IMS – IP Multimedia Subsystem facilitating Convergence and Competition

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Abstract

One of the most heated debates in the mobile industry today is the options how to converge the mobile and internet business domains, technologies and services. In the convergence there is obvious new value to be provided to the end users. New value is clearly needed to fuel a new cycle of fast growth in the businesses, which are still suffering the vapourised IT bubble of late 1990's. The mobile communications sector has been traditionally polarised into two competing camps, which both are now seriously investigating the best possible approach to achieve the convergence. The technical approaches however are partially different. The maximum added value of the convergence can materilise only if the technical differences can be hidden from the end users. Application and service interoperability should not be compromised regardless of some potential differences in protocols. A back-up option for the failure of standardization bodies to achieve full interoperability may be in the ever continuing Moore's law, which may allow software based radio concepts to hide the last crucial differences from the consumer.

Keywords

IMS, Internet, Multimedia, GSM, GPRS, UMTS CDMA2000, 3G

1. Introduction

The fundamental driver in networking is the value of the network, which is depending on the number of end points. The power "law" introduced by Robert Metcalfe claims that the value of the network is relative to the second power of the number of connected users. The law especially is applicable to the networks where any user has equal capabilities to access, connect and provide services. Similar laws have been presented even earlier by Sarnoff for unidirectional networks such as broadcasting. The value of such network is clearly less. According to Sarnoff the value is linearly comparable to the number of end points, ie. receivers of the broadcasted signal. Intuitively also the value is less, because the end points cannot communicate to each other. There are also further derivatives of the same idea, such as Reed's law and Kilkki&Kalervo's law dealing with internal grouping of the fully connected networks and the special value of the group. These laws emphasise the internal cohesion of the group as well as possibility to belong to several groups at the same time. The value of such network is estimated to be even in exponential relation to the number of groups. Peer-to-peer networks, conferencing services, Internet chat rooms and many other phenomena of today are the examples of the growing importance of groups. [1], [2], [3]

Phenomena of modern communication networks can not be fully analysed and explained without understanding of the fundamental underlying technologies. The evolution of silicon based integrated circuits has followed another important law, Moore's Law. When Gordon Moore as the Director of Research and Development Laboratories of Fairchild Semiconductor published his vision in 1965, it was relatively easy to believe that it may be correct, for the next couple of years but propbably nobody dared to claim that it will set the pace for so many industries for the next 50 years or maybe more. There is no reason not to believe in Moore's law at least for the next 10 years. Similarly the software industry has reached the inflection point during the last 10 years. The fundamental factor in software technologies is the emergence of general purpose platforms, such as Microsoft Windows and Linux, which both have made it possible to unleash the innovation at the end-points of the network. Naturally the capabilities of the network itself are important but refering to laws of Sarnoff, Metcalfe, Reed and others, centralised value in any network is only linearly important. [4]

When we look at the market and business environment today it is obvious that growth of wireless voice in

developed countiries has reached mature mass market phase. Similar situation may be estimated to be happen in developing countries within the next 5 years. Saturation in number of subscribers and increased compatition between operators have pushed the business into quite hard mode, where Average Revenue Per User (ARPU) is declining for most of the operators and for most of the customer segments.

Growth in the Internet is more stable and particularly broadband access and flat rate charging schemes appeal to consumers. Internet broadly speaking still lack the real time communication applications and therefore Metcalfe's law is only partially applicable. Internet today is also quite location dependent and not so many attempts to make Internet mobile have been successful. Best example is NTT DoCoMo's I-Mode service in Japan. I-Mode has gained good level of acceptance in relatively short time.

What is the fundamental barrier that must be broken in order to make the Mobile Communications and Internet to converge ? There are obviously may benefits to all users in such a converged network and there is propably nobody who seriously can claim that such a convergence is bad for the mankind. For some players it may look a bit destructive but even for them this should be seen destructive in creative way.

Standardization is seen both in telecom and in internet societies as good and essential facilitator of successful business in long run. There may be some different views how the standardization should be executed but the ultimate goal is already visible in all relevant standardization fora. But is it enough to simply develop the standards and technologies ?

2. Mobile Approach

Convergence seems to beginning from many different points and directions in unpredictable way. In this paper the angle of view is mobile oriented but at the same time the intention is not to be mobile specific. Especially when talking about convergence it is important not to be limited by any specific "domain" characteristics because this will easily lead to isolated thinking of networks, where value is obviously not more than the sum of the elements.

For mobile environment it is important to see and believe the gradual internal convergence of technologies and systems, including also kind of techno-darwinism, where some systems, technologies and businesses simply have disappered. In first generation of mobile services and systems each country had their own national approach. With the introduction of second generation mobile systems two important factors influced the development: All digital technology and liberalised telecom market. This lead to highly competitive markets which left only 3 (or 4 if we include national PDC system in Japan) main systems alive and where production cost due to scale of economies enabled consumers to adopt mobile technology. The bowling alley service naturally was voice. [5]

Mobile communications mass market has now been established and we are moving on to the 3rd generation of mobile systems. The ultimate goal of ITU and for many others too, was to develop one single technology and establish one single global market with the 3rd generation. The advantages were seen obvious. Currently it looks like world is polarized into two competing camps, where the centers of gravity are the current GSM market and current CDMA market. Both of these camps are implementing their own vision of 3rd generation, for GSM it is called UMTS and for CDMA it is called CDMA2000. It is important to realise that there are quite few companies or players, who unanomously are supporting only one of the camps. The fact of life is today that most of the players are represented in both camps which easily leads to idea of convergence on one level higher than the basic mobile technology.

Both major 3rd generation system concepts have been driven by enhanced radio interface demands. The core network development has been hiding behind the curtains. But gradually in both systems convergence towards Internet has started. Internet Multimedia Subsystem (IMS) is the target now for GSM/GPRS/WCDMA based UMTS as well as ALL IP network architecture for ANSI-95/ANSI-41 based CDMA2000. These two approaches are currently somewhat different. Therefore the interesting issue is: Will these two approaches finally make the radiosystems and cellular markets to converge also or will the two pole competition continue to the forseeable future ?

There are other 3rd or 4th generation developments on going such as TD SCDMA in China and "MOTO-MEDIA" project of NTT DoCoMo and Hewlett-Packard. These concepts can be seen either as simply competiting air interface technologies for the 3rd generation, where timing most likely is late, or as very initial concepting work to be used after 2010 and therefore timing is too early. In both cases it is safe to assume that the convergence of mobile and internet has already happended before these initiatives impact the market and therefore their relevance for this discussion is limited.

3. BRC, BRR and CSF

The aim of this paper is to discuss the factors impacting the succesful operation of IP based Multimedia services over wireless, primarely cellular systems. The framework used in this paper is based on three categories of factors.

Basic Requirements to Compete (BRC).

Basic requirements mean the fundamental features and functions, which all the service platforms must have. There maybe some saturation level in BRC above which there is less added value but there is fundamental minimum level, under which the service is not going to be used at all. Basic Requirements typically are available in all existing systems already. In case of Mobile communication BRC covers areas such as availability and number of services, performance and quality of the services and competitiveness of pricing. In these areas the new service must not be worse than the competition. In succesful case it is expected that some improvement should be available for all factors

Basic Regulative Requirements (BRR)

Often these requirements can be considered as part of BRC but in this case it is reasonable to deal with BRR separately. The Internet has been so far without any heavy regulation in most of the countries but with introduction of real time communication and also because the Internet is becoming a major technology in all societies more regulation is expected. Regulation with IMS is targeted to protect the consumer. Therefore the regulation should be considered primarely as positive element.

Critical Success Factors (CSF)

Critical success factors are the elements, which make any new concept fundamentally different from existing service offerings or technologies. The difference includes also the opportunity to create such a major discontinuity, which may have implications even to the structure of the industries. The CSFs may make the customers to abandon the old service and subscribe the new one. The fundamantal factor is that the old concept is not normally able to follow the new one and therefore is bound to become gradually obsolete. Mobility of 2nd generation cellular can be seen as CSF because it was highly appreciated by customers and for fixed PSTN/ISDN is was not possible to follow. It is important to note also the desperate attempts of old paradigm to copy but because the limited technical capabilities to support mobility and with heavy legacy in general in PSTN/ISDN these attempts were bound to fail. DECT is a great and sad example of such initiative.

In the case of IMS the fundamental paradigm shift which may be hard for current technologies and concepts to follow include elements such as support of innovation, support of unlimited number of business models and possibly also support of small world phenomenon. Possibility of the peers to communicate freely as they choose throught the networks, including cellular, wlan and local adhoc networks, using any multimedia content they like has been one of the successmodels of the Internet.

In the following chapters different angles of views are discussed. The conclusions address the BRC, BRR and CSF based on the discussion and summarise the current status of the work in different relevant areas for IMS introduction.

4. Standardization fora

When the race towards 3rd generation mobile systems started in early 1990 the development of 2nd generation was the main agenda of regional standardization bodies, ETSI, ARIB/TTC and TIA/CTIA/EIA/ANSI. Competition gradually made the markets and industry players to focus only two development paths as described above. This development was recognised first in ETSI, which actually managed to facilitate the creation of 3rd Generation Partnership Project (3GPP) to be forum for global UMTS development. 3GPP was open for anybody to join. This made it possible also to national standardization bodies and companies from Far East and from Americas to join the GSM bandwagon. [6], [7], [8]

This approach was so powerful that CDMA2000 promoters soon followed and created similar forum, 3GPP2 to develop the other major radio system standard forward. Similarly, almost the same national standardization organizations as well as corporations are represented in 3GPP2, also. [9]

Also in ETSI, it was noted that detailled service standardization may not be the best way forward. Therefore ETSI/SMG decided not to explicitely standardizise service beyond what has already been done for GSM. This created a vacuum, which originally was intended for operators' services for differentiation. These services, however, would have been typically non-interoperable between the operators and therefore this work never was taken very seriously

forward. After many individual attempts Open Mobile Alliance (OMA) was established by the market players close to 3GPP and 3GPP2 but OMA also warmly welcome the IT industry players, whose role in traditional telecom standardization naturally have been relatively small. [10], [11]

Internet standards have been developed by the Internet Engineering Task Force (IETF) since 1986. Role of IETF has not changed, except that especially 3GPP and 3GPP2 have developed very tight co-operation with IETF during the last few years. This is the consequence of the role of Internet Protocols gaining more and more importance and relevance also for mobile cellular systems. [12]

The worksplit between all these forums is not very clear and there has been some quite heated discussions on the details. On general level the intetntion is quite clear:

- OMA is supposed to be responsible on service and application level standardization.
- IETF provides the basic set of protocols for IMS and ALL IP network
- 3GPP and 3GPP2 develop the radio systems and architectures for the overall concept as well as some extentensions to IETF protocols to make them fit better to harsh radio environment.

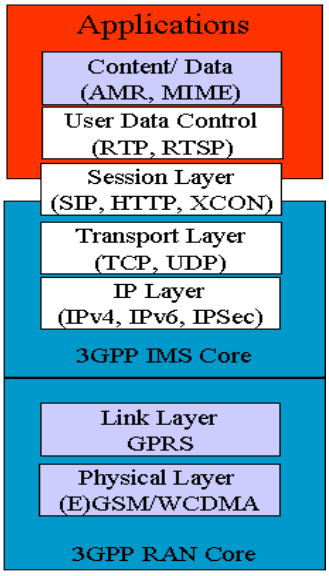

Figure 1. Role of standardization forums in the development of converging Mobile and Internet

The 3GPP in now developing the IMS as the next major step for UMTS and similarly 2GPP2 is in charge to develop ALL IP network architecture and technology to CDMA2000. IMS for CDMA2000 is called also Multimedia Domain (MMD). [13], [14]

There is one important achievement which has to be emphasised. The 3GPP has been able to set up a very good co-operation with IETF for the joint development of 3GPP IMS. The GPP2 has later on adopted even more IETF oriented approach for 3GPP2 IMS. This includes also visible role of the private (corporate) networks in the architecture of the 3GPP2 IMS. The 3GPP however aims faster towards the future with strong commitment to IPv6 and Quality of Service. Recently also OMA has established co-operation with IETF but there is some lecagy issues to be solved before this co-operation will proceed without significant friction. [15]

As an evidence of the fruitful co-operation there is up-to-date project management carried out by the 3GPP to track the work in IETF and also to point out the critical dependences. Current status of these IETF dependenced for IMS is that all the major session management dependences have been solved and therefore the basic IMS can be implemented. The new service specifications for Instant messaging, Presence, Group and Conferencing are still under development for Release 6 of 3GPP (June 2004). Also there are some significant open issues in WLAN interconnection, which are related to authentication, billing and charging. [16]

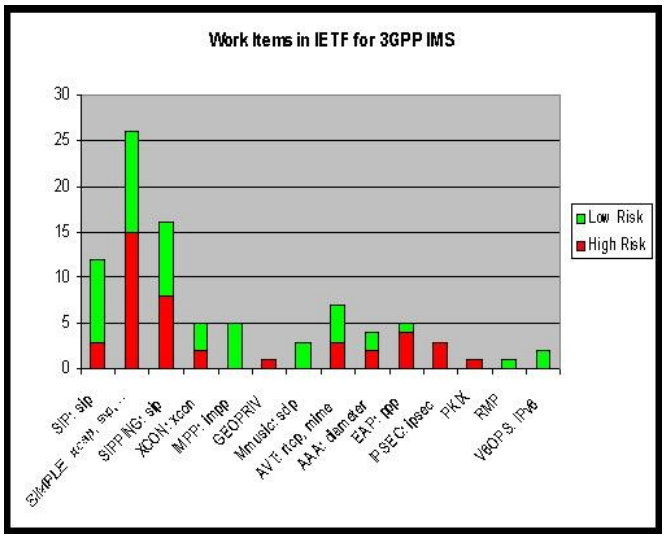

Figure 2. Work item dependences between 3GPP and IETF

The overall number of dependencies is currently 91. The value of this figure is to demonstrate the depth of

the co-operation. This does not list the complete number of details of IETF specifications used in 3GPP IMS but only the current dependences. The total number is naturally much higher.

Standardization and especially co-operation of the standardization organizations therefore seems to be a major driving for of the future IP based telecommunications systems. There is no doubt that the basic functionalities also must be available as global interoperable standards. The key question however, is that how much there is room for non standardised application and service level differantiation and innovation. [17]

5. Towards convergence of IP over wireless

IP Multimedia Subsystem and ALL IP Network Architecture are both addressing the same demand: Full service offering using IP protocols over mobile cellular radio interface. The harmonization discussins for IMS have been ongoing for several years and currently it looks like the IMS itself is going to be quite similar, if not the same for 3GPP and 3GPP2.

Role of Mobile IP

There is however one quite fundamental difference between the two approaches. In UMTS evolution mobility is based on GPRS mobility and roaming. IP services are offered on the top of the platform where Mobile IP does not have any real role. In CDMA2000 evolution the mobility is supported by Mobile IP. This difference will impact the way the end user is able to access services especially while roaming.

In long term the IP mobility is needed in all systems anyway. The reasons for this include the loose interworking model selected in 3GPP and 3GPP2 for WLAN interworking, wish of the most advanced operators to integrate also ADSL type IP access subnetworks into the same communication system and high demand for optimum routing also in IP services. Optimum routing was a difficult task in GSM network because it will require more co-operation and trust between the operators but its merits are very clear in improving the end user's experience of the communication. The most significant advantage in IMS is probably the reduced end-to-end delay, which in IP based networks may grow unacceptable high even without optimal routing. The GPRS network specifications do support optimal routing also but the current plans of the operators seem not to include this option. With IMS real time services it most likely becomes mandatory basic requirement to compete.

Mobile IP may have some challenges because static IPv6 addresses may reviel identity of the end user to parties who should not necessarily need to know. Privacy in future networks is surely very important factor and should not be overlooked.

The 3GPP2 network architecture is therefore more IP oriented and may be able to support better the end ot end IP connectivity. How important this difference will be can be estimated based on the speed how fast WLAN access networks are taken in use in 3GPP and 3GPP2 networks. If there is a major difference in this technology adaptation it may be indicative also for the future overall success of the network architectures. There question about roaming of WLAN may actually turn out to be a question of roaming based on Mobile IP. It is possible that actually 3GPP2 based CDMA2000 networks will support global roaming with Mobile IP earlier than WLAN. This is not a technology issue but business issue. Roaming is extremely important for CDMA2000 and roaming of IMS services makes no difference. There is also a business environment building to support roaming in CDMA community. Taking these two together may create an interesting pro-Mobile IP movement. [18]

There is also further work ongoing to enhance Mobile IP for fast handovers in WLAN environment. This is of medium importance for WLAN but has little if any importance for UMTS or CDMA2000 networks. In Wireless Wide Area Networks the spectrum efficiency and real high speed mobility management requirements are so much more complex than in WLAN that re-designing all that using Mobile IP based solutions is not justified. There is no service foreseen, which would behave any way better even if Mobile IP would be used inside the 3G radio networks for inter basestation handovers.

Current IMS is not taking mobility of the servers very seriously. It is however quite likely that terminal devices and their capabilities will develop fast during the next few years. It becomes possible to store and collect a lot of information, including multimedia content, video clips and images, in the terminal devices. A new range of rational use cases will emerge where the role of the terminal devices is more that of a server than client. IMS is in pricinpal client-client peer to peer model. But part of the opportunity space is not utilised if mobile to mobile direct connection can not be made easily. These connections will anyway be implemented using local connectivity but it would be of great value to operators to allow the same to happen also through IMS and Wide Area networks.

Service continuation

From end users' perspective the most important factor is service interworking and seamless service continuation in all domains. These two are however fundamentally quite different issues. As long as the terminals have only one type of radio access capability the only important factor is service interworking. This means that users of UMTS or CDMA2000 or WLAN may use the same service at the same time. As an example all of these users may join the same conference using their single mode terminal devices. This shall work as long as their single network coverage is available. The primary goal in IMS is to focus on service interoperability. This is the main factor for network effect as defined by Metcalfe. There is one major open issue today in IMS service continuation. This is the issue about default content formats. The 3GPP IMS default voice codec is adopted from GSM, ie. the Adaptive Multirate Codec (AMR). This codec has one common mode with 3GPP2 Enhanced Variable Rate Codec (EVRC). For good performance in Voice over IP traffic the voice codec should have as low net bit rate as possible. This is not the case for the common mode.

IMS in principle is able to run any content adaptation functions. For basic voice traffic it evidently will also do so especially for connections towards legacy PSTN/ ISDN networks. But for rich communication in IMS based networks it is very difficult to image how to do such adaptation in general case, ie. without breaking the encapsulation of content for IP.

Quality of the Service (QoS) has been a complex issue in the Internet for quite some time. The vastly increasing peer-to-peer traffic may force the Internet service providers to introduce QoS to their networks earlier than later. Also major IP network vendors are now supporting QoS in their recent products. In the Wireless IP the QoS has been taken into account from the beginning. This is especially so for 3GPP. The GPRS network is able to support QoS when the flows requiring different QoS are connected with different PDC contexts. WCDMA radio access network supports QoS also quite well. In CDMA2000 radio network ane specification has been develop and up to six separate flows with different QoS parameters can be handeled by the CDMA2000 air interface. Single PPP session is used on higher layer between the Mobile terminal and the Package Data network. Concept is a bit different from 3GPP apprach and there will be issues make these two to interwork seamlessly. [19]

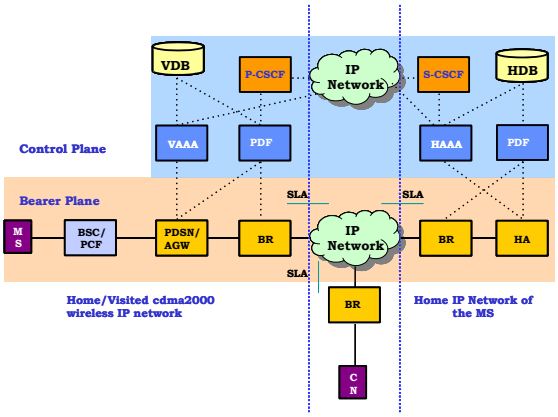

Figure 3. End to End Quality of service reference model as specified in 3GPP2. [20]

Both systems have possibility to optimise the IP headers for wireless transmission. Robust header Compression (ROCH) algorithm specified by IETF is supposed to be used. It is also use header removal but this is applicable to 3GPP2 VoIP traffic only. [21], [22]

Some Prevailing issues

The 3GPP specification has been created based on the Mobile Operators' needs. There has been high demand for security and control, which has led to the situation where GSM operators' networks are currently isolated island of Intranets, separately from the general Internet. In practise this means that all the flows, including user data is carried via home network. Similarly the assumption is that when WLAN access is used with the IMS, also the WLAN data flows will be routed via home network. Operators have build GPRS Roaming exchanges (GRX) to route the GPRS traffic. This approach is surely very safe and easy to control because the traffic never goes to the open Internet. But on the other hand this may impact the signal behaviour such as delays significantly. It is possible for the GPRS operators to optimise the delays and in principle provide also better QoS compared to the normal Internet. Routing always via home network allows the mobile operator to monitor the volume and timing of the data flows, which naturally is useful if operator wants to double check that the roaming charges between the operators is done properly. On the other hand this may create so much extra costs that it would be simply better to build trust rather than fences between the operators. [23]

In 3GPP2 specifications its is also assumed that Roaming and Quality of Service will become important items. The 3GPP2 network is connected at least in principal more openly to the Internet using IPv6, mobile IP and IETF based QoS. This may become an advantage for CDMA2000 IMS if the interworking

with fixed Internet can be handeled better. The 3GPP2 still recognises the need to control the QoS resources carefully and also to be able to charge for the service according to applicable Service Level Agreements (SLA).

Interworking with Legacy

Finally, both architectures will provide interworking with their legacy circuit switched telecom networks, GSM MAP and ANSI 41 core networks. Legacy services are available parallel to the IP services. It is somewhat unclear what is the role of interworking between the IP based and SS7 based services. The both architectures enable in principle full interworking with old services. However, when looking from the IMS point of view, the old networks do not provide any interworking with the new services. Potentially the value of network based interworking could be to relief the IMS development from re-development of many supplementary services, most of which make little sense in IP based paradigm anyhow.

The role of Open Service Access (OSA) is very similar also in both concepts. Role of this open network Application Programming Interface (API) is to allow third party application developers to get direct access to the core network data bases. Naturally there will be some data bases, especially location and presence related, where the value is obvious also to anybody developing applications. What is the relevance of the work by so called Parley Group for IMS services is to be seen. It may well be that the planned services will be focused mainly to support circuit switched telecom paradigm, including networks without IMS and IP capability. This appraoch hardly is crucial for IP based IMS services.

Controversial IP Issues

In the current IMS concept there are some design choices made, which must be implemented wisely. Originally as mentioned earlier the intention in 3GPP has been to use IPv6 systematically in the IMS. This is now beeing compromised because of many network operators are not willing to upgrade their networks to support IPv6 by the timeline of IMS. This will lead to dual stack implementations in all IMS capable terminals and other network elements. Also the default mode will most likely be IPv4. In GPRS system PDP Contexts support specifically either IPv4 or IPv6 (or PPP). This means that in dual stack operation also PDP Contexts shall be set according to the IP version. This will lead to additional delays in the process when terminals are connecting to the network, because they have to try both options and only then decide how the stacks are to be used. Naturally the design will be more complex and consume more memory and finally will be more expensive and worse in performance in the hands of the consumers. Dual stack implementation requires also two IP addresses per terminal and may become a real issue because of limited number of IPv4 addresses. SIP signalling assumes that the IP layer is available any time. Always On – mode in GPRS requires as many IP addresses as there are IMS activated terminals. Further on, unnecessary PDP contexts require resources in GPRS network and ultimately slow down the normal operation of the network.

Fixed Internet will stay with IPv4 for long time. Therefore in case of SIP interoperability some translation between IPv4 and IPv6 is anyway needed. Translators need to break the SIP signalling end-to-end integrity and therefore may not work, if some end-to-end integrity security measures are used. [24], [25]

Additional addressing and port translator, IPAMP is also needed. The functionality of IPAMP is very similar to any Network Address Translator (NAT), and these two functionalities can be easily integrated into the same physical device.

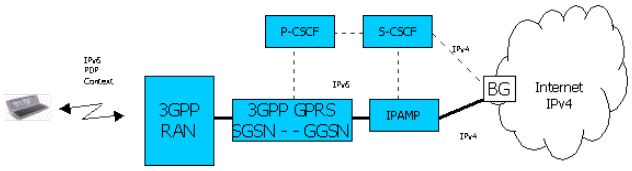

Figure 4. Interworking between IPv6 and IPv4 in 3GPP IMS. Source IETF

For non-SIP traffic it is possible to use temporary IPv4 addresses and for instant browsing within IPv4 network is doable with dual stack. The decisions are now final and therefore the task for system and device development teams is to minimise the damages.

One more issue in IMS is the decision to separate content and control flows. The positive effect is that this way it is possible to provide different QoS and security as wells charging for signalling and user data. But this may cause some unexpected phenomenon in application interworking and compatibility, if those applications assume traditional Internet and use signalling to probe the network. In the case of IMS this does not provide information about the network for use data. Operators have to be cautions not to route real time signalling flows totally separately from user data.

Main idea of separate signalling traffic is to route the SIP signalling through the Call Session Control

Functions (CSCF), or actually route the signalling via several of them, Proxy, Interrogating and Serving CSCF's. All of these control functions have a possibility to break the end-to-end SIP signalling by modifying the content of SIP signalling. The design goal for this is to guarantee proper interworking with legacy networks and also to support charging, including charging of additional elemenents, such as call related browsing as a total bundeled service package. This in best case will lead to nice service differentiation possibilities for operators but in worse case create a mess, where no third party services based on SIP signalling and end to end sessions will work.

6. Cost Competitiveness of IP based Wireless Services

Pricing and cost competitiveness is definitely one basic requirement to compete in case of IMS. Similar services are already available in Internet and mobility using non-IMS WLAN with roaming will definitely become one major opportunity. Where are the possibilities for IMS to compete ?

When we look at the current mobile voice call tariffs and cost structure, terminating fees clearly represent a major part. Intraoperator calls are in limited manner included in monthly fee. There is no change for IMS voice calls, ie. VoIP calls, to compete in this scenario, when the terminating part is outside the IMS network. Interworking with legacy services also from this perspective does not seem very lucrative. It is also obvious that VoIP over cellular have some inherent difficulties because of quite heavy overhead.

The cost competitiveness is based on the combination of voice and multimedia as well as combination of more complex scenarios like multimedia conferencing. If we compare e.g. GSM conference call and IMS related Push Over Cellular (PoC) conferencing, it is possible to achieve some significant cost advantages also. [26]

Similarly IP based paradigm will be comtetitive in some environments where SMS and MMS are competing with E-mail and WEB browsing is competing with WAP Browsing. The competitive position is not only based on cost but also end user experience has to be comparable. The fact of life is that in many cases the IP based services have clear cost advantange over current telecom value added services.

IMS can be seen as control mechanism, which can be used to control the prices of IP based wireless services. It is not very credible that the additional features and services and better performance of IMS over plain old Internet over cellular allow significantly higher price level than what is available without IMS. IMS also enables bundling of services in such as way that total cost of ownership for IMS users can actually be lower than using the unbundled services over cellular bit-pipe. The capability to taylor the services and tariffs using IMS can be seen as a tool for operators to set the prices in such a way that optimum prices are available for each user. This in principle optimises the use of the network resources and the profit the operator is able to collect.

7. Regulating IMS

IMS is gradually supposed to take over traditional voice traffic when end users migrate to rich real time convensational communications services. Therefore there is relevant concern about applicable regulation in different countires for IMS.

Areas subject to regulation in IMS can be devided into four basic areas.

The most immediate consideration is about the privacy of the end users. As mentioned above the GSM operators' intranet will take care of majority of the privacy concerns, as long as consumers can trust that non of the participating operators do not compromise the privacy, including that of roaming customers. With the IMS, there is a lot of new interesting real time data available about the subscribers like presence, location and others. These application servers are connected to IMS core and therefore the data may be available to non-authorised parties, also. The sitation become much more challenging when non-IMS SIP clients are used and non-3GPP networks may be used to connect to the 3GPP network application servers.

Lawful Interception is kind of opposite requirement imposed to all network operators today. This service for authorities is implemented for circuit switched voice traffic as a special functionality of the GSM core network. Voice is transported in the network in non-ciphered mode, which make the interception easy to implement. For real time IMS traffic this may be more challenging task to do. Currently the regulation of IP traffic is not well developed in most of the coutries but the working assumption is that similar regulation will become mandatory as in the circuit switched networks today.

Third area deals with emergency services using IMS core. The assumption is that there will be IMS only

network also. In such cases it is natural to require emergency call using IMS only network. Single mode IMS network is quite far in the future and for the long time, all the cellular terminals will include circuit switched capability parallel to packet based services and IMS. For the terminal with legacy support it may be much better way to use traditional emergency call as default. When IMS network is accessed with single mode Wireless LAN terminals, we may see the first needs also for single mode IMS emergency services. It is currently open, whether the emergency services should include other than voice media.

Last but not least area in regulation is higher level requirement of open (or what ever the regulation is set) competition between the market players. Separation of transport and services is clearly on the agenda of the EU. Liberalisation of the telecom market has clearly been a blessing for the European communications industry during 1990. When the technology creates a disruption, the regulators have to pay attention that the monopolies do not emerge based on the interfaces, which by accident have been speficied as closed or by global players who can use their vast networks to utilise the regulation of a country or region that fits best for them. Regional regulation in some cases may not be strong enough because during the recent years consolidation of the mobile network operators has created companies, whose home market is the whole world.

8. Supporting different value systems

In chapter 5 the issues with end-to-end transparency in SIP signalling were discussed. This is impacting the opportunities, how 3rd party service providers may or may not be able to provide services to the consumers. The current concept in 3GPP IMS is inherited from so called Virtual Home Enviroment (VHE) approach, which is supposed to make all the home network services to roam. These services may be provided in the home network by the home network operator or by any third party who has made a contract with the home network operator. IMS also includes standard interfaces to Parlay/OSA application servers. Hence at the first glance it looks like the operator's customer must be fully satisfied.

The strong home network operator role makes is challenging to other operators to provide any service without a solid contract with the home operator. As an example if the end user is roaming in another network it is difficult to use local services provided by this network without routing at least the signalling through the home network. Services might ne available physically just behind the corner but the signalling traffic and potentially also the user data traffic circulates all a-round the globe.

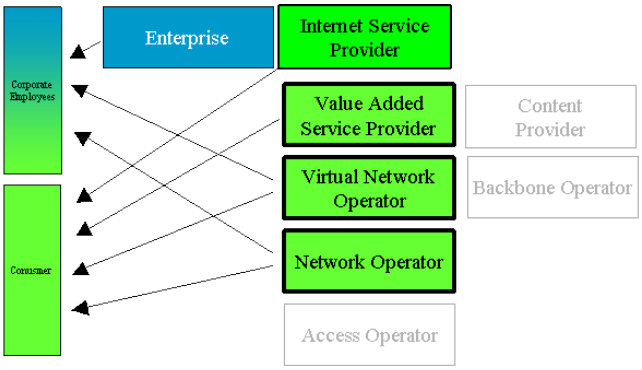

Figure 5. Simplified model of Value system in IMS.

Virtual network operators' role today is to co-operate with only one network operator, which may have several virtual operators competing to each other. But virtual operators can not make wholesale deals with several network operators and this way clearly demonstrate separation of network ans service layers. The situation in mobile networks will not change until the highest layers, ie. the ISP's and large corporations enter the market. With IP technology it is possible that many of the services will run outside operators networks. It is important that the specifications, regulation and business systems are capable to support any combination of roles. Value of the network is maximised when all the end points connected to the network are able to inter-operate. It is also important that the value systems can be developed to the direction, which can respond to market needs in optimum way. This will maximise the support of innovation.

In 3GPP2 networks the role of private networks at least in the standardization level is taken into account. Since CDMA2000 still is the challenger against the domination of the GSM/GPRS/WCDMA, it is possible that role of private networks in CDMA2000 system may gain stronger role.

9. Supporting Innovation

Innovation can take place anywhere but Internet has shown to use the power of innovations at the edge of the network. It is always possible to use 3GPP and 3GPP2 networks as bitpipes. This is important basic service required also by corporate customers, who want

to run their own services and not necessarily use operator services, for instance use wireless network as an extention to their Intranet VPN setup. Same quality of service requirements, possibly also same charging requirements will apply but in this case the signalling traffic will not go through separate path. Is it possible to serve the corporate customers if the focus in the network development has been in the different principal approach ? Is it rational to develop potentially two parallel designs ? Is it fundamentally possible to individual consumer to use the 3GPP and 3GPP2 wireless networks for his private services, ie. whether VPN based solutions may be available for corporate customers only. It is impossible at this point and time to make any conclusions how the future IMS networks will be provisioned but it is obvious that all the innovation can not be created in the core of the network. This is now a challenge to IMS networks in the competition against other wireless IP systems.

The 3GPP2 has defined a vision for the future of CDMA2000 based IMS or MDD. This vision includes a lot of evolutionary aspects for legacy support. It also enphasises operators possibilities to implement networks using phased approach. These are naturally very important factors for current operators and their vendors. The culmination point in the vision is the holistic view of standards based interoperability of the value added services. [27]

Aiming at full support of status quo in value systems dows not necessarily facilitate disruptive innovations, which finally will impact the behavious of the users and make the services so addictive that end users can not live without.

10. Conclusions

We have reviewed IMS concepts, which will be quite similar and in best case fully interoperable for both the 3GPP and 3GPP2 specified mobile networks, GSM/GPRS/WCDMA and CDMA2000. For the both networks the basic requirements seem to be satisfied quite well and the value of the network will be maximised because of interoperation and compatibility of the services between the networks. There will be some lower layer, below IMS, differences, especially in the area of IP mobility and Quality of service, which may cause some reduction and friction in the interoperation. In best case these issues will not jeopardize the value proposition of the IMS concept.

Basic regulative requirements can be fulfilled in both systems. This may mean some more stringent requirements than in the current day fixed Internet. But it is likely that with real time service support similar regulation will be applicable to fixed Internet also. This may create some friction but may also make Internet commercially even more succesful. This does not require that current paradigms for non-real time traffic must be changed.

Critical success factor in the future is the largest possible interoperability domain of any communication system. Varios additonal needs and business models of independent Internet Service providers as well as those of large corporations shall be supported by the IMS concept. This must be taken into account in the standards, regulation as well as in practical network implementations in order to maximise the value of IMS over any other competing IP based communication system.

Finally the capability to support new innovation will be very important for IMS. It is not clear if this is fully supported in the current approach, definitely it is not exploited. There is only a limited amount of innovation which can be done in the core of the network. Most of the innovation will take place at the edges. This has been experienced in the fixed Internet. Forcing network operators to provide bit pipes only will happen if the operators do not allow flexible application and service development. In best case independent service development and provisioning will utilise the IMS capabilities, enjoy security and charging mechanisms but it not obliged to subscribe to the total package. It is like picking the raising from the bun. These raisins can still provide lucrative business opportunities to network operators running the IMS core network and offering services, which people may choose but are not forced to use.

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