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Document for presentation:	**All-IP Network (AIPN) Feasibility Study; TR 22.978, Version 1.0.0**
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Abstract of document:
This document studies the feasibility of the progression of the 3GPP system to an All-IP Network (AIPN). More specifically, this document:

a) Identifies and describes the objectives and user, business and technological drivers for progression of the 3GPP system to an AIPN:
   i) Investigates the High Level Objectives, Motivations and Drivers and impacts upon current models (e.g. business/charging/service models)

b) Defines and develops the end-user and network operator aspects of an AIPN:
   i) Produces an AIPN vision.
   ii) Investigate needs and requirements associated with the evolution of the 3GPP System to an AIPN.
   iii) Investigates requirements associated with the reuse of legacy infrastructure and support of legacy terminals
   iv) Investigates leverage of technological convergence and cost effective introduction of new technology

c) Identifies the capability expansion required to introduce the AIPN concept into the 3GPP system

d) Evaluates whether an AIPN should be standardised within 3GPP, and in the case of a positive conclusion identifies the subsequent steps to be taken to achieve this by defining the scope, target, and roadmap for work to be undertaken within Rel-7 and future 3GPP releases.

Changes since last presentation to TSG-SA Meeting #:
None, initial presentation.

Outstanding Issues:
Clarification of the meaning of some terminology e.g. ‘centralised and common network control’, ‘seamless’

Clarification of application and service creation

Justification of CAPEX and OPEX reduction statements

Review of Impacts to Current Service Models

Consideration of control-loop based optimization of the running system in an autonomous way, self-healing for fast recovery of failures and increased robustness.

Based on resolution of the scope of AIPN changes to the text for heterogeneous access networks text may be necessary.

Clarification of ‘duplicated technologies’ and vision of terminal convergence in chapter 5.1.1.3

High-level principles of moving networks, ad-hoc networks and PANs.

General terminology definition improvements e.g. AIPN scope, Access Network/Core Network/Access Technology/Mobility concepts etc…

Contentious Issues:

None

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Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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x the first digit:

1 presented to TSG for information;

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Introduction

Introduction

The 3GPP system currently supports GERAN and UTRAN based Access Networks in conjunction with Circuit-Switched and Packet-Switched Core Network domains and IP Multimedia CN subsystem. The All-IP concept was initially introduced within 3GPP in Rel-4 with the standardisation of the MSC Server - MGW split core network architecture for the CS domain and extended from Rel-5 by the standardisation of the IP Multimedia CN sub-system. WLAN as an alternative access technology to access services of the mobile core network is recognized from Rel-6 onwards.

In order for the 3GPP system to cope with the rapid growth in IP data traffic, the packet-switched technology utilised within 3G mobile networks requires further enhancement. A continued evolution and optimisation of the system concept is also necessary in order to maintain a competitive edge in terms of both performance and cost. It is anticipated that the progression towards an 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. Moreover, it is important to ensure compliance with Internet protocols within future developments of the 3GPP system.

Additionally, the following aspects identified within TR 21.902 “Evolution of 3GPP System” [2] are considered relevant to the long-term evolution of the 3GPP system:

- *A seamless integrated network comprising a variety of networking access systems connected to a common IP based network supported by a centralised mobility manager*
- *A similarity of services and applications across the different systems is beneficial to users*
- *3GPP should focus on the inter-working between 3GPP Mobile Networks and other Networks considering mobility, high security, charging and QoS management*

Taking the above into consideration it is necessary to further define the All-IP Network (AIPN) concept, explore user, business and technological drivers and evaluate the feasibility of evolving the 3GPP system towards an All-IP Network (AIPN). Furthermore, aspects of the 3GPP system requiring enhancement need to be identified and developed in accordance with this common vision.

This report discusses the concept of an "All-IP" network. In the context of this report the term "All-IP" does not just refer to the transport protocol used within the 3GPP network. 3GPP Release 5 and Release 6 network can already be implemented just using IP transport and could in that sense be said to be "All-IP". In this report the term "All-IP" refers to the general concept of a network based on IP and associated technologies which provide an enhanced, integrated service set independent as far as possible to the access technology used.

1 Scope

This present document studies the feasibility of the progression of the 3GPP system to an AIPN. More specifically, this document:

a) Identifies and describes the objectives and user, business and technological drivers for progression of the 3GPP system to an AIPN:

i) Investigates the High Level Objectives

ii) Investigates Motivations and Drivers

iii) Investigates impacts upon current models (e.g. business/charging/service models)

b) Defines and develops the end-user and network operator aspects of an AIPN:

i) Produces an AIPN vision, taking into account the special requirements for the mobile community e.g. carrier grade, optimisation for the radio environment, recognizing support of multiple access network scenarios.

ii) Investigate needs and requirements associated with the evolution of the 3GPP System to an AIPN and identifies a 3GPP view on how IP technology and associated transport technologies should be evolved towards an enhanced multi-service network.

iii) Investigates requirements associated with the reuse of legacy infrastructure and support of legacy terminals

iv) Investigates leverage of technological convergence and introduction of new technology in a cost effective way e.g. how the introduction of an AIPN will enable significant cost reduction (CAPEX and OPEX).

c) Identifies the capability expansion required to introduce the AIPN concept into the 3GPP system (migration and co-existence)

d) Evaluates whether an AIPN should be standardised within 3GPP, and in the case of a positive conclusion identifies the subsequent steps to be taken to achieve this by defining the scope, target, and roadmap for work to be undertaken within Rel-7 and future 3GPP releases.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 21.902: "Evolution of 3GPP system".

[3] 3GPP TS 22.234: "Requirements on 3GPP system to Wireless Local Area Network (WLAN) interworking".

[4] 3GPP TS 22.101: "Service aspects; Service principles".

[5] 3GPP TS 22.105: "Services and service capabilities".

[6] 3GPP TS 22.228: "Service requirements for the Internet Protocol (IP) multimedia core network subsystem; Stage 1".

[7] 3GPP TS 23.125: "Overall high level functionality and architecture impacts of flow based charging"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

All-IP Network (**AIPN):** A network based on IP technology where various access technologies can be connected. The AIPN provides common capabilities independently from access technologies for all aspects (including mobility, security, service provisioning, charging and QoS) which enable the provision of services to users and connectivity to other external networks.

IP service: a service using an IP bearer provided by an IP service provider. For IP services data traffic is routed according to the IP addresses of the sender and receiver.

IP service provider: a service provider that provides IP services. This may or may not be a network operator e.g. the operator of an IMS would be an IP service provider according to this definition.

IP service subscriber: a subscriber to an IP service provider that uses IP services.

Seamless Service: services provided across access technologies and terminal capabilities. Provisioning of this service is continued between and within access technologies and between terminals with minimal degradation in the service as seen by the user.

End-user mobility: The ability for the subscriber to communicate using the device or devices of his/her choice,

Terminal mobility: The ability for the same UE to communicate whilst changing its point of attachment to the network. This includes both handovers within the same access technology, and handover from one access technology to another.

Session mobility: The ability for the subscriber to move a communication session from one of his/her devices to another.

For further definitions see [1].

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AIPN	All-IP Network
CAPEX	CAPital EXpenditure
OPEX	OPerational Expenditures
CPE	Customer Premise Equipment
SSO	Single Sign-On

For further abbreviations see [1].

4 Objectives and Drivers for progression to an AIPN

The high level objectives of the move to an AIPN and the drivers that are forcing this change are elaborated in the following sub-clauses.

4.1 High Level Objectives

The following are the high level objectives that the introduction of an AIPN should fulfil:

- **Universal seamless access** – an AIPN should allow users to connect to services from a variety of device-types and access methods. This should come about through the use of common protocols, addressing schemes and mobility management mechanisms The users may not need to know the access method used. Access methods may be selected and changed according to service needs and availability.

- **Reduction of cost –** an AIPN should deliver a cost reduction in both the CAPEX and the OPEX for network operators. This could come about through the use of common IT technology equipment and the reduction in the use of mobile network specific hardware and software.

- **Flexibility of deployment** – Network operators should be able to build and dimension their network according to the needs of their users. The AIPN design should be scaleable and should not preclude the option to use and inter-work with 3GPP defined Circuit Switched domains if required. This will ensure that network operators can introduce an AIPN and continue to make best use of existing network elements.

4.2 Motivations and Drivers

The current feasibility study aims at clarifying the notion of an "All-IP Network" (AIPN) within the context of 3GPP and to define requirements for an AIPN within 3GPP. There seems to be a common understanding in the mobile communications industry that the technical and commercial evolution of this industry sector points towards an AIPN. The term "All-IP Network"(AIPN), however, is not (yet) clearly defined and – depending on one’s view of the future – can mean many different aspects of anticipated communication systems that are based on IP.

It should be noted that the 3GPP system standardised up to and including Rel-6 already provides the basis for introduction of an AIPN in 3GPP. Building on the foundations provided in previous 3GPP releases it is possible to leverage and build upon existing capabilities to evolve the 3GPP system towards an AIPN.

In order to justify the development and evolution of the 3GPP system it is essential to have an understanding of the motivations for evolving the 3GPP system in a particular direction.

In doing so it seems worthwhile to collect and list trends and drivers of the mobile telecommunications industry that now or in the future can be expected to have significant impact on the industry. This is provided in the following sub-clauses. An assessment of these trends and drivers with respect to the evolution of IP-based core and access networks, terminals and service provisioning will make it easier to create a vision what an AIPN will look like.

4.2.1 User related and social drivers

4.2.1.1 Consumer trend demanding diversification of mobile services

Diversification as service specialisation:
As the market for mobile services grows there is an increased need to be able to offer diversified and flexible services to satisfy the varied needs of users. As the service market becomes more diversified services will become more specialised in order to satisfy the specific needs of users. With this there is a need for network operators to be able to offer flexible services quickly without a large amount of capital expenditure.

Diversification in terms of usage patterns:
In addition to the current pattern of mainly server-to-person services there will be a diversification of mobile services to include person-to-person, person-to-server, server-to-server service scenarios with a variety of different subdivisions and combinations. Users will also desire the ability to be able to integrate the various services to which they subscribe. In the future mobile networks will need to be able to provide these varied and integrated service environments and enable this to be achieved in a flexible and efficient manner.

Diversification in terms of service quality:
Different services will have different user expectations placed upon them e.g. in terms of service quality. The demands for the same service may also differ according to specific user of that service at a given time.

Diversification regarding access to services:
With the increase in the diversity of the access technologies available and as well as the increase in the number

of terminals that a single user possesses it will be desirable to have the ability to use services seamlessly across different access technologies and different terminals. Users will also desire the ability to use services `anywhere` at `anytime`. This leads to the conclusion that the provision of `seamless` and `ubiquitous` services will gain great prominence within future mobile services.

Deductions

- An AIPN would provide the ability to offer enhanced and flexible mobile services, quickly and cost effectively. An AIPN can also support the diversification of mobile network services, support service integration and would enable the provision of seamless and ubiquitous services across a variety of different access technologies and terminals.

- IP technology that enables detailed service control (e.g. QoS/session control) is already available and could be further utilised within mobile networks in order to support these enhanced services.

4.2.1.2 Human need to be able to interact with his personal environment

The mobile subscriber base has grown from a small number of high-end users to the mainstream in which the number of mobile phone subscribers exceeds 70% of the population in some countries. However, in the future mobile subscribers will not be limited to just human beings and the association with mobile devices will spread to other living things, such as pets, as well as machinery and household electronics. It can be foreseen that in the future there will be a ubiquitous mobile communication environment in which very many objects within a particular area may be associated with a mobile terminal and hence require the ability to connect to a mobile network. This will result in a substantial increase in the number of users and terminals that need to be accommodated by mobile networks. However, in this scenario a large number of terminals will be data-only and hence not require the ability for traditional speech communication from person-to-person. Due to the limited amount of available MSISDN numbering capacity it would be desirable to be able to accommodate new users and terminals without the need to associate an MSISDN with each terminal.

Deductions

- An AIPN would enable the accommodation of a vast number of users and terminals.

4.2.1.3 Social behaviour and the need to understand one's environment

Futurologists have identified some basic human behaviour patterns that have become increasingly important in modern societies. Two of them have been named "cocooning" and "clanning". "Cocooning" describes a behaviour in which an individual tries to isolate itself for a while from the surrounding society. It essentially expresses the wish for privacy with respect to permanent over-stimulation. "Clanning" describes the opposite phenomenon. It is the need of an individual to integrate itself into a "clan", a group of similar minded people. This is mainly observed with young people and is a well known finding in group dynamics.

A third social factor that becomes strongly apparent is the need for the individual to better understand their environment. While an ever growing data stream permanently pours over the individual it becomes increasingly difficult to filter out the relevant information content. This results in disorientation, the difficulty of self-organisation and the feeling of uneasiness about one's environment. Also, the capability to quickly filter out important information from that which is unimportant is a competitive advantage of the individual.

Deductions

- An AIPN will need to provide means that respect and ensure a user's need for privacy.

- The basic human wish to integrate oneself into social groups could be a good basis for services in an AIPN. Good examples are chat-rooms and the like.

- An All-IP system that offers services which allow an individual to gain a better orientation within their environment (geographic, social, business) will provide significant added value to its users.

4.2.1.4 The social trend of increasing differences in income within societies.

As a result of economic liberalism and globalisation societies in the western world undergo slow but significant changes. An important aspect of these changes is that differences in individual income increase. Any industry needs to take this kind of social trend into account when formulating their business strategies.

This implies that the market split into an (expensive) high end market and an (inexpensive) low end market will become even more pronounced than today.

Deductions

- An AIPN will need to provide at the same time very cheap low-end services and high priced high-end services for different customer types. For the same kind of service (e.g. voice) the respective QoS may be the differentiating criterion.

- Quality of Service needs to be regarded as a chargeable feature.

4.2.1.5 The need to satisfy user experience of 'early-adopters'

The adoption of new technology is heavily dependent upon the experience of this technology, through the services that are delivered over it, by its users as well as the general public that comprise the potential market for this new technology. Therefore, it is important that new technologies clearly demonstrate advantages over those that are already prevalent. The perception of users toward a new technology at its early phase of introduction is mainly determined by the experience of initial users, sometimes termed 'early-adopters', have when using this new technology. In terms of mobile telecommunications, in addition to the general ability to utilise more advanced functionalities and feature-rich services using a mobile phone, factors such as perceived communication delay, communication quality, connection set-up time and data transmission speed are highly visible to users experiencing new technology. Hence, factors that demonstrate the basic performance of the new system play an important role in demonstrating the benefits of new technology compared to those already available. Consideration of these factors clearly indicates that it is essential for future developments of the 3GPP system to clearly demonstrate to users the benefits of the enhanced capabilities compared to those already available.

Deductions

- An AIPN shall not degrade user experience. Additionally, it would be desirable for an AIPN to demonstrate to users improvements in basic system performance compared to the pre-existent capabilities of the 3GPP system.

- Factors such as perceived communication delay, communication quality and connection set-up time are important considerations for users when experiencing an AIPN as a new technology.

4.2.2 Drivers from a Business perspective

4.2.2.1 Mobile industry anticipating PS traffic to surpass CS

In the future it is thought that the amount of non-voice traffic, i.e. IP traffic within the PS domain, carried by mobile networks will equal and then surpass that of traditional CS voice traffic. Therefore, in the future mobile networks will need to be able to handle substantially increased volumes of IP traffic in a cost effective manner.

Additionally, in the future it is very likely that the there will be a variety of different traffic patterns for IP traffic including user-to-user and user-to-multicast, that needs to be optimally routed within mobile networks.

Deductions

- An AIPN will need to handle substantially increased volumes of IP traffic in a cost effective manner,.

- An AIPN will need to support optimised transport for user-to-user and user-to-multicast traffic.

4.2.2.2 Desire of operators to encompass various access technologies that are not specified by 3GPP

Although 3GPP is primarily concerned with the UTRAN and GERAN access technologies other access technologies can be utilised by the 3GPP system and used to provide mobile services. This has been recognised from 3GPP Rel-6 with the standardisation of 3GPP-WLAN Interworking [3]. In the future network operators will desire the ability to provide services to their subscribers optimised to the user's environment using a variety of diversified access technologies. Although the access technology utilised at a particular time within this environment may vary, it is likely that the services provided will have significant commonalities. Hence, in order to realise a multiple access technology environment in an efficient and cost effective manner it is desirable that the replication of network functionality be minimised. This clearly indicates that there is a need for a common network to be able to accommodate a variety of access technologies.

When accommodating various access technologies it is desirable that this is achieved with a minimum impact upon the access technologies themselves It is assumed that most new access technologies that are developed will incorporate IP technology and be optimised to carry IP traffic. Hence, in order to maintain a high level of compatibility it is necessary for the network accommodating these access technologies to also be based upon IP technology and be optimised to carry IP traffic.

Based on the reasoning presented above it can be concluded that in order to design a future proof system that is able to efficiently accommodate a variety of different access technologies it is necessary that the 3GPP system be designed as a common network that is based upon IP technology and optimised to carry IP traffic.

Furthermore, the development of new access technologies will not necessarily be in line with the development of the network therefore there is a need to be able to develop different areas of the network independently, e.g. develop the core network independently to the access networks.

In addition, it is desirable that a common IP network supports a centralised and common network control to accommodate these access technologies. Hence, enabling the network operator to remain the focus for the provision of mobile services

Deductions

- An AIPN would provide the ability to incorporate a variety of different access technologies with a minimum impact upon the non 3GPP specified access technologies to be accommodated.
- Using IP as the basis for a common network enables prevalent and low cost IP technology to be utilised. This allows the network to be deployed cost-effectively with the ability to provide common services using a common IP bearer throughout all the diversified access environments.
- An AIPN should support a centralised and common network control to accommodate the access technologies.

Editor's note: need to clarify the meaning of 'centralised and common network control'.

4.2.2.3 Marriage of IT- and telecom world

The influence of broadband Internet

With the emergence of broadband internet services there has been a rapid increase in the number of subscribers to IP services in recent years. Most notable is the growth in the number of subscribers to IP telephony services. This is expected to grow further and at an increasing pace as the broadband internet services of ISPs become more prevalent. This presents 2 points of major interest.

- Competition with broadband Internet
  The first is the need for network operators deploying the 3GPP system to offer competing services and so match this emerging trend.
- Interworking with broadband Internet
  The second is that as the number of IP service providers and hence IP service subscribers become more prevalent the need to interwork with these IP service providers will emerge in order to offer services between 3GPP subscribers and IP service subscribers of other networks. This must include easy mechanisms for roaming and settlement operations, so end-users can leverage the benefits of each network without incurring the high overhead of setting up separate subscriptions with each service provider.

Service creation with the support of the IT industry

While in 2G systems the IT world played only a minor role - everything was standardised by GSM. 3GPP - and even more so OMA - allowed more diversity by defining service enablers (e.g. "Presence") instead of standardized services, enabling the IT world to create services that can rely on these capabilities.

The main reason to do so was speed of service introduction. The IT industry is capable to provide IP-based services based on defacto standards in a much shorter time than it can be done by standardisation. Also, the mechanisms of the market - adopting these services according to market need and user acceptance - are more effective.

Deductions

- An AIPN would enable network operators to offer IP-based services and provide appropriate interworking methods with IP service providers.
- The AIPN should be able to support applications based on the capabilities of the AIPN. Care should be taken to ensure interoperability.

Editor's note: Text above to be clarified.

4.2.2.4 Need for increased system efficiency leading to substantial cost reduction in terms of both equipment (CAPEX), and operational (OPEX) costs.

In the future it is foreseen that there will be increasing pressure to decrease the investment costs for mobile network equipment and the cost per bit for traffic carried by mobile networks. The reasons for this are twofold. Firstly, the increase in IP traffic carried by mobile networks will lead to a general need to further decrease the cost of handling this traffic both in terms of equipment and transmission costs. Secondly, in the future there will be increased competition for network operators not only from mobile network operators using different radio access technologies, but also from IP service providers providing broadband IP services using access and transmission technologies other those of traditional mobile network operators, e.g. ISPs providing services using xDSL, Cable and/or WLAN without 3GPP interworking. The business and charging models, e.g. flat-rate charging, deployed by these IP service providers are not those common to traditional network operators implementing the 3GPP system. However, they do encourage heavy usage of IP services and as such network operators need to be able to deploy a cost effective network for IP services in order to compete in the wider market place.

CAPEX:

The same is true for CPE equipment. There are existing low cost, high quality SIP-based devices that are being used by non-mobile service providers. New technology could allow network operators to offer services to its customers using a public user identity via low cost fixed/WLAN devices via a broadband network. Some service providers have this capability today and thus all operators need to address the need to support low cost broadband capable CPE devices.

OPEX:

From an OPEX point of view, IP backhaul scales much better and is cheaper than traditional circuit switched network backhaul. If the goal is to move significant portions of CS traffic onto the PS network, then it will be expensive to migrate fixed network traffic via existing CS backhaul methods. Services must use end to end IP and intermediate networks must use IP as much as possible in order to provide a service that will have the cost points necessary for wide spread adoption.

Editor's note: Some justification of the above statements is desirable.

Deductions

- The cost of general-purpose equipment targeted for a wide-ranging general market is in general much less than that of specialised technology whose market is limited by specific criteria. An AIPN would enable the use of general-purpose IP technology with some modifications to tailor functionalities to the needs of network operators to provide mobile services. The ability to undertake large-scale deployment of general-purpose IP technology provided by an AIPN would enable significant improvements in system efficiency and overall reduction in the equipment (CAPEX) and operational (OPEX) costs for future mobile networks designed to handle a large amount of IP traffic.

4.2.2.5 Trend of the industry to align along the structure: access / transport / control / services

There seems to be a tendency in the industry for mobile telecommunication to adopt a horizontal structure into business units, which are mainly concerned with access, transport, control and services. This reflects the view of parts of the industry that these areas can be viewed as - more or less - economically independent fields. This view applies to operators as well as to manufacturers.

Deductions

- An AIPN should provide an architectural structure that allows a decomposition of the added value according to access, transport, control and services. In particular charging capabilities will need to take this into account.

4.2.2.6 Trend towards fragmentation of the value chain. Big players become "integrators", smaller players "specialists".

As a result of the two trends mentioned above a further tendency of the business can be observed: Big players become "integrators", smaller players "specialists".

For network operators this could lead to business models where big companies outsource parts of their traditional business (e.g. operation & maintenance, network planning and dimensioning, operating services) to third parties - preferably in low-cost countries. For manufacturers this would lead to a scenario in which large manufacturers become more of a system integrator of individual components for an AIPN. Smaller manufacturers would provide these components.

Deductions

- This trend seems to be less a driver than a result of economic processes. It would lead to a more modularised composition of an AIPN.
- On the other hand this supports the needs of network operators and vendors to reduce expenditures (OPEX and CAPEX).

4.2.2.7 Fixed/Mobile network convergence

Some service providers are enabling fixed/mobile converged services for their subscribers. This is being driven by a number of factors, including (but not limited to) company mergers/demergers, the maturity of available VoIP solutions and the proliferation of service bundling (e.g. mixture of voice, video, data and mobility services) by service providers to reduce churn and increase ARPU. An AIPN should ensure that operators wanting to provide fixed/mobile converged services can do so within the IMS framework.

Deductions:

- An AIPN needs to take into account Fixed/Mobile network convergence issues.
- An AIPN should ensure that new/enhanced services follow the IMS framework, so the service will be applicable to fixed/mobile converged networks.

4.2.3 Drivers from a Technology perspective

4.2.3.1 Evolution of next generation radio access systems (3GPP specified)

Similar to the transition from 2G (GSM) to 3G (UMTS) it is expected that future radio access systems will allow for a significant higher data rate of user traffic than today. However, there is a trade-off between data rate and user mobility. In other words, a user, who is moving at a high speed, cannot expect the same high data rate as a user that is standing still. In addition it may be envisaged that radio access systems can be optimised to particular user requirements (e.g. in terms of data rate, mobility, QoS) such that multiple different radio access systems could be used by the same network operator simultaneously, even within the same geographical area.

Deductions

- An AIPN shall take into account the capability of next generation radio access systems to provide significantly higher data rates to the user

- An AIPN shall allow for multiple radio access systems, optimised to particular user requirements

4.2.3.2 Progress of broadband wireless IP-based networks (non-3GPP specified)

Recently IP-based wireless technology has received a strong technological and economical boost. This has been fostered by industry standards (e.g. bluetooth) as well as internet standards (e.g. IEEE 802.11x, 802.16x, 802.20x). Partially these technologies have already found their use in commercially available off-the-shelf products (WLAN cards, access points), which provide relatively high data rates at low prices. These technologies are currently evolving towards higher – broadband – data rates and/or support of continuous mobility in wide service areas. Currently there are competing standards at different stages of their hype cycles in this field. These systems generally provide only part of the functionality of full-blown mobile networks (e.g. they do not allow sophisticated charging models). However, the need to provide 3GPP interworking with these technologies / networks has been shown already for 3GPP Rel-6 with the work item for 3GPP - WLAN interworking.

Deductions

- An AIPN shall be able to provide means to ease interworking with a multitude of broadband wireless IP-based networks

4.2.3.3 Progress in ad-hoc networking for user defined services.

Ad-hoc networks denote particular kinds of networks that may establish themselves automatically - "ad-hoc" - (i.e. without explicit administration) between mobile terminals. From today's perspective, generally all the activity concerning development in the field of ad-hoc networks (radio spectra, terminal communication and mechanisms to create ad-hoc networks) is happening outside 3GPP.
However, operators may benefit from letting ad-hoc networks interact with the AIPN, thereby creating traffic in the AIPN; e.g. there could be ad-hoc network access to public networks via AIPN by at least one of the ad-hoc network members serving as a kind of wireless connectivity gateway.

Examples for such ad-hoc networks could be personal networks, as described later in the present document, or CB-type radiocommunications amongst listeners to a pop concert. In the case of personal networks an AIPN may provide connectivity to a server in an operator’s network, in the pop concert example an AIPN may provide the capability for remote listeners to join.

Technically, an ad-hoc network is defined as a self-organizing and self-managing network of autonomous mobile terminals *without any infrastructure support*. In fact, it is this property which essentially characterizes ad-hoc networks, and as a consequence, no centralized radio resource management for ad-hoc networking necessarily exist.

Important aspects of ad-hoc networks which may impact an AIPN are:

- Identification, addressing and routing: If an ad.hoc network interacts with the AIPN, the AIPN may need to know about identities of individual members of the ad.hoc network (not only the "connectivity gateway"), be able to address them and route traffic to them.

- Authentication, security: in an ad-hoc network neither SIM resp. USIM/ISIM based identification and authentication nor ciphering on the air interface derived from authentication parameters can be assumed. In the case of at least one ad-hoc network member serving as a wireless connectivity gateway to the AIPN it should be ensured that this node can not compromise AIPN security.

Deductions

- Appropriate mechanisms for identification, authentication, addressing, ciphering and charging of members of an ad-hoc network interworking with an AIPN have to be established.

4.2.3.4 Dawning of new, radio based services (e.g. personal networks, RFIDs, multi-hop access networks)

Currently there is a lot of activity (research projects) on new services that are utilizing different kinds of IP-based radio networks. Examples of such services could be:

- personal (portable) networks, that allow interworking of different personal sensors/terminals
- RFIDs, that allow goods, to which a RFID is attached, to broadcast information about themselves,
- multi-hop access networks, that allow a user's terminal to act as a radio relay station for another user

Many of these new services are capable to create revenue for a network operator if they can easily interwork with (or be integrated into) a network operator's AIPN

Deductions

- An AIPN would benefit from a capability to facilitate interworking with (or integration of) these new radio based services

4.2.3.5 Reconfigurable Radio (Software Defined Radio - SDR)

Reconfigurable radio interfaces allow terminals to adapt/optimise its radio properties to the currently available radio network. This could allow an increase of spectrum efficiency. However, the network would need to support such a functionality of the terminal.

Deductions

- An AIPN would benefit from a support of reconfigurable radio interfaces in the terminal.

4.2.3.6 Web services

While not being specific to mobile networks Web Services are becoming increasingly important as a standardised interface to provide IP-based services. There is a general trend towards Web services within the industry. For example, in OMA a working group is dedicated to the evolution of web services in mobile networks and in many respects they are seen as a replacement (rather than an addition) of traditional service enabler interfaces such as CAMEL and the CORBA version of OSA/PARLAY.

Deductions

- An AIPN will need to support Web Service interfaces for service provisioning.

4.2.3.7 Multi-access

The introduction of multiple access systems within the same coverage area raises new operator and user requirements; the user may wish to influence the selection of the access system for use based on such aspects as supported QoS, mobility, pricing, coverage, etc. and the network operator may wish to influence the access selection by setting policies. Optionally, a user may even wish to use simultaneous multi-access as well.

Note that the selection of the access system must be easy for the end-user, e.g., it could be based on some preferences and the actual process can be partly or completely hidden.

It is expected that users using multiple access systems will require an appropriate service continuity experience as they switch from one access to another. This means that their sessions remain in operation, with minimal interruption. In addition, the services provided should be made access aware (e.g., choose video quality based on the available bandwidth).

Deductions

- An AIPN shall make use of the multiple access systems by providing support for appropriate handover between access systems, reachability over multiple access systems, access network-aware services, and optionally simultaneous multi-access.

- An AIPN shall provide support for access selection based on combinations of operator policies, user preferences and access network conditions.

4.2.3.8 Progress of advanced Traffic Engineering Technologies

As the number of users accessing multimedia and data service from 3G networks will continue to increase, huge amounts of IP traffic are expected to be handled by network operators. Due to the increase of the IP traffic, network bottlenecks may also appear in operator IP backbone, therefore, new challenges will be faced by the AIPN to provide guaranteed QoS to end-users for different types of services (real-time, non real-time) and also ensure that the transport network resource is used efficiently. This would enable e.g. over-provisioning in IP transport network to be avoided in order to save CAPEX for network operators.

Traffic engineering technologies, e.g. MPLS, advanced QoS routing algorithms, and dynamical load balancing among network entities are potential solutions to achieve this within an AIPN.

Deductions

- An AIPN will need to be able to guarantee QoS for different types of services (real-time, non real-time) and ensure efficient use of network resources. Traffic engineering technologies within the IP transport network may provide appropriate methods to achieve this within an AIPN.

4.3 Impacts to current models for the 3GPP System

The introduction of an AIPN will impact the current models upon which the design of the 3GPP system has been based. However, there is a legacy of success within the models that have been utilised up to now. Therefore, it is necessary that some consistency is maintained between the past and future aspects of the 3GPP system with the addition of the ability to adapt to the future environment in which system enhancements will be introduced.

Whilst there is a need to maintain current models, future enhancements in the 3GPP system, specifically the introduction of an AIPN should also enable introduction of new models and the creation of new opportunities for development of new functionalities and the provision of new services.

4.3.1 Impacts to current charging models

Users are aware and understand the current charging models such as Flow based charging and event based charging where a user pays for each time he/she uses a specific service, hence the possibility to provide these with an AIPN should be maintained. However, as the environment in which the 3GPP system is utilised adapts an AIPN should also provide the capabilities for and provide the necessary improvements in efficiency and cost reduction to enable new charging models to be introduced.

An AIPN should be flexible enough to support the different pricing models that are needed. Many Internet users expect that services such as email, news and search engines are free of charge and that they should pay only for the access via a flat rate pricing model. Other users will instead have to pay an additional amount according to the “calling party pays” principle. Therefore mobile operators will need to use sophisticated pricing models, including event based charging. AIPNs should support those models. What pricing model to utilize at a given time is dependant on the circumstance of the operator e.g. based on different strategies such as Cost Leadership or Differentiation. An AIPN needs to support a cost effective charging system in order to be able to quickly launch new services but yet be as flexible such that an operator can use price models such as:

- Charge extra for guaranteeing a QoS

- Charge extra for “Calling Party Pays”

- Charge for the transport

- Charge for the event

- Additional charge (positive or negative) for the simultaneous use (combination) of services
- Adjust the price for different reasons e.g. to reward certain users, enable subscription bands (e.g. gold, silver, bronze)

Further the charging system for an AIPN shall contribute to minimizing the credit risks for the operator. The charging system in an AIPN shall in a cost efficient manner support various access technologies with minimal impact on the terminal from a charging point of view. Further the AIPN shall from a control and charging point of view support different type of services e.g. RealTime and Bursty traffic such as PoC. Both real-time and none real-time schemes must be supported by an AIPN

In a multi-access environment the current charging and policy control architecture needs to be enhanced in order to allow for the business models defined in 4.3.2 e.g.

- The service provider having a relationship with the operator provides rating information and minimal QoS he assessed (as well as other content related polices) that apply for different Access Networks a service should have.
- For seamless handover between IP CANs in a multi access environment the subscription class/credit availability may allow service continuity or may not allow it. Hence based on subscription class different redirection points are applied e.g. for top up or to initiate a subscription such that credit are given for a service in a new Access Network.

4.3.2 Impacts to current business models

The current business model for network operators and manufacturers implementing the 3GPP system comprises of a value chain of users to network operators to equipment manufacturers. This current business model is the foundation for the success of the 3GPP community. Hence, the essence of this model should be maintained. This includes the need to maintain the focus upon network operator considerations and the need to maintain the core "mobile" aspects of the system. This requires maintenance of factors such as the provision of centralised network operator control and the ability to utilise the wireless interface as efficiently as possible.

With the cost reductions provided by an AIPN there will be greater freedom for network operators to apply varied business models within various environments. **Support for business models with distinct core/access/service separation**

More than today an AIPN will need to support business models that allow operation of core network, access networks and services by separate stakeholders. Often, the network operator will be the only stakeholder operating all three, core network, access networks and services, or these stakeholders will be individual business parts of a single operator company, e.g. one company branch operating the core network, another one UTRAN or WLAN access, while a third branch is concerned with end-user services, irrespective of the connectivity.

However, it should also not be precluded, that individual companies are able to operate core network, access networks and services in cooperation, but separately. An example of such a situation could be a 3GPP network operator, who has a business agreement with the operator of an interworked WLAN (or a different 3GPP operator operating a shared UTRAN in some region) and allowing a third party service provider to offer services to their own customers.

It is understood, that the user is still "owned" by the core network operator in the sense that the core network operator controls access of the user to the public network and has the prime commercial relationship with the user.

Therefore, an AIPN will need to follow architectural principles that facilitate operation of core network, access network and services by separate stakeholders. However this should not preclude the capability to efficiently operate all three domains by a single stakeholder, i.e. the network operator.

4.3.3 Impacts to current service models

Even if the 3GPP system already today through the PS domain allows the flexibility of IP based services, the introduction of AIPN may bring the model for how services are developed and provisioned one step further. The current model for how new services are introduced into 3GPP systems, often comprising standardisation of capabilities within 3GPP, followed by development by vendors and deployment by mobile operators, is rather cumbersome and has difficulties in quickly responding to changing market trends. Whilst also maintaining the traditional aspects of the 3GPP service model, it should be important to leverage new possibilities for service provisioning the introduction of an AIPN may enable.

There is a potential demand for an extremely wide variety of mobile services. To meet this demand new models for service provisioning are essential. An interesting comparison is the evolution of software applications within the computer industry. Only two decades ago software applications were limited in variety and cost was high. The emergence of a few de facto standards for software application environment propelled an unparalleled explosion of all thinkable and unthinkable kinds of software applications. The economy of scale has also made it possible for them to be provided at a much lower cost level.

The introduction of AIPN can similarly be an enabling factor for developing new models for easier, more flexible and more cost efficient introduction of mobile services. Today there exist several good examples where simplified service models have brought forward a wide variety of mobile services. But to meet the potential demand of mobile services, service models must continue to be developed. Most likely the broadest range of mobile services will be possible when responsibility for service provisioning is opened for third party service providers e.g. via web services. Using policy and control frameworks, applying flow based charging concepts, establishing the IMS framework, and providing different sorts of open interfaces, will be important tools for mobile operators to control how third party providers can provide their services. Changed business models must go hand in hand with this to give all parties incentive to put efforts into it. Like within the software application domain, it is by releasing the innovative force of a larger group of creative people and companies that we can meet the demand for mobile services in the coming decades.

Different service models do also need to exist for different categories of mobile services. Person-to-content, person-to-person, and machine-to-machine type of services should for example require different service models to enable faster, more flexible and more cost efficient service provisioning.

The work within 3GPP will allow an evolution of the 3GPP system to enable these more advanced service models and to keep mobile operators in control at their selected level.

Editor's note: Text above to be reviewed may be moved to an annex.

5 End-user and network operator aspects of an AIPN

Items identified for study within WID in S1-040426 are given below:

Potential service aspects to be investigated (non-exhaustive list):

Efficient methods for packet inspection purposes

Compatibility and reuse of existing standards (e.g. OMA, Web Services/Liberty Alliance Project, IETF, etc…) should be investigated where appropriate.

Interactions with, and impacts upon existing features, service enablers and services (e.g. IMS, Presence, MMS, SMS, CS voice, etc.) should be investigated.

The role of IP-address and its relation to existing identities/numbers (e.g. IMSI, MSISDN, e-mail address, web-address, SIP URI) should be investigated.

5.1 AIPN Vision

An AIPN would enable the convergence of access networks and services onto a common core network. In this emerging area users will demand more from their services and interaction with their technologies. Instead of the islands of capabilities that currently exist it is desirable to bring these capabilities under one umbrella whilst offering session continuity across multiple access technologies. This seamless offering will be characterised by the provision of an effective management of mobility that consists of offering users a telecommunication service, continuously and transparently when the user's terminal moves between various access networks or various services, whatever type of communication and wherever communication has been initiated. One of the key enablers within an AIPN will be the seamless mobility across terminals and technologies supported by a mobility manager that unobtrusively manages these interactions.

Delivering an AIPN will address these needs, extend the reach of 3G technologies and maintain a relationship with the user in each context. Multiple connected devices will enjoy interactivity adopting principles including single sign on, seamless mobility, context sensing and the unobtrusive device management.

5.1.1 Key aspects of an AIPN

The following are the key aspects of an AIPN:

5.1.1.1 Common IP-based network

-

  - Non-access specific mobility control equivalent to that provided by cellular networks i.e. mobility control within the network under the control of the network operator,across the same and different access technologies, that is not dependent upon specific access or transport technologies or IP version.

  - IP-based routing and addressing

- Enhanced session management

- IP transport

- Communication quality, i.e. QoS, equivalent to or greater than already provided

- Interworking with IP networks

- Interworking with legacy networks

- Functionality at the edge of the network to support different access methods, legacy equipment, s

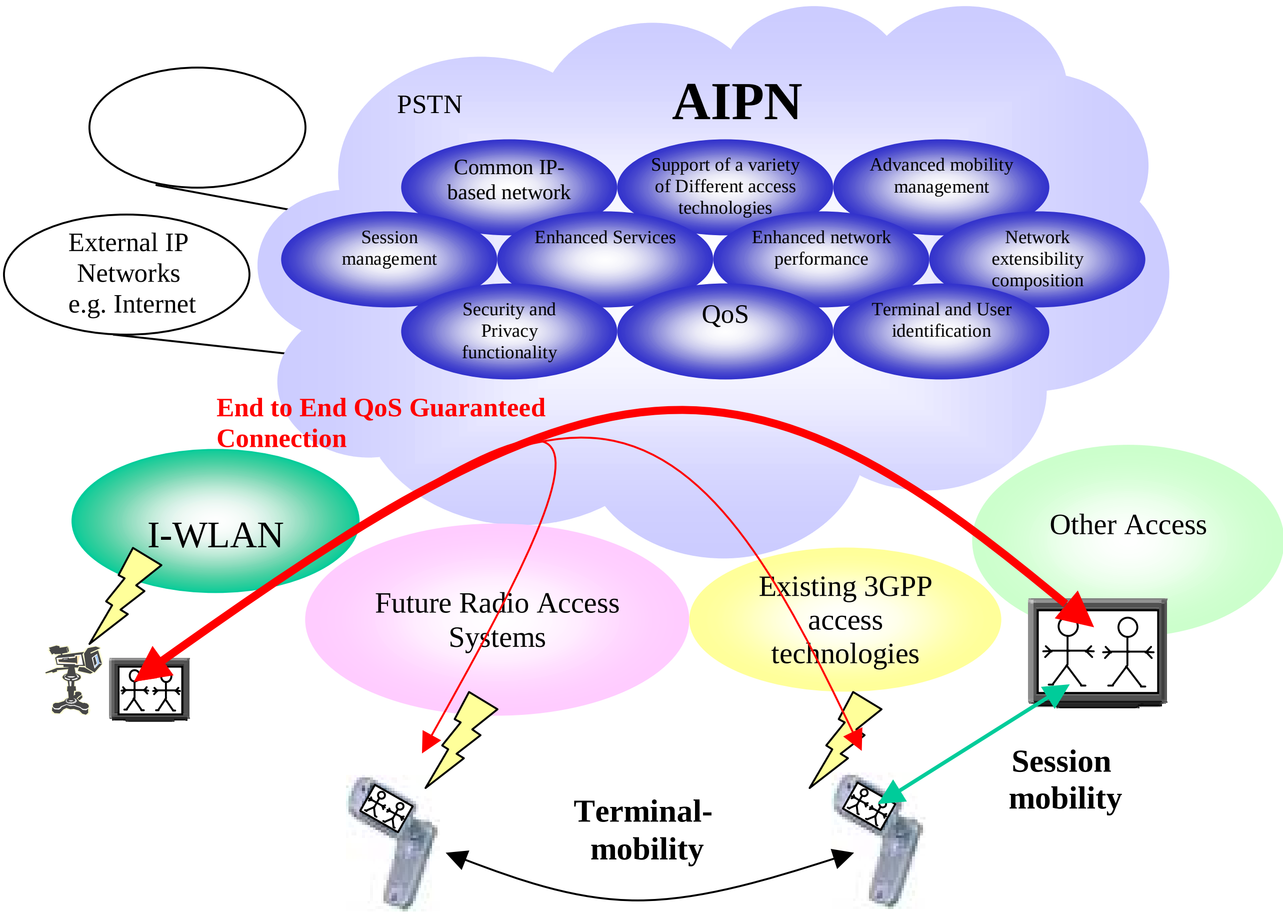


Figure 1: Visual representation of the key aspects of an AIPN

5.1.1.2 Support of a variety of different access technologies (existing and future)

- Service provision across different access technologies
  - Seamless service provision and handover across different access technologies

5.1.1.3 Take advantage of convergence of telecommunications and IT industries towards IP technology

- An AIPN should target to minimize the use of duplicated technologies (which should lead to a reduction in development/equipment cost).
- In the optimal case there should be no need for duplicated technologies.
- An AIPN will use the same networking protocols and solutions independent of the type of service being provided. I.e. independent on whether it is a "traditional" telecomm service or a "traditional" data service.
- Take advantage of terminal convergence.
- Telecom - Data convergence has been happening faster on the terminal side than on the network side. Today, the convergence on the terminal side is somehow limited by the slower pace on the network side. This has impacts on terminal complexity and, therefore, cost.
- It is very desirable that terminal viewpoint is considered in the AIPN network evolution.

5.1.1.4 Advanced mobility management:

- Mobility across access technologies.
  - Support fast handover and lossless handover mechanisms across different access networks and the capability to apply handover mechanism based on quality of service requirements of applications
- Resilience in the presence of network disruptions and intermittent connectivity.
- Solutions should be studied for making temporary network disruptions (e.g. due to short time network problems) and intermittent connectivity (e.g. due temporary radio failures) as transparent to services as possible.
- Multiple dimensions of mobility

The AIPN shall support several dimensions to provide mobility:

  - An end-user shall be able to use different devices (“end-user mobility”).
  - The terminal shall be able to communicate while moving. This includes both handover from one radio cell to another in the same access technology, or switching from one access technology to another in a multi-access environment. (“terminal mobility”).
  - The user may be able to move some or all of his active communication sessions from one of his devices to another. (“session mobility”) E.g., a user may wish to move a video streaming session from the handset to a car mounted TV screen.

Note that certain aspect of the services provided by the network may change as a result of mobility, but they must remain useful to the end-user.

To address these needs, advanced naming and addressing schemes are necessary that provide reachability for a given user or particular session.

Potential requirements:

- An AIPN shall incorporate naming and addressing schemes that address a given user or session.
- The AIPN shall support end-user mobility.
- The AIPN shall support terminal mobility.

- The AIPN shall optionally support session mobility.

5.1.1.5 Session management:

- Service adaptation to terminal capabilities.

  The services provided to users should be, as much as possible, independent of the terminal used. The network should be able to adapt the service (e.g. information rendering) to the capabilities of the terminal being used with minimum or no user interaction.

- Session mobility: seamless mobility of sessions between terminals.

  It should be possible to move sessions from one terminal (or a set of terminals) to another according to the preferences of the user e.g. automatically with minimum user involvement or based upon a specific user request/pre-determined user preference settings.

5.1.1.6 Access network selection

In an AIPN the applications are based on IP and will evolve towards access network independence. An AIPN is expected to support multiple access technologies.

The selection of the access network may need to take into account several aspects of an AIPN, e.g. service requirements of an application, load balance of the network, and charging & billing.

Potential requirements:

- The AIPN should provide a means to enable network selection based on a range of criteria e.g. user preferences, service requirements of applications, network condition or other operator defined criteria.

5.1.1.7 Enhanced services

- Support for advanced application services
- Provide seamless services (e.g. transparent to access technologies, adaptable to terminal capabilities, etc)

  Users should be able to move transparently and seamlessly between access technologies and to move communication sessions between terminals.

  An AIPN will be able to adapt services as much as possible to the capabilities of the user's terminal, allowing the user to access services independently of which terminal they are using.

Note: this may not be feasible in all cases (e.g. some services will require "minimum terminal capabilities" to be able to be accessed, with these "minimum capabilities" being service dependent), but an AIPN will be designed to enable this property in as many cases as possible.

- Support ubiquitous services (e.g. associations with huge number of sensors, RF tags, etc.)

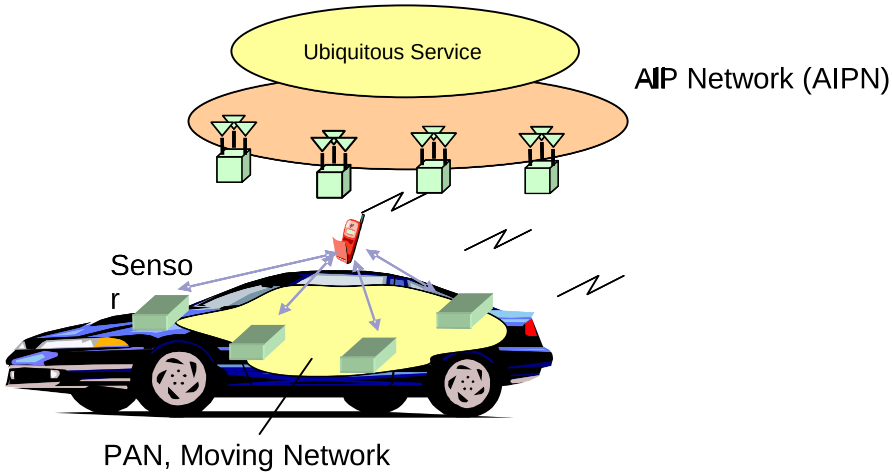


Figure 2: Support of ubiquitous services

- Improve disruption-prone situations when network connectivity is intermittent.

Disruption-free network connectivity may not be cost effective, or even feasible, in all cases (e.g. cell planning for full radio coverage for all services, disruption-free inter-access-technology handovers, disruption-free IP connectivity in all network links). An AIPN should consider solutions for making services as resilient to temporary lack or connectivity as possible.

5.1.1.8 Enhanced network performance

- Ability to efficiently handle a variety of different types of IP traffic including user-to-user and user-to-multicast traffic models
- Optimized routing of IP traffic
- Efficient usage of radio resources

5.1.1.9 Network extensibility/composition

- Facilitate integration of networks with different administrative domains (e.g. handle negotiation of administrative issues, security, trust, etc).
- Solutions should be studied for facilitating the integration of different networks of the same or different network operators in order to enhance the services provided to their customers, and enable the introduction of new services. This includes, but it is not limited to, the sharing of some parts of the network.
- Allow dynamic and flexible integration of "adhoc" networks at the edge (e.g. personal area networks, sensor networks, etc).

5.1.1.10 Network management

It should be considered to introduce self-managing technologies (e.g. Plug-and-Play) for faster deployment and reduction of operational cost. In particular, an AIPN should be designed from an early phase to include:

- Plug-and-play components to ease the setup and operation of the network.

Editor's Note: Aspects such as control-loop based optimization of the running system in an autonomous way and self-healing for fast recovery of failures and increased robustness needs consideration.

5.1.1.11 Maintenance and improvement of the level of security and privacy functionality

- Security equivalent to or greater than that already provided including the hiding of internal network elements

- Support for user privacy, e.g. location privacy, identity privacy

5.1.1.12 Quality of Service

- Network operators should be able to guarantee QoS within their networks.

- It should be possible to guarantee end-to-end QoS for a session between AIPNs. This includes the case where more than one network administration is involved in the provision of the end-to-end service.

5.1.1.13 Terminal and User identification

- Terminal identification in an AIPN should be scalable enough to cover a very large population of diverse terminals (e.g. huge number of sensors and RF tags as well as mobile terminals)

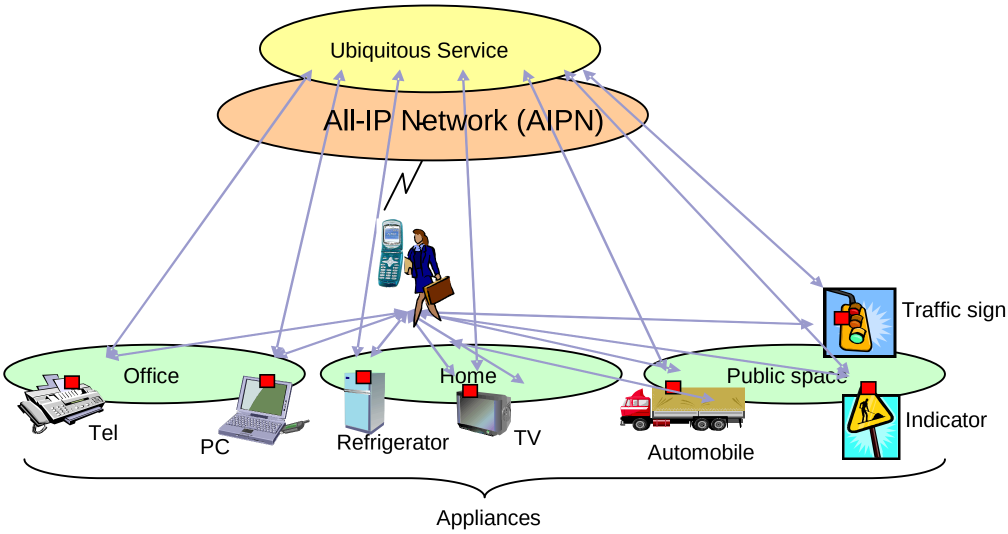


Figure 3: Terminal and User identification within an AIPN

Editor's Note: The storage of User identification within the UICC within an AIPN needs consideration.

5.1.1.14 Flexible future network development

- Extensibility

- Modularity of network functions and commoditization of network components. Open interfaces between appropriate network layers

- Ability to evolve individual network entities independently

- Evolution path from previous releases of 3GPP specifications i.e. Rel-6

5.1.1.15 Identity federation

- Federation of identity within an administration domain requiring no further authentication or registration.

Editor's note: to be clarified.

5.1.2 Continued support of 3GPP system key aspects within an AIPN

Together with the introduction of new functionalities to realise an AIPN several key aspects of the existing 3GPP system need to be maintained in order to ensure that an AIPN is developed in accordance with the needs of the 3GPP community.

The following represent key aspects of the existing 3GPP system that are to be continually supported within an AIPN:

5.1.2.1 Efficiency of resource usage

- Effective usage of power resources within mobile terminals shall be maintained within an AIPN i.e. evolution to an AIPN should not have adverse effects on the battery life of mobile terminals.

- The scarcity of the radio resource shall be respected within an AIPN by ensuring that radio resources are utilised as efficiently as possible.

5.1.2.2 Charging

- The capability to maintain support of existing charging models shall be provided within an AIPN.

5.1.2.2 Roaming

- An AIPN shall provide functionality as appropriate to enable continued support of international roaming between other AIPNs and legacy 3GPP systems.

5.2 Evolution of the 3GPP system to an AIPN

5.2.1 Requirements for the evolution of the 3GPP system to an AIPN

The following represent requirements for the evolution of the 3GPP system to an AIPN:

Note: The term "3GPP system" used within this section refers to the 3GPP system as specified up to and including Rel-6.

5.2.1.1 Build upon existing 3GPP capabilities

- Evolution of the 3GPP system to an AIPN shall leverage and build upon the existing capabilities of the 3GPP system wherever possible. System performance shall also be maintained and improved.

- The primary focus of evolution to an AIPN shall be the realisation of scenarios for a mobile network, including associated access technologies, operated by a network operator e.g. by maintaining the provision of network control under the centralised control of the network operator.

5.2.1.2 New access technologies

- Evolution of the 3GPP system to an AIPN shall not be limited to consideration of only those access technologies currently defined by 3GPP.

- Extensibility to enable implementation of the system step-by-step without adversely effecting basic system performance shall be provided within evolution of the 3GPP system to an AIPN. Evolution of the 3GPP system to an AIPN shall enable modularisation of the mobile network system as appropriate and provide an architectural structure that allows decomposition of common layers of functionality with open interfaces provided as appropriate.

- Evolution of the 3GPP system to an AIPN shall enable the accommodation of diverse devices.

5.2.1.3 Security and Privacy

- Evolution of the 3GPP system to an AIPN shall maintain and improve upon existing security and privacy features of the 3GPP system.

5.2.1.4 Network and mobility

- An AIPN shall be designed as a common IP-based network system hence evolution of the 3GPP system to an AIPN shall be realised with minimum duplication of network functionality wherever possible.

- Evolution of mobility mechanisms
- In the evolution towards an AIPN, the integration of the telecom and datacom worlds, which has been discussed for a long time, materializes. The integration of WLAN into 3GPP systems is already a good example of this. As part of this trend, the mobility mechanisms must be evolved.
- Nevertheless, new mobility mechanisms of AIPN must be introduced in such a way that there is a migration path from current 3GPP systems (i.e., Rel-6). New features, nodes or protocols should be introduced such that an incremental introduction is facilitated.
- Specifically, in the access network the large installed base of UTRAN and GERAN access systems must continue to be supported. In the core network, AIPN mobility mechanisms must be able to co-exist with current PS core network mobility mechanisms in a cost-efficient way.

Recommended requirements:

- An AIPN mobility solution must support an UTRAN and GERAN as possible access networks besides supporting alternative existing accesses such as WLAN and other emerging new technologies.
- An AIPN mobility solution must be able to co-exist with the current 3GPP PS core network in a cost-efficient way.
- An AIPN mobility solution should support seamless terminal mobility across various access technologies.

5.2.1.5 Evolution of 3GPP to keep current and facilitate new business models

- Requirements for support of business models with distinct core/access/service separation
  - Standardised functional interface between core network and access networks:
    To support business models with a distinct core/access separation a standardised functional interface between core network and access networks is required.
  - Evolution of IMS to control IP traffic of a user
    To support business models, that allow separate handling of IP based user services from the underlying transport system it could become necessary, that IMS is able to control and create charging information for IP flows to and from the user's terminal, that are currently not handled by IMS. An example would be FTP or TELNET.

5.2.2 Relation of the AIPN to existing capabilities

By the time AIPN deployment starts, a significant amount of R99/Rel-4/5/6 infrastructure will already be rolled out in many different networks. All major areas will be covered, most of them with high-speed HSDPA / HSUPA connectivity, and there will be many millions of subscribers with terminals compliant to such releases. Therefore, AIPN can only be introduced in a non-disruptive way in which existing equipment is reused as much as possible.

A way to maximize the amount of existing equipment that can be reused by AIPN is to take 3GPP Rel-6 as the starting point for AIPN from stage 1, 2 and 3 standpoints. This does come with requirements on backward compatibility, which do put restrictions on which solutions are possible for each given AIPN requirement that needs to be fulfilled. However, it also sets the starting point on a well known system, which is the only realistic way to proceed with AIPN.

Reuse of equipment is, however, a non-well defined term, so it should not be understood as a requirement for AIPN but more as a working assumption.

5.2.2.1 Reuse of legacy infrastructure

The current R99/Rel-4/5/6 3GPP system includes two domains, CS and PS. The focus for evolution for AIPN is the PS domain, including IMS, together with areas such as IWLAN. AIPN does not consider evolution from the CS domain standpoint but should still provide CS services for existing CS terminals.

AIPN will consider the PS, IMS and IWLAN infrastructure as a basis, but should not consider the reuse of CS equipment. CS infrastructure will still be used in real networks well after AIPN is rolled out, but it is expected that it will be slowly replaced by AIPN infrastructure once AIPN is introduced.

5.2.2.2 Reuse of legacy terminals

AIPN will be backward compatible on all existing Rel-6 3GPP UNI interfaces and, therefore, it will support all R99/Rel-4/5/6 terminals for all services that these terminals get under Rel-6.

Compatibility with legacy terminals for all new services enabled by AIPN should be considered in a case-by-case basis (e.g. it may be possible to provide session mobility even to existing terminals), but it is not a requirement for AIPN.

5.3 Migration and cost effective introduction of new technology

One of the primary motivations for the introduction of an AIPN is the ability to realise significant cost reduction when deploying the 3GPP system. This chapter will describe how this can be achieved.

The introduction of an AIPN will enable further utilisation of general-purpose equipment with some enhancements to tailor it to the needs of the mobile community. This will further enable the commoditisation of mobile network components and will not only make it possible for considerable portions of mobile networks to be built `off the shelf` but will remove the need to purchase wholly mobile network specific equipment that is expensive to purchase as well as maintain. With a basis of general-purpose technology equipment can also be maintained in a general manner and so the need for specialised equipment maintenance is removed.

In order to achieve a high level of cost efficiency instead of replacing all equipment it is necessary to enable old equipment that still performs adequately to be accommodated and reused in the new system design. It is also necessary to ensure that legacy terminals are still supported. This coupled with the introduction of new technology providing equipment and operational cost reductions should lead to a steady improvement in the cost effectiveness of the network overall without wasting equipment, including legacy terminals, that still provide adequate performance. Moreover, in the case legacy terminals are still used by subscribers, support of these should be maintained to enable continuation of service provision to the user and revenue generation for the network operator.

When an AIPN is introduced it should be designed to not only provide new improved functionality and performance but the system should also be extensible and if necessary it should be possible to deploy the system not in one single large scale implementation but step-by-step. This requires that the system be modularised and provide open interfaces between appropriate layers of functionality so that new functionality can be added as needed, and from the opposite point of view, functionality that is not required can be left out without reducing the performance of the system or leaving substantial deficiencies in the functionality of the network.

The accommodation of a variety of access technologies will enable a network operator to optimise their coverage for particular environments. For example radio access that does not provide a particularly high speed connection but can cover a wide area can be deployed nationwide, whilst an access technology that provides a high speed connection but has limited coverage can be provided in an environment in which there are users with high demands for speed but only require this over a limited area. This ability to optimise the access technology coverage enables network operators to offer services in a cost efficient manner which is not limited to just one or two methods for providing users with access to services offered by a network operator.

The ability to be able to develop different elements of the network independently, for example the ability to develop the access network independent to the core network enables investment to be focused on the area requiring enhancement, not on the network as a whole. Therefore, it is possible to design and develop the network efficiently and focus on specific aspects in order to achieve maximum returns.

5.4 Security and Privacy considerations

User and network security and privacy issues, despite being a key concern in today's networks, tend not to be in the top list of priorities when evolving existing systems or designing new ones. The results of this tend to be that security is added to the system instead of being native in the system, which translates into insecure systems or unnecessarily complex security solutions which are often very user unfriendly. For this reason security and privacy considerations are considered within the early stages of this Technical Report.

Note 1: The feasibility of "user issues" should be considered within the regulation for lawful interception that exists in some countries i.e. it may be required that some of the features above are disabled in some networks in order to comply with local lawful interception regulations.

Note 2: Further information regarding security issues is provided within Annex D.

5.4.1 Security Considerations

Transforming today's 3GPP system into an AIPN will introduce changes in the threat environment, introducing new threats but also changes in risk levels of already identified threats. Threats previously seen as having low risks may need to be reassessed leading to new security requirements and the need for new and/or improved security mechanisms. The changes in the threat environment will mainly be due to qualitative and quantitative changes in e.g.

- Threat environment (more and more severe attacks) but also increased risks of particular threats (i.e., the impacts and probabilities that attacks occur may increase as a result of the changed threat environment).
- System heterogeneity and multi-access (GSM, UMTS, WLAN, new accesses, etc)
- Fragmentation of security solutions
- Usage patterns (many more users of existing services and many new services)
- Requirements on user convenience (e.g. SSO, etc)
- Use of trust establishment mechanisms (To counter threats and to enable trusted transactions)

The changes in these areas will certainly motivate a review and revision of currently employed security principles and solutions.

An important process will also be to collect the high-level principles and requirements. Examples on proposed high-level requirements for an AIPN are:

- Security shall be equivalent or better than with the current system i.e. 3GPP Rel-6.
  - This includes support of:
    - easy portability of subscriber identities to different UEs
    - protection of unauthorized duplication
    - operator controlled update of and protected access to security algorithms
    - operator controlled distribution of security to peripheral devices
- An AIPN shall be security-conscious from its early phase, not just have security added later on. The shift to AIPN provides an opportunity to introduce new security paradigms and enhancements/upgrades and optimizations of current security solutions.
- Usability: maximum transparency to the user i.e. high levels of security should be provided with minimum user involvement.
- Ensure authenticity so that the user can trust the information he is receiving. This should cover private user to private user communications as well as private user to service provider communications.
- Networks shall be protected against attacks such as Denial-of-Service attacks and unauthorised access.
- Networks shall be able to authenticate each other and authorize services that need signalling between servers.
- Fast re-authentication shall be possible.
- Hiding of internal network elements shall be provided by an AIPN.
- It should be possible for the AIPN operator to select among several levels of security (e.g. 3GPP Rel-6 equivalent security or better)

Editor's Note: Detailed study of security issues to be undertaken in SA3 as appropriate. This TR is to be sent to SA3 when appropriate to ensure timely consideration of security issues.

5.4.1.1 Threat environment

The Internet is rapidly becoming a very hostile environment. Unless proper countermeasures are installed, the threats found in the Internet will soon be prevalent in mobile networks.

With 3G and upcoming extensions of it, many new players will enter the scene. Small and very large operators and service providers will work together to offer the services the users expect in a competitive way. At the same time, the equipment of the end-users will become more complex and capable. Users will connect PANs over multi-access links to the network and users will act as ad-hoc network extensions of the access network. In this environment, attacks may occur in many different places and in many different ways.

5.4.1.2 Network heterogeneity and traffic protection

Networks become increasingly heterogeneous as more and more types of access networks are tied into the cellular environment. To be able to handle new and legacy systems in a uniform way some generic principles for traffic protection have to be established. It is assumed that the existing principle that the system should protect user traffic over the radio access and into the network still holds. It is also assumed that user payload traffic is forwarded in plaintext unless protection is provided as an application specific service.

5.4.1 Privacy considerations

- User issues:
    - Location privacy. User location privacy should be guaranteed.
    - The location of a user has to be known by some instances in the networks to insure reachability and delivery of packets. But only these instances shall know the location to the necessary level of detail.
    - Communication confidentiality. Privacy of content and origin/destination of information in all user communications should be guaranteed.
    - The information send and received by the user should be protected in a way that neither the content nor the origination or destination of this information is accessible to non-authorised parties.
    - Non-disclosure of identity. Users should be allowed to hide their identity to non-authorised parties.
    - Users should be able to have multiple identities from different providers with the relationship between the identities hidden to particular providers (thus supporting privacy).

Note: 2 use cases on this issue are described in Annex C.

6 Capability expansion required for the introduction of an AIPN

Note: The term "3GPP system" used within this chapter refers to the 3GPP system as specified up to and including Rel-6.

The AIPN vision provided in chapter 5 of this Technical Report lists the desired capabilities of an AIPN. This chapter provides a detailed gap-analysis between the existing capabilities of the 3GPP system and the capabilities of an AIPN. Based on this analysis it will be possible to obtain a clear picture of the work that needs to be undertaken within 3GPP to evolve to an AIPN.

6.1 Existing capabilities suitable for an AIPN

It should be possible to evolve the 3GPP system to an AIPN without degradation in the capabilities [5] of the current 3GPP system whilst also maintaining the 3GPP system service principles [4]. More specifically, the following capabilities provided within the 22 series of 3GPP specification are felt to be suitable for an AIPN:

- Provision of IMS services [6]
    - Support for IP multimedia sessions
        - IP Multimedia Session control [4]
    - QoS for IP multimedia sessions

   - Support of multiple UEs with a single IMS subscription.
- Cost effective Control and Charging of IP Flows through FBC [7]
   - Identify IP flows for charging and policy control in a generic manner
   - Perform Real Time Charging
   - Support differentiated charging including zero rating of the bearer and event charging
   - Authorization of IP Flows
   - Awareness of user identity, subscription class, time-of-day, roaming status, QoS, Service input etc

6.2 New capabilities required for an AIPN

Note: The terms 'core' or 'core network' used in this section refer to the non-access related functionality of an AIPN

An AIPN will enhance the 3GPP system from the perspectives of providing enhanced functionality as well as improvements in system performance (e.g. communication delay, communication quality, connection set-up time).

Heterogeneous Access Networks mobility

An AIPN shall allow connectivity via a wide variety of access network technologies (both fixed and wireless). Some of these technologies are specified by 3GPP where others are developed and specified by other organisations.

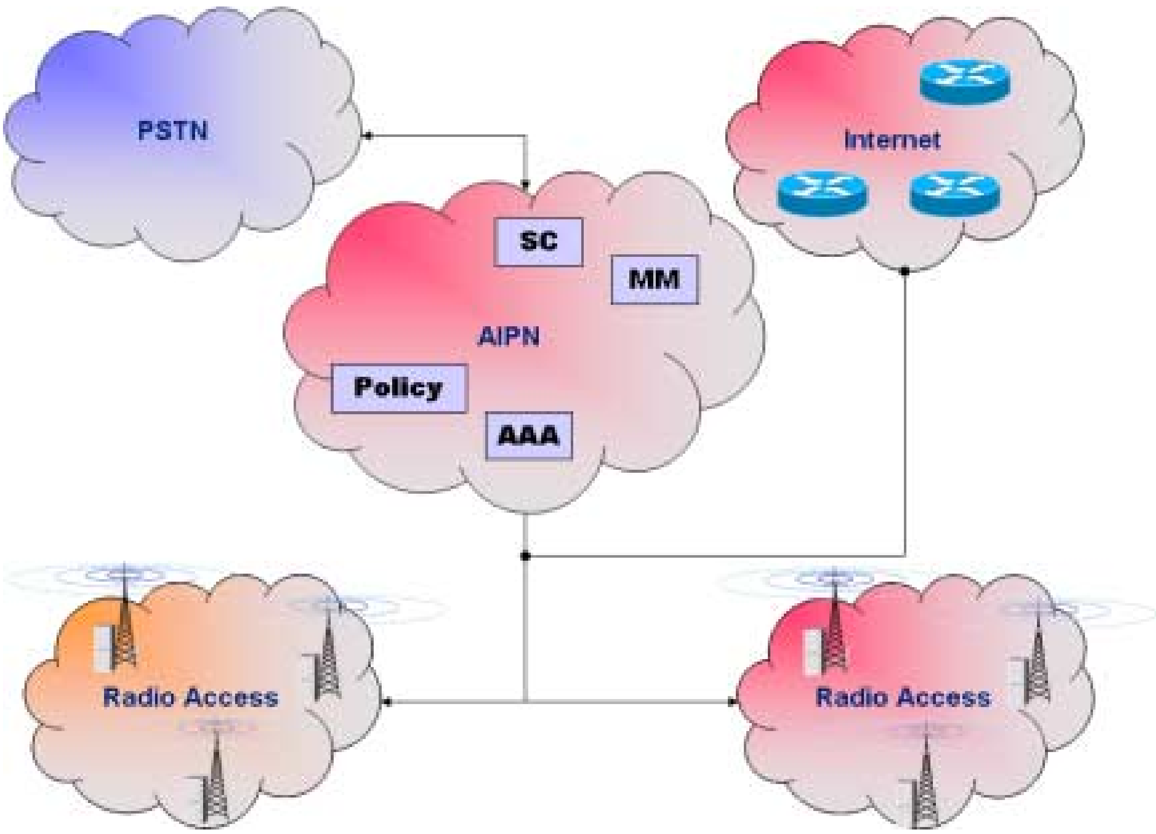


Figure 4: AIPN and Heterogeneous Access Networks

For the purpose of optimising the mobility among the diverse access technologies the AIPN shall provide open interfaces that allow the mobile operator to direct the terminal towards the most suitable access technology. The decision to move a terminal from one access technology to another should be based on the information available in the AIPN e.g. load balancing, subscriber's profile as well as on the information provided by the terminal. Mobility within a given non-3GPP access network is not under the responsibility of the AIPN.

The AIPN should provide then common open interfaces to allow the AIPN to exercise the control on the inter-access mobility of the terminal. Furthermore, AIPN should also provide other open interfaces that allow the terminal to access the other core network services needed for the management of the subscribers in the AIPN i.e. session control, AAA, policy control. (see picture above)

Suggested requirements:

- An AIPN should provide open interfaces to core network services such as MM in order to ease the terminal mobility across different radio technologies.

Editor's note: Scope of the AIPN to be resolved further. Based on this, changes to the above may be necessary. This is in relationship to whether the AIPN is just the core network or also includes the radio networks.

Support of a variety of different access technologies(existing and future)

Wireless coverage is different depending on the radio technology and the radio signals of each of the accesses used may not necessarily be available within a particular area. Also, in the future it may be possible for network operators to realise cost reduction by efficiently introducing appropriate radio systems within different geographical areas. Therefore, in order to faciliate efficient provision of services, an AIPN shall support accommodation of several access technologies (existing and future). The 3GPP system currently provides access via UTRAN and GERAN as well as I-WLAN but currently there is no detailed specification for accommodation of other access technologies. Therefore, it is necessary that the accommodation of access technologies be expanded to include other different access technologies within an AIPN.

Concerning the provision of IP based services an AIPN shall support provisioning services over several access technologies accommodated with an AIPN. However, there will be some differences for the provision of IP services over different access technologies hence it shall be possible for an AIPN to coordinate service provision across a variety of different access technologies.

Suggested requirements:

- An AIPN shall support accommodation of several access technologies (existing and future).
  - An AIPN shall support service provision across different access technologies.
  - An AIPN shall support adaptation of service provision across different access technologies.

Heterogeneous core network mobility mechanisms

An AIPN shall support not only a heterogeneous set of access network technologies, but also the inter-working of heterogeneous technologies in the core as well, with respect to mobility. This is needed because the AIPN will have to provide an evolution from currently deployed core network technologies. As an example, in an AIPN both legacy 3GPP PS mobility and IP based mobility schemes will co-exist.

In addition, heterogeneous mobility in the core brings further advantages due to the following reasons:

The access network technology, terminal technology, the services or roaming agreements provided may put varying requirements on the core network mobility solution.

The mobility mechanisms must also satisfy security, QoS or other requirements, which may also vary.

The core network may incorporate multiple administrative domains.

Heterogeneity of the core network mobility mechanisms allows local optimizations. E.g., parts of the core network may provide improved mobility performance by a solution that is tailor-made for the particular network configuration.

Suggested requirements:

- An AIPN must work with mobility mechanisms used by the specific networks it connects, including legacy mobility mechanisms of the current 3GPP PS core network.

Frequent core mobility

Since an AIPN shall allow for multiple radio access systems optimized to particular user requirements, it will need to support radio access systems with highly varying characteristics in terms of robustness, quality and throughput as well as complexity and geographical coverage.

While 2G and 3G access systems provided a RAN with mobility support that can cover a large geographical area, AIPN may need to accommodate access systems with RANs that provide mobility support only in a very limited area. In the extreme case, the access system may consist of base stations that are directly connected to the core network, or even access networks without any mobility management procedures at all.

Consequently, while in 2G and 3G networks most of the terminal mobility was handled in the radio access network and the core network had to handle only infrequent mobility, an AIPN shall support new access technologies where handovers between core network nodes are also very frequent.

As a result, handover support in the core network has to provide a seamless user experience. Note that the corresponding performance requirements for a seamless user experience will depend on the service provided. This seamless user experience must be maintained even with an increasing network size and increasing number of terminals.

Suggested requirements:

- The core of an AIPN must support procedures related to frequent terminal mobility between core network nodes.
- An AIPN mobility solution must support seamless user experience for all services provided by the network.
- The mobility solution must scale with the number of terminals and size of the network.
- The core of an AIPN must support access networks with very limited or no mobility management procedures.

Optimised IP session control

In principle it is assumed that session control within AIPN shall be optimised for user-to-user communication, i.e. from one user's mobile terminal to another user's mobile terminal, and for other traffic models such as those of streaming services, and shall be extended beyond IMS functionalities that already provided. Some new session control mechanisms are introduced within an AIPN e.g. session mobility, session adaptation to terminal capability and session control for user to multicast.

Suggested requirements:

- The IP session control mechanisms of AIPN shall be enhanced from the functionalities of IMS to provide session mobility, session adaptation to terminal capability and session control for user to multicast.

Support of increased IP traffic demand

As the number of users accessing multimedia and data services from 3G networks will continue to accelerate, huge amounts of IP traffic are expected to be generated in the AIPN. Therefore, an AIPN must be able to accommodate the large increase of IP traffic in the network whilst being able to guarantee QoS for different services, i.e. ensure that quality conditions for a particular communication are fulfilled without deterioration between the communication end-points, and ensuring that network resources are used efficiently. This will enable the additional cost to network operators to be minimised.

Advanced QoS control mechanism and traffic engineering techniques are possible methods to achieve better IP traffic performance and increase the efficiency of the network resource usage.

Suggested requirements:

- An AIPN shall be able to provide guaranteed QoS for services and use network resources with high efficiency i.e. ensure that quality conditions for a particular communication are fulfilled without deterioration between the communication end-points.

  Possible methods to achieve this within an AIPN include:

  a) The ability to control routing of IP traffic dynamically according to the actual resource usage condition from an end to end point of view which includes the end user devices, network entities and application servers and this could be achieved by using intelligent QoS routing algorithms taking into consideration of resource usage conditions.

  b) The ability to be able to monitor the network entities statistics in real time, e.g. current reserved resources, un-used resource in order to route IP traffic dynamically based on network condition.

Ability to effectively handle a variety of different types of IP traffic

AIPN is expected to handle different types of IP traffic, real-time e.g. VoIP, non-real time e.g. Web browsing, mission critical e.g. M-Commerce. However it is not easy to predict the traffic model in AIPN. Sometimes it will need to handle a large amount of IP traffic which requires higher QoS class traffic and less traffic for lower QoS class traffic and verse visa. This may result in a worst case scenario in which most of the network resources are used to handle higher QoS class IP traffic, e.g. guaranteed services, and so lower QoS class IP traffic, e.g. best effort traffic, suffers congestion and long delays.

It is believed that even under such situations, AIPN should still be able to provide satisfactory QoS to lower QoS class traffic e.g. best effort traffic. A possible method to achieve this could be to use dynamical load balancing mechanisms in the AIPN to control the load in the network entities in term of handling different type of traffic class according to the actual traffic model in real time.

- AIPN shall be able to support different levels of QoS according the type of the IP traffic.

- Mechanisms should be available to the operator to enable AIPN congestion for the lower QoS class IP traffic when large amount of network resource is used to handle higher QoS class traffic to be avoided. A possible method to achieve this could be by using dynamic load balancing among the network entities.

IP-based routing and addressing

Due to future increases in the number of users and terminals accommodated by mobile networks it is necessary to ensure that addressing and routing schemes can accommodate a number of users and terminals significantly greater than the present number of mobile subscribers. Due to the limited amount of available MSISDN numbering capacity it would be desirable to be able to accommodate new users and terminals without the need to associate an MSISDN with terminals for which there are no need to receive E.164 calls.

Moreover, adoption of 3GPP specific technology in existing 3GPP system results in cost increases for network operators (which are subsequently passed on to users) due to the need to deploy specialised network equipment. The use of specialised equipment also makes flexible service expansion difficult.

The use of IP technology is widespread which results in low costs for equipment based on IP technology. Moreover, the use of IP technology is standard throughout both the telecommunications and IT industries and it is necessary to enable the 3GPP system to be realised based wholly upon IP technology in the future. In particular, the use of IP technology for addressing and the routing technology within an AIPN is applicable.

Suggested requirements:

- An AIPN shall enable the accommodation of a vast number of users and terminals.

- Based upon industry trends IP technology shall be applied to the addressing and routing technology within an AIPN to enable accommodation of a vast number of users and terminals.

Network selection principles

Access technology selection

The introduction of multiple access systems within the same coverage area raises new operator and user requirements; the user may wish to influence the selection of the access system for use based on such aspects as supported QoS, mobility, pricing, coverage, etc. and the network operator may wish to influence the access selection by setting policies. Optionally, a user may even wish to use simultaneous multi-access as well.

Note that the selection of the access system needs to be easy for the end user, e.g., it could be based on some preferences and the actual process can be partly or completely hidden.

It is expected that users using multiple access systems will require an appropriate service continuity experience as they switch from one access to another. This means that their sessions remain in operation, with minimal interruption. In addition, the services provided should be made access aware (e.g., choose video quality based on the available bandwidth).

Suggested requirements:

- An AIPN shall enable use of the multiple access systems by providing support for appropriate handover between access systems, reachability over multiple access systems, access network-aware services, and optionally simultaneous multi-access.

- An AIPN shall provide support for access technology selection based on combinations of operator policies, user preferences and access network conditions.

Note: The user preferences shall be respected as long as they do not negatively effect the operation of the system.

Enhanced network performance

By the accommodation of various terminals and the diversification of the services some new types of communication are expected to appear.

Together with the diversification of the services, requirements for network resource utilization will also become diversified. It is necessary that network resources, especially for the wireless resource, be used effectively and efficiently, including selection of the access technology used based on the provided service.

Although the connection and routing method of the current PS domain is suitable for user-to-server communication, user-to-user communication will increase more and more as services and service usage diversifies. Therefore, it is necessary that an AIPN provides the ability to efficiently handle a variety of different types of IP traffic and has optimized routing mechanisms, in particular for user-to-user traffic.

Suggested requirements:

- An AIPN shall provide the following features:
  - Ability to efficiently handle a variety of different types of IP traffic including user-to-user and user-to-multicast traffic models
  - Optimized routing of IP traffic, in particular for user-to-user traffic.
  - Efficient usage of radio resources, including selection of access technology, based on the provided service.

Quality of Service

Though existing 3GPP systems guarantee end-to-end QoS for a session between 3GPP systems, a similar function is also needed for AIPNs. However, within an AIPN, this functionality shall be enhanced to be enable guarantee of end-to-end QoS across a variety of different access technologies. Also, it is required that the continuation of QoS provision be possible whilst moving within an AIPN including when moving across access technologies during handover.

Suggested requirements:

- It shall be possible to guarantee end-to-end QoS for a session between AIPNs. This includes the case where more than one network administration is involved in the provision of the end-to-end service.

- It shall be possible for systems for which it is feasible to guarantee end-to-end QoS continuously even when the terminal moves, and the access connection changes during communication i.e. the same communication is maintained across changes in access connection.

7 Conclusions

This chapter describes the conclusions of this Technical Report.

7.1 Overall Conclusion

This technical report has analysed the vision and the key aspects of AIPN and identified new capabilities to be specified for the 3GPP system to enable evolution to an AIPN. It is concluded that the features required for introduction of an AIPN into the 3GPP system require new specification work within 3GPP. The recommendation of this Technical Report is that the work be undertaken as a single feature and a new Technical Specification be produced to capture the service requirements for an AIPN. It is also recommended that in addition to the production of a new Technical Specification new requirements identified within this Technical Report relevant to existing features of the 3GPP system, i.e. indicating that expansion of an existing capability (e.g. IMS), be added to existing specifications where appropriate.

Note 1: When undertaking specification work for an AIPN care should be taken to ensure that service requirements are not duplicated across multiple Technical Specifications. This could be achieved by e.g. adding the text for a new requirement to a single Technical Specification and referencing this requirement within other Technical Specifications as appropriate.

Note 2: For further information regarding the capability expansion required for introduction of an AIPN see Chapter 6 of this Technical Report.

7.2 Roadmap for work within Rel-7

7.2.1 New requirements for introduction to the 3GPP specifications in Rel-7

New requirements for the 3GPP system that should be specified to enable introduction of an AIPN have been identified in Chapter 6.2 of this Technical Report. It is therefore recommended that the content of this chapter be used as a basis for introducing AIPN service requirements in to the 3GPP Technical Specifications in Rel-7. Additionally, the content of other chapters may be considered within specification work for an AIPN as appropriate.

The introduction of new functionalities and the enhancement of existing functionalities are necessary to achieve the multiple access accommodation and the mobility across multiple different access technologies which are the fundamental key aspects of an AIPN. For this reason it is recommended that these functionalities are captured by new services requirements for the 3GPP system with the highest priority.

7.2.2 Impact to specifications in Rel-7

The following table analyses the requirements in each of the subsections and indicates how these requirements can be introduced into the 3GPP specifications.

Chapter	Service requirement	Analysis	Relevant Technical Specification
Note 1: The introduction of aspects relevant to Technical Specifications not under SA1 responsibility is to be determined by the appropriate 3GPP TSG WG. Note 2: The content of the column entitled 'Relevant Technical Specification' is non-exhaustive, i.e. the introduction of requirements for an AIPN into Technical Specifications other than those stated may be considered if appropriate.			

7.3 Roadmap for work beyond Rel-7

This chapter shall provide a roadmap for work within 3GPP on an AIPN beyond Rel-7.

7.3.1 New requirements for introduction to the 3GPP specifications beyond Rel-7

This chapter shall list the foreseen new requirements that need to be introduced in the 3GPP stage 1 specifications beyond in Rel-7 to enable standardisation of an AIPN (if necessary).

7.3.2 Impact to specifications beyond Rel-7

This chapter shall describe the foreseen impacts to the 3GPP stage 1 specifications beyond Rel-7 to enable standardisation of an AIPN (if necessary).

Annex A: Impacted Specifications

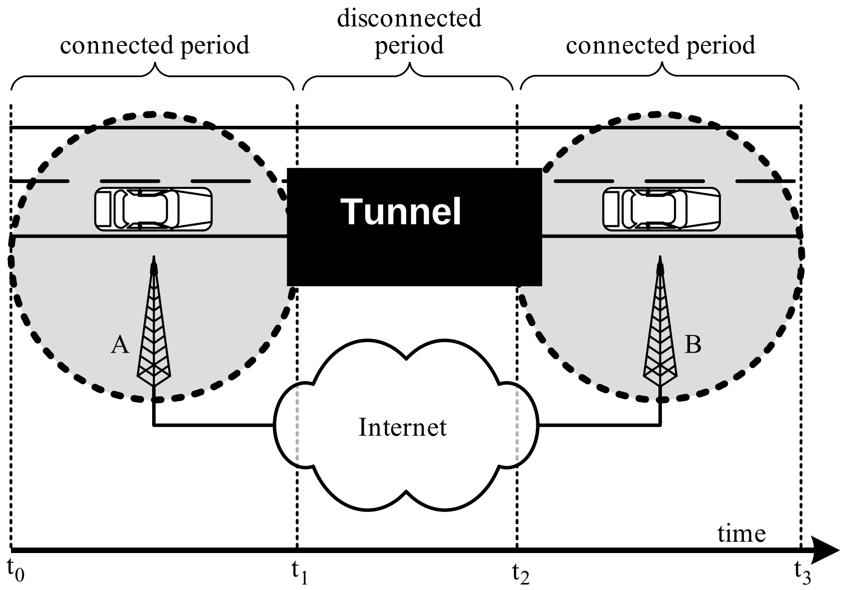
This annex shall provide a description of the foreseen impacts to 3GPP stage 1 specifications as a result of study within this TR (probably in the form of a table)

Annex B: Use cases for AIPN key aspects (Informative)

Resilience in the presence of network disruptions and intermittent connectivity.

Use case:

This use case is illustrated in the figure below.



The user is driving a car. While being under good radio coverage, he starts an IMS session with several media. The car goes through a tunnel where there is no radio coverage, and comes out of the tunnel into good radio coverage a minute later. Connections using disruption resilient transport protocols are automatically re-established and these protocols restore the communication to the point they where before the interruption.

Service adaptation to terminal capabilities.

Use case:

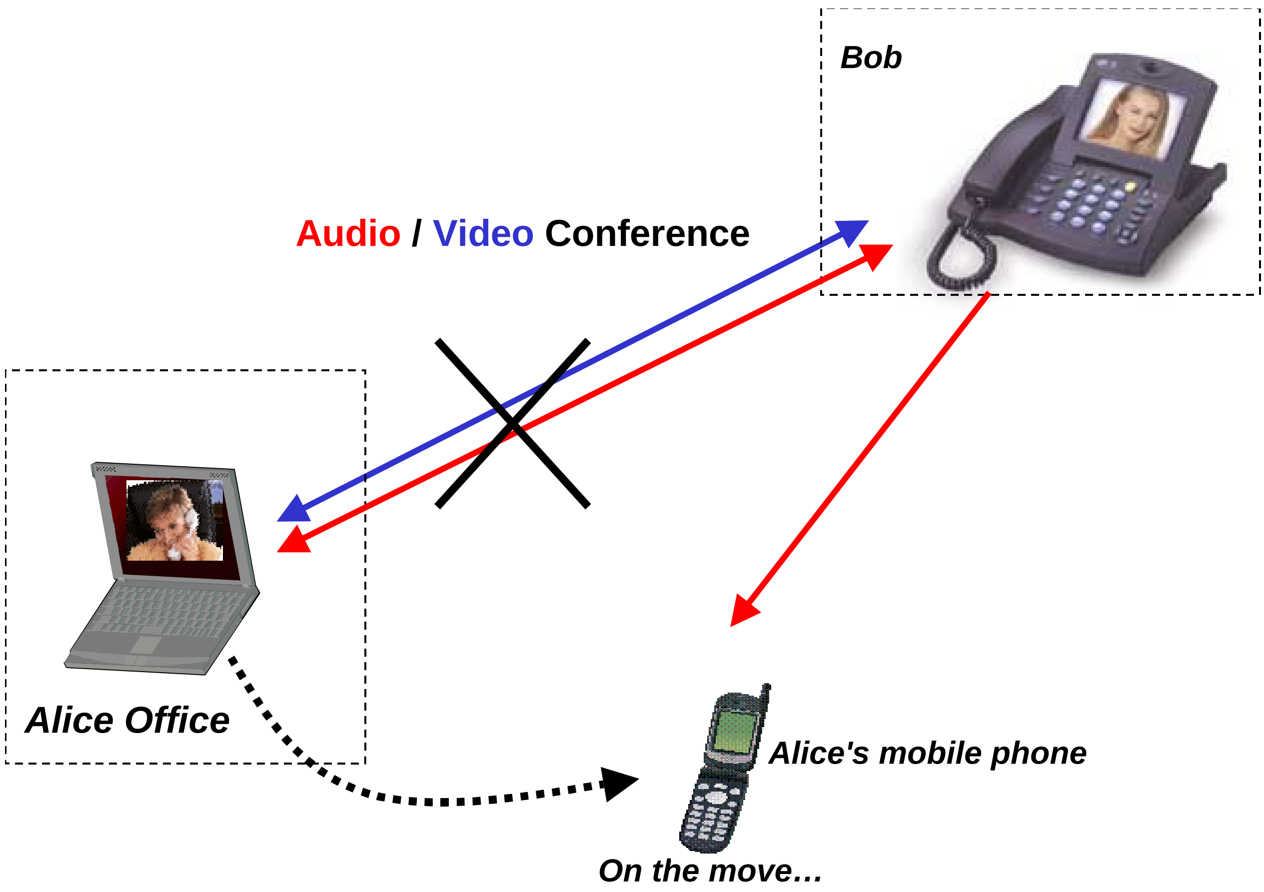
This use case is illustrated in the figure below.

Alice has a mobile device and Bob has a fixed one. Both devices have equal audio but different video capabilities in terms of screen size, number of colors and video codecs supported. Alice establishes a multimedia connection with audio and video components to Bob. The terminal capabilities are discovered and it is realized that Bob's terminal has better video capabilities than Alice. The terminal informs the network that it is unable to support new the new video codec and the AIPN then introduces a video transcoder in the path of the video media to adapt the video signal (stream, codec, format, etc) to the video capabilities and bit rates available on each side of the transcoder.

Session mobility: seamless mobility of sessions between terminals.

Use case:

This use case is illustrated in the figure below.

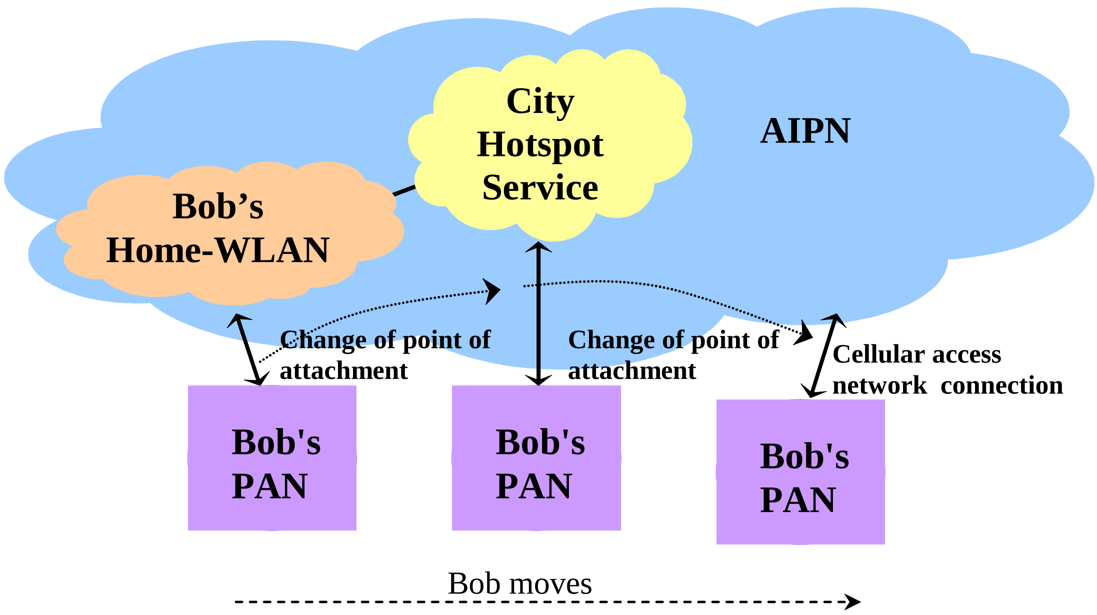


Alice and Bob are having a multimedia session with audio and video components using two high-end multimedia terminals in their offices. Alice needs to leave the office to take the car to visit a customer. She requests a session transfer. AIPN then transfers the session to her mobile phone.

Facilitate integration of networks with different administrative domains (e.g. handle negotiation of administrative issues, security, trust, etc).

Use case:

The following picture illustrates this use case.



Bob has his own personal area network (PAN). While at home, this network is composed with the Home Area Network using WLAN, which in turn connects externally with a local hotspot service, which in turn connects to a cellular network. Bob's PAN, Bob’s Home-WLAN, the local hotspot service and the AIPN cellular access network are under different administrative domains. Still, if Bob moves outside coverage of his Home-WLAN, his PAN will communicate with the outside world via the local hotspot service. If he moves outside coverage from the hotspot service, his PAN will communicate with the outside world via the AIPN cellular access network.

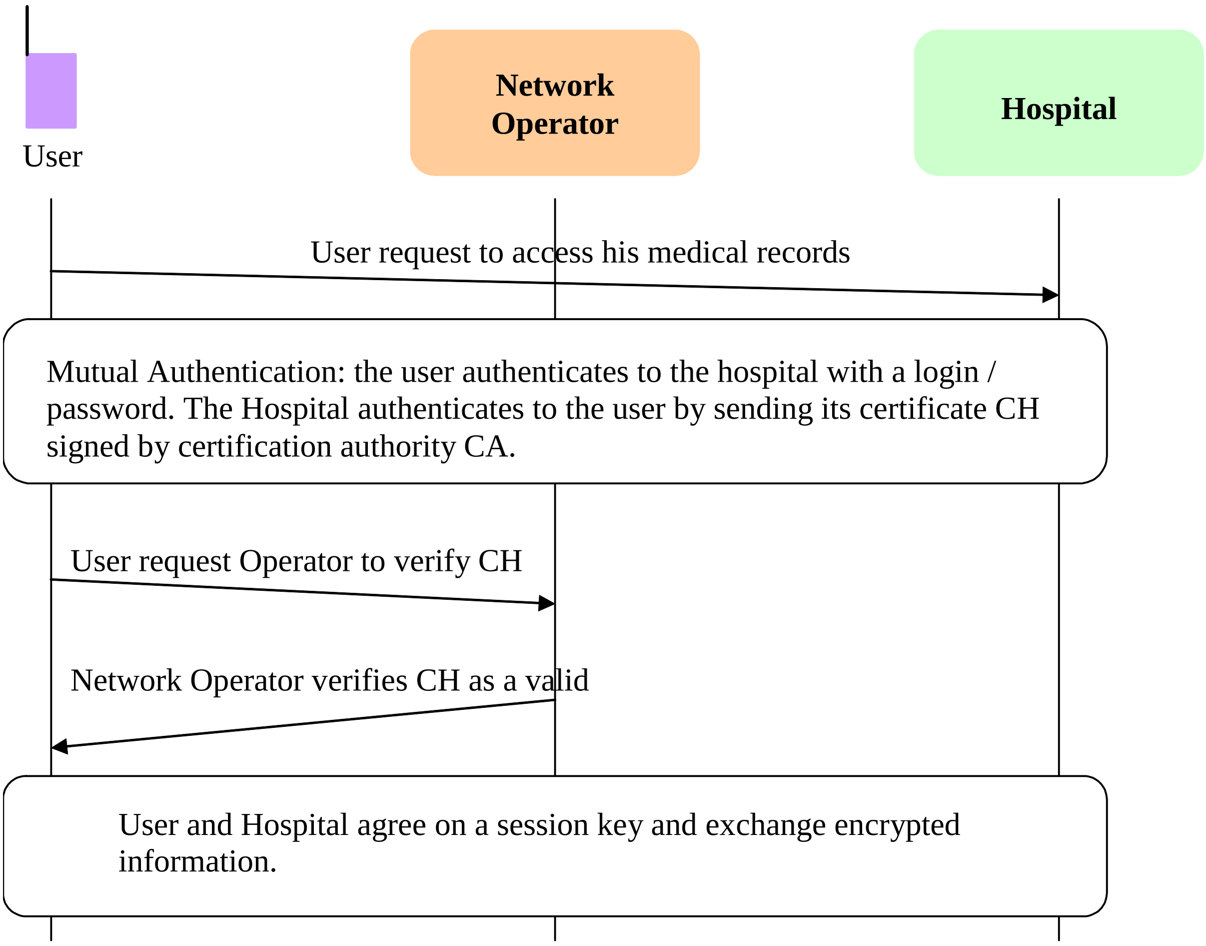
Annex C: Use cases for Security (Informative)

User issues: Ensure privacy and authenticity so that the user can trust the information he is receiving. This should cover private user to private user communications as well as private user to service provider communications.

Use case:

using the operator as certificate checking authority.

The figure below illustrates this case:



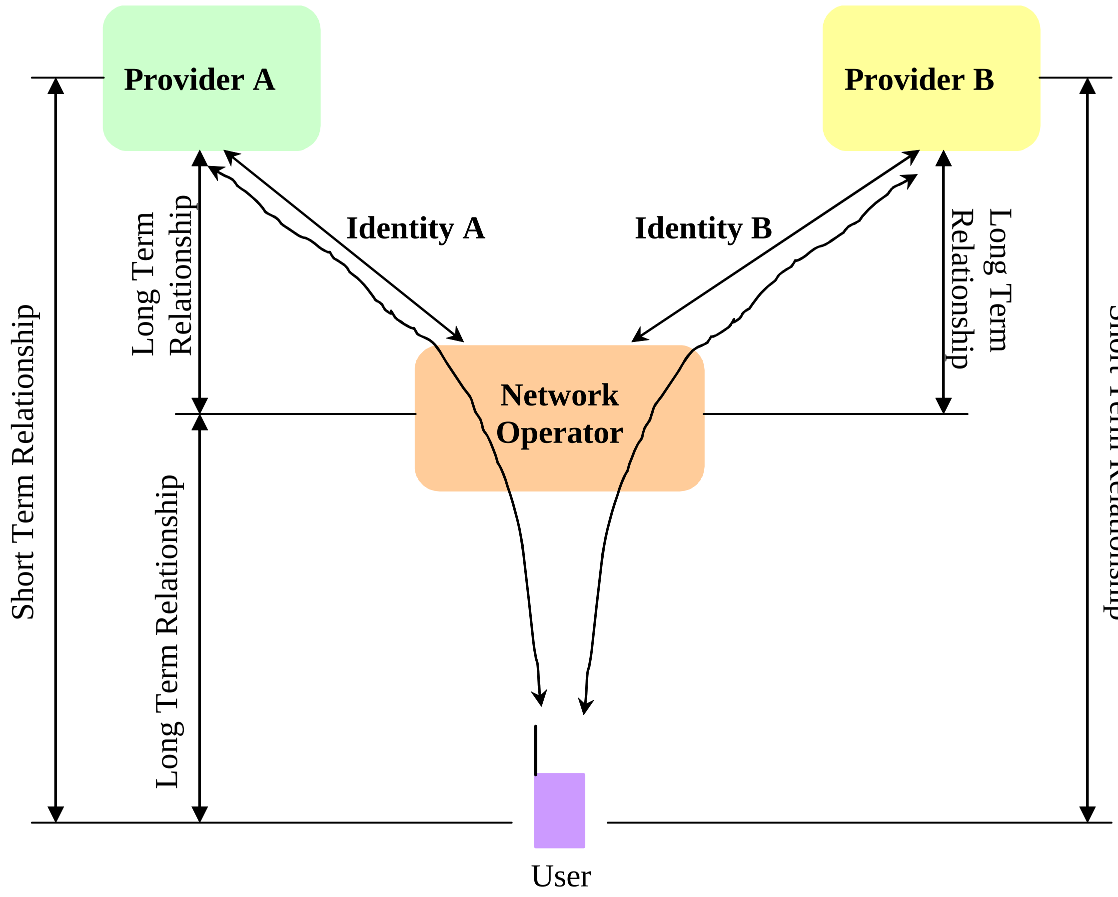
A user wants to access his medical records, stored in the hospital server, with his mobile terminal. The user connects with the hospital and authenticates itself. The hospital authenticates to the user by sending a certificate CH signed by certification authority CA. The user, however, does not recognize CA and asks the network operator to check the validity of CH. The operator checks the validity of CH and informs the user about the positive result. At that point the user is sure that the information is really coming from the hospital.

User issues: Multiple user identities. Users should be able to have multiple identities from different providers, with the relationship between identities hidden to particular providers (thus supporting privacy).

Use case:

the network operator generates temporary identities for the user to be used towards different providers.

The figure below illustrates this case:



The user wants to connect to two providers but keeping full privacy. The network operator enables this possibility by acting as a mediator. The network operator allows the user to gain access to the two providers with completely different identities. Both identities are temporary ones and can not be correlated in any sense by just looking at log records in Provider A and Provider B.

In order to enable this type of service, the providers have to establish a "trust relationship" with the network operator, so that he can perform accounting towards that network operator for the services provided to the network operator's subscribers.

The user already has a long term relationship with the network operator, and will be billed by the network operator for services he accesses via external providers.

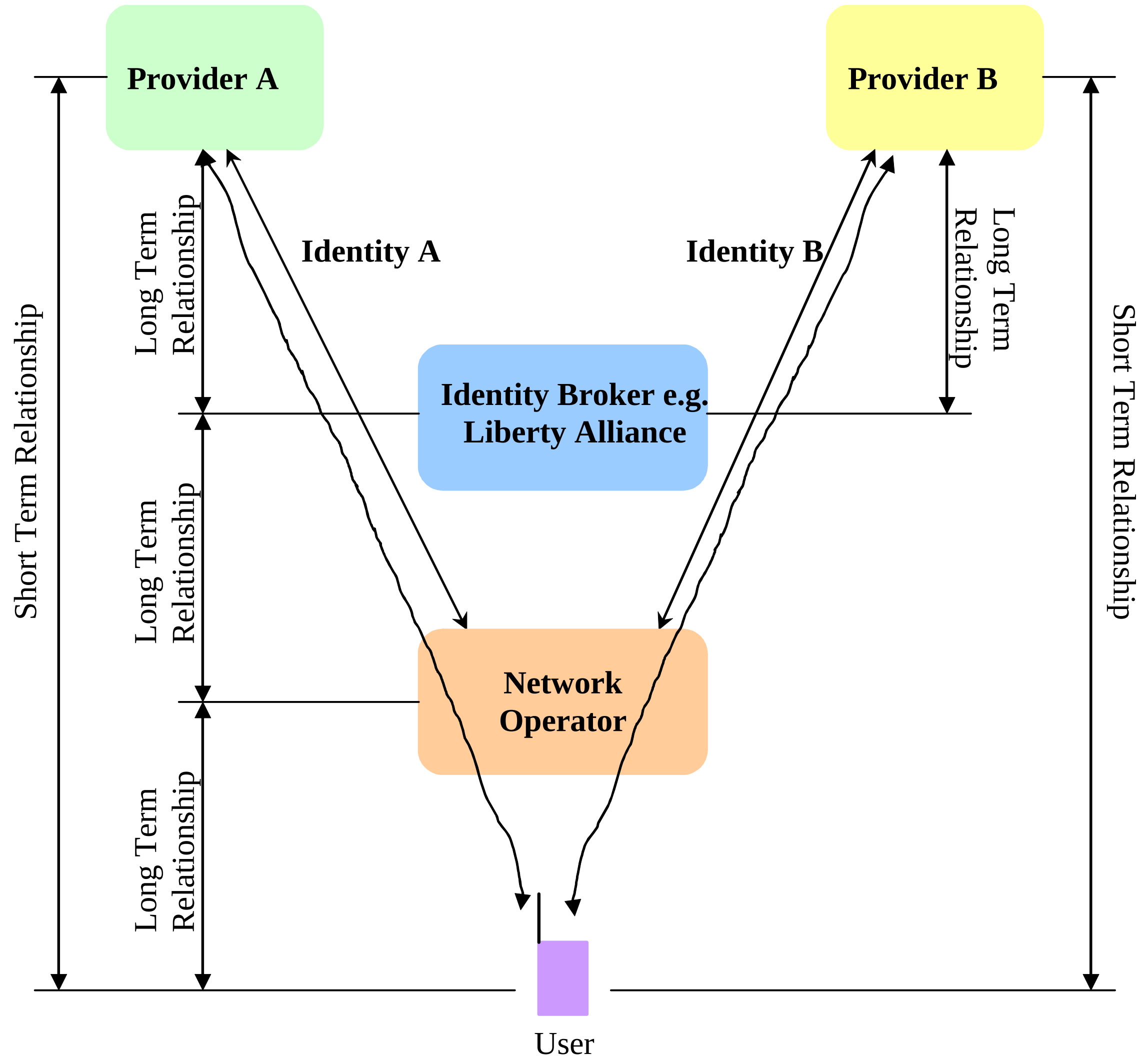
The network operator does know the user's real identity and the temporary pseudonyms that he has given to the user to access services from external providers. The network operator can then correlate the real and temporary identities for billing purposes.

Use case:

the network operator generates temporary identities for the user to be used towards different providers. An identity broker ,e,g, Liberty Alliance, acts as the long term trust relation center.

This use case is similar to the previous one, but in this case the network operator does not have a long term trust relationship with the providers, instead the network operator has a long term relationship with an identity Broker, e.g.

Liberty Alliance, and the identity broker has a long term trust relationship with the external providers. This case is illustrated in the figure below:



The user wants to connect to two providers but keeping full privacy. The network operator enables this possibility by acting as a mediator. The network operator allows the user to gain access to the two providers with completely different identities. Both identities are temporary ones and can not be correlated in any sense by just looking at log records in Provider A and Provider B.

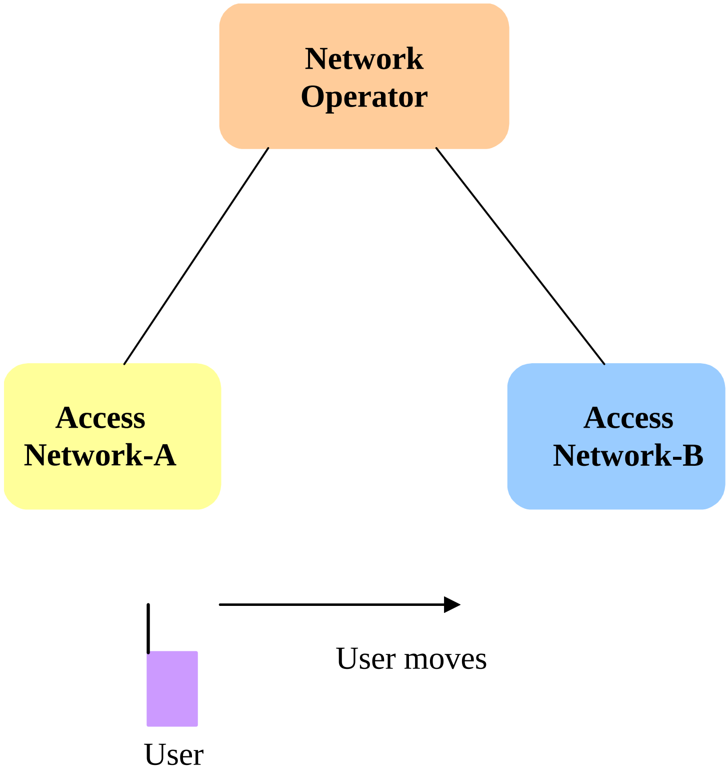
The network operator however, does not have a trust relationship with the providers but has one with an identity broker e.g. Liberty Alliance. The providers also have a trust relationship with the identity broker. So the identity broker is used as the common trust point to for the providers to offer services to the network operator's subscribers. The network operator can offer these services fully protecting the privacy of its subscribers.

Network issues: Fast re-authentication shall be possible..

Use case:

fast re-authentication in handovers between access networks.

The figure below illustrates this case:



The user is initially connected to Access Network-A and has a session with several media established. He moves towards Access Network-B, which may be under a different administrative domain than Access Network-A. In this case there are mechanisms for fast authentication to continue communication across Access Network-A and Access Network-B.

Note: In this case the user's terminal needs to support the access technology of each of the access networks

Annex D: Security Issues (Informative)

These issues are very high level and many aspects need to be investigated further to be able to specify them more clearly. This could e.g., include:

- Investigating how and where to realize policy enforcement functionality to get the most general, efficient and secure solution to protect the end-users and the operators' networks.
- Reviewing architectural and protocol features to get a better understanding of how to protect the network against attacks such as denial-of-service.
- Investigate how to develop a homogenous SSO concept taking privacy and anonymity requirements into account.
- Investigating the need for end-to-end security solutions.

In summary, the challenges will be in understanding the new risks to identify any new or lacking security requirements, and of course finally ensuring that the right mechanisms are in place.

To mitigate the problems and protect users and systems and to deter from attacks different types of policy enforcement functions are needed to build trusted domains. Policy enforcement should cover

- Available network services. General purpose IP access may be restricted or tunneled securely through the network.
- Traffic/content inspection in network to stop download of malware and intrusive content.
- Spam control
- Blocking of not trusted services and service providers
- Traffic separation
- Traffic origin (e.g. prohibit source IP address spoofing).

There will be a need for policy enforcement controlled by end-users and by network operators and a need to investigate how and where to realize policy enforcement functionality to get the most general, efficient and secure solution.

End-user policy enforcement will become a very important function, which networks will have to provide. One particularly important area is to control distribution of location information. However, presence information in general could be just as sensitive.

For protection against denial-of-service attacks, architectural and protocol features have to be reviewed**.**

D.1 Trust domains

Often, the only means to deter attackers and mitigate threats are to build logging and detection systems to make the risk of getting caught sufficiently high. Thus, it will be critical to define trust domains, means to establish trust, authenticate and authorize users and systems, and put requirements on trusted hardware (especially end-user equipment). A key issue is if monolithic mobile phones can become the trusted devices in which network operators can enforce different policies.

A specific issue is how to design the trust model when ad hoc extensions of access networks are offered by ordinary end-user equipment. Should all such traffic just be tunneled through the ad hoc extension or should there be some policy enforcement performed. There is also the question of who is responsible for the traffic from the ad hoc network. Either the originating device of the traffic or the relaying device (or both) has to be responsible. Since they belong to different end-users, maybe having different network operators, this may pose a problem.

Another issue is how to enforce policies in multi-access environments. One threat scenario is that a user connects his device to two different domains with different “trust levels”.

D.2 Trust establishment

There is a need for different trust establishment mechanisms e.g. for end-users towards network operators, end-users towards service providers, between end-user and between service providers. These mechanisms may be identical but could also be based on different principles if that would make them more efficient.

The natural choice for authentication of end-users towards the network operators is of course (X)SIM based. However, public key based systems may have advantages for other situations. The DRM solutions also show the need for secure authentication of trusted hardware.

A basic end-user requirement is that security mechanisms should be automatic and invisible to the end-user. User authentication and authorization should be able to be performed with a minimum of user interaction. At the same time, legitimate requirements on user privacy and even anonymity should be able to be catered for. Current work in SA3 (GAA/GBA) and Liberty show that there is a need for simple and uniform trust establishment mechanisms for service provisioning at different levels.

To increase user convenience, make systems less complex, simplify application development a common, standardized, homogenous SSO system taking privacy and anonymity requirements into account is needed. Today, we are moving towards a situation in which we have a set of diverse user authentication and authorization mechanisms tailored for different services.

D.3 Network heterogeneity and traffic protection

Specific issues that need to be reviewed are

- Location of the network point of trust. Network point of trust means the first network point at which user payload traffic is available in plaintext format. Simultaneous multi-access should be taken into account.
- Should user authentication and key agreement be performed on layer 3 (IP-layer) to enhance “portability”.
- Layer 2 protection is needed to protect system signaling and protect against Denial of service attacks. How to establish keys?
- How to handle the situation that in the future user payload traffic and end-user equipment control signaling traffic may have different endpoints in the network
- New means to derive and distribute keys based on an initial user authentication.

D.4 End-to-end protection

With the introduction of IP based conversational multi-media over an AIPN, many users could feel a need for better end-to-end protection of their communication. A natural first step would be to introduce end-to-end integrity protection to guarantee the authenticity of data. Confidentiality of data may also be required (e.g. government agencies). Thus, the AIPN should be designed to allow efficient end-to-end protection of multimedia sessions. Here it might be beneficial to deploy (new) generic protocols for key management and data protection to limit signaling and computational load in the terminals. Lawful intercept requirements have also to be considered.

Annex E: Change history

Change history											
TSG SA#	**SA Doc.**	**SA1 Doc**	**Spec**	**CR**	**Rev**	**Rel**	**Cat**	**Subject/Comment**	**Old**	**New**	**WI**
10/6/04								Initial TR skeleton provided to SA1 mailing list by rapporteur for comment.	-	0.0.0	
18/6/04								Version updated based on comments received on the SA1 mailing list.	0.0.0	0.1.0	
30/6/04								Version updated to include text proposed within contributions to AIPN SWG held during SA1#25.	0.1.0	0.2.0	
1/7/04								Version updated based on end-to-end review of version 0.2.0 created in the AIPN SWG held during SA1#25.	0.2.0	0.3.0	
2/8/04								Editorial updates proposed by the rapporteur and discussed on the SA1 mailing list.	0.3.0	0.4.0	
28/8/04								Output of AIPN SWG in Vienna August 2004	0.4.0	0.5.0	
14/10/04								Output of AIPN SWG during SA1#26, October 2004	0.5.0	0.6.0	
3/11/04								Raised to version 1.0.0 for presentation to SA #26	0.6.0	1.0.0	