AROMA White Paper

A QUALITATIVE TECHNO-ECONOMIC ANALYSIS ON EVOLUTIONARY 3GPP ALL-IP ARCHITECTURES

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Abstract

The purpose of this white paper is to report a qualitative techno-economic analysis of the technology trends and steps related to the evolution of 3GPP architectures, which has been developed in the IST AROMA[1] project [1] (www.aroma-ist.upc.edu). Within the context of the evolution of mobile systems, the purpose of the study is to evaluate in a qualitative way the influences among economic values (CAPEX, OPEX, and revenues), economic drivers, and technology evolution trends and steps. The relations between technology and economics are explained in terms of qualitative tables which show how some emerging technologies may influence/determine the economic aspects in the telecommunications field. It is worth noting that the analysis carried out in this work aims to provide an overall and clear view concerning the addressed topic. Nevertheless, for this reason the work is not meant to provide any immediate economic comparison between different options concerning network technologies and architectures, since it is of course determined by a lot of operator-specific characteristics, not applicable in a generic context.

Results of the study summarized hereby can be found with greater details in deliverable D14 [2] developed within AROMA WP2, where techno-economic analyses and evaluation of the technical outputs of the project are performed.

1 AROMA PROJECT OBJECTIVES SUMMARY

The objective of the AROMA project is to devise and assess a set of specific resource management strategies and algorithms for both the access and core network part in order to guarantee the end-to-end QoS in the context of an all-IP heterogeneous wireless network. In order to accomplish the above objectives, the project evolves around two main activities: (1) algorithmic development and simulation by means of advanced simulation tools, and (2) demonstration of the technology by means of implementing real time for proof of the concepts developed in the project.

More in detail, the following activities are addressed in the project:

- Identification evaluation and validation of advanced Radio Resource Management (RRM) algorithms for GERAN, UMTS-R99, HSDPA, HSUPA as well as WLAN technologies

[1] Acronym of the FP6 IST STREP project entitled "Advanced Resource Management Solutions for Future all IP Heterogeneous Mobile radio environments", started in January 2006.

- Development of advanced Common RRM (CRRM) solutions, covering among other: CRRM algorithms exploiting the non-homogeneous system conditions, load-sharing CRRM algorithms using GERAN and UTRA MBMS or CRRM algorithms and Cross layer RRM algorithms based in IP-RAN.
- Identification evaluation and validation of innovative end-to-end QoS strategies considering both radio and core network aspects under a variety of conditions, also including: MPLS and lower-layer interaction for end-to-end support, IP-RAN traffic engineering strategies and mobility issues
- Development of mechanisms allowing an automated tuning of the CRRM/RRM algorithms and corresponding parameters via network management software
- Development of techno-economic evaluation on the impacts of the novel solutions considered by the project.

From the activities carried out by the AROMA project it is evident that the project aims not only to asses and understand how to maximize the potential benefits coming from the medium-term evolution of the considered radio-access technologies (e.g. HSDPA/HSUPA, MBMS) but in parallel also to promote and investigate potential benefits coming from a long-term evolution towards an all IP heterogeneous mobile network architecture. In this context, the RAN architecture should be also evolved to accommodate future IP-based networks, which allow a common transport even in different access networks, simple resource management, and easy heterogeneous inter-working. The target scenarios specification are fully described in successive stages in [3], [4].

On the other hand, in order to support end-to-end QoS in a heterogeneous wireless mobile environment, an appropriate interaction between the QoS management entities of the core network (CN) and the Common Radio Resource Management (CRRM) in the radio part is crucial. These kinds of issues are extensively covered in the project; e.g. several results on these issues can be found in [5], [6].

Last but not least, in order to complement and complete the technical investigations on the addressed topics, also techno-economic evaluation on the economic impacts of the solutions investigated by the project as well as by the legacy IST-EVEREST project are carried out (ref. [2], [11]). In fact, the commercial impact of the studies carried out within the project is expected to be viable in the years 2010-2015, from the much hoped-for commercial success of 3G networks until their full maturity. It is anticipated that the progression towards an evolved 3G All-IP Network (AIPN) may enable leverage of information technology (IT) hardware and software with general-purpose, and mobile network specific software that should provide cost reduction (CAPEX and OPEX) for infrastructure equipment and applications of 3GPP based mobile networks.

2 AROMA ALL-IP REFERENCE NETWORK ARCHITECTURE

In the AROMA project a smooth network architecture migration from the current networks into an all-IP architecture is foreseen. The long-term vision for the reference architecture proposed in AROMA is aimed at capturing the major trends in network evolution coming from 3GPP LTE/SAE (Long Term Evolution/System Architecture Evolution) [8], [9] as well as other innovative proposals. In this sense, the main aspects of the reference architecture envisaged as long-term vision are:

- Flat network hierarchies for the overall network are considered: user traffic processing nodes are kept at minimum (e.g. user plane traffic only processed at the evolved Node-B and at a single network node within the entire evolved access network).
- Radio access technologies are still those specified under 3GPP R6 for UTRAN and GERAN. Thus, AROMA does not target to analyze 4G radio access technologies.
- Several models for the allocation of Radio Resource Management functions can be used (e.g. RNS server or distributed RRM in evolved Node-Bs).
- Interworking with legacy 3GPP systems is possible through either “loose” (i.e. by means of core network interfaces) or “tight” (i.e. radio level coordination) coupling approaches. Pros and cons of these interworking possibilities are for further study.

Figure 1 illustrates the main aspects of the reference architecture considered in AROMA for this long-term scenario. Notice that entities represented in the figure within discontinuous boxes are the ones still under discussion within 3GPP LTE/SAE.

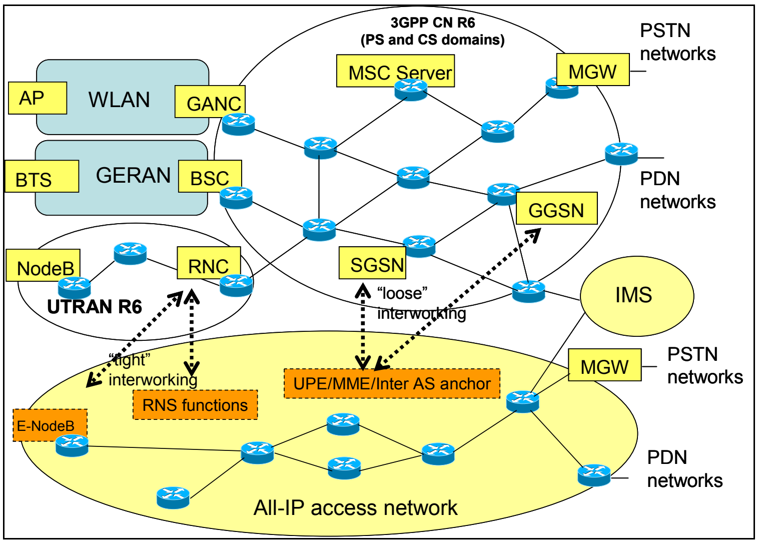

Figure 1 - Long-term architecture for all-IP network considered in AROMA

3 ECONOMIC VALUES AND DRIVERS

The first step of our analysis has been the identification of a number of important economic trends in the evolution of nowadays 3G mobile networks towards the AROMA all-IP architecture, which is compliant with the specification activity related to 3GPP evolution, widely known with the acronym of LTE/SAE (Long Term Evolution), ref. [8], [9]. A useful definition for the term "economic driver" may be the following one: "A mix of external factors, events, general trends of the TLC domain which have a direct or indirect impact on ore or more economic variables (such as, for example CAPEX and OPEX) which influence the TELCO operators margins and which induce them to evolve the TLC networks in order to keep an appropriate level of return of invested capital". In the performed analysis, of course, the factors which influence the economic margins of telecom operators and induce them to evolve their networks according to a development trend compliant to the technological assumptions of AROMA project are mainly considered.

A general consideration about TLC mobile industry is that, as an effect of market saturation, a relevant profit margin for an operator may be obtained over all by lowering CAPEX and OPEX, because the revenues are expected to grow very slowly or to keep constant. More in detail, several forecast assumptions about the growth of mobile voice and data revenues services in European estimate that the average total annual growth will be of around 6%, mainly driven by the growth of mobile data and internet services, as e.g. reported in Figure 2 [10].

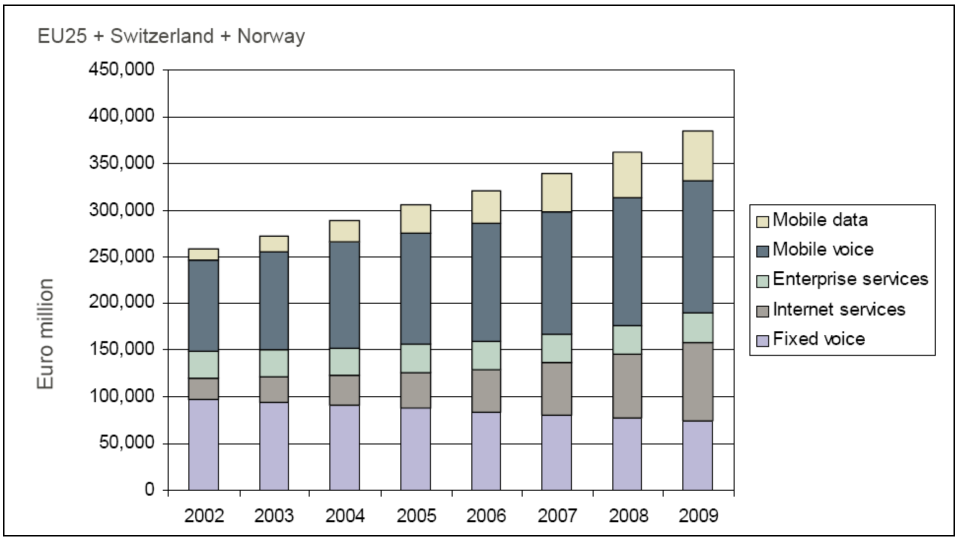

Figure 2 - Forecast on European telecom market development [10]

For the above mentioned reason, it is considered very important to distinguish which is the main effect that an economic driver produces. A categorization based on this issue is proposed:

- **Drivers which influence the CAPEX**

  These are economic drivers which may produce a reduction on investments by lowering cost of capital assets like technical plants or by adoption of more efficient technologies.

- **Drivers which influence the OPEX**

  A foreseen reduction on operational expenditures may contribute to enhance the margin or at least to keep it unchanged while giving enhanced and higher quality services, or the same kind of services but in a more efficient manner. In this case we consider the case of a higher or similar quality of services obtained by reducing operation and maintenance costs, and not to the quality as it is perceived by the user, which mainly affects the willingness to use the service and is therefore considered a driver which influences the revenues.

- **Drivers which influence the REVENUES**

  An enhancement of the revenues obtained by the introduction of new services or by upgrading the existing ones, or by attracting new customers, effectively influences the obtainable margin. Also in this case, it may be acceptable to keep existing revenues without incrementing them, especially when many operators are competing for a market share, by using retention policies in order to face the pressure due to a very competitive environment.

The most relevant economic drivers within the context of evolution towards the evolved mobile architectures have been identified and explained in detail in the analysis (ref. [2], section 4) and their membership to one of the three different categories reported above is pointed out. Several quantitative forecasts, coming from different sources, have been also taken into account in order to perform the categorization work of the identified drivers. In [2] also specific sections where it is explained how the attribution of every single driver to a specific category has been done can be found.

The result of the considerations reported in [2] is the synoptic Table 1, which shows a whole view of all the drivers with the associated category. An arrow which is pointing up means that the corresponding value increases as an effect of the driver, an arrow which is pointing down means that the corresponding value decreases as an effect of the driver.

	CAPEX	OPEX	REVENUES
Preservation of investments made for existing systems	⇩	⇩	
Graduality in the introduction of new services	⇩	⇩	
User demand for better performances and greater mobility			⇧
Convergence between different industries (media, consumer, electronics, ICT)			⇧
Spectrum management			⇧
Updated IPR regime	⇩		
New emerging business models			⇧
IP convergence		⇩	
Social trends			⇧

Table 1 - Economic drivers and categories associated

4 TECNOLOGY EVOLUTION TRENDS

“Technology evolution trend” is defined here as a general trend in technology evolution which is supported by one or more technical implementations, also named as “Technology evolution steps” because they represent an incremental step (typically with a roadmap of likely release dates) in the evolutionary path of existing networks. For example, the introduction of an OFDM based radio interface is a technology evolution trend because many existing and future implementations adopt it as a basis for the radio interface. LTE/SAE and WiMAX, instead, are two examples of evolutionary steps which both adopt the foreseen technology trend (OFDM based radio interface).

In Table 2 the identified technology evolution trends are listed and it is specified which are the economic drivers that are influenced by some of them. In the table below a “YES” value indicates that the technology trend influences the driver by enhancing it, whereas a “NO” value indicates that the technology trend is apparently opposite to the specified driver (that means that the trend decreases it). Each row is commented in subsequent sections, by giving explanations on the value that were chosen to fill the table.

	Preservation of investments made for existing systems	Gradualness in the introduction of new services	User demand		Convergence between different industries (media, consumer, electronics, ICT)	Spectrum management	Updated IPR regime	New emerging business models	IP convergence	Social trends
			User demand for better performances	User demand for greater mobility						
OFDM based radio interfaces	NO		YES	NO		YES	YES			
Core Network Evolution	NO							YES	YES	
All-IP paradigm	YES	YES			YES			YES	YES	YES
Terminal and application evolution	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES
Broadcast solutions	YES/NO		YES		YES	YES		YES		YES
WLAN and cellular convergence (GAN)	YES		YES	YES		YES		YES	YES	YES

Table 2 - Influence of technology trends on economic drivers

4.1 OFDM based radio interfaces

This kind of technology represents a big switch with respect to previous existing systems, both for network equipments, because new radio base stations are required, and for the mobile terminal side, because backward compatibility must be guaranteed, so dual-mode terminals with a multiple radio chain will be needed. This is the reason why choosing **NO** (at this study) to specify that preservation of investments made for existing systems is not guaranteed.

Due to the good spectral efficiency and to the technological fitness of this technology for high bit rate services, **YES** has be chosen to specify that it meets the user demands for better end user performance.

On the other side there is a risk related to the fact that the mobility support of the new OFDM based systems may be worse than in CDMA case, so a **NO** value was specified to say that it doesn't necessarily meets the user expectations in terms of mobility.

This technology foresees the possibility of using narrower frequency bands, so promoting a more flexible usage of the spectrum resources, so a **YES** value for the spectrum management driver was chosen (it's simpler to use a number of small available frequency bands with respect to WCDMA).

It's still to evaluate in full detail, but it's quite clear, that one of the causes of OFDMA introduction is the attempt to reduce or cancel the royalties due to the companies that posses at the moment the key patents for CDMA technologies [14]. A **YES** value is so justified for describing the positive effects that this technology may induce on an updated IPR regime.

4.2 Core Network Evolution

This type of technology represents a big switch with respect to previous existing systems because new equipment must be introduced. This is the reason why **NO** has been chosen to specify that preservation of investments made for existing systems is not guaranteed.

The availability of new open interfaces makes the admission of new mobile operators easier, especially in the case of MVNO and BVNO, which do not own a real network, but must connect to an existing one. This is why we specify **YES** to specify that new emerging business models have an advantage with respect to this technological trend.

The convergence with IP is enabled by the sharing of the basic network architecture principles so a **YES** value is considered when talking about IP convergence economic driver.

4.3 All-IP paradigm

The preservation of investments already made for IP backbone is done for the Core Transport Network. Even for the backhauling network it's possible to reuse the investments already done for the Core Transport Network. For example, if a GBEthernet network already exists, a new B-Node will be introduced by simply connecting it to the nearest local loop, avoiding the introduction of a new transport circuit to the local switch. This is the reason why **YES** has been chosen to specify that preservation of investments made for existing systems is effective.

It's very easy to introduce a service which already exists in the IP world, then to verify if it is of interest also in a mobile scenario, then to extend it by adding scalability in short time. For that reason a **YES** value is put with respect to the "Gradualness in the introduction of new services" driver.

This is the way to have the ICT most diffused paradigm perfectly compatible with a TELCO operator network, so a **YES** value is chosen for the driver of convergence between different industries.

The availability of new open interfaces that are IP-compliant makes the admission of new mobile operators easier, especially in the case of MVNO and BVNO, which do not own a real network, but must connect to an existing one. This is why **YES** has been chosen to specify that new emerging business models have an advantage with respect to this technological trend.

The convergence with IP is enabled by the sharing of the basic network architecture principles and also in detail vision, so a **YES** value is considered when talking about IP convergence economic driver.

Being familiar with IP applications and services makes it easier the social acceptance by this technology; the communities already existing on Internet may extend to the mobile Internet and this represent a significant added value which is essential for the diffusion of this technology in a mobile environment, so a **YES** value is specified with reference to social trends drivers.

4.4 Terminal and application evolution

When using multi-mode terminals, the link with existing network is guaranteed. This is the reason why **YES** has been chosen to specify that preservation of investments made for existing systems is effective.

This also allows a gradual introduction of new services, by using old existing networks and technologies. For that reason a **YES** value is put with respect to the "Gradualness in the introduction of new services" driver.

This is of course a pre-requisite for giving advanced services, with better performance and in greater mobility, so **YES** is specified both for used demand for better performance and greater mobility.

The Mobile TV is a good example of a service which is pushed by the introduction of enhanced terminals and which represent a convergence with media and ICT industries, so a **YES** value is chosen for the driver of convergence between different industries.

When using multi-mode terminals, the management of spectrum is more flexible, so a **YES** value for the spectrum management driver was chosen.

If those terminals are multi-mode they anyway use the existing CDMA mode, so they cannot benefit from an updated IPR regime. A **NO** value is justified for that reason.

The introduction of DRM modules on a terminal is for example a necessity when introducing some new business models, so a **YES** value is justified in order to specify that new emerging business models have a relation with respect to this technological trend.

The convergence with IP is enabled by the usage of evolved terminals, so a **YES** value is considered when talking about IP convergence economic driver.

All the instant messaging and presence services, which will be probably integrated in future mobile devices contribute to the extension of communities already existing on Internet to the mobile Internet and this represent a significant added value which is essential for the diffusion of this technology in a mobile environment, so a **YES** value is specified with reference to social trends drivers.

4.5 Broadcast solutions

The preservation of investments already made for 3GPP networks is effective for MBMS technology [12] which is based on UMTS networks, whereas DVB-H [12] relies on a completely different and separated network. This is the reason why we chose **YES** to specify that preservation of investments made for existing systems is done in the MBMS case, **NO** in the DVB-H case.

The broadcast/multicast mode permits a higher QoS because only one stream is distributed (independently from the number of users), so it is possible to use higher bit rates, at a higher quality; **YES** has been chosen to specify that it meets the user demands for better performances.

This is the way to have a broadcast network integrated with a TELCO operator network, so a **YES** value is chosen for the driver of convergence between different industries.

When using the broadcast channel, the exploitation of the existing spectrum is better, so a **YES** value for the spectrum management driver was chosen.

These technologies allow a broadcast operator to enter the mobile business model (and vice versa). This is why **YES** was chosen to specify that new emerging business models have an advantage with respect to this technological trend.

The huge diffusion of TV users in our society represents a significant added value which is essential for the diffusion of this technology in a mobile environment, so a **YES** value is specified with reference to social trends drivers..

4.6 WLAN and cellular convergence (GAN [13])

GAN dual-mode terminals allow a customer to use broadband wireless where available and the existing cellular network elsewhere, so investments already made for both technologies are preserved. This is the reason why **YES** was chosen to specify that preservation of investments made for existing systems is effective.

The WiFI technology has higher bit rate. Moreover, the mobility of WiFI users is limited to hot-spots but together with UMTS we may have a greater mobility, so **YES** is specified both for used demand for better performances and greater mobility.

When using GAN terminals, the management of spectrum is more flexible (because both licensed and not licensed bands are used), so a **YES** value for the spectrum management driver was chosen.

These technologies allow a fixed operator to partially enter in the mobile business model (e.g. when using GAN terminals with home ADSL connections). This is why **YES** was chosen to specify that new emerging business models have an advantage with respect to this technological trend.

The convergence with IP is enabled by the sharing of the basic network architecture principles of WiFI networks, which are IP-centric, so a **YES** value is considered when talking about IP convergence economic driver.

The fruition of services in hot-spot location (airport, station, hotel, pub, etc.) is a very strong social trend, so a **YES** value is specified with reference to social trends drivers.

5 TECHNOLOGY TRENDS RELATION WITH ECONOMIC VARIABLES

The logical combination of the two previously introduced tables shows the way technology trends influence and determine economic values, such as CAPEX, OPEX or Revenues. Each red arrow pointing down represents a link between an economic driver, which is related to the technology trend, and the economic value, which is supposed to be reduced thanks to the new technology trend. It is worth noting that the numbers of the arrows that are depicted in each cell of the table does not have the meaning of a relative weight related to how the economic values are influenced in a quantitative way. For example, five arrows in a cell do not necessarily represent a revenue increase quantitatively greater than the case which has two arrows. This simply means that we have found five qualitative links between the two items, and they are fully described in our detailed analysis. This also justify the fact that it is possible to have both an up and a down pointing arrow in the same cell, representing two links with opposite effects. As it is not a quantitative comparison, it makes no sense to make an “algebraic” reduction of arrows pointing in opposite directions.

	CAPEX	OPEX	REVENUES
OFDM based radio interfaces	⇧⇩	⇧	⇧⇩⇧
Core Network Evolution	⇧	⇧⇩	⇧
All-IP paradigm	⇩⇩	⇩⇩⇩	⇧⇧⇧
Terminal and application evolution	⇩⇩⇧	⇩⇩⇩	⇧⇧⇧⇧⇧⇧
Broadcast solutions[2]	⇩	⇩	⇧⇧⇧⇧⇧
WLAN and cellular convergence (GAN)	⇩	⇩⇩	⇧⇧⇧⇧⇧

Table 3 -Technology trends relation with economic variables

6 TECHNOLOGY STEPS AND TIMESCALE

The technology trends are the basic components of some real implementations which have a specific timescale and that can be defined as “technology steps”. In AROMA analysis six main technology steps have been considered; their currently assumed timescale and the relation with previously defined technology trends, is depicted in Table 4.

[2] Please note that the values reported in table are related to MBMS solutions, whereas CAPEX and OPEX for DVB-H have the opposite values. In subsequent tables the different values are properly introduced in the two options

	Year	OFDM based radio interfaces	Core Network Evolution	All-IP paradigm	Terminal and application evolution	Broadcast solutions	WLAN and cellular convergence (GAN)
MBMS	2008				X	X	
DVB-H	2007	X			X	X	
GAN	2008				X		X
WiMAX Mobile	2009	X	X	X	X	X	
LTE	2010	X	X	X	X	X	
IMS	2007			X	X		

Table 4 - Relation between technology steps and technology trends

In the following paragraphs the technology steps are presented together with the "logical product" coming from the previous analysis. All the arrows given in Table 3 are collected for the every technology trend belonging to the technology step according to Table 4. A short description of the technology step and the influence between the technology step and the economic values, as it is indicated by the present analysis, is given in subsequent tables. Please note that the number of arrows is not relevant to determine the corresponding quantitative weight, but it simply denotes that there are many different qualitative effects which influence it. For every technology steps it is given the year of the corresponding timescale.

6.1 MBMS & DVB-H

The technologies involved in this study, DVB-H and MBMS, are both in charge (with other technologies not included in this study) of delivering mobile broadcast services. Both of them are complementary, whereas DVB-H is focused in broadcast service, MBMS applies more to multicast service.

		CAPEX	OPEX	REVENUES
MBMS	2008	⇩⇩⇧⇩	⇩⇩⇩⇩	⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧
DVB-H	2007	⇧⇩⇩⇩⇧⇧	⇧⇩⇩⇩⇧	⇧⇩⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧

Table 5 - Relation between MBMS & DVB-H technology steps and economic value

6.2 GAN

WiFI GAN (UMA) refers to the specific use of WiFi unlicensed spectrum (IEEE 802.11a, b, g, h) to deliver Fixed Mobile Convergence services. Users will be able to move and handover between cellular networks and public and private wireless networks using dual-mode handsets.

		CAPEX	OPEX	REVENUES
GAN	2008	⇩⇩⇧⇩	⇩⇩⇩⇩⇩	⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧

Table 6 – Relation between GAN technology step and economic value

6.3 WiMAX Mobile

WiMAX is defined as Worldwide Interoperability for Microwave Access by the WiMAX Forum, formed in June 2001 to promote conformance and interoperability of the IEEE 802.16 standard, officially known as Wireless MAN. The Forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL". IEEE 802.16e-2005 (formerly named, but still best known as, 802.16e or Mobile WiMAX) provides an improvement on the modulation schemes stipulated in the original (fixed) WiMAX standard. It allows for fixed wireless and mobile Non Line of Sight (NLOS) applications primarily by enhancing the OFDMA (Orthogonal Frequency Division Multiple Access).

		CAPEX	OPEX	REVENUES
WiMAX Mobile	2009	⇧⇩⇧⇩⇩⇩⇩⇧⇩	⇧⇧⇩⇩⇩⇩⇩⇩⇩⇩	⇧⇩⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧

Table 7 - Relation between WiMAX Mobile technology step and economic value

6.4 LTE/SAE

3GPP LTE/SAE is the name given to a evolutionary framework within the Third Generation Partnership Project to improve the UMTS mobile phone standard to cope with future requirements. Goals include improving efficiency, lowering costs, improving services, making use of new spectrum opportunities, and better integration with other open standards. The LTE/SAE activity will result in the new evolved release 8 of the UMTS standard, including mostly or wholly extensions and modifications of the UMTS system.

		CAPEX	OPEX	REVENUES
LTE/SAE	2010	⇧⇩⇧⇩⇩⇩⇩⇧⇩	⇧⇧⇩⇩⇩⇩⇩⇩⇩⇩	⇧⇩⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧

Table 8 - Relation between LTE/SAE technology step and economic value

6.5 IMS

IMS is a service platform for operators to support IP multimedia applications. Potential applications include video sharing, PoC, VoIP, streaming video, interactive gaming, and so forth. IMS will enable mixed and dynamic services Please note that a specification for IMS conformance terminal test is currently being developed so a connection between the corresponding technology trend and technology step has been taken into account.

		CAPEX	OPEX	REVENUES
IMS	2007	⇩⇩⇩⇩⇧	⇩⇩⇩⇩⇩⇩	⇧⇧⇧⇧⇧⇧⇧⇧

Table 9 – Relation between IMS technology step and economic value

7 CONCLUSIONS

In this work some techno-economic aspects concerning the evolution of mobile system toward the future all IP architecture have been addressed. The most relevant characteristics of the main novel emerging technologies in the mobile telecommunication field (such as OFDM based air interfaces, MBMS, DVB-H, WiMax, LTE, etc.) have been taken into account in order to evaluate future potential economic impacts of the considered technology steps. Techno-economic considerations on the main issues related to the addressed topic have been developed paying particular attention to the clear definition of a methodology useful to achieve the results reported in this paper. More in detail, the proposed methodology consists on considering the relation between economic drivers and technology trends, and the way the formers influence the economic values (CAPEX, OPEX and revenues) in order to reach a final synthesis which directly links the technology steps to the qualitative effects they have on the economic values.

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Bibliography

[1] F. Casadevall et al., “Overview of AROMA Project”, IST Mobile Communication Summit 2006.

[2] R. Farotto et al., “Economic evaluation of AROMA all-IP architecture”, IST-AROMA Project, Deliverable D14, Apr. 2007.

[3] R. Ljung et al, “Target Scenario Specification: vision at project stage 1”, AROMA deliverable D05, Mar. 2006.

[4] R. Ljung et al, “Target Scenario Specification: vision at project stage 2”, AROMA deliverable D11, Mar. 2007.

[5] O.Sallent et al., “First report on AROMA algorithms and simulation results”, IST-AROMA Project, Deliverable D09, Nov. 2006.

[6] O.Sallent et al., “Intermediate report on AROMA algorithms and simulation results”, IST-AROMA Project, Deliverable D12, Mar. 2007.

[7] F. Casadevall et al., “Overview of the EVEREST. project”, IST Mobile Summit 2004

[8] UTRA-UTRAN Long Term Evolution (LTE) and 3GPP System Architecture Evolution (SAE), http://www.3gpp.org/Highlights/LTE/LTE.htm

[9] 3GPP TR 25.913, “Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN)”

[10] Eva Lindqvist from Telia Sonera, “Proceedings of Informa 3G LTE Conference”, London, 18-19 October 2006

[11] A. Barbaresi et al, “Economic evaluation of legacy IST-EVEREST RRM/CRRM algorithms and solutions“, IST-AROMA Project, Deliverable D08, Sep. 2006.

[12] Siemens Market Research, "Mobile Broadcast & Multicast Services", October 2005

[13] 3GPP TS 43.318 “Generic access to the A/Gb interface; Stage 2”

[14] Analysts: IPR issues could haunt 4G, LTE. Mobile WiMax, 20/2/07, http://www.wirelessnetdesignline.com/news/197007626

ACRONYMS

3GPP	3rd Generation Partnership Project
BVNO	Broadband Virtual Network Operator
CAPEX	CAPital Expenditures
CRRM	Common Radio Resource Management
DVB-H	Digital Video Broadcasting - Handheld
GAN	Generic Access Network
GERAN	GSM/EDGE Radio Access Network
HSDPA	High-Speed Downlink Packet Access
HSPA	High-Speed Packet Access
HSUPA	High-Speed Uplink Packet Access
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LTE	Long-Term Evolution
MBMS	Multimedia Broadcast and Multicast Service
MPLS	Multi protocol label switching
MVNO	Mobile Virtual Network Operator
NGMN	Next Generation Mobile Network
OFDM	Orthogonal Frequency Division Multiplexing
OPEX	Operation Expenditures
RRM	Radio Resource Management
QoS	Quality of service
SAE	System Architecture Evolution
TELCO	TELecommunication COmpany
UMA	Unlicensed Mobile Access
UMTS	Universal Mobile Radio Access Network
UTRA	UMTS Terrestrial Radio Access
VoIP	Voice over IP
WCDMA	Wideband Code Division Multiple Access
WiMAX	IEEE 802.16
WLAN	Wireless Local Area Network