member to have Internet connectivity; more efficient use of available resources due to load balancing; lower OPEX by using shared infrastructure; Network scalability dependent on the resources shared by the community members; rules and principles of network operation have to be defined within the community; WMNs are vulnerable in terms of security; the communitarian network solution competes directly with legacy network operator business models; increased complexity; need for tight interoperability between heterogeneous technologies
	Content	cheaper access to services through shared communitarian

	Providers	WMN; more customers; new interface needed towards network operators
Cloud Networking (CloNe)	End-users	better QoE due to faster response times; no need to buy costly game consoles when the game service in the cloud; SW updated in the cloud, not in the terminals
	Enterprises	reduced cost of engagements for new subcontractors; Increased product innovation; increased choice of subcontractors
	Content Providers and Production Companies	greater number of viable engagement opportunities; low cost of opportunity for new projects; lower cost compared to deploying the delivery infrastructure by itself; increased competition on the game production and deployment; prevents illegal game copying
	Cloud Site Operators and Network Operators	increased business volume; optimized utilization of bandwidth; new business models; have to deploy and operate the distributed cloud architecture in the network; potential to strengthen the role in the game industry by adding new capabilities in the networks; network performance is of paramount importance for the End-user QoE in game industry

ANNEX 2: Interconnection Regulation Issues

The technology implications on Interconnection regulation, i.e. potential regulatory issues related to interconnection in the context of the new concepts have been classified into the following categories (see section 6.4.4): Framework and procedural issues, Commercial issues, and Technical and operational issues, Table 11.

Table 11. Technology implications on Interconnection regulation.

Network of Information (NetInf)	Framework and procedural issues: ▪ adequacy of regulatory guidance for interconnection negotiations ▪ availability of interconnection between the existing and new players for various types of services ▪ non-discriminatory and equal access to interconnection facilities ▪ non-discriminatory and equal access to Name Resolution Systems ▪ availability of rules from a regulatory authority for interconnection negotiations, and independent and timely dispute resolution ▪ availability of global rules for interconnecting NetInf's between regions and countries Commercial issues: ▪ level and structure of interconnection charges; for new concepts these are the key items to be clarified ▪ payment for modifications to facilitate interconnection ▪ resale of network facilities and services, and unbundling of interconnection charges for different network components Technical and operational issues: ▪ availability of open standards for interoperability across technical interfaces ▪ optimal location of Points of Interconnection (POI) ▪ access, e.g. by virtual network operators, to unbundled network components including interconnection links, billing systems, operations support systems etc. to provide advanced services ▪ equal ease of customer access to competitive networks and systems ▪ quality of Interconnection, including availability of sufficient Interconnection capacity to avoid congesting ▪ the timely provisioning of interconnection services and facilities
Open Connectivity (OConS)	Framework and procedural issues: ▪ as in NetInf ▪ availability of cooperation strategies/schemes between involved actors to select the most appropriate path(s) according to the requirements of the requested service ▪ availability of global rules for interconnecting multi-paths

	between regions and countries Commercial issues: ▪ as in NetInf ▪ level and structure of interconnection charges on multi-paths Technical and operational issues: ▪ as in NetInf ▪ availability of interconnections across multi-paths ▪ how to enable and control an efficient distribution of traffic load among different available networks (depending on the device types, user needs and operators' preferences) and avoiding dangerous bottlenecks on some links or parts of the network ▪ availability of protocols for the dynamic management /selection of resources (interface, access, path) and cooperation strategies between involved actors ▪ availability of multi-protocol standards ▪ availability of standards for interconnecting and interoperability between wireless mesh networks and gateways to Internet ▪ interoperability and cooperation between heterogeneous access technologies/various types of networks ▪ quality of interconnections on multi-paths; dependence of quality on the requested service
Cloud Networking (CloNe) concept	Framework and procedural issues: ▪ as in NetInf ▪ the ownership principles for a public cloud; cloud site operator ▪ non-discriminatory and equal access to a service in a cloud (universal service access); quality of access ▪ non-discriminatory and equal interconnections between clouds ▪ ensuring the availability of cloud capacity for providing e.g. such services which are essential for a society ▪ pricing rules of the cloud capacity ▪ availability of global rules for interconnecting clouds between regions and countries Commercial issues: ▪ as in NetInf ▪ availability of business models that support the migration of privately hosted cloud services to a public cloud ▪ level and structure of interconnection charges between cloud sites; QoS of interconnection Technical and operational issues: ▪ as in NetInf ▪ availability of standards for interconnection of clouds ▪ availability of interconnection capacity between clouds; quality of interconnections ▪ technologies needed for the virtualisation of the cloud networks; separation of virtual infrastructures of different providers; interconnections between virtualised clouds ▪ scalability with respect to the nr of clouds that an infrastructure

	can provide ▪ optimisation of access performance by optimising the assignment of service requests to clouds and servers; how to take into account the current load of servers

ANNEX 3: Wikileaks

According to Wikipedia [100], WikiLeaks is an international non-profit organisation that publishes submissions of private, secret, and classified media from anonymous news sources and news leaks. .The site, that published its first document in December 2006, has not formally identified creators, even though it has been represented in public since January 2007 by Julian Assange, an Australian Internet activist who describes himself as a member of WikiLeaks' advisory board.

The site was originally launched as a user-editable wiki, but has progressively moved towards a more traditional publication model and no longer accepts either user comments or edits, taking advantage of the work of few regularly working people and over 1,200 registered, unpaid volunteers.

In April 2010, WikiLeaks published news footage from the 12 July 2007 Baghdad airstrike in which Iraqi civilians and journalists were killed by an Apache helicopter, as the Collateral Murder video; in July 2010 they released Afghan War Diary, a compilation of more than 76,900 documents about the War in Afghanistan not previously available for public review; in October 2010 almost 400,000 documents, called the Iraq War Logs, were released: this allowed every death in Iraq, and across the border in Iran, to be mapped. In November 2010, WikiLeaks began releasing U.S. State department diplomatic cables. According to Wikipedia, releases of US diplomatic cables inspired the creation of a number of other organisations based on the WikiLeaks model (for links see [101]):

- Brussels Leaks should be focused on the European Union, but is not working yet.
- TradeLeaks it is “dedicated to openness and transparency in trade and commerce. We provide an anonymous way for consumers and sources within organisations to leak information about businesses directly to the public, by posting information and source material directly onto our website."
- Balkan Leaks is aimed to "promote transparency and fight the nexus of organized crime and political corruption in the Balkan states" sharing in an anonymous way confidential documents related too this area
- Indoleaks is an Indonesian site that seeks to publish classified documents primarily from the Indonesian government.
- RuLeaks, born to provide translated versions of the WikiLeaks cables, has started to publish its own content as well.
- PPLeaks and PSOELeaks, about Partido Popular and PSOE leaks and scandals.