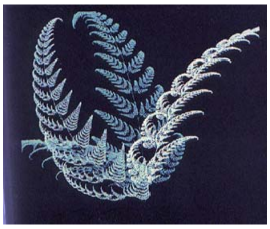


D6.1 Part B: “Prospective studies on the socio-economical aspects of the Connected Society”

Status and Version:	Final Version	
Date of issue:	16.01.2007	
Distribution:	Public	
Author(s):	Name	Partner
	Daniela Guarnieri	MIP
	Monica Corrado	MIP
	Richard Tateson	BT
	Antonio Manzalini	TI
Checked by:	Antonietta Mannella	TI

Table of Contents

1 Introduction

1.1 Purpose and Scope

A new technology design and its consequent putting on the market are not supposed to be based only on supply-side needs, but also on the customers' needs and expectations. The objective of socio-economic research in CASCADAS project is to pick out customers' needs and hence an estimate of future demands towards specific technology in the most exact way possible.

Indeed, in the past, the lack of correspondence between the perception of the product or technology manufacturer at the time of the launch (supply-side) and the perception of the consumer has caused a wrong structuring of the technological research phase and, consequently, big flops or overestimation of potential market. For that reason one major condition is that this document will be based on a socio-economic foundation for its estimates of future trends, rather than a supply-side opinion. Just to give some examples, the following Figure illustrates the need for this requirement by highlighting some of the successes and failures in predicting the impacts of telecommunications innovations, showing the different viewpoints of providers and customers towards a product or technology at the time of launch. As we can see, the WAP technology was overrated by the Telecom Industry while the consumers thought that it was too expensive, with no useful services and difficult to use.

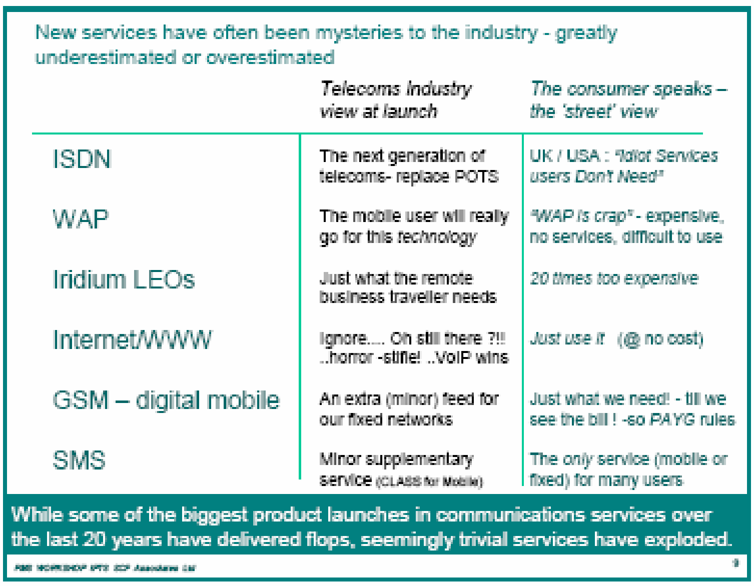


Figure 1 – Successes and failures in Telecom industry.

Thus the attempts at assessing the future success of a communication product may need a far more thorough analysis of evolutionary trends in the Society and economy in general, and not solely one based on a supply-side, techno-centric view; so, this is the reason for such socio-economic studies.

The **main goal of socio-economic research** is to express the link among people, technology and CASCADAS project. So it’s possible to state that the principal aim of socio-economic studies within CASCADAS is to support end-to-end research activities for the duration of the project, taking into consideration both social and technological aspects. The relationship is mutual with the socio-economic both informing, and being informed by, the purely scientific research.

This document deals with the ***Prospective Studies***, concerning the first period of the project life. Their fundamental objective is to explain the contribution of the CASCADAS project to the “Connected Society”, focusing on 2020. For that reason, the first step is the definition of the consolidated vision and strategic needs of the Connected Society, in order to understand contributions and open issues to be addressed by CASCADAS solution and the state of art on Autonomic Communications.

The Prospective Studies are the basis on which to build a business model for new paradigms of communication and networking systems (*Organisational Studies*) and to assess the model’s potential (*Assessment Studies*). Then, it will be possible to evaluate the business model impacts resting on results coming from the assessment phase through a cost/benefit analysis. The outputs of this final step will be the *Impact Studies* of the CASCADAS outputs on the Connected Society itself.

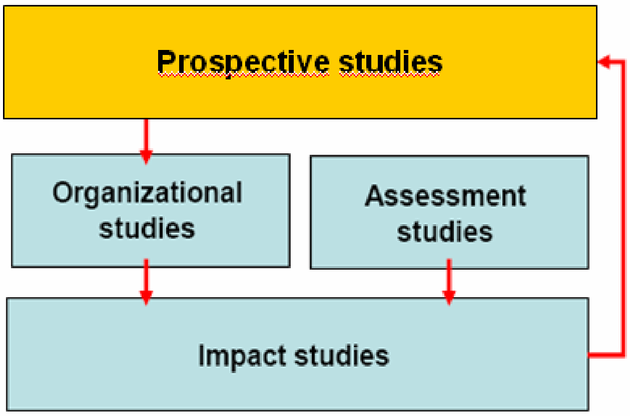


Figure 2 – The path of socio-economic studies in CASCADAS project.

To succeed in **Prospective Studies goals**, two research lines have been followed:

1. customer-side line: the goal is to understand *customers’ strategic needs* as regards the communication field on 2020;
2. supplier-side line: the goal is to understand what are *suppliers’ strategic drivers* pushing them to invest on Autonomics to reduce costs or improve gains.

Future Situated and Autonomic services stem from the comparison of customers' and suppliers' needs to take into account the two sides of the market. Finally, some application and infrastructural scenarios are described to give an overview of real scenarios in which CASCADAS vision will be applied. In the following, the research stages above mentioned are better detailed.

The first research step is to outline the **"Connected Society" vision**. Main inputs come from the investigation of Society, the Telecommunications market and the economic situation in Europe, taking into account both the current situation and the medium-long term one (please see the left cluster in Figure 3). In fact, a global social view is useful to define people's interest in a technology like that proposed by the CASCADAS project. Starting from these researches, possible strategic needs of future customers are drawn in order to extract the principal advantages from being connected everywhere and anytime.

Then the second step is the **analysis of fundamental technologies required to build the Connected Society**, delineating main Situated and Autonomic Communications "SACs" characteristics (please see the central cluster in Figure 3). Techno-economic research clear the way for understanding future market conditions. Every positioning evolution for the duration of the project will be monitored both on consumer and business markets through the mapping out of SACs' potential positioning on the Hype Cycle[1] for the Emerging Technologies, compared to others that will be active in the same field. The term "potential" is used because SAC technologies are not active on the market, but they will only be in the future. Market analysis will also take into account the strategic drivers that can push technology providers to develop or invest in an AC system to compare providers' needs to customers' ones. In fact, only if the strategic drivers led providers towards the satisfaction of customers' strategic needs will it be possible to understand what kinds of services can be provided in the future. Moreover, enabled (providers' side) and desirable (customers' side) autonomic services will be strongly affected by SACs' adoption level on the part of the population (high or medium-low adoption, depending on economic situation), as well as the technological maturity in the next ten years.

The final step of the methodology (please see the right cluster in Figure 3) has the purpose of applying all research and results in specific reference scenarios, not only from the application area of interest viewpoint, but also the infrastructural one. Following this classification, we will take into consideration **application scenarios** in pervasive ("Smart Environments Supporting Independent Living" and "Behavioural Pervasive Content Sharing") and non-pervasive ("Distributed Auctions") field, as well as evolutionary **infrastructural scenarios** to serve as reference for network or service layer within future architectures ("Next Generation Service Infrastructures and Ubiquitous Grid Computing"). As far as the application scenarios is concerned, further information and details are available within D6.1-part A "Description of application scenarios and of the services to be provided".

[1] The Hype Cycle is Gartner's annual predictions on how a range of technologies will develop over the next 12 months and how they will be positioned in the Emerging Technologies life cycle.

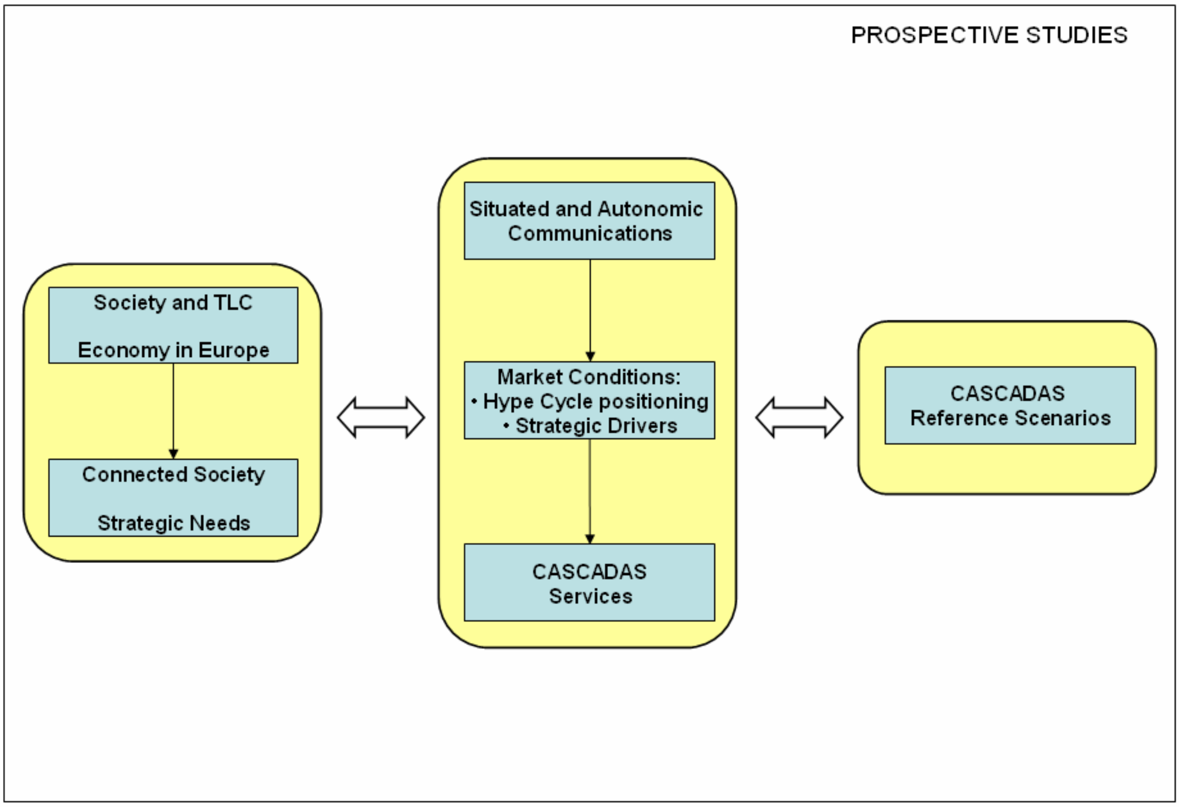


Figure 3 – The prospective studies' methodology in CASCADAS project.

In conclusion, the present deliverable has the purpose of (please see Figure 4):

- Outlining research boundaries for people and technology clusters;
- Defining the "Connected Society" vision and people strategic needs, from a social viewpoint, and presenting the main findings on Autonomic Communications, from a technological viewpoint;
- Dealing with future market conditions within two aforesaid clusters;
- Understanding the relationships between the two clusters, defining enabled and desirable services (respectively, enabled by providers and desired by customers).

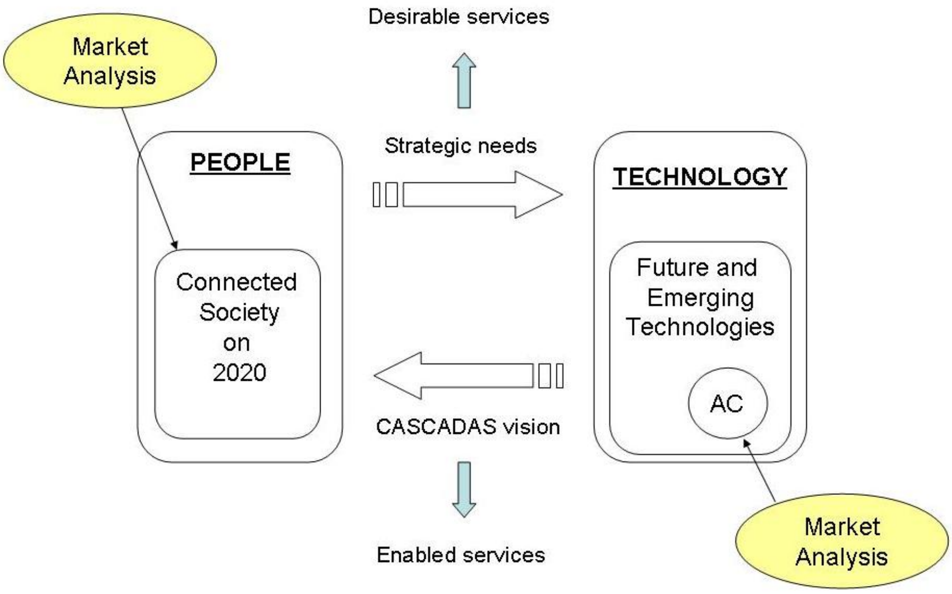


Figure 4 – The deliverable D6.1 – part B scope and boundaries.

1.2 Reference Material

1.2.1 Reference Documents

[1] Simon Forge, Colin Blackman, Eric Bohlin – "The demand for future mobile communications markets and services in Europe" – Institut for Prospective Technological Studies, April 2005.

[2] A. Kalis – Report on FET consultation meeting on Communication paradigms for 2020, Area: Cognitive Sensor Networks – Brussels 3-4 March 2004

[3] Imrich Chlamtac, CREATE-NET Research Association – "Autonomic Communications: from Internet to the future, via autonomic systems?" – Brussels, 13 January 2005

[4] Janna Quitney Anderson, Lee Rainie – "The Future of the Internet II" – Pew Internet & American Life Project, September 2006

[5] www.tilab.it

[6] Editorial Staff Gartner – "Next IT Challenges: Global Sourcing, Connected Society, Real-time Infrastructure" – Barcelona, 18 March 2004

[7] Fabrizio Sestini – Situated and Autonomic Communications – Barcelona, 18 May 2004

[8] The well-connected society – may 2005

[9] Maslow – "A Theory of Human Motivation" – The Psychological Review, vol.50, pp. 370-396, 1943.

[10] http://dai-labor.de/376.0.htm

[11] www.cordis.lu/ist/fethome.htm

[12] Michael Smirnov, Fraunhofer FOKUS – "Report on FET consultation meeting on Communication paradigms for 2020, Area: Autonomic Communication" – Brussels 3-4 March 2004

[13] Raouf Boutaba, Michael Smirnov, Silvia Giordano – 1st International IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2005) – June 18, 2005, Taormina

[14] Michael Smirnov, Radu Popescu-Zeletin – "FET : Frontier Research on Communication and Networking, Autonomic Communication" – Fraunhofer, Institute FOKUS

[15] Raouf Boutaba, Michael Smirnov, Silvia Giordano – "Report on 1st International IEEE WoWMoM Workshop on Autonomic Communications and Computing (ACC 2005)" – June 18, 2005, Taormina

[16] www.zdnet.com

[17] www.morerfid.com

[18] www.tekrati.com/research/News.asp?id=7596

[19] http://www.pec-forum.com/servizi/Arpu3G.htm

[20] http://en.wikipedia.org/wiki/Average_rate_per_user

[21] http://www.pec-forum.com/servizi/trend_arpu.htm

[22] Networked and Electronic Media, European Technology Platform – "Strategic Research Agenda" – 31 January 2006.

[23] Harmeet Sawhney – "Wi-fi networks and the rerun of the cycle" – Info, Vol.5 No. 6, 2003, pp.25-33.

1.2.2 Acronyms

AC	Autonomic Communications
EC	European Commission
EU	European Union
FET	Future and Emerging Technologies
ICT	Information and Communication Technology
I/O	Input/Output
IST	Information Society Technologies
IT	Information Technology
PDA	Personal Digital Assistant
SAC	Situated and Autonomic Communications

SDM	System Definition Model
SOA	Service Oriented Architecture
TCP/IP	Transmission Control Protocol /Internet Protocol
WLAN	Wireless Local-Area Network

1.2.3 Definitions

Autonomic Communication

Always-on technologies: devices with permanent communication connections, rather than on-demand connectivity, allowing services to "push" information to the owners rather than waiting for the owner to send a request ("pull"). For example, it include PDAs, smart phones, Smart Personal Objects Technology (SPOT) watches that display customized information broadcast over wireless networks, Bluetooth headsets and MP3 players, coupled with wireless communications technologies.

Autonomicity: the capability of services to dynamically adapt their behavior and properties without human intervention in reaction to contingencies and with the goal of preserving specific functional or non-functional properties despite such contingencies. The general properties of an autonomic (self-managing) system can be summarised as four objectives (self-configuring, self-healing, self-optimising and self-protecting) and four attributes (self-awareness, environment-awareness, self-monitoring and self-adjusting).

Autonomic Computing: metaphor based on biology when the autonomic nervous system within the body is central to a substantial amount of nonconscious activity that allows us as individuals to proceed with higher level activity in our daily lives. The aim of using this metaphor is to express the vision to enable something similar to be achieved in computing to create the self-management of a substantial amount of computing function. In this way users are relieved of low-level management activities, allowing them to place emphases on the higher level concerns of running their business, their experiments or their entertainment.

Autonomic Communication: it has the same motivators of the Autonomic Computing concept, with particular focus on the communications research and development community, so as to understand how an autonomic network element's behaviours are learned, influenced or changed, and how these affect other elements, groups and networks. The ability to adapt the behaviour of the elements was considered particularly important in relation to drastic changes in the environment, such as technical developments or new economic models.

Context awareness: the capability of services to know what is happening in the current context (e.g., what situations are occurring), and of autonomously adapt their behaviour to that. Situations can relate to network, social or physical context.

Cross- or non- layered architectures: the power of cognitive sensor networks lies in the networks themselves, rather than in the nodes. Since the intelligence of the network must be enhanced to cope with diverse goals, cross-layer architectures or software-based non-layered architectures must be sought to achieve coordination between nodes and optimization.

Data storage and access: storage will improve so rapidly that the cost of keeping everything will be cheaper than the cost of deciding what to keep. This will result in a phenomenon called "perfect recall", digital trails that capture people's every move that can reclaimed when needed.

Distributed and Context Based Applications: cognitive sensor networks that connect the physical and self-ware. This research will explore paradigms for horizontal self-organisation for coordination, control, management, security, evolvability, etc. at micro- (atomic unit of control and communication), and macro- (composed Autonomic Communication systems) levels.

Environment-awareness: the system is aware of current external operating conditions.

Implementation: one of the main challenges is to be able to implement sensor and actuator nodes that will be able to support the concept of bridging the physical and the digital world.

Real-time infrastructure: these will use sensor network management technology and event-driven architecture to build architectures capable of capturing, storing and analyzing trillions of transactions.

Scalable: the design principles chosen for a system should be practically applicable to small systems, as well as very large (possibly heterogeneous) systems.

Self-organisation: applied to a behaviour, it means a collective behaviour that is not explicitly programmed in each individual but emerge at the level of the group from numerous interactions between these individuals that only follow local rules with limited, incomplete information. The expression "not explicitly" means that the behavioural rules do not refer to the global pattern that will emerge.

Self-configuration: system’s ability to readjust itself automatically; this may simply be in support of changing circumstances or to assist in self-healing, self-optimisation or self-protection.

Self-healing: mechanism concerned with ensuring effective recovery when a fault occurs, identifying the fault and then, where possible, repairing it. In proactive mode, it monitors vital signs in an attempt to predict and avoid health problems.

Self-optimisation: when a system is aware of its ideal performance it can measure its current performance against that ideal and has policies for attempting improvements. It may also react to policy changes within the system as indicated by the users.

Self-protection: the system will defend itself from accidental or malicious external attack. This means being aware of potential threats and ways of handling those threats.

Self-awareness: the system is aware of its internal state.

Self-monitoring: the system is able to detect changing circumstances.

Self-adjusting: the system is able to make its adaptations as a consequence of self-monitoring.

Sensor networks: these networks will provide new ways to measure and monitor physical environments in minute detail, with almost no human effort. Everything will be connected and its location known.

Service-driven: (in the Autonomic Communication area of interest) the networks of an Autonomic Communication platform and its applications can support the business life cycle, enabling a service-oriented requirement and trust driven development of Autonomic Communication application-driven networks.

Situated and Autonomic Communication: autonomous intelligent network, which takes into account the location of its nodes.

Connected Society

Mobility: the definition of mobility is related to the Society (look at the meaning below), therefore the services have to be delivered in every place, for all people and not only in a certain project area of interest. This means that it’s possible to have Total Mobility (every place and every people) and Local Mobility (specific place and specific people).

Penetration in the market: in this study, the degree to which a technology is adopted by a community (also The Connected Society).

Potential positioning: in order to understand the projects/technologies positioning into the future Autonomic Communication market we will refer to the Gartner's Hype Cycle for Emerging Technologies.

Quality of Service: in this deliverable, the quality is related to the ability of the technological infrastructure to make possible the deliver of the services in an easy and quick way.

Society: this expression is used in its widest meaning, encompassing all mankind.

Strategic need: people's need that entail a change in the long term, having irreversible effects and producing broad results, in term of benefits too.

1.3 Document History

Version	Date	Authors	Comment
1.01	15/03/2006	Daniela Guarnieri Monica Corrado	Initial document
1.02	31/03/2006	Daniela Guarnieri Monica Corrado Richard Tateson	Update based on improvements about open issues and contributions by BT
2.01	18/04/2006	Daniela Guarnieri Monica Corrado	Update based on improvements about strategic needs
3.01	22/06/2006	Daniela Guarnieri Monica Corrado	Change of ToC and consequently contents adjustment.
4.01	29/12/2006	Daniela Guarnieri Monica Corrado Richard Tateson	First draft of the complete deliverable
4.02	15/01/2007	Daniela Guarnieri Monica Corrado	Final version of D6.1 – Part B

		Richard Tateson Antonio Manzalini	

1.4 Document overview

The main results of this document are:

Chapter 2

- The study of possible economic scenarios (in 2015-2020 years) on which focus our attention:
  - Smooth Development
  - Constant Change
- A first research about target market within each economic scenario selected:
  - Smooth Development:
    - Consumer market
    - Business market
  - Constant Change:
    - Business market
- The definition of the Connected Society

Chapter 3

- The definition of people's communication strategic needs

Chapter 4

- The definition of what Situated Autonomic Communications are
- The definition of providers' strategic drivers

Chapter 5

- The description of the CASCADAS vision
- The description of CASCADAS reference scenarios (application and infrastructural scenarios)
- The definition of a list of possible services to be provided within different application scenarios
- The validation of scenarios' choice showing that they satisfy providers' and customers' needs (respectively strategic needs and drivers)

2 The Connected Society on 2020

The point of departure of socio-economic prospective studies is the definition of the Connected Society idea on 2020 year, though long term forecasts can never be exact.

In fact, it's really difficult to carry out any exact forecast when we are talking about future and emerging technologies, because a current market of reference doesn't even exist to start analysing the situation. For that reason, focusing on changes about people's communication needs is really interesting and also important as these needs will determine weather future technologies are adopted or not. Following the same reasoning in the Autonomic Communications field, this document aims at directing the CASCADAS vision development following the trends of communication needs, society and economy in order to come to the Connected Society definition and the way through which open communication issues can be addressed by the CASCADAS solution itself.

In such a wide forecast interval, the evolution of the world economies can follow different ways and this will positively or negatively affect the introduction on the market of the technology developed by the CASCADAS project. In fact, economic development drives up disposable incomes of customers and this, combined with real user strategic needs, controls consumption – what is bought and how much is bought [1].

For all these reasons economic scenarios have to be developed in order to allow the examination of choices by both consumers and business customers from a socio-economic perspective. Scenarios are not intended to give a prediction but a supposition of what might happen in certain circumstances. They describe plausible future eventualities. In consequence, they cannot forecast exact outcomes in economies or technologies, but they do offer a perspective to provoke 'what if' analysis, to discuss and identify the relevant factors and technological research directions.

2.1 Future economic trends on 2010-2015 years

Five scenarios of different socio-economic conditions have been taken into consideration to explore user needs and motivations. These scenarios are [1]:

- "**smooth development**": EU economies will be united to provide growth and development, in a fair and managed way that brings prosperity across all 25[2] members.
- "**economic stagnation**": the EU economy will slowly decline, as did the Japanese economy between 1988 and 2003. Outputs gradually shrink and government policy reactions to strong deflation are unsuccessful or frozen. EU economic growth falls behind that of Asia.

[2] In 2005, at the time of the research writing EU countries were 25, but now we should talk about 27 countries (Romania and Bulgaria joined the EU on January 1st 2007).

- "**constant change**": the economy will overall follow a moderately positive trend, with ups and downs. Ad hoc growth and recession often occur in parallel in different areas or countries, with stop-go progressions and regressions in specific areas of the EU. However, prosperity slowly increases for many in the EU.
- "**financial crash**" in European Union: an economic disaster within the EU and spreading beyond, comparable to the 1929 crash, but with effects for over 5 years.
- "**disaster**": natural disaster, major war or nuclear/chemical/biological accident or terrorist attack seriously impact EU economy long-term, to 2020 and beyond, possibly making a small part of the EU uninhabitable temporarily. Other regions (ASEAN – Association of South-East Asian Nations, NAFTA – North American Free Trade Agreement) affected but not so seriously.

Each of these scenarios was analysed in the long-term [1], that is by ten/fifteen years, to outline typical behavioural pattern coming from different socio-economic conditions in order to explore user strategic needs and motivations that could drive them to the utilization of an autonomic, situation-aware communication technology.

It's interesting to map out the positioning of five scenarios within a plane showing their social (favourable or unfavourable) and economic (favour or inhibit the take up of future communication services) conditions, so that having a clear view of their mutual positioning (please see the following Figure):

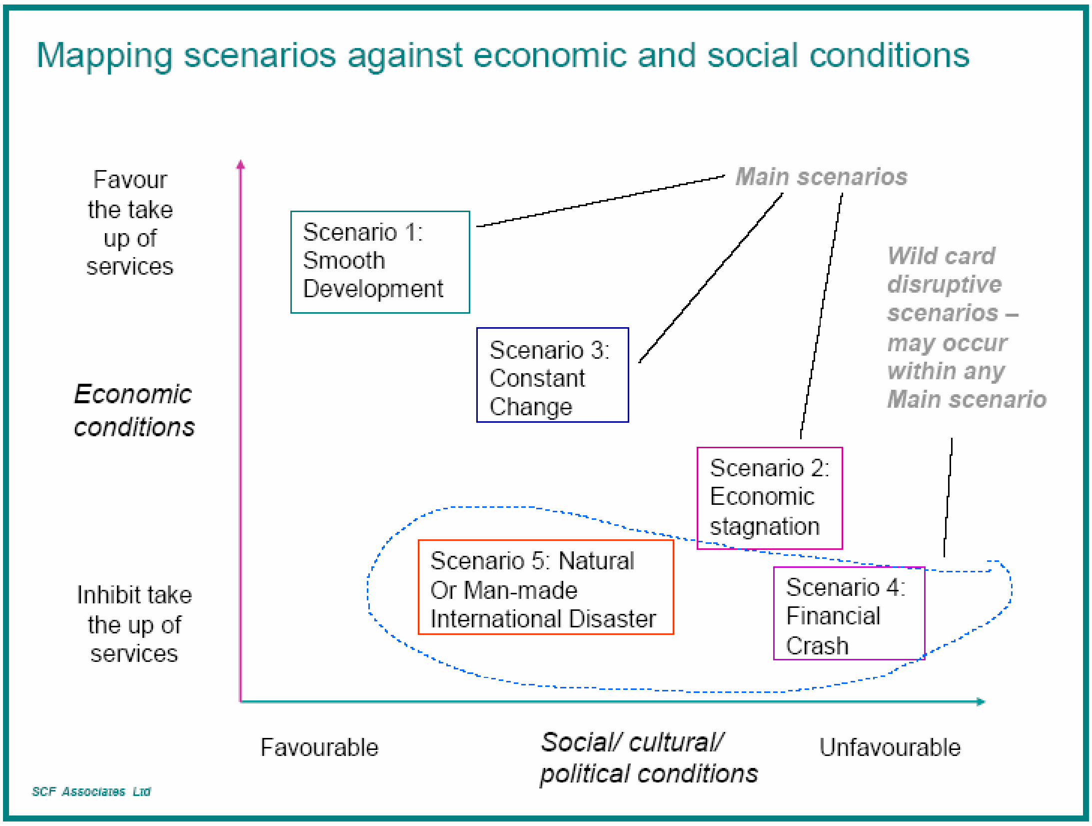


Figure 5 – Mapping of five scenarios against social and economic conditions.

The Figure shows that Scenarios 4 and 5 are disruptive ones and so they will not bring the Society to be well-disposed to new services, on the contrary economic conditions will inhibit the take up of the services themselves. That is why two above-mentioned scenarios are the least interesting ones for the CASCADAS project purposes because they will not enable the deployment of innovative services such as CASCADAS ones on a large scale. It should be noted that both scenarios 4 and 5 could create some niches for CASCADAS technologies. For example, relating to unmanned ecological monitoring in scenario 5 or the use of mobile technology to support non-traditional economic activity in scenario 4 (witness the effect of mobile telephony in Africa today).

After expert consultation [1], it was further agreed that three Main Scenarios were enough to reflect the range of possibilities facing Europe over the next 15 years, and precisely:

- **smooth development**
- **economic stagnation**
- **constant change**

In any case, Scenarios 4 and 5 may occur within Main Scenarios for limited periods.

Main Scenarios will enable the adoption of innovative communication services (please see Figure 5), with two different layers of adoption:

1. High adoption:
   - Scenario 1, Smooth Development
2. Medium-low adoption:
   - Scenario 2, Economic Stagnation
   - Scenario 3, Constant Change

These hypothesis will be draw on in Chapter 5 "CASCADAS vision on Autonomic Communications" (when services adoption will be better analysed) and are supported by the following brief examination of the three Main Scenarios in the period 2010-2020.

<u>Scenario 1: Smooth development</u>

Economic and social factors

- Knowledge work for about 80% of the population.
- Increased move towards single parent families, single person households.
- High disposable incomes of a median of € 6000 per year and per person across EU.
- ICT is a positive force, accelerating the economy. Sophisticated systems based on ICTs give better service at far lower cost.

- The service sector, makes up some 75% of the EU's output. It is supported by a new generation of ICTs based on mobile (radio) technology which contribute measurable benefits.
- A key example is in health systems, which have enormous potential for cost cutting and whose cost would be increasing without the new technology. Public service wireless systems for mobile-government, and operation of the environment in policing and surveillance are important.
- Europe uses 4G wireless judiciously to generate new demand just as GSM did, for high technology services and products, as a way to turbo-charge the economy. After 2010, new EU services and technology to exploit the free bands take off, despite protests from governments and incumbent mobile operators, who have received or paid fortunes for 3G licences, giving a lower cost mobile infrastructure.

Usage of Services

- Spread of distance working.
- Most people's waking day is spent in use of some form of communication or processing.
- Complex online shopping experiences will be popular from about 2012 onwards.
- Distance learning services over mobile networks assure through-life learning and retraining.
- Equipment for the interactive services connected over WiMax 2.
- Voice-SMS are popular.
- The entertainment market in services and their support gadgets for entertainments, especially sports and music/videos, will grow up.
- Machine to machine communications at all levels from industrial plant to consumer goods like cars becomes important in the final Epoch, as 2020 approaches.

Industry structure and Technical offerings

- From 2007 onwards Europe invest heavily in early forms of 4G, often built on 3G protocols with ad hoc mesh structures and new optimisation policies for routing, all being founded on a new security structure.
- Investment in a new secure IT infrastructure beyond today's Internet and PCs. The majority of devices, but especially smartphones and PDAs, move away from anything resembling a Wintel architecture. By 2011, a new generation of software, firmware and hardware structures will be designed around secure operations.
- From around 2006 on the Internet and current computing technology (PCs especially) are considered unsuitable foundations for communications and processing in a computing and networking world that has become highly malicious. From 2008 the Internet is replaced by communications structures

expectant of attack and which are highly robust. This is essential to conserve the trust of users. Mobile handsets and portable computers become strongly resistant to attacks as their usage spreads and users' dependence becomes absolute.

<u>Scenario 2: Economic stagnation</u>

Economic and social factors

- White collar employment continues to fall, accelerated by off-shoring of the most mundane business processes. Technology is used to create simple efficiencies in routine work, not to open new doors to employment in new pursuits, so it eliminates employment generally.
- The EU stagnates with active employment gradually falling from its already low 2002 level of 64.3% of the active population to 60% after 2010, reaching less than 55% by 2020.
- In initial stagnation years the unemployment rate reaches an EU average of 15%, rising to over 20% by 2020 (but for those aged under 25 or over 50 it is nearly 50% in many countries).
- The effective taxable base reduces by 20% between 2005 and 2020 as the population ages, and unemployment increases while salaries diminish in real terms by 2% annually over this period.
- Deflation in most consumables occurs except in housing, whose price is stagnant and so it increases in real terms. Energy prices for heating, lighting and transport are also growing in real terms far more rapidly, while average interest rates are kept fairly high at around 7%.
- The costs of higher education are increasing across the EU at around 5% to 10% per year so fewer can afford to enter higher education and gain better paying skills, apart from an élite. This pushes the disparity of incomes further forming a pyramidal class structure and excluding many.
- The unemployed gradually turn to alternatives in bartering. A grey economy of undeclared revenues becomes near 25% of GDP by 2020. A new "green" economy flowers in agricultural regions centred on barter in agricultural products, services and manufactured goods. By 2020, the combined green and grey economies in many EU members account for over 60% of the total GDP.
- The number of citizens below the poverty line increases to over 12%, reached in 2010, then 15% in 2015 and 18% by 2020. Under-nourishment and poorer health affects 20% of people in the EU.

Usage of Services

- Due to industry structure, and the falling disposable income, consumer prices in all telecommunications services remain comparatively high and may even increase in relative terms.
- ICTs, especially advanced wireless systems, tend to be used only in large business organisations and their spread into consumer segments is slow and

even reverses. Around 2009-2011, a new generation of IT is introduced which reduces service sector employment by approximately 25%.

- EU citizens have an increasingly negative view of IT and tend to reject it.
- Only very minimalist very low cost services succeed in the consumer segment, predominantly prepaid so costs can be controlled. Advanced consumer services are limited to high end elite.

Industry structure and Technical offerings

- There is a conflict between traditional pricing of services based on a growth economy, in line with an incumbent's traditional expectations, and the real desires of consumers, which cannot be satisfied on lower pricing due to the lack of competition.
- Effectively there are no new market entrants as market access is held back by the incumbents, through predatory pricing and cross-subsidising services.
- A phased succession model is enforced for any follow-on from 3G mobile systems so many operators (and some key suppliers) are slow to implement 4G. Governments and operators consort to preserve 3G mobile licence dominance and resist 4G takeoff so that 3G systems dominate the market. No real evident or latent market pressures for 4G services arise. In the EU, the market stays with 2.5G, 3G and 3.5G (faster data download, etc) though globally there may be some more advanced initiatives. Even in the scenario of economic stagnation Wi-Fi will probably continue to spread and threaten 3G viability.

<u>Constant change</u>

Economic and social factors

- Constant economic output change, up and down with ad hoc growth and recession, often in parallel in different geographic markets, but moderately positive overall.
- European level initiatives do not set the scene or rule except as background of moderation and scene setting in employment laws, company law and bureaucracy.
- Small and Medium Enterprises (SMEs) are the key to growth, employing 85% of the active population with 95% of the new jobs.
- Everyone is a migrant from some other part of the EU, or possibly far further afield.
- Thriving local regions appear that have all or some of the following – low cost of living (specifically housing to keep down salary costs, the key cost driver in a knowledge-based society), an educational surplus of well-qualified people (all ages), centres of excellence in a high technology.
- Disposable income is generally low and employment is highly fragmented by geography, sector and working conditions. Disparity in incomes is large, but

instead of being between the working poor and the rich with non-earned wealth, it is between the working and the unemployed.

Usage of Services

- To meet the needs belonging and social comfort, long distance links are required to talk to family and also to find new work when the local economy fails.
- Communications are an essential household expense to stay in touch with disparate families at home and friends and family in multiple regional centres, and also for searching for new work, in another region perhaps, and for re-skilling.
- Communications needs displace other items in a personal budget giving a relatively large spend on telecom services.
- Lifestyle services become crucial to support a migrant lifestyle. Convenient access to secure financial transactions is a must for the legions of migrant workers, and for the entire financial sector.
- The services must be highly easy to use and convenient as most people are time-poor, and they must be trusted, that is secure for remote transactions.

Industry structure and Technical offerings

- 'Guerrilla' markets arise, as an outgrowth from opportunistic investments in parallel technologies to 3G[3] and 2G mobile. New entrants appear, starting with VoIP over WiFi, combined with early unlicensed spectrum for long distance WiFi (low cost point to point forms an alternative infrastructure). Good quality IP Voice over WiFi (dual mode handsets) is offered. Security problems of WiFi solved, and power requirements of WiFi become refined (to microwatts).
- Regulators allow unlicensed bands for WiFi voice and high speed data services, with a major spurt in unlicensed bands beginning from 2010.
- WiFi networks spread in an ad hoc pattern across the USA, Asia and into Europe. WiMax pushes in fast behind, to interconnect and finally displace WiFi, due to its roaming option, and a range of 50 kms and up to 70Mbps bit rates with a base station switch price of €100,000. WiMax 2.0 also challenges CableTV (CATV) and fixed line broadband access. A niche industry appears to serve the long distance

---

[3] 3G, or 3rd-generation, is the generic term used for the next generation of mobile communications systems. The new systems will enhance the services available today and offer multimedia and Internet access and the ability to view video footage. In communication systems field, analogue mobile phones were the first generation; digital marked the second generation. 3G is loosely defined, but generally includes high data speeds, always-on data access, and greater voice capacity. Finally, The 4G will be a fully IP-based integrated *system of systems* and *network of networks* achieved after the convergence of wired and wireless networks as well as computer, consumer electronics, communication technology, and several other convergences that will be capable of providing 100 Mbps and 1Gbps, respectively, in outdoor and indoor environments with end-to-end QoS and high security, offering any kind of services anytime, anywhere, at affordable cost and one billing.

market with rock-bottom equipment costs, especially in LDDPDG’s (Long Distance Directional Propagation Ducting Guides, i.e. recycled Pringles tins).

- A complete 4G mobile system with roaming handover and mesh working appears from Asia and is implemented to act in dual mode and so augment WiFi, and subsequently, WiMax. 4G grows fast (increasingly so after 2010), starting through a limited offering from the new market entrants, such as the WiFi service providers. In the EU, some new entrants are offshoots of the incumbents, with a business model based on economy pricing of voice and data.
- The pattern of take off in Europe is with dual-mode and then multiple-mode handsets - first stage is existing mobile systems (2G-GSM/GPRS/3GPP) and WiFi-WiMax, with customer contracts over multiple bundled networks. In a second stage, a limited form of 4G mesh technology appears as high speed mobile with WiFi air interfaces and WiMax (after 2010) but a complete 4G environment takes some 6 years to arrive (up to 2016), in the form of pockets of access across the EU, that cover economic, not political regions.

To summarize, as outlining these long-term scenarios, it should be considered that the economic world development will not be homogeneous, but it will have different trends depending on the **following variables**:

- **disposable income**, also related to macro- geographic areas and their economic development and financial conditions;
- actual **level of technological development**;
- **age**, **sex** and **ability in the use of the technology** from future customers;
- **people’s motivations and needs**.

It’s further important to assume that customers in 2020 (consumer and business) will be far more educated in using and creating a lifestyle around advanced services, having grown up with the technology. So a first basic hypothesis concerns people’s future technological maturity that will influence the breadth of the future customer base (this aspect will be better explained in next Chapter 5 “CASCADAS vision on Autonomic Communications”).

The **above listed variables** tied to development trends varied considerably across three scenarios, as the economic conditions in each drove users in different directions. Talking about **motivations and needs**, in the ‘Smooth Scenario’ the need arose for sophisticated services such as education support, whereas in the ‘Stagnation Scenario’, low-cost services aimed at more basic lifestyles were more important. In the ‘Change Scenario’, the need arose for wireless services as an essential link for migrant workers to maintain family ties and organise a new life away from their home countries. Logically, the most important driver for growth in the use of future technologies in all scenarios was the general **economic development and financial conditions**. Apart from this, different drivers were seen as being critical for each scenario. According to the survey no single application was seen to be dominant, though simple voice was important in all scenarios, especially in ‘Economic Stagnation’.

Coming back to the research [1], Figure 6 shows total **estimated traffic**[4] **for each of the three scenarios** considering that they will strictly affect the technological improvements over next fifteen years and hence the users' needs of integration and communication. Analysis of the results showed that between 2010 and 2015 the differences between the scenarios are relatively small. It is only after 2015 that big differences in traffic volumes become apparent. An increase in the number of users from 2015 was supported by evidence such as the consolidation of an European internal market for mobile services, the expansion of Machine to Machine communications (M2M) or the fact that consumers will be familiar with and will demand mobile broadband services. It should be also noted that growth may have different origins. In the 'Smooth Scenario', huge growth came from individual consumers, whereas in the 'Change Scenario', growth from consumers was steadier, most of the growth resulting from increased use by enterprises. In the 'Stagnation Scenario', consumer traffic was very limited indeed and almost all of the traffic resulted from enterprise use.

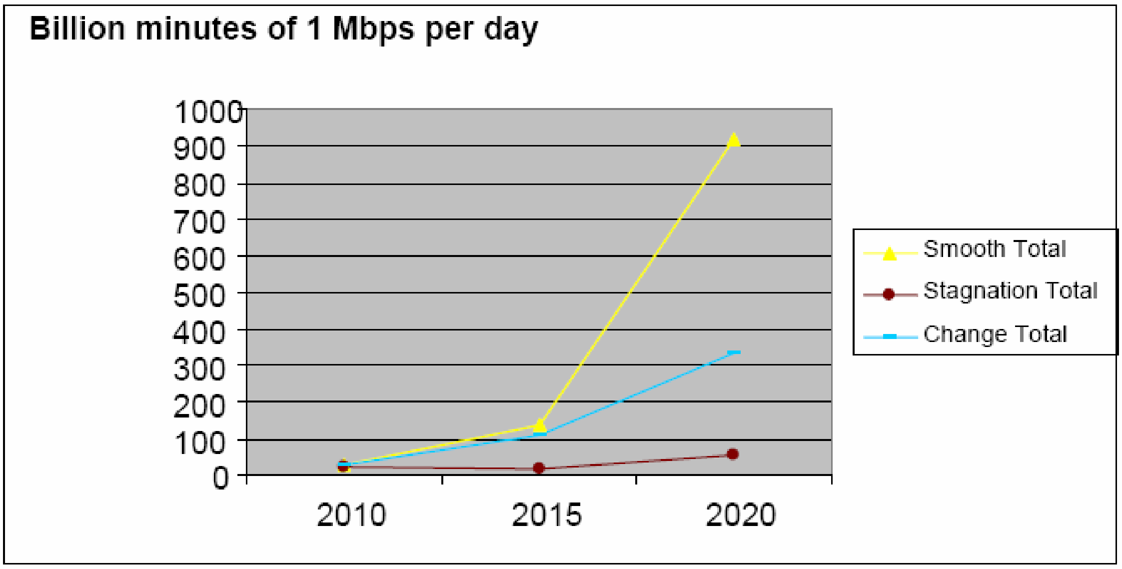


Figure 6 – Total traffic estimations for the three Main Scenarios.

In summary, Figure 6 shows that the **Smooth Development Scenario** may require the highest amount in terms of traffic so it should be the **most interesting** for the SACs' services development and on which CASCADAS Consortium should focus the attention. On the other hand the questionnaire responses within the research [1] rated the **Constant Change Scenario** as the **most realistic**, while 'Smooth Development' was seen as slightly less convincing than 'Economic Stagnation'. Focusing on the likely scenario, Figure 7 shows the estimated traffic for the 'Constant Change Scenario', differentiating consumers and business users.

[4] Traffic of data through wireless and mobile Internet network, measured in Mbps (Megabit per second).

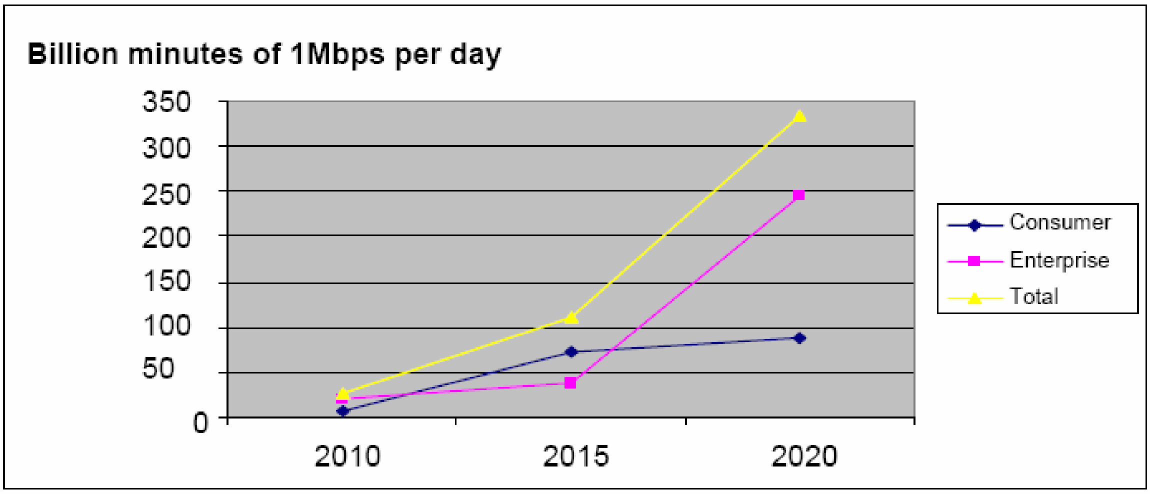


Figure 7 – Estimated traffic within the "Constant Change" scenario.

The most of the traffic requests should hence come from business customers, and this trend should be more and more marked in the long term (2015-2020 years).

In consequence, future release of **socio-economic studies will take into consideration both scenarios** considering that:

- the **Smooth Development** scenario is most in favour of the diffusion of new communication paradigms and the spread of the SACs' services in the market could reach both **consumer and business market**;
- the **Constant Change** scenario is more likely to be reality, but in this case only **business market** may be really interested in SACs' services.

2.2 The Definition of the Connected Society

The definition of the Connected Society should be contextualized in the Smooth Development scenario, as the most favourable scenario for the SACs' services, and the point of departure should be the study of the enabling technology at the bottom: the Internet.

Currently, the Society is witnessing an age of computing ubiquity where our work and home environments are increasingly enveloped by computing and communication resources. However, exploiting such distributed resources to provide meaningful, useful, and usable communication services actually comes at high development and maintenance costs. In addition, while the full potential of such resources is far to be fully exploited, the services provided within them are not flexible and far to be fully satisfying to users.

The vision for new communication paradigms is formed by the fact that technology and consequently communications are mainly driven by the urge to make our lives better. Throughout human evolution, human lives become better with the use of any kind of tools. Technology and ICT tools are one of the more intelligent tools, the greater the degrees of freedom people possess to move towards better health, knowledge, productivity and safety [2].

The same trend can be noticed in the three stages of Internet evolution (please see following Table 1) and their related changes in integration improvement [3]. In the third step people will become a real Service Provider, following their own habits, attitudes, interests and sharing with other people their contents.

Stage of Internet evolution	Integration type	Examples
Data transport engine	People integration	E-mail service: Everyone becomes its own post office
Information retrieval Content provisioning system	People and information integration	World Wide Web: everyone becomes its own server
Beyond Internet	People, information and environment integration	Everyone becomes its own Service Provider

Table 1 - The three Internet stages.

Evidently, these scenarios will be supported and permitted thanks to future technological development in communication devices and facilities for the purpose of improving people's life and then services at their disposal. So, a social need will influence technological development.

At the same time Internet will have an effect on social, political and economic life in next years, so technological trends will influence social trends in a bilateral exchange between technology and people clusters.

Main **effects of the Internet evolution to the Society** can be [4]:

- **The deployment of a global network**: global, low-cost network will be thriving in 2020 and will be available to most people around the world at low cost. Insecurity that the policy climate will be favourable for such Internet expansion. The centre of the resistance will be in the businesses anxious to preserve their current advantages and in policy circles where control over information and communication is a central value.
- **Human control over technology**: humans will remain in charge of technology between now and 2020. However some fear that technological progress will eventually create machines and processes that move beyond human control. On the other hand, leaders who exercise control of the technology might use this power inappropriately.
- **Transparency vs. privacy**: there is a widespread expectation that people will wittingly or unwittingly disclose more about themselves, gaining some benefits in the process even as they lose some privacy. This fact will not involve that the world will be a better place in 2020 due to the greater transparency of people and institutions afforded by the Internet; in fact, it might be that the benefits of greater transparency of organisations and individuals would outweigh the privacy of costs but it might not be too.

- Compelling or "addictive" **virtual worlds**: those who are connected online will normally devote more time to sophisticated, compelling, networked worlds by 2020. This will foster productivity and connectedness and be an advantage to many.
- The fate of **language online**: *English* will be the world's lingua franca for cross-cultural communications in the next few decades. But notable numbers maintained English will not overwhelm other languages and, indeed, Mandarin and other languages will expand their influence online. At the same time Internet will allow the preservation of languages and associated cultures, facilitating linguistic diversity and languages evolution over time.
- **Investment priorities**: there are two main goals for the world's policy makers and technology industry to pursue: *building network capacity* and *spreading knowledge about technology* to help people of all nations.

All the above mentioned factors will change considerably and rapidly the relationship among humans, environment and technology and in this relationships the information exchange will have an important role. At the present time, there is a clear separation between the the physical world of things (principally devices, environment and people that is the Society) and the virtual world of information (please see Figure 8): people are in contact with the environment in which a specific person live in and can come into contact with the information either directly or thanks to devices support.

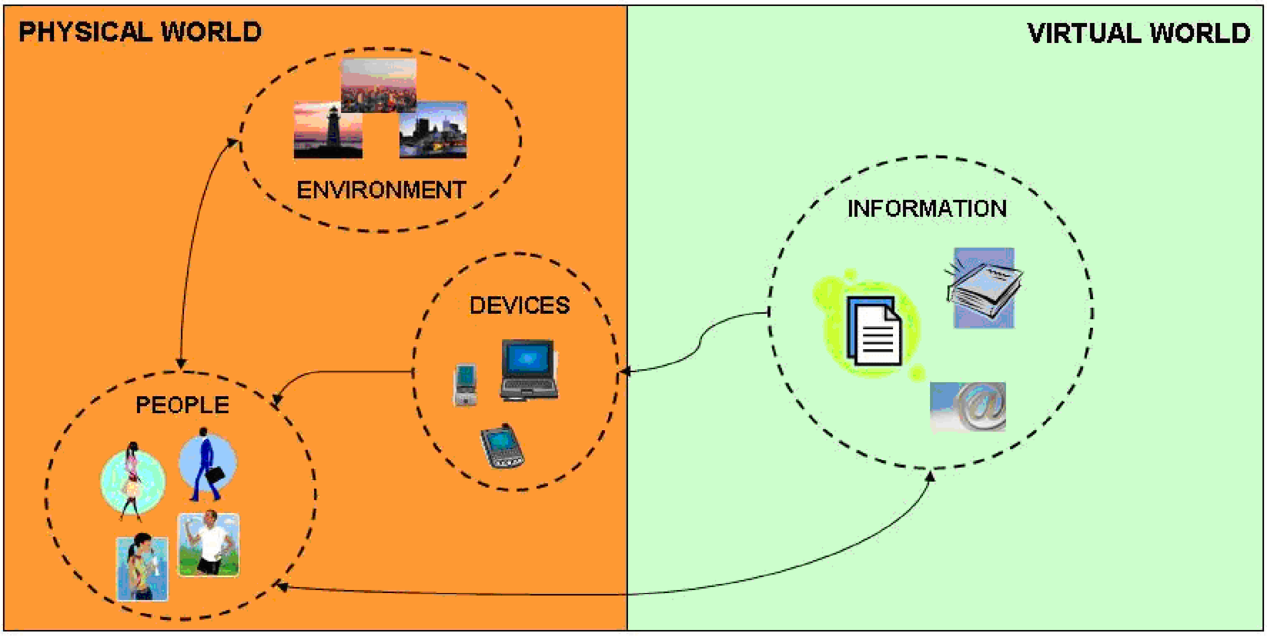


Figure 8 – The current clear separation between physical and virtual worlds.

The diffusion of the information through ICTs channel is therefore strictly correlated with the diffusion of devices among people. By 2008, that is in medium-term, one third of mankind will be connected to a mobile device and this percentage will reach the hundred per cent in the western industrial countries [5]. Accordingly, it will be likely that people have the opportunity of being connected to the Internet all the time and everywhere, fully achieving the union between communication and mobility. Thanks to continuous improvement of devices diffusion, people will need services more and more in arm's reach, flexible and personalised.

Ultimately, continuing with this trend during the next fifteen years, there will be a shift at the intersection of the physical world of people, objects and places, and the virtual world of information [6] coming to **"The Connected Society"**: the clear separation line will not exist any more (please see Figure 9).

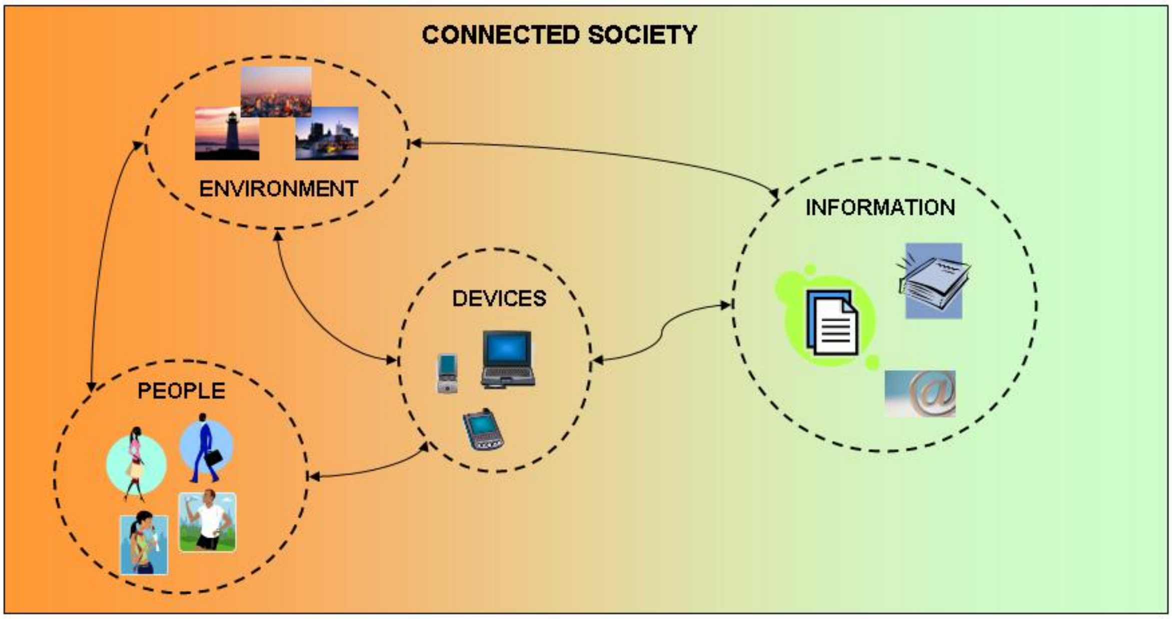


Figure 9 – The Connected Society.

The vision bound to the Connected Society is that of a world pervaded by ubiquitous communication facilities, offering their services to the users and capable of self-organizing and self-preserving their functionalities without any direct human intervention [7]. The main feature of future communication paradigms will be the ability to adapt to an evolving situation, where new resources can become available, administrative domains can change and economic models can vary accordingly [7]. This means that one of the principal research trends will be context awareness and the final goal is enabling the user to build his personal service through all the available devices.

In such a scenario, humans are not required to be in the loop except for the initial action of injecting the needed service components in the systems. Yet, service developers, system managers, as well as end-users, would of course retain the capability of overriding any decisions made on their behalf, via proper tools via which to dynamically intervene on the system or on specific services, without stopping them but simply forcing some goal-directed self-reorganization in it.

Consequently, in a not-so-distant future, the everyday activities of citizens will be supported by a ubiquitous environment of autonomic networked services that will always be available to cater dynamically to their needs in a situation-aware manner. The Internet as we know it today will become like an immense organism of composite, highly distributed, pervasive, communication services that will enable a wide range of new activities that are simply not possible or practical now:

1. by autonomously detecting and organizing the knowledge necessary to understand the general context – physical, technological, social, user-specific and request-specific – in which they operate, and
2. by autonomously adapting their characteristics to all those situations – i.e., by spontaneously aggregating and orchestrating their activities accordingly .

In particular, we expect services to be autonomously able to:

- improve our interactions with the physical world by providing us with any needed information about our surrounding physical environment, and by exploiting such information to adapt and enrich their behaviour on the basis of the actual environmental characteristics;
- get the best of the network infrastructure and associated resources, being able to adaptively ensure sufficient quality of service, guarantee security, and tune to user needs and preferences, independently of the actual network characteristics;
- facilitate our social interactions, by reflecting and exploiting the social context in which we are employing a service (although acquiring and using such information raises security and privacy issues, their careful exploitation will open up a wide range of valuable possibilities).

We must emphasized the distinction between an offensive approach to social integration in ICT policy and a defensive one [8]. Offensive means projects that use the new possibilities of ICT proactively in order to open up new opportunities and to bridge social gaps, whereas defensive measures merely try to avoid or reduce the risks of ICT-inherent discrimination.

In fact, ICTs run the risk of widening the gap between those who have and those who do not have access to information, training and jobs, thus deepening pre-existing social disparities. But they also open new job opportunities and offer new means of coping with everyday life for handicapped and elderly people. They introduce new methods of teaching and visualising complex matters: in other words, they create new opportunities for socio-cultural enrichment and integration. They can also create new routes to information and marketplaces which circumvent existing and, and possibly restrictive, hierarchies and middlemen.

Summarizing, the Connected Society will be based on next-generation communication services allowing people to:

- be dynamically deployed in a network and autonomously make sense of their operational environment, both social and technological;
- self-organize and self-optimize their overall behaviour accordingly, and made themselves ready to serve users;
- be ready to opportunistically self-reorganize their activity and self-tune their properties to adapt to ever-varying conditions and situations;
- be resilient with respect to failures as well as attacks, in order to preserve their functionality and quality.

Further information about next-generation communications' features and trends are available in Chapter 4 "The Situated Autonomic Communications".

3 The Strategic Communication Needs

The development of the aforesaid "Connected Society vision" will be basically directed to live up to the evolution of **people's strategic communication needs**, that is people's needs that entail a change in the long term, having irreversible effects and producing broad results, in terms of benefits too.

This social evolution in people's needs will be clearly followed by a technological evolution of infrastructures and devices, with regard to the ICTs and Internet too.

As seen in the previous section (please see Table 1*)*, the third stage of Internet evolution will lead humanity **beyond Internet** because of the emergence of environment integration: people will be able to make use of Internet services in a new way more customized, context-aware and really mobile. This is the scenario in which Autonomic Communications can make the most of people's need of communication services.

In any case, major **motivations and needs** will **vary considerably across the scenarios**, as the social and economic conditions in each one will drive users in different directions. Thus, there will be significant differences in communication needs and trends depending on epochs.

In the following, Table 2 shows the evolution of people's social needs in years to come, by economic scenarios (Smooth Development, Economic Stagnation and Constant Change) and epochs (2010, 2015 and 2020) [1]:

	Scenario	2010	2015	2020
1.	**SMOOTH DEVELOPMENT**	Generating knowledge work through affordable re-training. Ubiquitous employment discovery, access and retraining.	Control of everyday life - ease of access to convenience services. Support for extended family 'tribes'. Ease of trade at low cost. Expansion of business reach geographically.	Advanced support services at low cost for health, social requirements, education International co-ordinated working across the EU or globally.
2.	**ECONOMIC STAGNATION**	Belts tighten in the family and the firm. Disposable income and consumption restricted. Search for lower costs of doing business. Simple SME support. Search for security.	Reducing outlays. Seeking employment either in conventional or in underground economies. Operating business at low cost. Simple business services. Support for rural communities at low cost	Simple lifestyle at minimal cost. Support for trading and bartering in a non-enterprise based economy. Support for migrant workers overseas including financial remittances.

	Scenario	2010	2015	2020
3.	**CONSTANT CHANGE**	Access employment - find - retrain Simpler infrastructure and laws for SMEs.	Support to (re)build life in new regions. Support for clustered communities of SMEs. Conserve cash to live through downturn.	Build remote environment – through constant contact with remote family, perhaps remote work and training. Distributed business operations across EU.

Table 2 – Analysis of people's social needs by scenario and by epoch.

It's interesting to highlight that needs are more sophisticated and challenging when economic conditions are good. This is a normal people's reaction to social conditions and, in general, to any other life situation.

In 1943 Maslow proposed a schema to rationalize **human needs dynamics** through a **hierarchic model** [9]. This model has been built on the basis that mankind is unsatisfied in nature: when a man satisfies needs of a certain "layer", new wants are sprung from the next one, starting from primary needs (physiological needs) up to safety, acceptance, status, personal fulfilment (please see Figure 10):

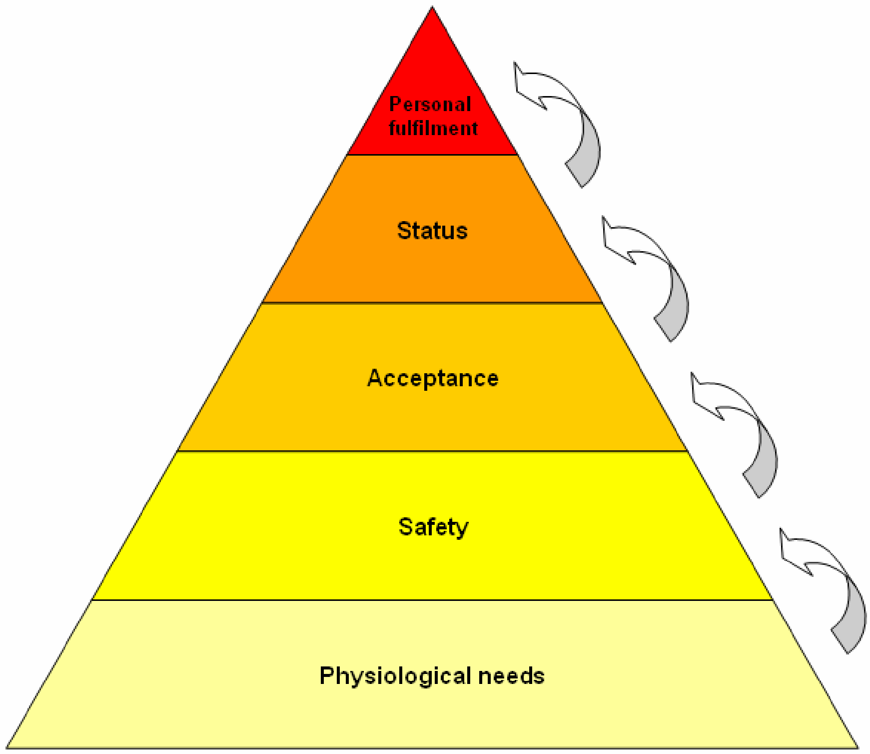


Figure 10 – The Hierarchy of Needs for people.

Communication strategic needs fall within social needs so the same model can be imagined for communication needs: the hypothesis understood is that **the refinement of**

people’s communication requirements is dictated by economic scenarios. Better economic conditions will lead to higher level needs in the Maslow’s pyramid.

In fact, in a situation of economic stagnation (please see Figure 10, Scenario 2), socio-economic conditions of the population will lead to a request of medium-low level communication needs since people will satisfy their own communication needs on a medium-low level on average.

On the contrary but for the same motivation, in a smooth development situation (please see Figure 10, Scenario 1) socio-economic conditions will lead to a request of high level communication needs (on average).

In a constant change situation (please see Figure 10, Scenario 3), instead, peaks of high level communication needs will alternate with periods of medium-low level requests.

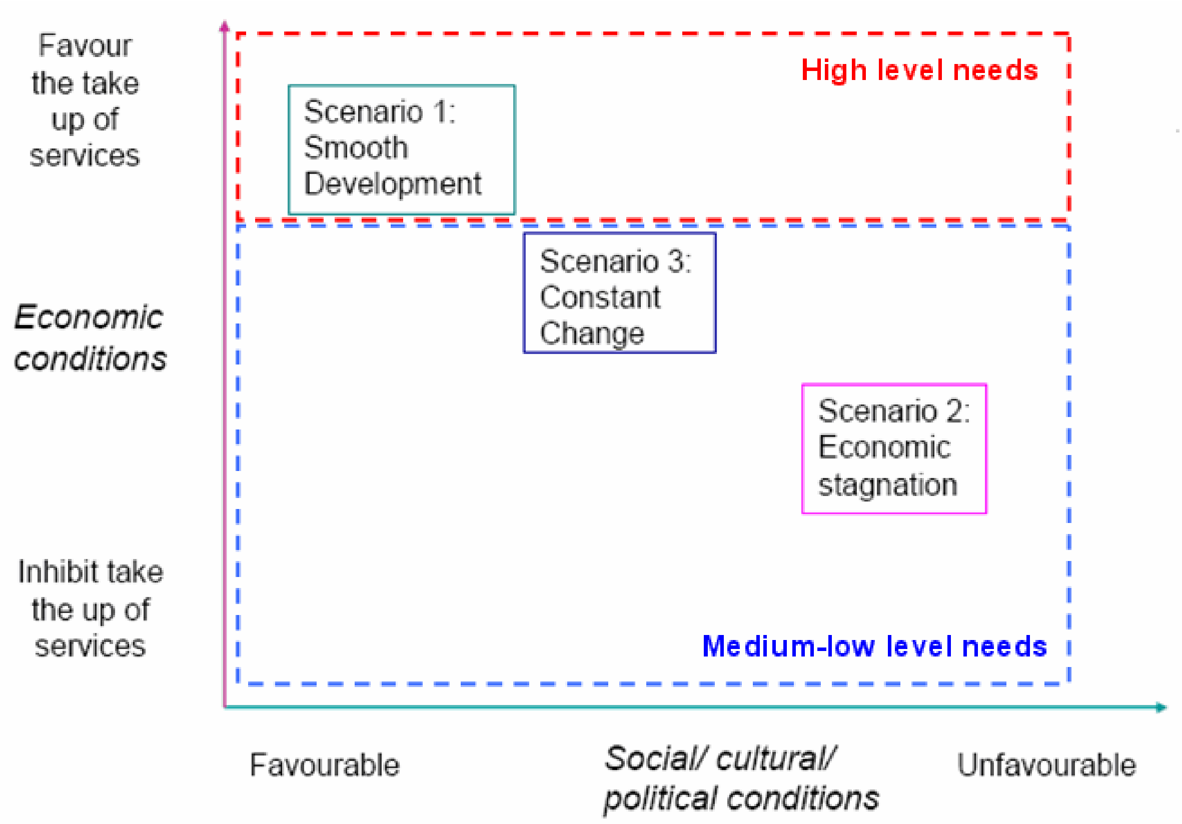


Figure 11 – Correspondence between levels of need and economic conditions.

It’s important to underline that the qualitative level of needs (high or medium-low layers) is an average level. In each economic scenario, in fact, there will always be some groups of population that will have high or medium-low quality needs, distinguishing themselves from the prominent trend above described. Thus, economic conditions will have an impact on population percentages having one or the other kind of need.

The following users' strategic communication needs are inferred supposing that high level communication needs will be required. This means that technological development scenario will be based on the third Internet paradigm (stage beyond Internet, please see Table 1) and economic conditions will lead to a smooth development (please see Figure 11). This way , people's strategic needs have been contextualized in the best situation for the penetration and development of next-generation communications.

In this evolved scenario people's strategic needs will be:

1. **Situation-aware services**:
   - Necessity of *communication and content services reacting locally on customers' and environment context changes*;
   - *Customers' freedom of movement* (e.g., mobility, nomadicity) *during the use of communication and content services* [5]: currently people can use Internet services only staying about in the same place. For example, a user who has a connected laptop or PC station can exploit the Internet services through a fixed connection or wi-fi. The limitation in mobility during the use of Internet services creates a limitation in the possible situations where the services could be applied. This way, people have some unsatisfied needs due to the impossibility of being free to move. In the 2020 scenario, the same user will be in a "beyond Internet age" characterized by the Connected Society, and so will be able to take advantage of Internet services everywhere and any time. The ubiquitous sensor networks will make everywhere and any time connection possible, achieving mobility;
   - *Personalization of the services* anticipating customers' needs and requests: the Internet services now available are standardized or personalized on customer during the design phase of the service. So, every modification has to be re-designed and then added to the latest version. There is a need of a very long cycle of operations before reaching the new required service.
     Thanks to context awareness, this cycle of operations will not be necessary because of the automatic adaptation to the evolution of user's personal characteristics and context. Practically, the aim will be realizing solutions to authenticate customers in every situation, keep their profiles, retain dynamically updated information about the user's context and then customize the service;
   - Positive interactions of new communication paradigms for the *simplification of human life* (e.g., helping in solving social issues).
2. **Quality of Service (QoS):** the quality is related to the ability of the technological infrastructure to deliver the services, to reduce response time and access problems to the minimum. The users' strategic needs tied to these two aspects are:
   - *Overall stability of services*
   - *Different classes of QoS*
   - *Easy and quick access to any service anytime, anywhere, any object*: this new paradigm will be used to be applied in scenarios where quickness of system response is very important (e.g., disaster recovery). In such cases, people need to enjoy services as soon as possible. Today, indeed, the speed of the system response is not always provided, for example because of the "hop by

hop" transmission or the lack of appropriate number of hot spots deployed in the environment;

3. **Security and trustworthiness of distributed communication system**: people demand that personal data transactions are reliable in any future services they use, especially the newest highly personalised services. Indeed, no user will make full use of future services in a considerable way without the opportunity of making a safe transaction. In consequence, security is not only a strategic need but also a crucial requirement in order to reach a good penetration of services in the Autonomic Communication market.
4. **Ubiquity and pervasivity**, taken as the extent of the service range (e.g., in multiple and dynamic contexts, ranging from sensor networks to virtual networks of humans).

4 The Situated Autonomic Communications

After having defined the “Connected Society vision” (please see Chapter 2 “The Connected Society on 2020”) and analysed the socio-economic environment, it’s necessary to focus the attention on technology.

In fact, as today’s society evolves in a Connected Society, it’s becoming necessary to tap into technology to improve our life-styles, our work processes and our interactions with each other. Information technology will move from being something separate and apart from us, to being as much a part of our everyday experience as our clothes and personal belongings [6].

The emerging world is pervasive and strives to integrate people, environment and knowledge giving more importance to services offered by the technology than to the technological evolution itself. In consequence the supporting communication systems, including IP networks, will be service oriented rather than technology oriented and will have to be autonomic, scalable and adaptive, to respond to the social communication needs [6]. Last statement contains the reason why scientific research carried out by CASCADAS project are application-driven rather than technology push. This guideline is followed in socio-economic studies too: in fact, each deduction and open issues to be addressed by CASCADAS arises from people’s strategic needs tied to future communication necessities and not from technical development.

The future information society is expected to stem from new world scenario above mentioned and rely heavily on wireless technology. Its advances in communication are expected to enable a radical new communication paradigm grounded on self-organized information and communication systems. In this new networking environment, the users' mobile devices are the network, and they must cooperatively provide the functionality that is usually provided by the network infrastructure (e.g. routers, switches, servers).

Traditionally a network is viewed as a self-contained system of information channels [7]. Such an information and communication network never exists in isolation, but relates in intricate ways to the environment within which it extends, and which is itself a networks.

The appearance and pervasion of intelligent communication devices will have a great impact on the view to communication networks. Not only the network traffic needs to be managed, but also the topology of the net, now continuously evolving with millions of ad-hoc mobile nodes, is subject to permanent changes [10]. Context and network constitute a new complex entity, whose existence, state, dynamics and evolution cannot be fully understood without taking into account both constituents; its value derives from the synergy between the different constituents.

In such a vision, the new communication paradigms should focus on the development of truly intelligent, self-cognitive networks that no longer act as a means to simply propagate information from one machine to the other, but become a living partner of individual and social activities, and will play a significant role in person- and society-focused communications [7]. These networks will be able to bridge the physical world with the digital world and to promote health safety, productivity and knowledge through communication of the network with the environment (please see Figure 9).

Important research challenges need to be tackled in a dynamic communication environment, such as intelligent service match-making, flexible service provisioning, service creation, development and management, as well as multimodal human access to services under consideration of quality, safety, and security issues.

Four technologies areas will be the keys in creating and supporting these issues [6]:

- sensor networks
- always-on technologies
- data storage and access
- real-time infrastructure

Cognitive sensor networks will be built with the deployment of large numbers of autonomous sensor and actuator nodes that, in a dense network, will be able to acquire localized and situated information of certain metrics gathered from the physical and/or digital environment [2].

Thus, sensor networks will be used to monitor environmental phenomena and identify emerging threats, or they can be used to monitor the functionality of physical/digital/cyber networks and be able to foresee and cope with emerging problems. In other words, the use of sensing and measuring equipment in a physical and/or digital network can increase its self-cognition.

The network elements should have the capability to reconfigure themselves in order to best fit communication intentions, to observe and to react by self-organisation to context changes without explicit user interaction. This way the network itself grows out of the applications and the services that end users want. It is service-driven, situated, autonomously controlled, self-organised, distributed, technology independent and scalable [11].

A discipline has been proposed, namely "Autonomic Communication", to study the individual network element as it is affected by and affects other elements and the often numerous groups to which it belongs, as well as the network in general [7].

Autonomic Communication is a paradigm in which the applications and the services are not ported onto a pre-existing network, but where the network itself grows out of the applications and the services that end users wants. In other words, Autonomic Communication has a broad scope, addressing all aspects of communication by empowering network elements to best fit communication intentions, to observe and to react in future networking and networked business by self-organisation to context changes without explicit user interaction [12].

In general, a Pervasive Autonomic Communication Environment "PACE" (please see Figure 12) is characterised by the individual and collective awareness of the current communication system and additionally by the incremental adaptation to the system dynamics [10].

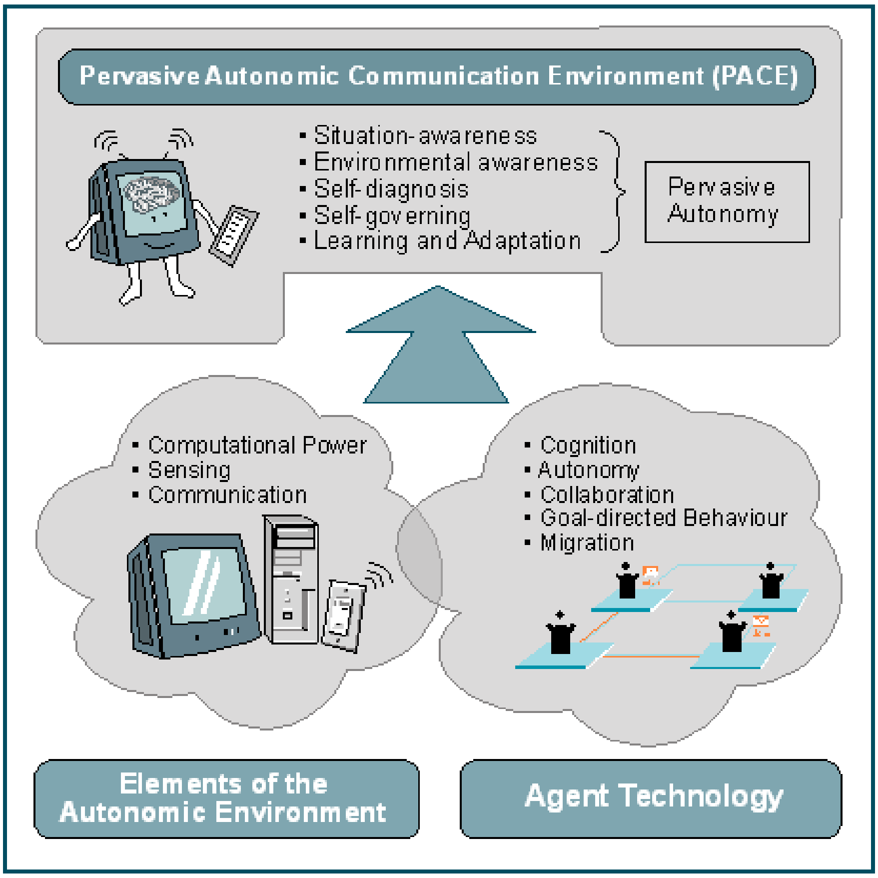


Figure 12 – A Pervasive Autonomic Communication Environment.

The reasoning and decision-making capabilities of each autonomic element are based on goal-driven. All strategies for data acquisition, information assembly, sharing and communication are enhanced by knowledge derivation, representation and dissemination.

Basic types of activities within the PACE are:

- negotiation for resources, access rights, permission grant, etc.
- subscription and notification for events from peer elements
- classification and prioritization of system events
- making a choice to resolve a conflict situation
- forcing human interaction/alarm triggering to resolve and learn from new situations

Within this context, it's arguable that automatic resource discovery is the fundament for the realisation of self-behaving systems with properties such as self-healing, self-configuration and self-optimisation [10]. This is the real innovation of an Autonomic System.

In fact, modern communication systems and theory have been build under the hypothesis of components that are cooperative, standard, and with the same objectives and the same knowledge. Autonomicity introduces in the network the possibility of free choice, and this can make systems selfish, different from one another, and with different goals, and different information [7].

There are several challenges that have to be addressed in order to pave our way from the current technology to the vision of cognitive "sensorized" societies. These challenges include several issues integrating interdisciplinary areas of research, from implementing the nodes to building the intelligence of the network [2]:

- implementation
- cross- or non- layered architectures
- Autonomic Situated Communications
- Distributed and Context Based Applications

All the four sides will be under consideration in the CASCADAS Integrated Project.

The last few years has seen a huge growth in research activity into autonomics, first focusing on Autonomic Computing but now also encompassing Autonomic Communications. However, by covering a wide variety of research topics from context-aware systems, ad hoc networks, policy-based management to multi-agent systems, self-organizing systems, bio-inspired systems, etc., the current explosion in workshops and journal special issues in this area risks presenting an unfocussed vision of autonomics as a research topic [13].

It's now undeniable that autonomic communications and computing have the potential to revolutionize communication and computing fields, and several research efforts are converging on this area. Ubiquitous and self-organized Internet, ad hoc networks, wireless sensor networks are expected to be some of the basic building blocks of pervasive computing environments.

The research in this area will be centred on networking "selfware", a novel approach to perform network control as well as management, middle box communication, service creation and composition of network functionalities, etc. [14]. Specifically for Autonomic Communications, self-healing and self-protection were presented the main challenges, especially for distributed wireless networks.

From a socio-economic point of view, autonomics deal essentially with empowering people's life, noting that the way humans interact with an autonomic system must focus both on the trust humans place in that system, as well as the trust the system has in the human policies, though humans must remain in ultimate control [15]. So, researchers must be able to manage this trust relationship between human users and autonomic system in the context of costs/benefits trade-off. It's interesting to note that many of the costs in introducing autonomic communication would be taken by network element vendors while the benefits are experience by the network operators, so a strategic alliance is needed to guide the direction of autonomic communications.

All aspects tied to CASCADAS business model and competitive analysis for the new Autonomic Communication paradigm will be treated in depth within D6.4 "Organisational Model for new communication paradigms (1st release)" due in M18.

4.1 Findings on Market Conditions

The goal of this paragraph is to map out the positioning of the Situated Autonomic Communications (SAC) on the Hype Cycle for the emerging technologies (business and consumer market). SACs' positioning in the Hype Cycle graph will be analysed and compared year by year and for the duration of the project, in order to monitor CASCADAS technology evolution in relation to other Future and Emerging Technologies (FETs).

The Hype Cycle is Gartner's annual predictions on how a range of technologies will develop over the next 12 months. All technologies are positioned taking into consideration their visibility on the market and life cycle phase. So it highlights the progression of a technology from conception (the first "technology trigger") that starts the process through to peaks of inflated over-expectation, on trough disillusionment and eventually culminating on the "slope of enlightenment" which is usually when companies understand the technology's relevance and role in a market or domain and then can start to make real money [16]. Precisely Gartner's Hype Cycle Model follows five stages [17]:

1. Technology Trigger: a breakthrough, public demonstration, product launch or other event generates significant press and industry interest.
2. Peak of Inflated Expectations: during this phase of over enthusiasm and unrealistic projections, a flurry of well-publicised activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits. The only companies making money are conference organisers and magazine publishers.
3. Trough of disillusionment: because the technology does not live up to its over inflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
4. Slope of Enlightenment: focused experimentation and solid hard work by an increasingly diverse range of organisations lead to a true understanding of the technology's applicability, risks and benefits. Commercial, off-the-shelf methodologies and tools ease the development process.
5. Plateau of Productivity: the real-world benefits of the technology are demonstrated and accepted. Growing numbers of organisations feel comfortable with the reduced levels of risk, and the rapid growth phase of adoption begins.

In the following, Gartner's Hype Cycle for FETs and major technology trends in 2005 and 2006 will be presented.

2005

In 2005, Gartner has assessed the maturity, impact and adoption speed of 44 technologies and technologies trends as shown in Figure 13:

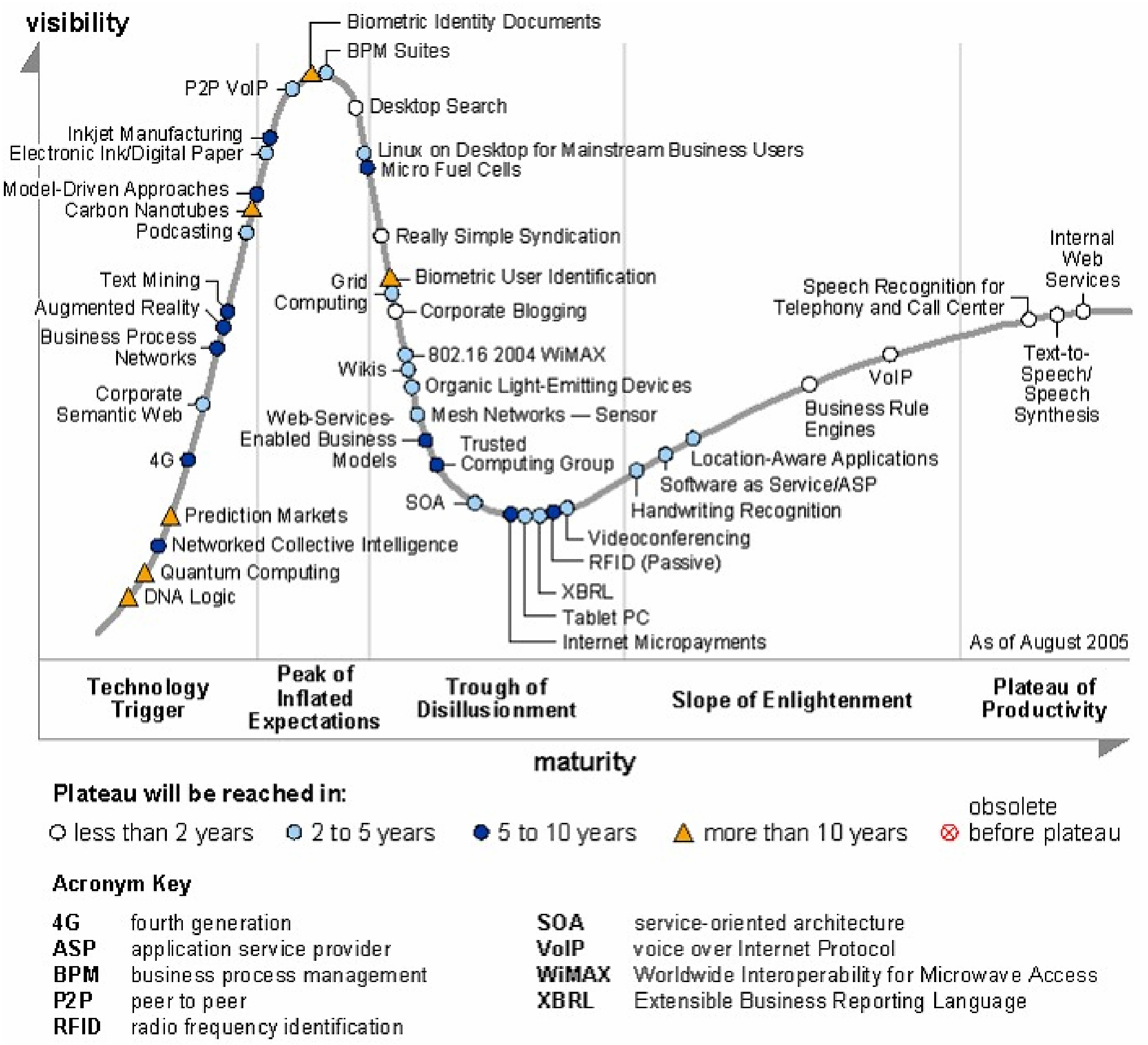


Figure 13 – The 2005 Hype Cycle on Emerging Technologies.

The Emerging Technologies Hype Cycle covers the entire IT spectrum, but three key technology themes are highlighted as being particularly significant, and precisely technologies that will enable the development of Collaboration, Next Generation Architecture and Real World Web. Hereafter a brief focus on these three aspects is presented.

Collaboration

A number of key collaboration technologies designed to improve productivity and utlimately transform business practices are identified in the 2005 Hype Cycle:

- **Podcasting**. It's a method of subscribing to audio broadcast which are then delivered to the PCs or digital media players. It will grow increasingly as the market for content continues to fragment, which will lead to a massive shift in radio, and ultimately TV content delivery. Podcasting will be successful largely because it is an extremely efficient method for delivering audio and spoken-word content to niche audiences and as such could become an important corporate communications tool.
- **Peer to Peer** (P2P) **voice over IP** (VoIP). Vendor-proprietary, peer-to-peer VoIP is another promising emerging area, although security concerns still need to be addressed. Consumer services like Skype will make inroads into the business market and predict that it will be important for collaborative and multimedia applications as well as low-cost communications.
- **Desktop Search**. It is another important area in emerging technology, but, even with Google, Microsoft and Yahoo are competing for customer attention and adding to the hype, customers are not exhibiting much interest in buying solutions. Even so desktop search has become a standard feature in Microsoft Longhorn on 2006 and should reduce content recreation, increase content reuse whilst raising productivity.
- **Really Simple Sydication** (RSS). Other promising area include RSS, a simple data format that enables web sites to inform subscribers of new content and distribute content more efficiently by bypassing the browser via RSS reader software. RSS is widely used to sindacate weblog content but its corporate use is only starting to be tapped for activities such as corporate messaging.
- **Corporate Blogging**. It's at a similar stage having reached the peak of hype in 2004 although mainstream firms have not yet got involved. This technology involves the use of online personal journals by corporate employess, either individually or in a group, to further company goals. Its impact will be on projecting corporate marketing messages primarily and secondarily in competitive intelligence, customer support and recruiting.
- **Wikis**. A simple, text-based collaborative system for managing hyperlinked collections of web pages: it usually enables users to change pages or comments created by other users. Wikis are becoming available from commercial vendors. However, they are widely used as collaborative, distributed authoring systems for authoring systems for online communities, especially those using open-source projects.

Next Generation Architecture

It's recognised that Next Generation Architecture could constitute the third big era in the IT industry's history, the first having been the hardware era and the second belonging to software. These emerging technologies will form key pillars of the new architecture:

- **Service Oriented Architecture** (SOA). SOA uses interactive business components designed to be meaningful, usable and useful across application or enterpise boundaries. Despite the current disillusionment with SOA, a support for growing and maturing is expected for this technology within 10 years, although many changes in user and vendor organisations and technologies are required before SOA reaches its full potential. However, in the long term, Gartner believes that SOA has the potential to be transformational to a business.

- **Web Services-Enabled Business Models**. These productivity-boosting models represent a new approach to doing business among enterprises and consumers that would not have been possible without the benefits of web-services. However enterprises are still wrestling with what web services will do, Web Services-Enabled Business Models will have to wait for more mature standards and clearer examples.
- **Extensible Business Reporting Language** (XBRL). This is an Extensible-Markup-Language-defined standard for analysing, exchanging and reporting financial information. XBRL helps organisations meet multiple financial reporting needs through a single instance of financial data. It also improves the timeliness and accuracy of financial and regulatory reporting, validation and distribution. Financial accountinf software vendors are already incorporating XBRL but regulatory and transparency pressures increase the singinificance and likelihood of XBRL adoption.
- **Business Process Platforms** (BPP). BPP provides business process flexibility and adaptability. They use SOA design principles and are metadata and model-driven. Business Process Platforms should enable business process fusion and move innovation from business application vendors to BPP ecosystems.

Real World Web

Adding networking, sensing and processing to real-world objects and places is creating a "Real-World-Web" of information that will enhance business and personal decision-making. Three technologies from 2005 Hype Cycle must be highlighted as help to make this vision a reality:

- **Location-aware applications**. These are mobile enterprise applications that exploit the geographical position of a mobile worker or an asset, mainly through satellite positioning technologies like Global Positioning System (GPS) ot through location technologies in the cellular network and mobile devices. Mobile workers will use either a PDA or smartphone, connected via Bluetooth to an external GPS receiver, or stand-alone positioning wireless device. Real-world examples include fleet management applications with mapping navigation and routing functionalities, government inspections and integration with geographic information system applications.
- **Radio Frequency Identification (Passive)**. Otherwise known as RFID, passive Radio Frequency Identification has been somewhat over hyped in recent years although vehicle-based are strong. It involved the tagging of very small chips to arbitrary types of objects. These chips transform the energy of radio signals into electricity then respond by sending back informatio that is stored on the chip. The most conducive environments for passive RFID are chaotic or unstrucutured business processes where RFID's abiitly to read without a direct line or sight gives it the edge over traditional bar-coding methods. These mignth include such

diverse activities as manufacturing, healthcare, logistics, animal tracking and laudry automation.

- **Sensor Mesh Networks**. Mesh Networks are ad hoc networks formed by dynamic meshes of peer nodes, each of which includes simple networking, computing and sensing capabilities. Potential impact areas include military sensing, product tagging and building automation.

Although the specific technologies change over the years, the Hype Cycle’s underlying message endures. For that reason, skipping from 2005 year analysis to 2006 one, it’s not relevant to focus the attention on a specific technology trend, but on trends of a technologies group, being consequence of future customers’ specific behaviours.

2006

Gartner’s 2006 Emerging Technologies Hype Cycle assesses the maturity, impact and adoption speed of 36 key technologies and trends during next ten years.

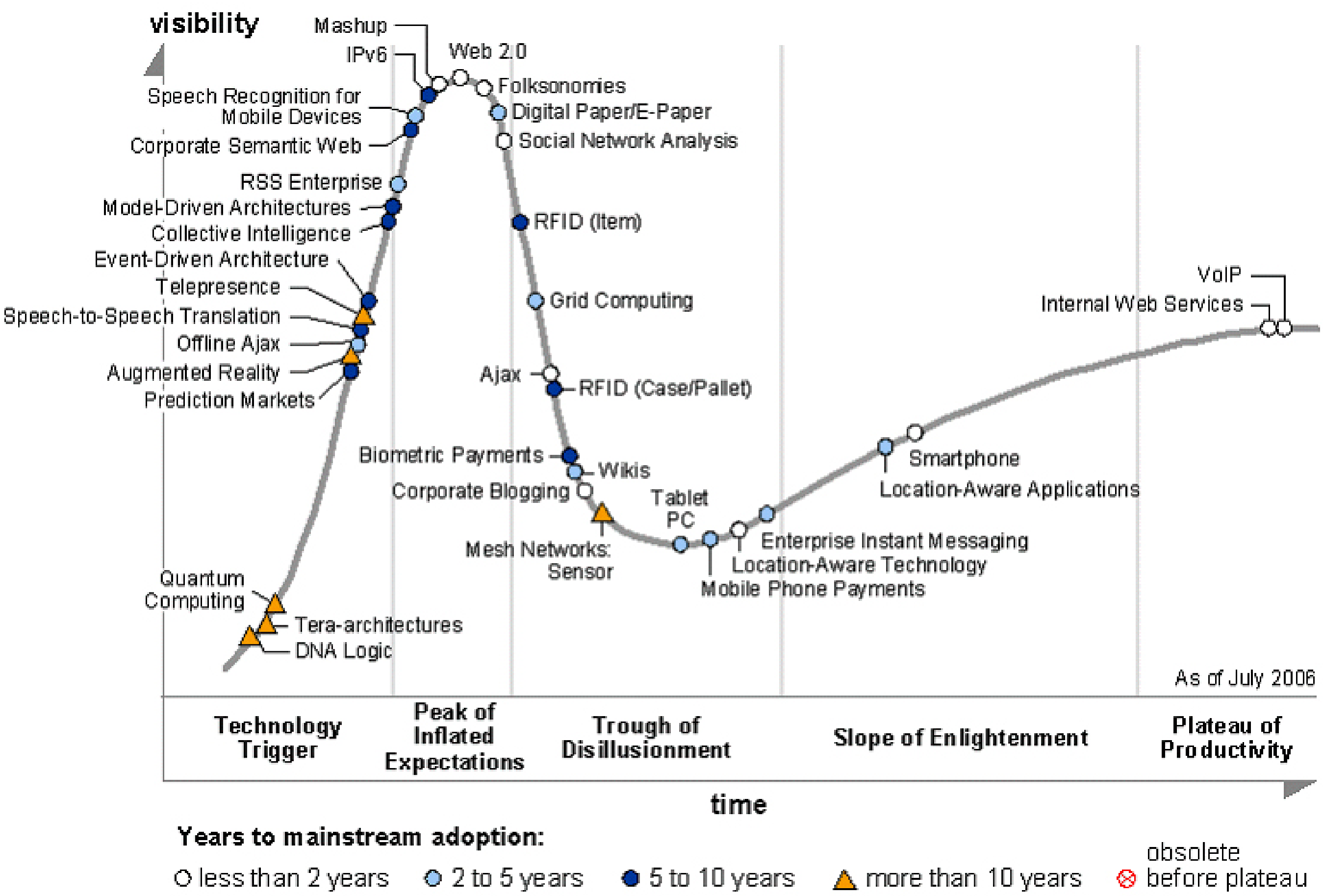


Figure 14 – Gartner’s Hype Cycle for Emerging Technologies in 2006.

2006 Hype Cycle’s version highlights three technology themes: Web 2.0 technologies, location-aware technologies (in the Real World Web field) and application architecture [18]. Moreover it acknowledges the growing consumerisation of IT. In fact, many of the Web 2.0 phenomena have already reshaped the Web in the consumer world. Companies need to establish how to incorporate comsumer technologies in a secure and effective manner for employee’s productivity, and also how to transform them into business value for the enterprise.

Web 2.0

Web 2.0 represents a broad collection of recent trends in Internet technologies and business models. Particular focus has been given to user-created content, lightweight technology, service-based access and shared revenue models. Technologies rated as having transformational, high or moderate impact include:

- **Social Network Analysis** (SNA). SNA is the use of information and knowledge from many people and their personal networks. It involves collecting massive amounts of data from multiple sources, analysing the data to identify relationships and mining it for new information. Furthermore, it can sussessfully impact a business by being used to identify target markets, create successful project teams and indentify unvoiced conclusions. This technology is evaluated as high impact, that is enabling new ways of performing vertical applications and resulting in significantly increased revenue or cost savings for an enterprise, and capable of reaching maturity in less than two years.
- **Ajax.** It is a collection of techniques that web developers use to deliver an enhanced, more-responsive user experience in the confines of a modern browser (for example, recent version of Internet Explorer, Firefox, Mozilla, Safari or Opera). A narrow-scope use of Ajax can have a limited impact in terms of making a difficult-to-use Web application somewhat less difficult. However, even this limited is worth it, and users will appreciate incremental improvements in the usability of applications. High levels of impact in the business value can be achieved when the development process encompasses innvoations in usability and reliance on complementary server-side processing (as is done in Google Maps). This technology is also reated as high impact and capable of reaching the maturity in lass than two years.
- **Collective intelligence**. It is an approach to producing intellectual content (such as code, documents, indexing and decisions) that results from individuals working together with no centralised authority. This is seen as a more cost-efficint way of producing content, metadata, software and certain services. Collective intelligence is rated as transformational, that is enabling new ways of doing business across industries that will result in major shifts in industry dinamics, and is expected to reach the mainstream adoptio in five to ten years.
- **Mashup**. A “mashup” is a lightweight tactical integration of multi-sourced applications or content into a single offering. Because mashups leverage data and services from public Web sites and web applications, they’re lightweight in implementation and built with a minimal amount of code. Their primary business benefit is that they can quickly meet tactical needs with reduced development

costs and improved user satisfaction. Mashup is rated as moderate on the Hype Cycle, that is providing incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise, but is expected to hit mainstream adoption in less than two years.

Real World Web

Increasingly, real-world objects will not only contain local processing capabilities – due to the failing size and cost of microprocessors – but they will also be able to interact with their surroundings through sensing and networking capabilities. The emergence of this Real World Web will bring the power of the Web, which today is perceived as a “separate” virtual place, to the users’ point of need of information or transaction. Compared to 2005 Hype Cycle, a new technolgoy has been added to the above list as high impact rating:

- **Location-aware technologies**. It is the use of GPS, assisted GPS (A-GPS), Enhanced Observed Time Difference (EOTD), enhanced GPS (E-GPS), and other technologies in the cellular netowrk and handset to locate a mobile user. Users should evaluate the potential benefits to their business processes of location-enalbed products such as personal navigation devices (for example, TomTom or Garmin) or Bluetooth-enabled GPS receivers, as well as WLAN location equipment that may help automate complex processes, such as logistics and maintenance. Whereas the market sees consolidation around a reduced number of high-accuracy technologies, the location service ecosystem will benefit from a number of standardised application interfaces to deploy location services and applications for a wide range of wireless devices.

Concerning above listed technologies in the Real World Web segment, it’s possible to add 2006 trends:

- **Location-aware applications**. An increasing number of organisations have deployed location-aware mobile business applications, mostly based on GPS-enabled devices, to support queue business processes and activities, such as field force management, fleet management, logistics ad good transportation. The market is in an early adoption phase, and Europe is slightly ahead of the United States, due to the higher maturity of mobile networks, their availability and standardisation.
- **Sensor Mesh Networks**. Technologically aggressive organisations looking for low-cost sensing and robust self-organising networks with small data transmission volumes should explore sensor networking. The market is still immature and fragmented and there are few standards, so suppliers will evolve and equipment could become obsolete relatively rapidly. Therefore, this area should be seen as a tactical investment, as mainstream adoption is not expected for more than ten years.

Applications Architecture

The software infrastructure that provides the foundation for modern business applications continues to mirror business requirements more directly. The modularity and agility offered by service oriented architecture at the technology level and business process management at the business level will continue to evolve through high impact shifts such as model-driven and event-driven architectures, and corporate semantic Web. Technologies rated as having particularly high impact include:

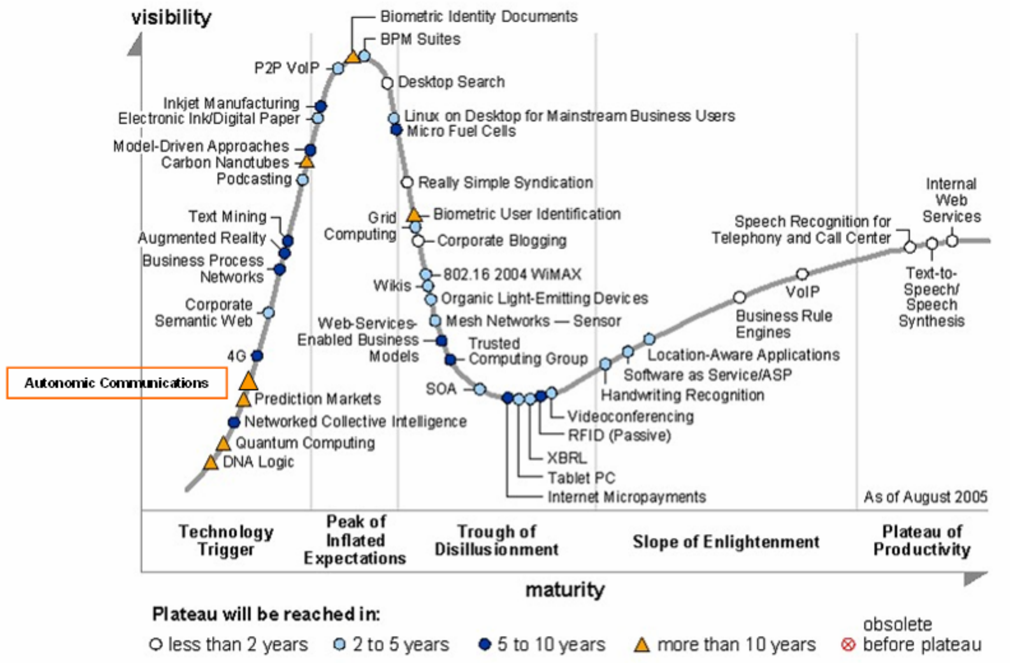
- **Event-driven Architecture** (EDA). It is an architecural style for distributed applications, in which certain discrete functions are packaged into modular, encapsulated, shareable components, some of which are triggered by the arrival of one or more event objects. Event objects may be generated directly by an application, or they may be generated by an adapter or agent that operates non-invasively. EDA has an impact on every industry. Although mainstream adoptionn of all forms of EDA is till five to ten years away, complex-event processing EDA is now being used in financial trading, energy trading, supply chain, homeland security, telecommunications, logistics and sensor networks, such as those based on RFID.
- **Corporate Semantic Web**. It applies sematic Web technologies, semantic markup languages (for example, Resource Description Framework, Web Ontology Language and topic maps), to corporate Web content. Although mainstream adoption is still five to ten years away, many corporate IT areas are starting to engage in semantic Web technologies. Early adopters are in the areas of enterprise information integration, content management, life sciences and government. Corporate Semantic Web will reduce costs to improve the quality of content management, information access, system interoperability and data quality.

Making a combined analysis of trends related to 2005 and 2006 years, it's possible to notice that some of technological trends can be considered as point of departure for future Connected Society vision based on Situated and Autonomic Communications. For example:

- the big push to realize a Real World Web in which environment changes are measured and objects/people localisation is usual;
- the birth of users' communities sharing knowledge and information and interacting each other;
- the formation of Internet business models in which users will directly create service contents (beyond Internet phase);
- the development of information architectures and applications favouring the flexibility and personalisation of services offered to customers.

In consequence it's affirmable that current estimation about technological trends in next ten years supports the Connected Society vision based on Situated and Autonomic Communications (SACs). Hence, a future **technological maturity in 2015-2020** is supposable: the autonomic components will be deployed on the market, and their integration and all workings logics related to the components will be ready too. So, SACs will be likely to reach the Hype Cycle plateau of productivity within next 15 years (please see Figure 15). Currently SACs are likely to be positioned in a technology trigger phase (considering both 2005 and 2006 curves above presented), that is their visibility on the market is limited to the research field.

2005



2006

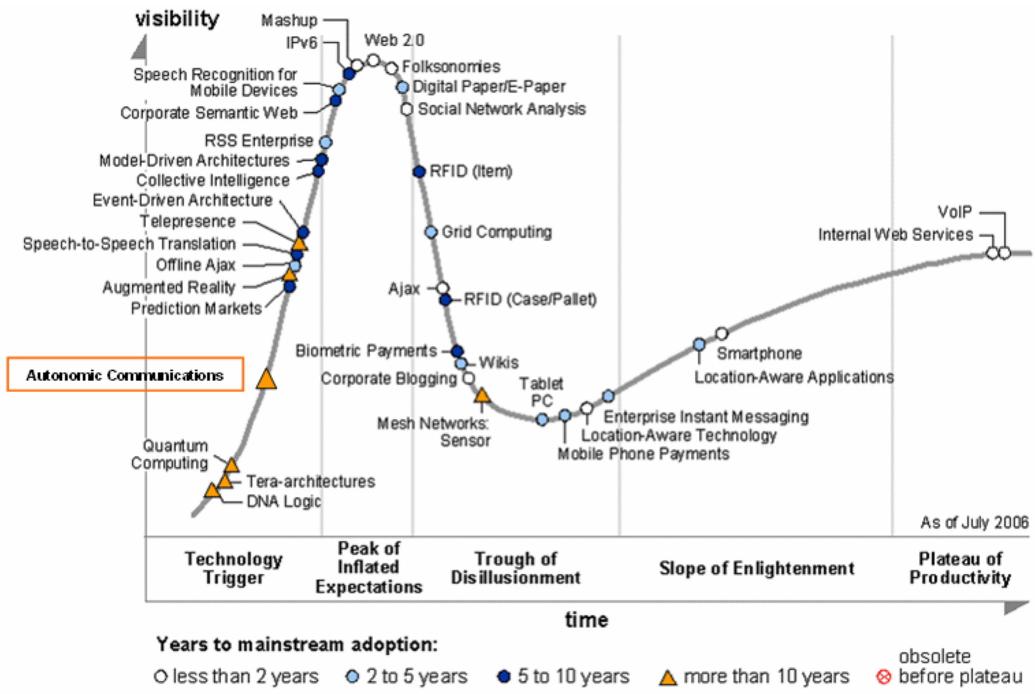


Figure 15 – Autonomic Communications positioning in the Hype Cycle for Emerging Technologies.

Although supposing that in 2015-2020 the technological maturity will be so high operators will be able to provide situated autonomic services, it has to be taken into consideration that services adoption by customers is strictly linked to qualitative level of their needs (please see Figure 11). So, a second hypothesis concerns **situated autonomic services adoption**, that can be of **high or medium-low level** depending on different parameters, such as economic conditions or age. Future studies (Organisational and Assessment ones) will analyse in depth different cases of SACs' services adoption, making a market segmentation to find CASCADAS target market and an estimate of possible revenues within each segment.

4.2 The Strategic Drivers

The market analysis on Autonomic Communications future trends (developed in Section 4.1 "Findings on market conditions") has shown a FETs' market trend that favour the Connected Society creation and hence the satisfaction of people's and future customers' strategic needs. The realization of such scenario is possible only if technology providers have an advantage in developing and putting on the market new technologies such as SACs. Thus, it's important to analyse what could be future strategic drivers pushing providers to invest in Situated and Autonomic Communications market.

Current situation in the telecommunication market shows that operators have seen their own Average Rate per User (ARPU) come down in many European countries, as well as the growth rate of the subscribers' number for mobile services (notwithstanding the absolute value continues to growth in 2006 too) [19]. The ARPU measures the average monthly revenue generated for each customer unit, such as cellular phone or pager, that a carrier has in operation [20]. These values are really important because one of the most pushing motivations for an operator to search new services has to be founded in the need of holding the ARPU high [21] and constantly improving subscribers' number. For example in the past , in Japan, every week there was 100.000 new subscribers to i.mode service, that exceeded 5 million of users in March 2000. The strategies pursued and the implementation speed allowed to swing from an ARPU of $75 a month to a value of $98 a month: the value increase was due to voice traffic (50%), data (30%), subscription fee (12%) and contents (only 8%).

So, operators need to find a way to reverse this trend. In the medium term the right way seems to be the mobile data and mobile Internet. Moreover, smaller carriers can play an important role, though bigger operators tend to more and more enlarge their sphere of activity from a geographic point of view. In fact, the personalization of services will be fundamental in immediate future and most of the operators haven't got to this day an accurate profile of their customers. Or else, if it exists, it doesn't necessarily contain useful information to give to the user the service he/she needs in the moment and the way in which he/she needs it. Smaller operators can put into action this necessity and find a new competitive niche, being capable of understanding in an optimal way their customers and following them with contents they need. Thus, having a firm financial base is obviously an advantage, but applications that will drive the market can come both from a little operator and a global player. A more detailed analysis of market players, economic relationships among them and market dynamics will be picked up in D6.4 "Organisational Model for new communication paradigms (1^{st} release)" due in Month 18.

The Service Provider' perspective is and will be focused on the satisfaction of strategic drivers tied to:

1. generating new revenues, providing new communication and content services or revisiting the old ones;
2. optimizing costs, reducing Capex and Opex through the enhancement of Network and Service infrastructures.

The Autonomic technology can help operators in reaching both objectives. In fact, SACs can:

- facilitate the offer of new services based on the Autonomic Technology or allow the entrance in new markets ⇒ possible new revenues
- refresh existing services taking advantage of SACs' technological properties in order to create services meeting better users' needs (e.g., personalization of services depending on user's habits) ⇒ possible new revenues
- make more effective the technological infrastructure through a new design of network and service layers in the architecture (further information are available in Section 5.2) ⇒ possible lower costs
- overcoming current technology bottleneck in the network/service layer of the architecture caused by high traffic ⇒ possible lower costs

If the strategic drivers above mentioned drove operators towards the satisfaction of customers' strategic needs (please see Chapter 3 "The Strategic Needs"), then the Autonomic services' supply will be likely to be reality (please see Figure 16). On the contrary, one of two market sides wil not have sufficient convenience to invest in the Autonomic services (provider-side) or be interested in them (user-side).

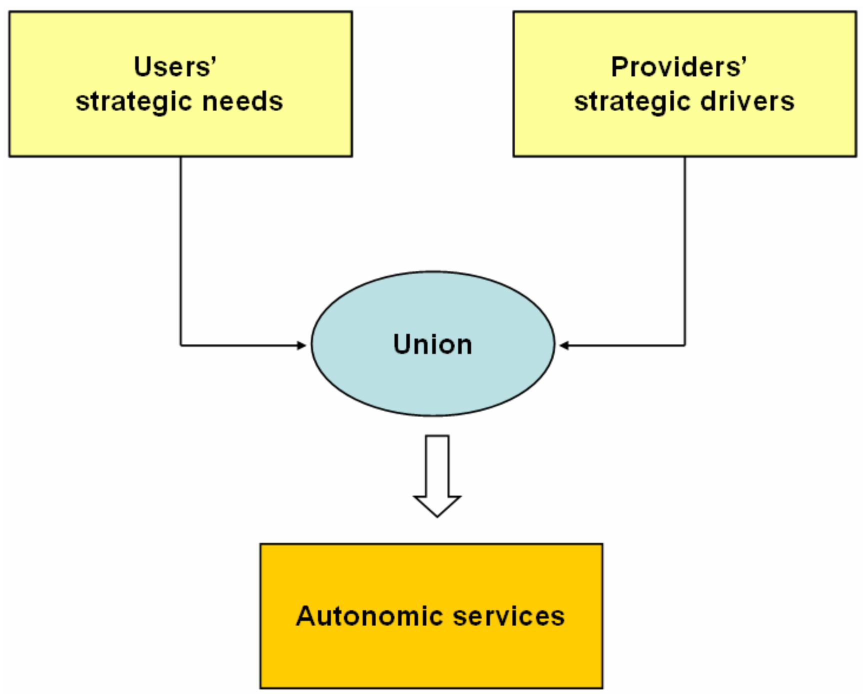


Figure 16 – The future presence of Autonomic services in the market.

CASCADAS goal will hence be outlining a technological vision on SACs that will satisfy Society needs (users’ and providers’ ones) and allow the implementation of situated autonomic services being the mirror of both users’ and providers’ trends. Further information about CASCADAS vision and SACs’ services are available respectively in Sections 5.1 “Description of CASCADAS vision” and 5.3 “Enabled and Desirable Services”.

5 CASCADAS Vision on Situated Autonomic Communications

5.1 Description of CASCADAS Vision

The CASCADAS vision is of a large number of autonomous elements (ACEs) which have certain generic abilities allowing them to exert their autonomy. These include gathering information, sending information, and reacting to information about other elements.

Each ACE also has its own individual abilities which we imagine will usually allow it to perform all or part of an information processing task.

In other words ACEs all behave autonomously and each has its own job or special skill.

The generic autonomous behaviours have been described as:

- Situation Awareness – the ability to gather information about the current environment and act on it
- Semantic Self-organization – the ability to gather information about the demand for information processing impinging on this ACE, the special abilities of this ACE and the special abilities of 'nearby' ACEs and act on it
- Self-similarity – an ACE may itself contain other ACEs, whereupon its special abilities are the union of those of all those contained ACEs. An ACE may be contained within another ACE. When interacting with other ACEs the 'size' of an ACE (whether it contains many other ACEs for example or is itself an 'atomic' lone ACE) is immaterial – information passing, logic performed and action taken are performed the same across all scales.

These apparently rather abstract behaviours have highly practical implications for the performance of systems composed of such ACEs. They enable adaptive responses to both the nature of demand and level of demand placed on the system. They also allow the system of ACEs to allow for, and even exploit, whatever networking constraints may be placed on the system – for example the concept of network 'distance' (whether this be understood in logical, addressing terms, physical networking constraints or monetary cost of certain connections relative to others).

To become a bit more concrete in what we're describing here, even though we lose some generality, consider a system which, through design or adaptation, is well set up to offer a moderately complex service 'XYZ' in a certain part of the network. As demand changes, the system can respond in a number of ways:

- Scenario: Demand for 'XYZ' persists in the network but is now originating in a more 'distant' part of the network.

  Adaptation: 'XYZ' can migrate to be closer to the demand. It may achieve this either as a single ACE comprising three atomic ACEs (X, Y and Z as you would guess!), or as three separate atomic ACEs, or as a single ACE which contains the full service XYZ as its own special ability.

- Scenario: Demand for 'XYZ' falls but demand for 'X' increases

Adaptation: Atomic ACEs offering X will be able to colonise at the expense of the pre-existing 'XYZ' service. This may come about by migration in of ACEs from other parts of the network or by the break-up of an 'XYZ' super-ACE into its components (if that is indeed how the original demand was being met)

- Scenario: Demand for 'XYZ' rises.

  Adaptation: The original 'XYZ' ACE can 'grow' (consume more local resources to meet growing demand) or 'spread' (send duplicates to nearby network location where resources may be available). Atomic X, Y or Z ACEs and other XYZ ACEs (whether they are atomic or contain X, Y and Z ACEs within them) can migrate in from other parts of the network.

Thus the CASCADAS vision is of a system whose responsiveness to the demands placed on it is completely flexible, limited only by the granularity at which the special abilities of atomic ACEs are specified and the hard constraints of the underlying network. Now, having understood in detail the current and likely future societal demands on ICT, and had a flavour of the core technical aims of CASCADAS, we are in a position to look for concrete ways in which CASCADAS might respond to Society's demands.

5.2 The Reference Scenarios

CASCADAS vision will be developed taking into consideration specific scenarios, both from application viewpoint and infrastructural ones. In fact, this is the only way to give an application-driven mark to scientific research in the project.

In the following reference **application scenarios** will be listed without a detailed description (because already provided in D6.1 part A "Description of application scenarios and of the services to be provided" or other submitted deliverables), but they are only grouped in two macro-clusters:

1. Services for pervasive applications:
    - Smart Environments Supporting Independent Living
    - Behavioural Pervasive Content Sharing
2. Non-pervasive, communication-intensive applications:
    - Distributed Auctions

This distinction is interesting to carry out socio-economic research because the needs pushing people to use (or not) a certain application could change depending on the kinds of applications themselves. In this case, depending on pervasivity or non-pervasivity of the application. Similarly services in greatest demand vary depending on the application scenario taken into consideration. In consequence, this distinction will be used in next Section 5.3 "Enabled and Desirable Services" and in organisational, assessment and impact studies, if necessary.

Concerning **infrastructural scenario**, instead, we need to notice that the autonomic components framework under development in CASCADAS could be adopted and exploit innovative solutions for Service Layers to create advantages for both Customers and Operators/Providers in the evolutionary direction of Connected Society. Specifically a Service Layer is normally defined as a set of platforms, functionalities, systems and data for the creation and execution of services; current solutions includes also related interfaces towards a control layer and systems for management and provisioning (please see Figure below).

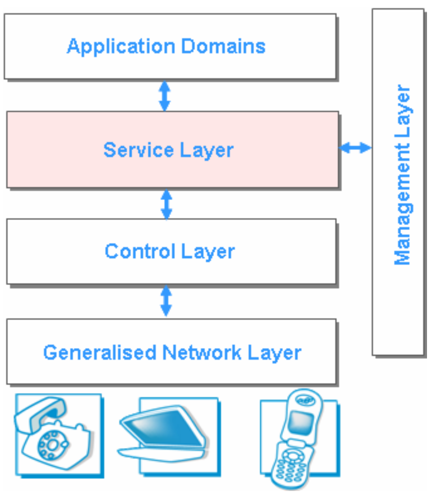


Figure 17 – The Service Layer.

According to an Autonomic vision, services could be flexibly and easily executed and provided starting from highly distributed Telco-ICT enablers data and information (for example, presence, messaging, location). These data and information could also be available even outside the context of a single Operator, according to proper business models based on cooperation.

Key requirements characterizing an Autonomic Service Layer are:

- High scalability
  - Optimization due to parallel throughput-oriented workload instead of peak response time
- Effective management of huge "data and information"
  - Opening to highly distributed environments and context
- Self-managing capabilities
  - hiding/reducing complexities to human operators
  - reducing human errors
- High overall availability
  - low-cost Hardware smart Software

Further information about the Autonomic Service Layer is available in D8.2 "CASCADAS White Paper".
The above architectural scenario may offer some advantages for future customers and service providers.
From the Customer viewpoint such a Service Layer may offer:

- "Simpler and better approach" to service
  - Customization of services (Customers' profile, context, …)
  - Services meeting better(or even anticipating) Customers' needs
  - Pervasiveness of contents and communications service

From the Service Provider viewpoint such a Service Layer may offer:

- Cost Optimization
  - Enabling an horizontal TLC-IT integration
  - Using low-cost H/W and smart autonomic S/W
  - Adopting self-management (self-configuration, self-healing, self-optimization, etc.)
- Generating New Revenues
  - Picking the opportunities offered by some ongoing trends (and the future related evolutions) of the web (e.g. Web2.0, Web3.0, etc.) with more flexible and open solution for executing services
  - Enabling new business models based on sharing resources, service enabler (TLC and IT) and data highly distributed

In conclusion, the autonomic approach to evolve the network has the following objectives:

- increasing the efficiency
- improving the network management
- increasing the flexibility

showing that CASCADAS vision can satisfy what users and providers will expect from an situated and autonomic system.

It's suitable to compare the strategic communication needs (SAC Users side) with the strategic drives (SAC Providers side) to justify scenarios' choice:

- *strategic communication needs*: the list of the strategic needs has already been showed in Chapter 3, here it's showed that they are satisfied within the selected application and infrastructural scenarios. In next Table 3 a strategic needs' ranking is made, using an evaluation method from one to three stars. Higher is the stars' number and higher is the strategic need's satisfaction level in the related scenario.

	Application Scenarios		**Infrastructural Scenario**
	Services for pervasive Applications	**Non-pervasive communication-intensive applications**	**Evolutionary architectural enablers**
Situation-aware services :	******	******	******
Local reaction on context changes	***	***	**
Freedom of movement	**	*	*
Personalization of services	**	*	**
Simplification of human life	***	***	***
Quality of Services:	******	******	******
Overall stability	**	**	**
Different classes of QoS	*	**	*
Easy and quick access	**	***	***
Security and trustworthiness	*******	*******	*******
Ubiquity and pervasivity	*******	*****	******

Table 3 – Satisfaction of strategic needs in application and enabler scenarios.

- *strategic drivers*: as already stated, the enabler scenario increase provider revenues (through the creation and provision of communication and content services) and decrease network capex and opex (through the enhancement of network and service infrastructures). Hence, the infrastructural scenario enable the offer of new services based on SAC or old services but run in a more efficient way (network side) and better tailored to customers requests within selected application scenarios.

5.3 Enabled and Desirable Services

Looking from today into the future, one can imagine only a small set of services and applications such an infrastructure with an Autonomic Service Layer will enable [22]. Although it is always difficult to anticipate the ways the consumers will appropriate future technologies, a general opinion is that the move towards electronic distribution of content will be ubiquitous in the years 2015-2020. This will imply a radical change of the delivery paradigm during that period, which will imply strong technology evolutions (decrease of physical media, increase of network throughput, severe requirements on security, etc.), but also the development of new service concepts which will make use of network capabilities in terms of ubiquity, storage and interactivity.

The **methodology** followed to outline future Situated Autonomic services starts from the analysis of the **demand** to understand market **trends and development**. Then, the demand trend allows us to deduct future **services enabled by providers and desired by customers** depending on their services' adoption level (high or medium-low adoption). In fact, as for strategic needs, the economic situation will affect users' service adoption causing different interest towards SACs' services (please see next Figure):

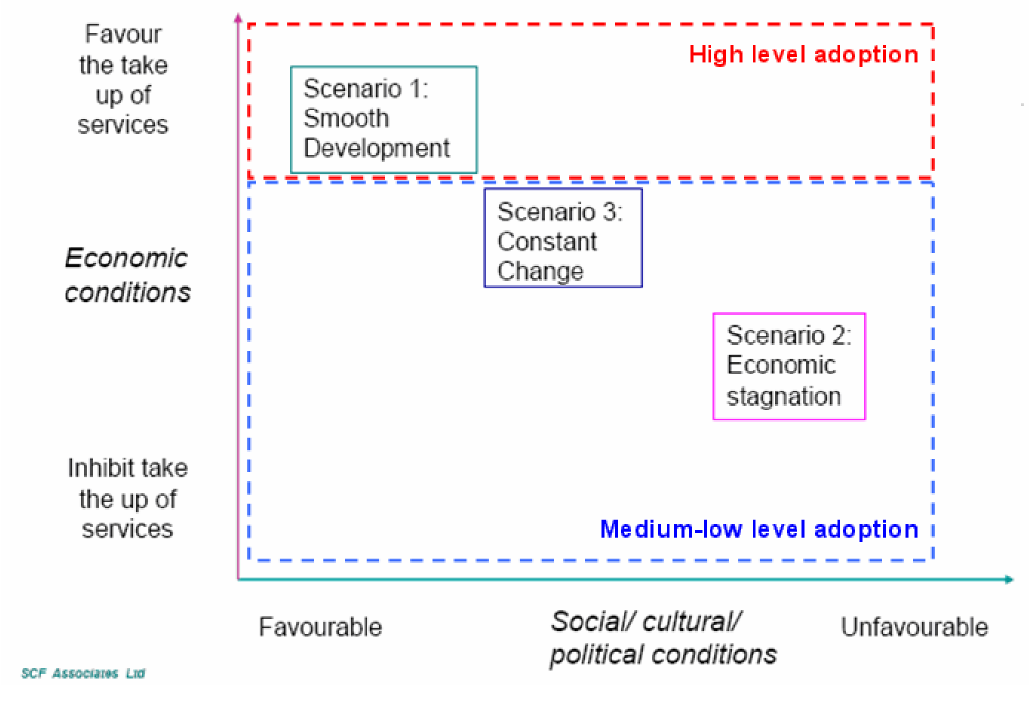


Figure 18 - High and medium-low adoption of SACs' services against economic conditions.

In consequence, all enabled services provided by telecom operators could be differently adopted by users depending on future economic scenario. At the end of this paragraph, the differences in the services' adoption will be presented.

The first goal of this section is to take a look at the demand along the lines of customer appeal. Following the work done by Sawhney [23] on the progressive replacement of technologies by those with higher accessibility, and combining this with a measure of utility in terms of the consumer's values together with pricing of services against disposable income, it's possible to examine which technologies will be likely to fail and which to succeed. In the three dimensions of these parameters, the optimal space, where demand is high, is indicated as illustrated below [1]:

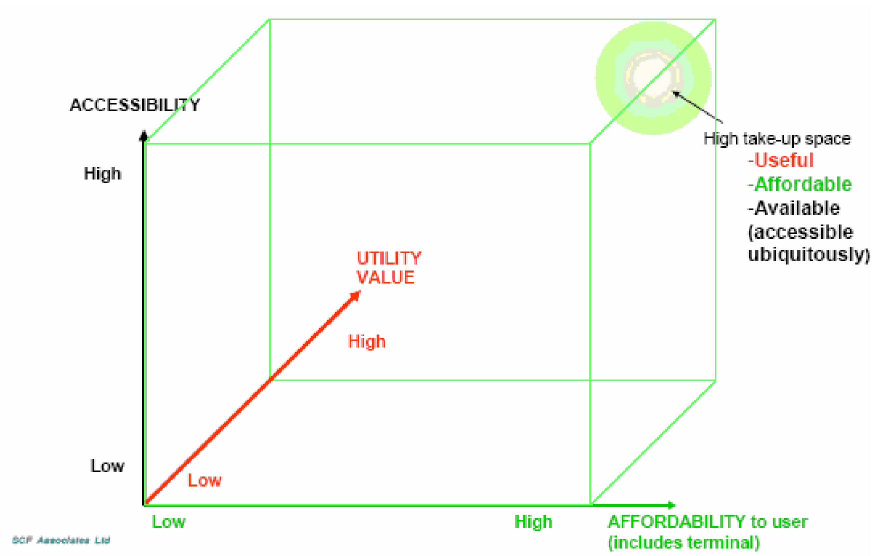


Figure 19 – The potential take-up of services.

Following this three-dimensional space, we can map successes and failures of current and past years technologies relatively to a range of services offered publicly:

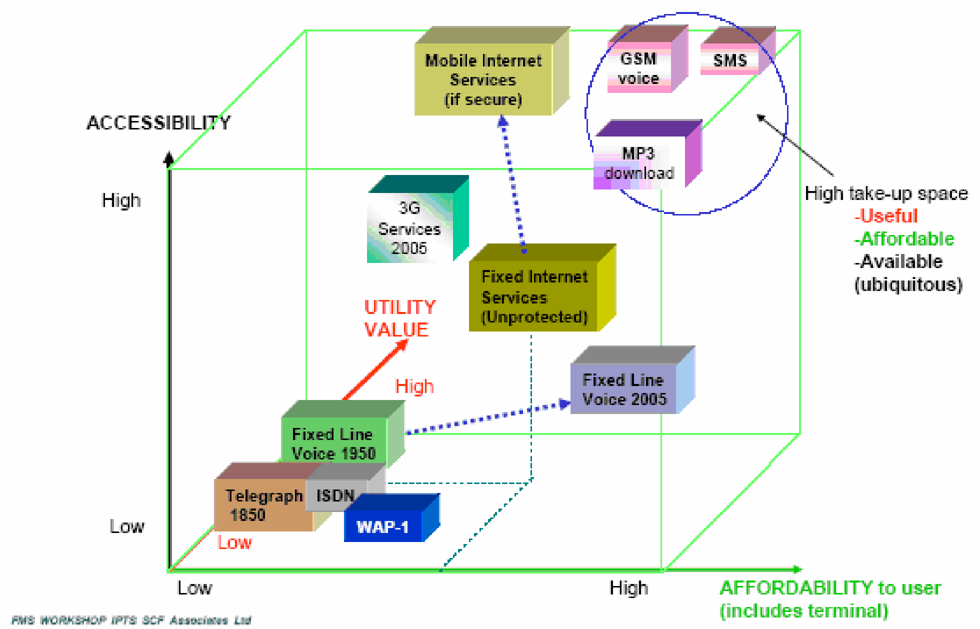


Figure 20 – Mapping the potential of services to succeed.

In the future the locus of the driving forces in the telecommunications (wireless and mobile) market are likely to change, in part because of a qualitative change in the way communication services will be used. In fact, the context for analysis will change to be set by the explosion of usage in developing countries, principally Asia. We can see the potential take-up to 2020 building a market of perhaps 5 billion users, with the most sophisticated devices ever seen in the consumer world in the hands of billions. An estimate of mobile communication services' users is shown below:

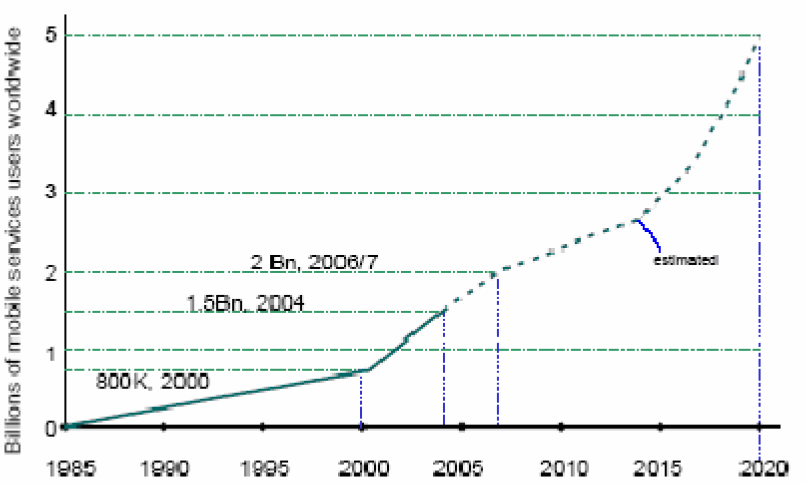


Figure 21 – The global user population growth.

This new users' population will have different habits and the demand trend will be affected by their behaviours. In general, the **demand trend against price** has been studied for some time: here we consider a demand following the **Dupuit Curve** (1840) where the usage of a service is fundamentally dictated by cost (please see Figure 22). More recent analyses suggests that demand can go non-linear at some price point [1], where the user sees a "perception of freeness" – that is the price point where the user views the service as free, not inhibited by costs. Thus demand can take off very suddenly. This is the phenomenon that has driven take-up in 2G and SMS in particular. The pattern is illustrated below:

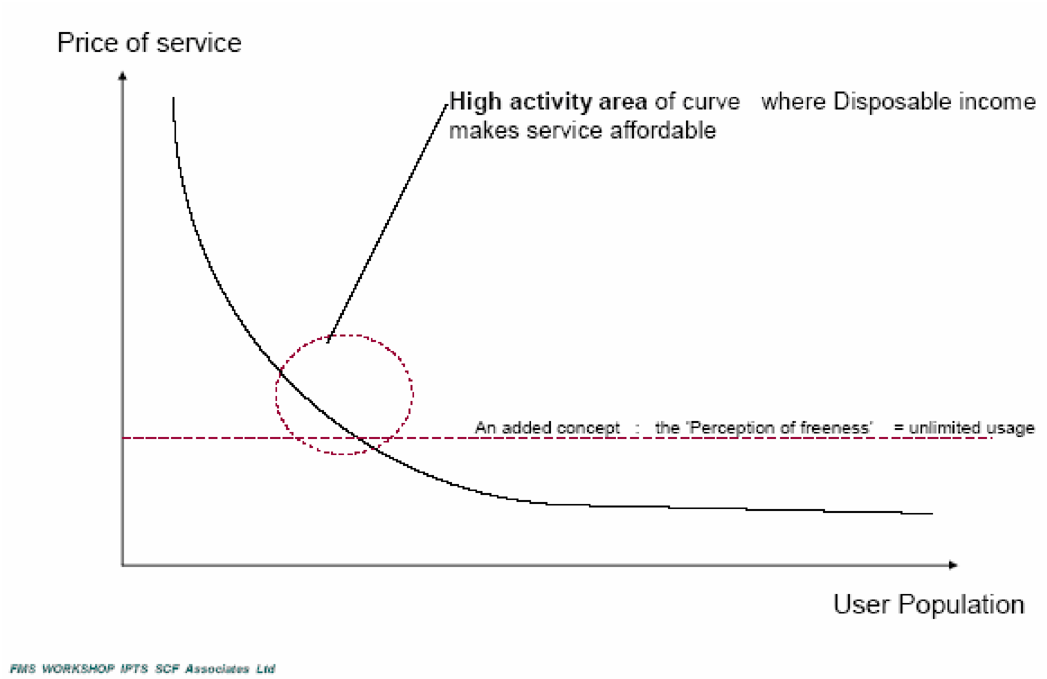


Figure 22 – The relationship between demand and price.

Consequently, we see demand as set by price point as the key forecasting parameter. If the price point is correctly combined with “product”, five developments could also drive up demand [1]:

1. The evolution of whole new segments of demand for communication services, specifically *machine to machine*, may become a major segment of the business market.
2. The move towards lifestyle services using wireless communications – for instance m-commerce and m-banking. But many such lifestyle services for personal organisation and convenience will only become major products if secure communications can provide a *trusted transaction* environment for the consumer.
3. The trend for the handset to be used for a range of entertainment media, some of which may be the major users of bandwidth among consumer services. Also, the segment may move towards *peer to peer* content exchange, in which the consumer originates pictures, text/blogs, music, etc, as much as content sales by third party content providers to customers.
4. Arrival of sophisticated positioning-related services, such that *location-enabled applications* take off for both business and consumer segments.
5. Transformation of the business processes of whole industry segments – for instance health – by the availability of *ubiquitous communications at low cost*.

The demand-side of the market will move from a communications based industry to one more driven by whole range of high level sophisticated applications, including machine to machine (e.g., telemetry sensors) as much as by human interactions [1]. The business of supplying mobile and wireless services of all kinds will move progressively towards applications services with content provision for lifestyle, business and entertainment services and away from simple carriage of bit streams for communications.

Furthermore, the convergence which is currently starting to happen between various industrial sectors such as telecommunications, broadcasting, information technologies, media and content providers, and consumer electronics, will eventually lead to the birth of a new sector [22]. Frontiers between telecommunications and broadcasting are already starting to blur as on the one hand e.g. telecommunications operators are providing access to television channels in addition to access to the Internet and to phone calls (what is called "triple play"), and on the other hand e.g. satellite broadcasters are starting to offer interactive services such as pay-per-view and video on demand in addition to accessing traditional TV channels. This trend will only continue at an even faster pace in the next few years, enabled by a number of new and innovative technologies that will become more and more widely available (please see next Figure).

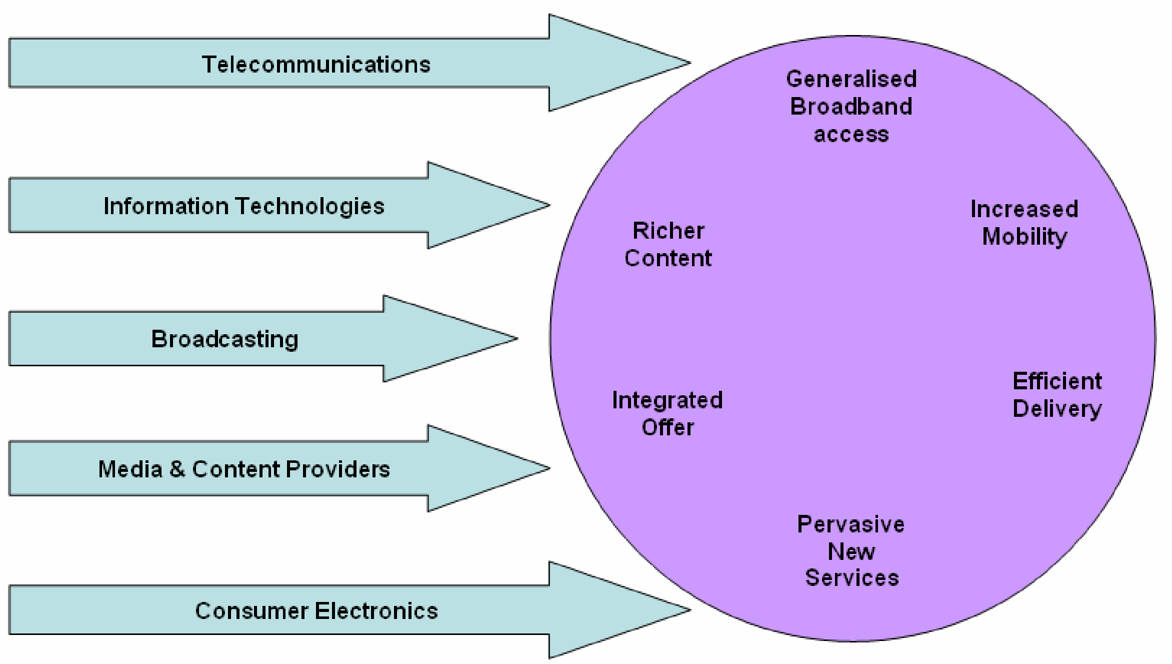


Figure 23 – The future market convergence.

People want to reach other people (communication), seek all kinds of information (e.g. news) and entertainment media, using any kind of devices transparent of underlying networks, easily, efficiently, securely, with fun, any time, any place. To accomplish this vision, future ubiquitous broadband networks will orchestrate an enriched user experience and future convergent service platforms will deliver any application and content managing a single customer profile. The business model of broadcasters, telecom operators and service/content providers will become convergent regarding audiovisual technologies. New business models must be built on the basis of open service interoperability, seamless end to end services architecture, in such a way that e.g. digital television services can be accessed in a transparent way. Further information about future business model will be available in future deliverables "Organizational Model for new communication paradigms".

Although it's always difficult to identify the applications that will be successful several years ahead, some future Autonomic services have been drafted, also highlighting some aspects identified as key elements of services that digital convergence will enable [22].

Enabled Services

e-Applications

e-Services delivery platforms enable the provision of services via all kinds of networks available to the consumer. Internet technologies will most likely be an important component.

e-Learning solutions

New e-Learning applications based on e-Services will play a major role in the development and true adoption of the Connected Society. The new e-Learning solutions will be driven by the following scenarios:

- Personal environments will be populated by personal communication and computing devices, accessories, wearables, implants. e-Learning solutions creating a competitive advantage for European business and will facilitate especially SMEs exploring new markets.
- Mobility and ubiquitous access will be a key challenge for in-field job training needs.

Pervasive content and communications services, for example:

Pervasive gaming

Pervasive games are games that are always present, available to the player. These games can be location sensitive and use several different media to convey the game experience. A more technological description for pervasive games is that they refer to the seamless integration of network technologies and the provision of mechanisms for the gamer to interact with gaming applications and platforms, and virtual or physical game elements without the need to understand the underlying connectivity and technical networks. Within the pervasive game domain the user is always connected in multiple ways, via multiple devices. As technology advances remove the largest constraints for terminals and transmission, there will be a growing range of multimedia personalised (including on the move) forms of entertainment and new games emerging.

Digital cinema and content delivery

Extensive content digitalisation and pervasive availability of interconnected broadband digital networks will open the way to new delivery channels for customers. The traditional entertainment material which is currently distributed to users through physical reels (for cinema professionals) and DVD's (for the general public) will migrate to non physical delivery systems. This will be the major change for a large part of the content industry (for instance film producers and distributors) which will have to reconsider their business models with new generation of theatres, but also with on-line contents. Moreover the emergence of the Internet as another channel to provide content to the consumer will make possible new usages of contents (with more flexibility) but will also introduce the network operators as another stakeholder in the content distribution arena. Depending on the actors and the type of public considered, electronic content delivery can take several aspects:

- A major evolution concerns films for public watch in theatres. This is a Digital Cinema, a B2B application in which a series of actors which were not confronted to digital networked technologies will have to change their know-how and adopt an ICT-based approach, with file transfer over open networks, software and electronic billing.
- Television over IP: the addition of a TV service to the traditional interactive services already operated on networks is obviously a new channel to reach the end consumer at home.

Some electronic content delivery mechanisms (and businesses) can also be imagined to take benefit of all the components available at the users' home or in the network, and/or based on the assumption that most users will be connected to some bandwidth wireless network.

Personal Advertisement and content push on interactive TV, for example:

Advertising for new media content

Advertising has been an important source of revenues for media companies. In the new media era, digital and interactive media creates new opportunities and challenges for this business. New forms of cross-media advertising (TV shows + SMS) are emerging and campaigns can be more specifically targeted to content on-demand consumers (marketing one-to-one). Digital advertisements can be easily copied and made suitable for different platforms and media channels. Campaigns can more easily be created for multi-channel media and the overall categorized visibility rates controlled in an easier way. There exist flexible concepts to increase the reach of an advertisement campaigns but seamlessly adaptable to fragmented user groups or even individuals.

Pervasive Autonomic Social Networking, for example:

Enriched personal communications

We communicate with a person, or people, not only via voice call numbers, IP addresses, or similar identifiers. An enriched personal communication system provides the best way and mode to communicate with a certain person or group, regardless of the situation. Like all primates, humans are inherently social animals and social networking is a basic need. Humans generally have many different layers of social networks surrounding them. Group communication helps staying in touch with these social groupings. The communication sphere of a person needs to provide for mechanisms for easily adding, deleting and modifying these groupings. The success of any service or application will depend on how users rate its usefulness and how intuitively and easily services can be used. In business usefulness will be measured in organisational efficiency and profitability. Generally speaking many present applications have been created from boundaries set by technology and with minimal user interaction. In the European context there are also questions like multilingualism, different social background and disabilities, differences between the technological infrastructures which needs special attention. Demography and individual user age will also have profound influences on the usage and perceived usefulness of services.

Personalisation service creation

Enabling individuals and consumers to create personal applications is seen to be of extreme importance for the future landscape. There is an inevitable change going on, facilitated by broadband availability and driven by the need for communicating and experience sharing. For individuals to become "prosumers", that is a person who is simultaneously a produces and a consumes. In the medium-term perspective emphasis should be put on developing open interfaces with open software solutions to enable easy applications development. In the long term perspective a modular approach should be developed which would enable everyday users to easily configure their own applications by using graphical or other easy to use interfaces. The system or service platform would configure the applications.

Autonomic Search Engines, for example:

Tools for content discovery

In a near future world where content on demand is available everywhere from many providers, finding appropriate content for the user needs (discovery) becomes of the utmost importance. Imagine the Internet without any search engines; it would be very much harder, if not impossible, to find information. In the future discovery can be both of specific pieces of content and also packages of related content. The discovery engine should have some intelligence, remembering previous choices selected and using that information to steer new searches. The normal, current use of discovery is for a search to be conducted, followed by the subsequent download of the information being sought. However an alternative view is that the search could be based on an example or based on searches one has made previously (based on a profile that could be stored in the network rather than locally) or on some consensus view. Network storage of profiles has the advantage that it is available from any client device.

Multimodal interactivity with the remote environments

Telepresence

Telepresence services provide a virtual environment for humans to control devices, robots, etc., in a hostile or remote real environment. In a telepresence system the human uses displays and body-operated remote actuators and sensors to control distant machinery. Telepresence is the experience of being fully present at a live real world location remote from one's own physical location. Experiencing presence and telepresence does not depend so much on the faithfulness of the reproduction of the physical aspects of external reality as on the capacity of simulation to produce a context in which social actors may communicate and cooperate.

Two main targets may be pursued:

- Business application for remote communication and collaboration (e.g.: pipeline video inspection for maintenance and repair, distance learning).
- Tele-operation through specific devices (e.g.; subsea work in deep waters, hazardous situations, remote surgery).

Remote management, for example:

Autonomic solutions for environmental management and energy efficiency

Autonomic "management" of traffic and people

The remote management of network nodes is becoming more and more sophisticated, capable and complex. The range of devices available is growing exponentially, as is the effort that is required to install and manage them. Remote management will become increasingly important, as will the ability to manage a user's network remotely. As new devices are installed into a network, there should be some form of dialog among the device, the access gateway and the network or a controlling entity in the network. This exchange of capabilities will not only allow the access gateway to manage the device in the home network but also allow the network to manage configuring services and requirements for that device.

Micropayments

Micropayments are small, usually one off, payments made for a given piece of content or service. They allow for billing for small amounts collected centrally and then distributed to the appropriate content/service provider. Rules to control Micro Payments are applied can be complex, particularly in the case of acquiring rights to a complicated set of content, especially if that content is dynamically reconfigurable. Micro Payments act as an enabler for people to buy or sell services which otherwise they might not be bother to buy (or to change for). Micro Payments are components of larger services, rather than a completely separate service. So, a future network might implement Micro Payments as a core part of its basic capabilities, and thus potentially make any data transfers subject to charging, if required. Related to micropayments there is also the development of services such as ***Distributed Autonomic Auction of goods, MM contents, resources, etc.***

Above-listed services will be adopted in different measure depending on the economic situation in 2015-2020 years, as shown in Figure 18.

It is assumed that in a good social situation ("Smooth Development" scenario) the probability that the enabled services will be spread among the users' population is really high. So a high level adoption is foreseen for all SACs' services on average (three stars evaluation in next Table).

On the contrary, when economic condition are not positive, people's disposable incomes will decrease and only basic services will be adopted by the average population. The term "basic" should obviously be referred to the period under consideration that is 2015-2020 years. At the same time, companies and Public Institutions could be the driving force for SACs' services adoption. Following this reasoning, eApplications, Micropayments and

Autonomic Search Engines are likely to be the most required services by consumer market, while personal advertisement and content push on interactive TV is likely to be the service in which companies should invest the most (two stars evaluation, please see next Table). Remaining services should have a niche development (one star evaluation).

	Adoption	
	High	**Medium-low**
eApplications	***	**
Pervasive content and communication services	***	*
Personal advertisement and content push on interactive TV	***	**
Personalisation service creation	***	*
Autonomic Search Engines	***	**
Multimodal interactivity with the remote environments	***	*
Remote Management	***	*
Micropayments	***	**

Table 4 – High and Medium-low adoption of SACs' services enabled by providers.

In summary, it has become quite common to emphasize that without content whatever advanced network technology offer has no value. In the coming years, it is expected that **more and more content** will be **created by the end users**.

- The digital content will be exchanged within the family but also within groups resulting into some convergence between personal communication and content and will add to the content created by the professionals.
- To support that exponential growth, tools will be required to produce and exchange that content according to Open formats, and Content protection will become crucial.
- On the other side, when accessing content, all sorts of content adaptation and personalisation to the consumer's preferences and context will be performed requiring specific tools.
- The users will be faced to an enormous amount of information accessible in various places. Without assistance it will become impossible to retrieve the relevant content from media libraries, which stresses the importance of metadata and semantic search engine technologies.

Services and application will require the **ubiquitous presence of networks**. Network is something that end user should not see in normal operating conditions. To reach that performance with the demanding constraints, the **current network technologies have to**

be improved. The topics below have been identified as strongly contributing to the realisation of the goal.

- Network architecture: the main challenge of the coming years is the increasing number of multimedia devices requiring advanced composite services. Network technologies must provide an answer to that challenge in terms of network organisation, throughput, efficient resource usage, capacity to extend service provision in sustained decrease of cost conditions.
- Network based intelligence for end to end service control: the Situated and Autonomic Communications applications will trigger an increasing number of sessions and flows. To support those applications with the relevant QoS, more intelligence will have to migrate to the periphery of the network, close to the users.
- Seamless service provisioning: in order to perform seamless services on a variety of networks with different technologies and especially different architectures, a cross-network model must be developed and implemented.
- Network planning and optimisation: efficient deployment and operation of a new network technology is a key factor of the adoption and final success of that technology. Tools have to be designed to plan the multi technology networks for SACs' services, taking into account the dynamic adjustment of network parameters that could become a demand of those services.
- Security and privacy: the universal adoption of on-line digital services stresses the need for security provisions in order to prevent any intrusion within the private user areas.
- Ubiquitous multimedia networking: in order to provide the adapted connection or content to the users whatever their location, some combination of network technologies with location awareness, automated profiling and content trans-coding has to be considered.

Key elements of new services **are terminals and user devices**:

- Convergence of audiovisual, informatics and communications will trigger Home multimedia devices combining more and more complex IT functions (for instance high capacity storage and high computing power) with network interfaces and demanding human interfaces such as HD display capability. Among those devices the "Mobile" terminals will require more and more of the above features with severe constraints on size, weight and power consumption.
- Other types of home devices are Gaming terminals. It is anticipated that those devices will become key in the integrated world of NEM. At present those terminals have a proprietary status, but the development of open middleware could help to overcome that issue.
- A particular role within the home is devoted to the Residential gateway, which is not properly a terminal but has a privileged position within the home network. As a mandatory element of connected homes, it will be in the position of supporting many services to the consumers.
- A response to the complexity of functions that a single device has to incorporate is the concept of Virtual distributed devices, which in fact is the application of networking to the many terminals that everybody carries on himself. In this area almost everything has to be designed and a high level of innovation is expected in this area.

Beyond technology there are other critical aspects that also need to be tackled so that services can be adopted to users. One is the **European regulatory landscape**, which may does not allow innovative solutions to be broadly deployed. Europe, being a union of 27 independent Member States (and soon probably more), tends to have various regulations that are in line with national priorities. The big challenge ahead of us is that this does not prevent European technology to be widely deployed in all European countries. The existing regulatory bodies should take into account that the convergence of these sectors is accelerating and should make every possible effort to support and promote the broad adoption of European technologies and standards.

Another critical issue is **interoperability**. Applications and services that are and will be more and more available to all citizens and businesses will use various types of infrastructures to transport voice, images, and more generally all types of data: telecommunications networks whether fixed or mobile, using various technologies; cable; satellite; etc. In addition the user will have access to such services via a multitude of terminals, such as TV, PC, mobile phone, PDA, as well as new multimedia terminals that may be fixed e.g. in the home, nomadic, or mobile. Therefore interoperability between all these terminals and the various transport networks needs to be ensured. This is the only way to prevent a monopolistic situation to occur, which may be detrimental to European cultural diversity and European independence.