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Foreword

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The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

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:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

At a time when the first release of the 3GPP 3G standard has stabilised, and the first 3GPP compliant networks are going live, the ITU is already working towards elaborating a framework for the future development of IMT-2000 and systems beyond IMT-2000. In addition, a number of research initiatives worldwide are investigating technologies and techniques that might fall within that framework. It is therefore timely, that 3GPP look at how its systems will evolve in the future to meet the requirements of the user and the industry, and to make use of emerging technologies.

1 Scope

The present document describes a long term, high level roadmap, intended to guide the future work of 3GPP. It is focussed on items pertinent to the evolution of 3GPP specifications, and identifies concepts and trends to be considered by 3GPP when defining future work items. It does not contain details of proposed technologies, rather it contains pointers to direct the activities of the appropriate TSGs in elaborating future releases of the 3GPP standard. As a result, not all of the topics covered herein are within the remit of 3GPP to discuss, and description of such items will not be extensively developed. E.g. Spectrum is an ITU-R/WRC issue and therefore outside the scope of 3GPP. The document is designed to be a "living document" and will be updated accordingly over its lifetime in order to reflect future developments and innovations.

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".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [1] apply.

3.2 Abbreviations

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

LIF	Location Interoperability Forum
WAP	Wireless Application Protocol
WRC	World Radiocommunication Conference

4 The current scope of 3GPP and its Releases

4.1 3GPP Releases

The current scope of 3rd Generation Partnership Project (3GPP) is to produce globally applicable Technical Specifications (TSs) and Technical Reports (TRs) for:

- a 3rd Generation Mobile System based on evolved GSM core networks and the radio access technologies that they support (i.e., Universal Terrestrial Radio Access (UTRA) both Frequency Division Duplex (FDD) and Time Duplex (TDD) modes); and
- the Global System for Mobile communication (GSM) including evolved radio access technologies (e.g. General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE)).

In addition, 3GPP shall consider the long term evolution of its systems.

The 3rd Generation Mobile System and the Global System for Mobile communication (GSM) and their capabilities are developed in a phased approach. In the following the content of the 3GPP Releases is briefly outlined.

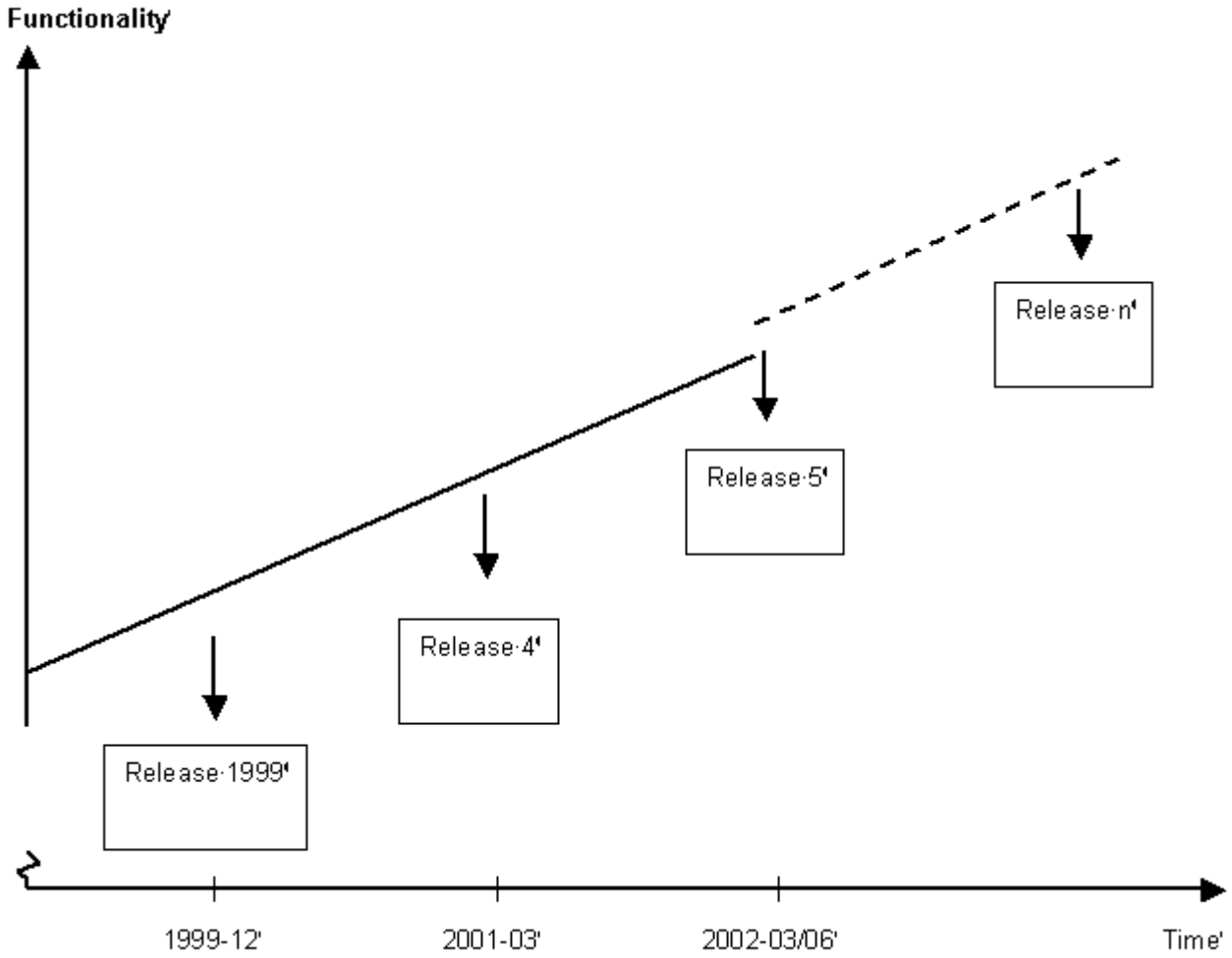

Figure 1: 3GPP Releases for enhancements/improvements of the 3GPP Mobile Network

4.1.1 3GPP Release 1999

3GPP Release 1999 is the first release from 3GPP and covers specifications for a complete mobile system. 3GPP Release 1999 contains, but is not limited to, UTRA FDD and 3.84 Mcps TDD modes, UTRAN Iu, Iub and Iur interfaces, GSM based evolved core network, USIM, AMR speech codec, Multimedia Messaging Service (MMS), Location Services (LCS), a broad range of supplementary services, Customized Applications for Mobile network Enhanced Logic (CAMEL); Open Service Access (OSA) and telecommunication management.

The 3GPP Release 1999 was functionally frozen in December 1999.

4.1.2 3GPP Release 4

3GPP Release 4 is a further enhancement of 3GPP Release 1999.

3GPP Release 4 contains, but is not limited to, UTRA FDD repeater function, low chip rate TDD option, 700 MHz support for GERAN, e2e transparent packet streaming service, Tandem Free Operation, Transcoder Free Operation, IP transport of CN protocols, bearer independent CS core network, CAMEL enhancements and OSA enhancements.

The 3GPP Release 4 was functionally frozen in March 2001.

4.1.3 3GPP Release 5

3GPP Release 5 is a further enhancement of the previous releases.

3GPP Release 5 contains, but is not limited to, the initial phase of the IP Multimedia Subsystem (IMS), High Speed Downlink Packet Access (HSDPA), UMTS in 1800/1900 MHz bands (release independent), Wideband AMR, IP transport in the UTRAN, Iu for GERAN, Gb over IP, CAMEL enhancements, OSA enhancement, Global Text Telephony (this is a Release independent Feature, not a Rel-5 Feature), Location Services enhancements, UTRAN sharing in connected mode and security enhancements.

The 3GPP Release 5 was functionally frozen in March 2002 and the remaining part in June 2002.

4.1.4 3GPP Releases 6

Work is currently ongoing for 3GPP Release 6. It is planned that 3GPP Release 6 will contain, but will not be limited to: Multimedia Broadcast/Multicast Service (MBMS), Network Sharing, Priority Service, Wireless LAN/UMTS Interworking, IMS Phase 2, Push Services and Presence.

4.1.5 Future 3GPP Releases

The present document addresses the evolutionary aspects of subsequent 3GPP Releases.

4.2 Interactions with other industry fora

4.2.1 Internet Engineering Task Force (IETF)

As a result of the introduction of the IP Multimedia CN Subsystem, the dependence on IETF RFCs has significantly increased, with 3GPP defining requirements that impact the IETF work. The relationship with IETF is moving away from one where 3GPP simply adopts the protocols as applicable (as was the case in Release 1999 and Rel-4), with 3GPP actively participating in the develop of the protocols for Release 5 and in the case of Release 6 defining the system requirements, from which the protocol requirements can be determined and passed to IETF to provide the solution. To coordinate that work, 3GPP has put in place the following:

- an IETF Liaison Rapporteur to work with the officials of IETF;
- tracks the dependencies on work in IETF through the 3GPP Work Plan;
- provides 3GPP requirements drafts into IETF through contributions from individuals.

4.2.2 Open Mobile Alliance (OMA)

OMA is a new industry forum, which is working on service enablers for mobile systems. The working relationship between 3GPP and OMA is still being developed. Currently, 3GPP is dependent upon work within OMA that was formerly being done with fora such as WAP and LIF. In this case, the requirements have been defined by 3GPP and the protocols are being defined by OMA e.g. for LCS and MMS.

In the future there is the possibility that OMA will be defining service enablers that 3GPP will need to:

- provide interworking to;
- provide network capabilities to support the service.

5 Focus areas and Stakeholder expectations

A number of drivers have been identified for the evolution of the 3GPP system. These drivers can be categorised as expectations coming from a number of different "Stakeholders", in that each Stakeholder has its own expectations of what evolution will deliver. Table 1 gives a summary of the stakeholders and their expectations. They have been grouped under focus areas. Some drivers appear under more than one focus area. It is recognised that new services/functions shall provide new streams of revenue.

Table 1: Mapping of Stakeholder expectations to Focus Areas

Focus Area	End User Expectations	Network Operators Expectations	Manufacturer/Application Developer Expectations
Ubiquitous access for a core set of services, delivering IP based services at moderate data rates (hundreds of kb/s) over the widest possible proportion of the world.	Ubiquitous mobile access Appropriate quality at reasonable cost (including terminal cost) Easily understandable user interface.	Reduced cost of terminals and network equipment based on global economies of scale. Need to reduce cost of network ownership and ongoing operations. QoS and Security management.	Access to a global market
Flexibility in services provision; including charging, ease of use.	Easy access to applications and services Inter-Operability of services between diverse systems independent of access technology Easily understandable user interface Large choice of terminals Enhanced service capabilities.	Ability to provide differentiated services; Flexible charging; Ad hoc networking integration shall allow the full operator control of all the nodes involved Mobile nodes should request and obtain operator"s authorisation for every service requiring the usage of radio or network resources.	
Cost containment; relates to cost savings as seen by each stakeholder.	Appropriate quality at reasonable cost Long equipment and battery life. User friendly charging capabilities.	Optimisation of resources (spectrum and equipment). Flexibility in the network configuration; Access type selection optimising service delivery; Reduced cost of terminals and network equipment based on global economies of scale. Need to reduce cost of network ownership and ongoing operations. Maximized usage and sharing capabilities between 3GPP systems and systems beyond 3G (sharing of terminal, USIM, network elements, radio sites). Limit number of options in order to ease deployment and network configuration for multi-vendor infrastructure, handsets and roaming. Need a standardized set of OAM&P (Operations, Administration, Management & Provisioning) interfaces.	Reduced cost of terminals and network equipment based on global economies of scale. Access to a global market. Open physical and logical interfaces between modular and integrated subsystems. Programmable platforms that enable fast and low cost development.
Security related issues of services; including all aspects related to the protection of information, fraud prevention etc.	Availability of a trusted environment (Security of identity, personal data and "conversations").	Single authentication (independent of the access network).	
Performance.	Enhanced service capabilities Improved system performance in terms of responsiveness and reduced delay in sending/receiving data.	Optimisation of resources (spectrum and equipment). Trusted environment based on USIM/UICC.	

6 Technology Evolution

6.1 Statements and Assumptions

A number of basic assumptions are made for this high level roadmap as follows:

- future is evolution not revolution;
- where possible, existing techniques/technologies should be re-used (potentially through co-operation with external fora);
- requirements setting should be improved, e.g. by including commercial considerations;
- three horizontal layers are applied in 3GPP architecture definition: access/connectivity layer, service enablers layer, and applications/services layer;
- the 3GPP architecture separates user, control and management related information flows into their own planes;
- the description of the 3GPP System Future Evolution is split in two parts:
  - 3G Enhancements (short to medium term evolution);
  - 3G Long Term Evolution;
- different domains and layers of the system may evolve at different paces, partly due to the pace of technical development within the domain, and partly due to regulatory windows of opportunity, such as, WRC-07. This means that specification work on Short/medium and long term capabilities will overlap. As a general rule, the borderline between short/medium term and long-term evolution is in approximately 4-5 years time (around 2007-2008), for the availability of the specifications. Hence, some of the long term specifications may be available close to this borderline and before all the specifications for the short/medium term are complete.

In considering the future evolution of the 3GPP system it is further recommended that:

- the layered architecture model allows rapid development of new applications and services, but allows also the integration of new radio and network technologies on the access/connectivity layer;
- decoupling between horizontal layers is adopted as a design principle;
- access technology specificities are considered and taken into account when justified by application and system performance gains;
- 3GPP should also in the future define clear interfaces between different subsystems of the 3GPP system to facilitate development of each subsystem according to its evolution phase;
- mechanisms to manage the provision of third-party services over decoupled networks are introduced.

6.2 3G Enhancements (short to medium term evolution)

The Short/Medium Term phase of the evolution is marked by the fact that the requirements for many of the changes are known today. Hence, it is easier to be more specific on what enhancements may be made to the 3GPP system.

6.2.1 Radio access network technology

Short to medium term evolution of 3G radio access should aim for improved radio performance, support for better UE performance, and optimisation of radio access network architecture. Improvements to radio performance include:

- higher spectral efficiency;
- improved coverage;
- radio protocol optimisation for shorter radio access latencies (both call set up and round-trip-time).

Further improvements of RAN performance (radio performance, RAN architecture)spectral contribute to lower costs of service delivery. For best effort type of traffic at least two times the cellular throughput of HSDPA (Rel-5) should be achieved. Important techniques to be considered are e.g. multi-antenna both in Node B and UE (multi-streaming and diversity) and efficient utilisation of multicast/broadcast solutions. In addition for better user experience higher bit rates in the order several hundreds of kbps for dozens of users per cell should be possible in wide area deployments.

Radio protocol optimisation should take into account the overall end-to-end performance requirements as seen by the end-user. Of particular importance is the delay contribution of radio access for delay/response sensitive services like interactive gaming.

Techniques that enhance the UE performance especially in terms of power consumption should be targeted for. This may involve e.g. higher peak data (in the order of 20-30 Mbps) rates.

Joint utilisation of 3G cellular and alternative access technologies (e.g. WLAN) creates a multi-radio concept which potentially can improve the user experience e.g. in terms of increased capacity and very fast local access. Radio access solutions that enable low cost/power efficient multi-radio implementations and improved overall performance (data rate, spectral efficiency, capacity, delay) should be studied.

Radio access network architecture should be further optimised especially for packet data communication. This would improve the efficiency of the network and also lower the involved implementation costs.

6.2.2 Core Network

The following enhancements to the 3GPP core network system are considered to be realisable in the short to medium term:

- a Harmonized IMS between 3GPP and 3GPP2:
  - a Harmonized IMS is highly desirable for operators to provide the opportunity of service transparency, seamless roaming and common application across all evolving IMT-2000 systems;
  - a single IMS reference model should be adopted and consistent terminology used to describe common IMS functional entities;
  - 3GPP and 3GPP2 should work to ensure interoperability between the 3GPP IMS terminals and 3GPP2 MMD terminals (a 3GPP IMS terminal can set up a session with a 3GPP2 MMD terminal and vice-versa);
  - application level intersystem IMS roaming should be supported. A 3GPP IMS terminal supporting the visited network"s access network, IP transport technology and IMS discovery mechanisms, should be able to roam into a 3GPP2 network and use the capabilities of visited P-CSCF to access home IMS and vice-versa);
- service expandability and application service support;
- security support;
- further optimisation, especially for packet data communication, of the core and radio access network architectures to improve the efficiency of the network and also lower the involved implementation costs.

In addition, it is expected that short to medium term enhancements will improve system flexibility, scalability, interoperability and robustness.

6.2.3 Service Provision

A number of short to medium term enhancements have been identified from the service provision perspective. These include:

- the establishment of flexible charging capabilities;
- access to a very large market through a high similarity of application programming interfaces;
- fast, open service creation, validation and provisioning;
- enhanced QoS and security management;

- Service Portability – Global Roaming;
- the ability to monitor and measure Service Level Agreements on End to End Basis;
- the ability to adapt content to user requirements depending on terminal, location and user preferences;
- automatic service adaptation as a function of available data rate and type of terminal;
- the definition of enhanced APIs:
  - generic APIs which allow application creation. The APIs should include interface with underlying QoS capabilities;
  - a simple IMS interface towards external networks;
  - APIs for Application delivery;
- Seamless Service Provision & Service Interworking:
  - from the user access perspective;
  - across different environments;
- Service harmonization(or interoperability):
  - as varieties of application services are expected to explode every year, seamless application interoperability will be the key factors to satisfy users. It is undoubted that service interoperability can be fully supported on the common service platform but, 3GPP and other external bodies have their own services which already almost completed their technical works;
  - 3GPP should focus on developing common service platform and providing service interoperability for the work already being done, such as MMS service between 3GPP and 3GPP2.

6.2.4 Operations Support Systems

The following enhancements to Operation Support Systems are considered to be realisable in the short to medium term:

- improved OAM&P (Operations, Administration, Maintenance, & Provisioning) and customer care possibilities;
- the definition of a standardized set of OAM&P interfaces to simplify operations and optimise costs;
- the exploitation of inherent network functions such as security, authentication, charging, etc.
- the inclusion of requirements from new functions.

In addition, it is expected that short to medium term enhancements will result in improved charging, security and testing.

6.2.5 User Equipment

The following are seen as enhancements from the User Equipment perspective, that will appear in the short to medium term:

- more easily understandable user interfaces;
- increased equipment and battery life;
- increased standby and activity times;
- larger choice of terminal models and terminal types;
- support of secure download of applications to the UE.

6.2.6 Smartcards

In the short to medium term it is expected that enhancements will appear that enable:

- support of secure download of UICC applications;
- establishment of the UICC as a cornerstone for all kind of trusted relationships (e.g. via powerful crypto processors);
    - support of the UICC as secure token for e.g. keys generation, rights management, e-signature, biometric identification, etc.
- advanced high-speed communication protocols for the terminal ↔ UICC interface;
- support of the UICC as a secure repository of personal data, due to the increasing size of the available memory on the UICC (from Megabytes and above);
- support of the enhanced set of USAT commands to increase the interaction with the terminal and different applications on the same UICC.

6.2.7 Security

In the short to medium term advances in security are expected that will:

- enable re-use of 3G based USIM/UICC centric identification and authentication for roaming between 3GPP and non-3GPP based networks by providing adequate means to non 3GPP networks to make use of 3GPP Security mechanisms;
- establishment of the USIM/UICC centric 3GPP security mechanisms as a cornerstone for all kind of trusted relationships;
- introduce the necessary state of the art protection mechanism needed to cope with the increased threats due to overall IP-based network and terminal connectivity.

6.3 3G Long Term Evolution

The Long Term Evolution is somewhat blurry and is marked by *visions* of what the future wireless networks should evolve into. The 3GPP Long Term vision is still a little hazy, as are other visions, and will gradually come into focus through a careful study of market trends, understanding of future user requirements and the availability of new network and wireless access technologies. Thus, only the outline of the proposed 3GPP Long Term evolution is presented.

6.3.1 Radio access network technology

In long term, the performance improvements (spectral efficiency, higher bit rates, shorter delays) of 3GPP radio access should be continued. Long term target peak data rates are:

- up to 100 Mbps in full mobility, wide area deployments;
- up to 1 Gbps in low mobility, local area deployments.

The long term spectral efficiency targets are (for best effort packet communication):

- in a single (isolated) cell, up to 5-10 bps/Hz;
- in a multi-cellular case, up to 2-3 bps/Hz.

Reaching the peak data rate targets may take place by gradual evolution of existing 3GPP (UTRAN) and alternate access means (e.g. WLAN), but also new access techniques should be considered according to the availability of additional or re-allocated spectrum, as defined by WRC.

6.3.2 Core network

The following reflect a vision of longer evolution of the 3GPP core network 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 broadband and multiple bearer service capability;
- interworking between 3GPP Mobile Network and other Networks:
  - a similarity of services and applications across the different systems is beneficial to users, and this has stimulated the current trend towards convergence. In the future operators may complement their cellular networks with a mix of technologies that could incorporate WLAN, digital broadcast, satellite and other access systems. This will require the seamless interaction of these systems in order for the user to be able to receive a variety of content via a variety of delivery mechanisms depending upon the particular terminal capabilities, location and user profile;
  - different radio access systems will be connected via flexible core networks. In this way, an individual user can be connected via a variety of different access systems to the networks and services he desires;
  - 3GPP should focus on the interworking between 3GPP Mobile Networks and other Networks considering mobility, high security (identification, authentication, ciphering, lawful interception), charging and QoS management;
  - examples of other networks may include ad hoc networks, home networks, device networks and sensor networks etc.
- ad hoc networking approach:
  - as a means of increasing overall flexibility of their network, 3GPP operators may want their 3GPP networks to interwork with ad hoc networks;
  - depending on the progress and deployment of ad hoc networks, the 3GPP organisation should pursue interworking between 3GPP networks and ad hoc networks using the approach taken to develop interworking between 3GPP networks and WLANs (i.e. consideration needs to be taken for management of identification, authentication, security, charging, network resources (e.g. QoS), regulatory aspects, etc.);
  - one of the potential benefits of the Ad Hoc Networking approach is e.g. self-configuration, self-balancing and self-healing capabilities which may have applicability to 3GPP networks;
  - ad-hoc networking research and development is currently quite active though there is not now a clear consensus on definition, scope, or architecture principles.

NOTE: The role of ad-hoc networks and their implications needs to be defined.

6.3.3 Smart Cards

In the longer term Smart Cards will be available that support data streaming enabling services based on the ciphering / deciphering of encrypted data using a new enhanced interface protocol.

6.3.4 Architecture Evolution

In the long term evolution of 3G network architecture intrinsic resilience shall be a guiding principle.

The evolution goals shall be:

- achieve a lower cost of ownership by providing "Carrier Grade Reliability" without requiring the use of high reliability platforms;
- provide a fault tolerant network by means of the 3GPP defined architecture;
- provide enhanced scalability of network nodes by means of the 3GPP defined architecture.

NOTE: This does not preclude the further future use of high reliability platforms.

7 Other influences

7.1 Regulatory issues

Following established 3GPP practice, regional regulatory requirements that affect the work of 3GPP shall be taken into account. The assessment of each of these requirements as being optional or mandatory needs to be carried out case by case. Requirements relevant to one region should not unduly affect the implementation in other regions.

7.2 Spectrum

Spectrum is an ITU-R/WRC issue and outside the scope of 3GPP. However, 3GPP should consider technologies that make new and innovative use of spectrum, whilst future standards should include provision for equipment to be able to operate in all frequency bands over a global harmonized frequency range.

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2003-09	SP-21	SP-030518	-	-	Approved at TSG SA meeting #21	2.0.0	6.0.0
2007-06	SP-36				Upgrade to Rel-7, no technical change	6.0.0	7.0.0
2008-12	SP-42				Upgrade to Rel-8, no technical change	7.0.0	8.0.0
2009-12	SP-46				Upgrade to Rel-9, no technical change	8.0.0	9.0.0

History

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