**IST-2003-507581 WINNER****D1.4 v1.0***Final requirements per scenario*

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Abstract:

The objective of WINNER is to develop a single new ubiquitous radio access system concept whose parameters can be scaled or adapted to a comprehensive range of mobile communication environments from short range to wide area. To contribute to this objective WPI Scenarios is dedicated to the definition of the most promising scenarios to encompass all anticipated significant user needs of 2015 with a new radio technology. Starting from these scenarios analyses, we derived future user requirements, while grouping applications within a minimized set of 18 service classes. This deliverable contains the final results for the service classes' requirements and the traffic models. This gives the key elements to analyse a scenario in such a way that you could translate it into service class requirements and associated traffic models.

Keyword list: requirements, generic applications, service classes, traffic models

Disclaimer:

Executive Summary

This document presents the final output from WP1 during phase 1 of WINNER.

The objective of WINNER is to develop a single new ubiquitous radio access system concept whose parameters can be scaled or adapted to a comprehensive range of mobile communication environments from short range to wide area. The ubiquitous radio access system concept will provide terrestrial communications including point to multipoint, but not including the BAN and PAN elements.

The objective of the scenarios WP has been to develop user requirements to be met by the WINNER system concept, from a user centric process, rather than a technology driven approach.

Analysing and crossing many inputs linked to usage scenarios such as user groups, user motivations, external references scenarios, scenarios elements, we proposed a classification of 10 generic applications and 18 service classes. Each service classes are described with their main user requirements that should help to fill the gap between applications and system requirements. This work has been done independently from technical issues and choices while trying to stay as exhaustive as possible.

Moreover, in order to give and update all elements relative to the new user requirements for WINNER, we proposed 6 traffic models, including new and updated formulas according to our service classes' proposal.

A preliminary methodology for analysis on business and economic aspects has been proposed by WP1 and should be continued during WINNER phase 2

Lastly, an example case study is included to show how the service classes and traffic models can be applied to user scenarios to identify the related requirements.

The document is organized as follows:

In chapter 1, an introduction of this deliverable is presented.

Chapter 2 concerns services classes. The first part gives guidelines to discriminate service classes characteristics. It shows how you can choose the service classes starting from qualitative criteria. A second part underlines the differences between service classes' characteristics and air interface requirements.

Chapter 3 presents the traffic models developed and/or modified for WP1.

In chapter 4, a case study is presented. Based on a WINNER scenario, an in-depth analysis of applications required for the scenario is developed, including associated services classes, traffic models and main requirements from a user point of view.

In chapter 5, an analysis on service classes against system concept is proposed.

Chapter 6 proposed an analysis on service classes against business domains.

The most relevant conclusions are summarised in chapter 6.

Abbreviations

3GPP	Third Generation Partnership Project
ACELP	Algebraic Codebook Excited Linear Predictive
AR	Augmented Reality
BAN	Broadcast Area Network
BER	Bit Error Ratio
CBR	Constant Bit Rate
CIF	Common Intermediate Format
CNG	Comfort Noise Generator
CS	Circuit Switched
DAB	Digital Audio Broadcasting
DVB-T, S, C, H	Digital Video Audio Broadcasting (Terrestrial, Satellite, Cable, Handheld)
FCC	Federal Communications Commission

FTP	File Transfer Protocol
FWA	Fixed Wireless Access
GoP	Group of Pictures
GPS	Global Position Satellite
GPRS	General Packet Radio Service
GUI	Graphical User Interface
HDTV	High Definition Television
HTML	HyperText Markup Language
IP(v6)	Internet Protocol (version 6)
ISM	industrial, scientific, medical
ITU	International Telecommunications Union
LAN	Local Area Network
MMS	Multimedia Message Service
MP3	Mpeg1 layer 3
MPEG	Motion Picture Expert Group
MPMLQ	Multi-Pulse Maximum Likelihood Quantization
PAN	Personal Area Network
PC	Personal Computer
PCM	Pulse Coded Modulation
P-MP	point-to-multipoint
QCIF	Quarter Common Intermediate Format
QoS	Quality of Service
RAN	Radio Access Network
RAT	Radio Access Technology
SERR	Service Requested Bit Rate
SID	Silence Insertion Descriptor
SMS	Short Message Service
SYSA	System Assigned Bit Rate
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunications System
URL	Uniform Resource Locator
UWB	Ultra Wideband
VAD	Voice Activity Detection
VBR	Variable Bit Rate
VGA	Video Graphics Array
VNC	Virtual Network Computing
VR	Virtual Reality
WINNER	Wireless World Initiative New Radio
WLAN	Wireless Local Area Network
WP	Work Package
WWI	Wireless World Initiative
WWW	World Wide Web

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Table of Contents

1. Introduction.....	1
2. Services classes.....	1
2.1 Synthesis of the WINNER service classes – application-oriented services – generic applications	1
2.1.1 Service classes table.....	1
2.1.2 Generic Applications and application-oriented services.....	3
2.2 Guidelines for service classes’ characteristics (data rate, delay...)	5
2.3 Difference for characteristics between service classes and air interface.....	7
2.3.1 Bit rate requirements for air interface:	7
2.3.2 Delay requirements for air interface:.....	7
2.4 WINNER service classes Vs existing systems.....	8
2.5 Conclusion.....	10
3. Traffic models.....	11
3.1 Traffic Models Summary.....	11
3.1.1 Internet/Browsing	11
3.1.2 Conversational Voice Model	13
3.1.3 Video Streaming	14
3.1.4 Streaming of audio.....	16
3.1.5 File transfer.....	17
3.1.5.1 File Transfer Protocol (FTP).....	18
3.1.6 Interactive activities	19
3.1.6.1 Internet Gaming	19
3.2 End-to-end Traffic Models issues	20
3.3 Conclusion.....	21
4. Case Study: a day in a life of a young person	21
4.1 Introduction	21
4.2 The case studies	22
4.3 Case study conclusion	28
5. WINNER System Concept Analysis	28
5.1 WINNER System Concept	28
5.1.1 Architectural Aspects	29
5.1.2 System Aspects.....	29
5.2 WINNER System Modes	29
5.2.1 Deployment Concepts	29
5.2.2 Physical Layer Concepts	30
5.2.3 System Modes	31
5.3 User Scenarios vs. System Concept Analysis	31
5.4 Conclusion.....	33
6. Business and Economic Analysis	33
6.1 The Generalised Business Framework	33
6.2 Using the Business Framework.....	33
6.2.1 The Generalised Business Framework	34
6.2.2 Actors.....	34
6.2.2.1 Network owner (site owners, infrastructure owners).....	35
6.2.2.2 Network / connectivity provider	35
6.2.2.3 Equipment suppliers.....	35
6.2.2.4 Service creator	35
6.2.2.5 Service provider	35
6.2.2.6 Content provider	35
6.2.2.7 Content owner.....	35
6.2.2.8 Content and Service aggregators.....	35
6.2.2.9 Advertisers.....	36
6.2.2.10 End users (including machines)	36

6.2.2.11	Financial enablers / institutions.....	36
6.2.2.12	Third party security / authentication house.....	36
6.2.2.13	User context analyser and profile manager/owner	36
6.3	Example Domains.....	36
6.3.1	Traditional Mobile Telco Domain	36
6.3.2	Broadcast Domain.....	37
6.3.3	Fixed Internet Domain	37
6.4	Summary	38
7.	Conclusions	38
7.1	D1.4 conclusion	38
7.2	General conclusions on WP1 work for WINNER phase 1	39
8.	References	39

List of tables

Figure 2-1	: Service Classes and characteristics.....	3
Figure 2-2	: Generic Applications for WINNER - Layered approach	5
Figure 2-3	: Example of services mapping onto service classes for multimedia.....	6
Figure 3-1	: Structure of a WWW page.....	11
Figure 3-2	: Sequence and parameters for a WWW session	12
Figure 3-3	: Choi's Behavioral Model	12
Figure 3-4	: Single Speaker Model.....	13
Figure 3-5	: Video Traffic Model: IBB and PBB blocks generation flow.	15
Figure 6-1	: Generalised Business Framework	34
Figure 6-2	: Traditional Mobile Telco domain.....	37
Figure 6-3	: Broadcast domain.....	37
Figure 6-4	: Fixed Internet domain.....	38

List of figures

Table 2-1	: Service Classes and characteristics.....	2
Table 2-2	: Generic Applications	4
Table 2-3	: WINNER service classes Vs existing systems	10
Table 3-1	: WWW traffic model parameters and distributions	12
Table 3-2	: Parameters for Voice modelling with Exponential Distribution.....	14
Table 3-3	: Audio traffic model parameters and distributions.....	17
Table 3-4	: File size table	18
Table 3-5	: FTP Traffic Model Parameters.....	19
Table 3-6	: Internet Gaming traffic model parameters and distributions [15].....	20
Table 5-1	: WINNER Physical Layer Modes.....	30
Table 5-2	: WINNER System Modes.....	31

1. Introduction

This document presents the final state for WP scenarios work for WINNER phase I.

The objectives of WINNER is to develop a single new ubiquitous radio access system concept whose parameters can be scaled or adapted to a comprehensive range of mobile communication environments from short range to wide area. The ubiquitous radio access system concept will provide terrestrial communications including point to multipoint, but not including the BAN and PAN elements.

General assumptions about WINNER can be found in doc [1] [2] [3] .

In previous stages ([1] [2] [3]), the usages scenarios composed of scenarios elements have been identified. These initial scenarios have been developed from the motivations of some key user groups without any reference to the technology. These scenarios had been studied regarding the requirements needed from WINNER. A thorough analysis of these scenario elements has led to the definition of generic applications (group of usage scenarios by applications type) and a list of service classes with their requirements.

Since the service classes, generic applications and other works done in WP1 are now definitive, we developed in this document a case study. This is for two main reasons. It helps the user of our work to better understand how he can apply such a classification to divide scenario into services classes and then get the requirements. On the other hand, it illustrates all the work done in WP1 and gives probably a better idea on what are the service classes used in the case study. Finally, it helped WP1 to make final adjustments and slight corrections to the service classes and generic applications proposed in D1.3 [3] .

We also developed a general guideline about service classes, showing an example of how you can obtain service classes considering qualitative aspects and map your applications onto service classes. We also warn the reader to the fact that characteristics for service classes are not supposed to be identical to requirements for the air interface. Both are not viewed from the same level or layer.

Another important output of the WP1 work is the definition of new/evolved traffic models applicable for the generic applications and service classes developed. This work has been begun previously and we are now able to synthesize all those different traffic models in this document.

At last, work began earlier and dealing with system concept analysis and business analysis has been continued. The idea behind both parts is to confront our service classes to the system concept and to business considerations.

2. Services classes

2.1 Synthesis of the WINNER service classes – application-oriented services – generic applications

2.1.1 Service classes table

A synthesis of the service context table was made taking into account four dimensions: data rate, delay, error rate and traffic type. The result of this synthesis was the table of service classes which covers the range of all the identified scenario elements.

The four dimensions are:

- data rate: from few kbps to 50 Mbps
- delay: highly interactive (<20ms), interactive/control (20 – 100 ms), conversational (100 – 200 ms), few seconds (>200ms)
- error rate: 10^{-3} , 10^{-6} , 10^{-9} BER
- traffic type: SERR (Service Requested Bit Rate), SYSA (System Assigned Bit Rate), Point to Region (see section 5.1.1 in [1])

The following table represents in text format the mentioned synthesis taking into account all dimensions (Data rate, Delay, Error Rate and Traffic Type dimensions)

Service Class	Data Rate	Traffic type	Delay	Error Rate	Exemple applications
1. Real time collaboration and gaming	1-20 Mbps	SERR	highly interactive (<20ms)	$10^{-6} - 10^{-9}$	Telepresence/Videoconference Collaborative work Navigation systems Real-time Gaming
2. Geographic real time datacast	2-5 Mbps	SERR Point to Region	highly interactive (<20ms)	10^{-6}	Real time video streaming Collaborative work
3. Short control messages and signalling	8-64 kbps	SERR	Interactive /control (20 – 100 ms)	10^{-9}	Alarms Remote Control Sensors Presence driven transfer (lightweight content)
4. Simple interactive applications	64-512 kbps	SERR	Interactive /control (20 – 100 ms)	10^{-6}	Presence driven transfer (heavy content) Interactive geographical maps (remote processing)
5. Interactive high multimedia	2-5 Mbps	SERR	Interactive /control (20 – 100 ms)	10^{-6}	Rich data call Control Video broadcasting/streaming Robot security
6. Geographic interactive multimedia broadcast	2-5 Mbps	SERR Point to Region	Interactive /control (20 – 100 ms)	10^{-6}	Video broadcasting/streaming Localised map download
7. Interactive ultra high multimedia	10-50 Mbps	SERR	Interactive /control (20 – 100 ms)	$10^{-3} - 10^{-6}$	High quality video conference Collaborative work
8. Simple telephony and messaging	8-64 kbps	SERR	Conversational (100 – 200 ms)	$10^{-3} - 10^{-6}$	Voice telephony Instant messages Lightweight multiplayer games Bets and gambling
9. Data and media telephony	64-512 kbps	SERR	Conversational (100 – 200 ms)	$10^{-3} - 10^{-6}$	Audio streaming Video telephony (medium quality) Multiplayer games (high quality)
10. Geographic datacast	64-512 kbps	SERR Point to Region	Conversational (100 – 200 ms)	$10^{-3} - 10^{-6}$	Localised datacast/beacons Audio streaming
11. Rich data and media telephony	2-5 Mbps	SERR	Conversational (100 – 200 ms)	$10^{-3} - 10^{-6}$	High quality video telephony Collaborative work Standard data call
12. LAN access and file service	Up to 50 Mbps	SYSA	Conversational (100 – 200 ms)	10^{-6}	Access to databases, filesystems,
13. Multimedia messaging	8-64 kbps	SYSA	Few seconds (>200ms)	$10^{-6} - 10^{-9}$	Messaging (data/voice/media) Authentication (m-payment, m-wallet, m-ticket, m-key etc.) Web browsing (light weight)
14. Lightweight browsing	64-512 kbps	SERR	Few seconds (>200ms)	10^{-6}	Messaging (data/voice/media) (medium weight) Access to corporate database (lightweight) Audio on demand Web browsing (medium weight) Internet radio
15. File exchange	Up to 5 Mbps	SYSA	Few Seconds (>200ms)	10^{-6}	Access to databases (heavy weight), filesystems, Video download/upload Peer-to-peer file sharing
16. Video streaming	5 Mbps	SERR	Few Seconds (>200ms)	10^{-6}	Video streaming (normal)
17. High quality video streaming	30 Mbps	SERR	Few Seconds (>200ms)	10^{-9}	Video streaming (archival)
18. Large files exchange	Up to 50 Mbps	SYSA	Few Seconds (>200ms)	10^{-6}	

Table 2-1 : Service Classes and characteristics

The following plot represents in pictorial format the mentioned synthesis taking into account three dimensions (Data rate, Delay, Error Rate dimensions)

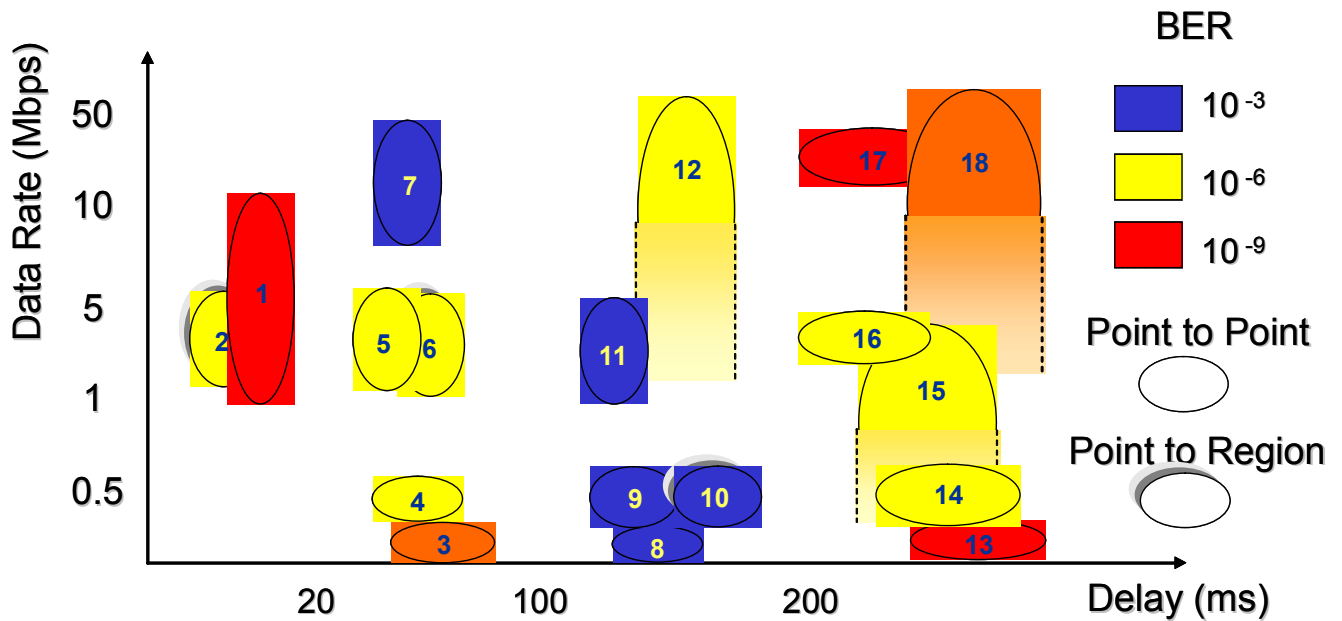


Figure 2-1 : Service Classes and characteristics

2.1.2 Generic Applications and application-oriented services

From the service context analysis of the scenario elements, it was revealed a great variety of different applications. These applications were covering most of the existing telecommunication applications and some promising future ones. These applications in many cases were appearing similarities in many points. By considering these similarities, a much shorter list of generic applications was developed. Each generic application correlates a group of different applications with common characteristics mainly from the user point of view and not based on pure technical attributes.

The table below describes these ten Generic Applications and their associated application-oriented services with some description and identification of their main characteristics.

Generic Application	Application-oriented services	Main Characteristics	Description
1 Telephony / Conference / Chat	1. Voice telephony	Symmetric traffic Medium interactivity	Simple voice data telephony with a wide variety of options as regarding the quality or the techniques.
	2. Video Telephony	Symmetric traffic Medium interactivity	Video telephony of different quality based .on the network and the device capabilities.
	3. Video Conference	Symmetric traffic Medium interactivity PT-to-MPT	Multiparty video communication.
	8. Instant Messaging, Chat, Forum	Symmetric traffic Medium interactivity	Messages with very short delivery time for instant discussions, either through text and/or low quality audio and/or video of limited size.
	23. Tele-presence	Symmetric traffic Medium interactivity	Virtual transmission of the presence of a physical person to a remote physical or virtual place.
2 Messaging	4. Voice messages	Highly asymmetric traffic Low interactivity (pull)	Simple voice messages.
	5. Short data messages	Highly asymmetric traffic No interactivity (push)	Small/limited size data messages delivering unformatted text or small size data with no guaranteed delivery time. The messages delivered automatically to the user.
	6. Multimedia Messages	Highly asymmetric traffic Low/no interactivity (pull/push)	Messages that deliver formatted text, pictures, video, audio or any other type of files, up to limited total size. The messages are stored remotely until the user request them (similar to e-mail), or they are delivered automatically to the user.

3 Broadcast	7. Broadcast and Public Info	One-way traffic PT-to-Region	Transmission of data to a region where every adapted device can receive it.
	17. Media Broadcasting	One-way traffic No interactivity (push)	TV and radio broadcasting, through the mobile network in a specified area, which could be very wide (e.g. globally) to very narrow (a building or a room).
	13. Information Sharing	Asymmetric traffic Low interactivity PT-to-MPT	Sharing information with a group of people of common interest or for a common purpose
4 High interactive Applications	9. Network Games	Symmetric traffic High interactivity	Multiplayer network games, from simple lightweight lottery games, to very heavy 3D fast action games.
	22. Collaborative work	Symmetric traffic High interactivity	Interactive and remote communication with exchange of information in real-time and through audio/video/data calls. Apart from persons, the communication may concern machines as well.
5 Secure Connection	10. M-payment and secure authentication	Asymmetric traffic Low interactivity	Financial transactions performed through mobile devices.
	14. Secure Browsing and Transfer	Asymmetric traffic Low interactivity	Accessing of e-commerce Internet style web sites anywhere reliably and securely through a mobile device
	19. Intranet Access	Asymmetric traffic Low interactivity	Access an Intranet through a very secure wireless connection.
	20. Database Access	Asymmetric traffic Low interactivity	Access to database, upload and download files, browse and search the database content through secure wireless connection.
6 LAN/WEB Access	11. LAN Access	Asymmetric traffic Low interactivity	Access a LAN and all the LAN's resources.
	12. Internet Style Browsing	Asymmetric traffic Low interactivity	Access Internet style web sites anywhere through a mobile device
7 Streaming Applications	16. Streaming Media	Highly asymmetric traffic Low interactivity	Streaming of audio, video clips and radio or television programs.
	15. Advertising	Highly asymmetric traffic No interactivity (push)	Personalized, context aware advertisements.
8 Navigation / Guidance	21. Navigation and Guidance	Asymmetric traffic Low interactivity	Navigation system which with the use of enhanced geographical maps and context awareness leads the users or vehicles to their destinations and also can propose potential places of interest.
9 Remote Control	24. Control	Asymmetric traffic Medium interactivity	Remote control of machines like robots, house equipments, etc. The control can be done by a person through a mobile device or by an other machine connected in the network.
10 Transfer of Files	18. Transfer of Files	Highly asymmetric traffic Low interactivity	Transfer of any type and size files. In some cases the transmission time can be specified and guaranteed.

Table 2-2 : Generic Applications

A Generic Application consists of a control flow and one or more generic dialogs. This application also can be presented as the middle level in a layered structure. On the top of the layered structure is the group of application-oriented services, and at the lower level of this hierarchy is the group of service classes, associated with the generic application.

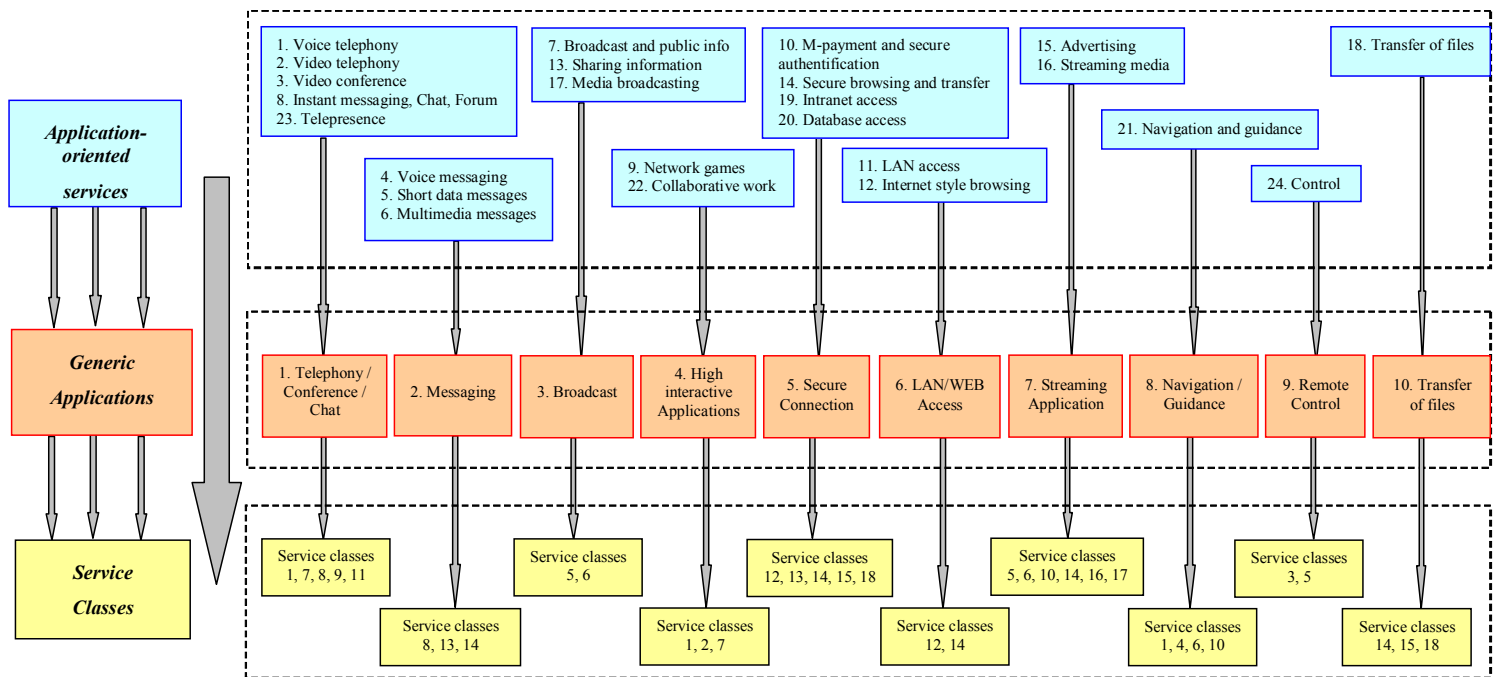


Figure 2-2 : Generic Applications for WINNER - Layered approach

2.2 Guidelines for service classes' characteristics (data rate, delay...)

In this section we describe qualitative mapping from a given end-user type of service and the service classes most suitable to deliver this service. Such mapping emphasizes the different service classes a given service can use depending on the perceptual quality the end user experiences. Generic guidelines, which will be expressed constructing a decision tree, will show the mapping. The tree is a chain where a user dreaming of a final service can roughly discriminate the most suitable service class out of the eighteen proposed service classes, based on the perceptual quality of the service expressed qualitatively.

The decision tree will also help to follow the bifurcations from a generic service to different service classes. Since the mapping is expected to be qualitative, the tree branches discriminating among service classes must be expressed through qualitative statements. This way, the technical background is hidden to tree's user. That makes sense since decision tree's user a priori doesn't know technical requirements for the envisioned service: he is looking for them.

Examples of discrimination criteria that might be stated within branches are the following: (expressed qualitatively or functionally, and including existing standards as reference).

- **Video-type services:** depending on quality (boundaries: codec-based: MPEG-x, DVD, perception-based: framing rate, image quality, user tolerance to artefacts), depending on interactivity: high / conversational / streaming / downloading.
- **Audio-type services:** depending on interactivity (conversation, streaming, downloading), depending on quality and information needed for the intended application (computer aided voice recognition, telephonic voice, enhanced voice – for emergency calls –, CD-quality audio, enhanced CD audio additional stereophonic channels).
- **Gaming-type service:** depending on experienced or required interactivity (Simulator games / Arcade games / RPG Games / Strategy games), depending on quality and size of data exchange (this qualitatively expressed).
- **Messaging-type services:** depending on size and added features (SMS, E-mail, attached Images or audio, attached Multimedia...).
- **Browsing-type services:** depending on experienced latency on application (Real-time information browsing and mining / Web browsing / Application specific: database, filesystems), depending on data exchange amount (expressed qualitatively).

Some representative standards have been included in order to help this qualitative discrimination. Although the standards, especially multimedia codec ones, will surely become obsolete at the time of WINNER system deployment

and thus will be substituted by other oncoming, further enhanced ones; it makes lot of sense to include them as a today's common reference regarding perceptual quality. Although these standards can deliver variable bit rates and thus can perform within a large range of perceptual qualities, they are mostly intended – and understood – as bearers of a given quality level for a given application.

In the next figure, we show an example decision tree for a concrete service type. It has been chosen an aggregate of multimedia services embracing audio and video. This has been chosen because of the high number of application scenarios of multimedia services, thus their future interest, and the wide range of perceptual qualities associated with such services.

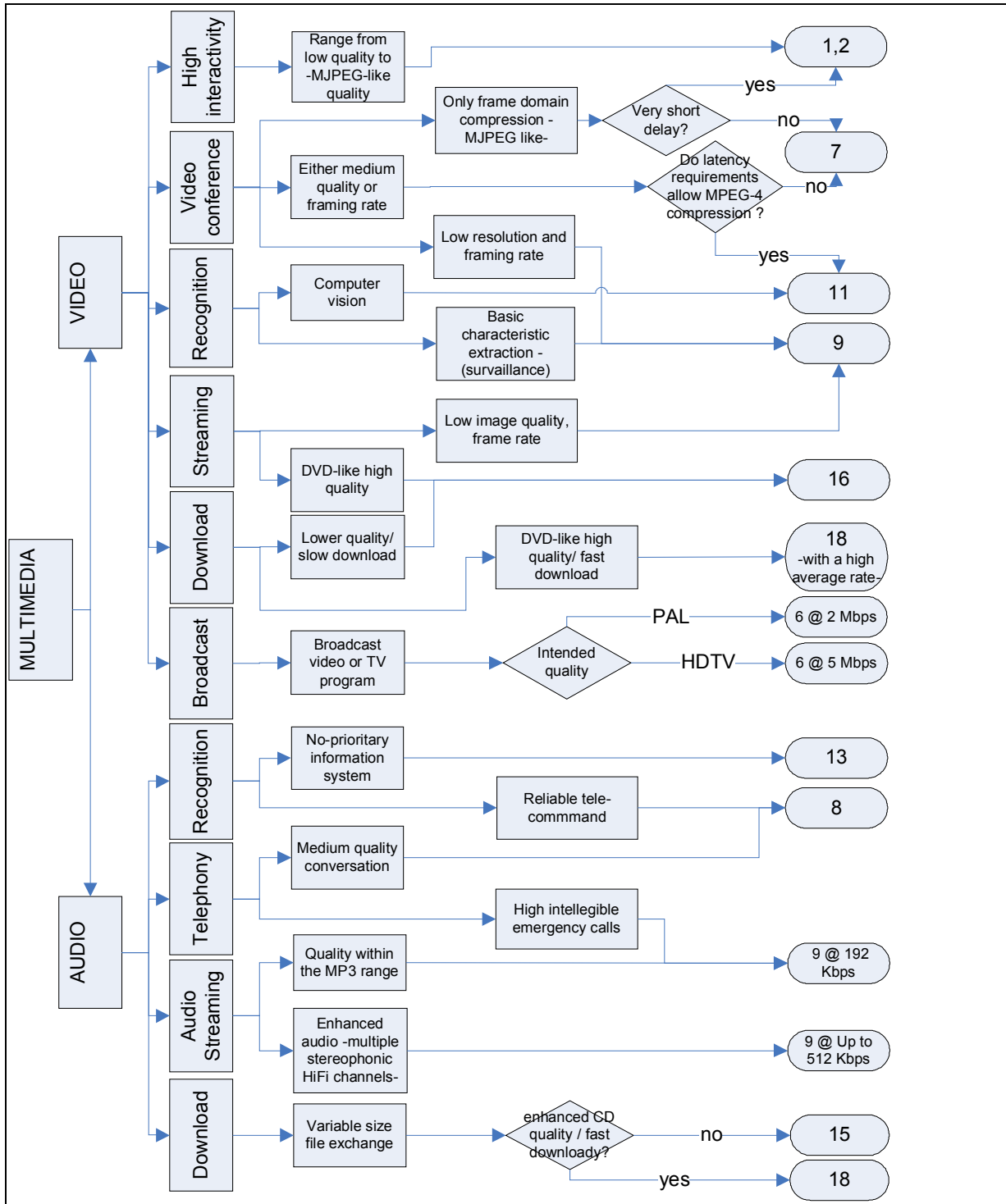


Figure 2-3 : Example of services mapping onto service classes for multimedia

2.3 Difference for characteristics between service classes and air interface

Several causes have been identified that lead to differences between service classes requirements expressed at user's application level, and the slightly different (tighter) requirements when they are translated to the WINNER air interface. First of all, it must be noticed that in general, for the selected scenarios of WINNER, a user can demand several different service classes at the same time. Such an addition means an approach with figures must be considered in an aggregate manner in mostly cases.

Afterwards must be considered several inefficiencies introduced when crossing the different layers of the stack, from application layer towards the air interface and vice versa. These inefficiencies modify the air interface requirements mainly at two points: bit rate and delay.

2.3.1 Bit rate requirements for air interface:

A first inefficiency is introduced when performing the segmentation onto network layer packets. WINNER will be an IP based system, thus conveying the raw data on IP packets. Does exist inefficiency due to the necessary overhead of IP packets. IPv6 is the a priori enabler protocol for packet transfer in future core networks. Within previous deliverable D1.3 [3] are included models of IPv6 packet overhead that can be taken as reference.

A second inefficiency factor is the segmentation within and beneath Layer 2 – MAC and PHY –. Arrived packets to the air interface undergo a successive scheduling, thus breaking the relative large IP packets onto smaller transmission units. A problem arises when there are different data packet sizes related to different service classes. For instance the data packet sizes of service class 15 'File exchange' and 3 'Short control messages and signalling' are deemed to be rather of a different size. The problem must be overcome providing the required granularity when scheduling at MAC and PHY level. However this granularity is to be properly traded-off for others figures of merit such as coding efficiency and retransmission delay. The main feature of the current design within WINNER is a two-stage scheduler joining two by-passable inner and outer encoders, coding respectively long and short transmission units. Thus transmission granularity can be chosen arbitrarily depending on the need, and inefficiency is minimized to a no significant level.

Finally, either service classes demanding very low bit error rates or highly interactive, delay-sensitive service classes will require an effective higher data rate through air interface. In the first case due to a deeper error correction coding. In the second case, since the retransmission protocols use is bounded, the peak throughput must be properly tuned, i.e. slightly increased.

2.3.2 Delay requirements for air interface:

The air interface design must cope up with the possible tight delay requirements resulting from service classes delay requirements once subtracted the delay introduced by core network. Several other IST projects (Daidalos, Ambient Networks) aim totally or partially to develop a QoS guaranteed core network infrastructure that introduces minimum delays on transported packets. These latencies on core network are still to be established: until the end of first trials there will not be reliable results. As reference consider today's circuit-switched networks latency, which is about 100 milliseconds. Any future IP core network supporting the WINNER system would have to exceed that benchmark to be viable.

Also, it must be noticed that in an emerging IP-harmonised world with multiple, interconnected networks of different types, IP packets can carry out several hops across these networks undergoing accumulated delay. A particular case is when both end-users of a given communication belong to the WINNER system. In that case, transmitted packets undergo only two times the air interface delay plus the core network latency.

Finally, the delay introduced by the processing at user application level must be considered. Multimedia codec, for audio and video, introduce a non negligible delay, especially at the encoding process. In some cases, for high interactive applications, it might mean the disabling of any codec at all, thus representing this media transmission a much higher peak bit rate requirement than in compressed form. Entropic compression and encryption /de-encryption are also other procedures that introduce noticeable latency into data transmission.

2.4 WINNER service classes Vs existing systems

The following table presents the qualitative mapping of service classes into some currently available systems performed within deliverable D1.3 [3]. The analysis has been pushed further by including rate, latency, mobility and coverage items. This leads to a better technical discrimination of the gap the WINNER system is required to cover with respect to coexistent legacy systems (i.e., UMTS, WLAN, HSDPA and others). The mapping has been done recalling the simplest system able to closely provide a given service class, what means that other systems can also cover same service class. The analysis results into which service classes are currently delivered (the case of service classes highlighted in green in the table), which ones may be partially overlapped to other legacy technologies (service classes highlighted in yellow), and which service classes are definitely not covered by existing systems (highlighted in red). The last set of service classes thus represents a clear opportunity for the WINNER system. Note that even though a system may be able to deliver a single instance of a given service class, it may not be able to provide combinations of multiple (same or different) service classes. This is another area intended to be addressed by the WINNER system.

Service Class (Coloured matching scale)	Example application	Optional system providing this service class and its performance in terms of rate, latency and supported mobility and range				Comments
		Optional existing system // Similar current application	Rate [Required // existing]	Latency [Required // existing]	Mobility /Range [Required // existing]	
1. Real time collaboration and gaming	Telepresence Real time Gaming	WiMAX is currently the only system able to provide such high peak data rates.	Symmetric 20 Mbps // Symmetric (70/2) Mbps OTC	<20 ms // 100 ms	LM & SR // Any mobility & range.	* Latency is too high for high interactivity. * WiMAX is a WMAN system. Difficultly could it cope up with aggregated demand for this service class in a WWAN scenario.
2. Geographic real time datacast	Real time video streaming Collaborative work	This high data rates can be approached with HSDPA/ HSUPA systems in optimal network conditions.	Asymmetric 5 Mbps // DL 14, UL 6 Mbps OTC	<20 ms // 100 ms	GM & SR // LM & SR for the highest rates	* HSDPA/HSUPA throughput at common network conditions equals 1/10 ideal one. * No high mobility support. * Latency is too high for high interactivity.
3. Short control messages and signalling	Alarms Voice control Sensors	Current mobile phone technology -UMTS- // Already developed mobile alarm and information systems.	Asymmetric 64 Kbps // Symmetric 384 kbps	20-100 ms // ~200 ms	Any mobility & range // Any mobility & range.	* UMTS latency may be high for some specific applications.
4. Simple interactive applications	Presence driven transfer Interactive geographical maps	Application data transfer up to 384 Kbps in UMTS.	Asymmetric 512 Kbps // Symmetric 384 kbps	20-100 ms // ~200 ms	Any mobility & range // Any mobility & range.	* UMTS features up to 1920 Kbps OTC in optimal -rate on network operation- conditions. * UMTS latency may be high for some specific applications.

5. Interactive high multimedia	Rich data call Robot security	This high data rates can be approached with HSDPA/ HSUPA systems in optimal network conditions.	Asymmetric 5 Mbps // DL 14, UL 6 Mbps ATC	20-100 ms // 100 ms	LM & GR // LM & SR for the highest rates	*HSDPA/HSUPA throughput at common network conditions equals 1/10 ideal one.
6. Geographic interactive multimedia broadcast	Video broadcasting/streaming Localised map download	Combination of DVB-T for downlink and UMTS for return channel // Existing proposals for hybrid broadcast services.	Asymmetric 5 Mbps // DL 24 Mbps, UL 384 Kbps	20-100 ms // 200 ms	GM & SR // LM & GR	*DVB-T supports only lower quality at highest mobility. *The latency of return channel over UMTS, prevents high interactivity. *WiMAX may also be a good alternative.
7. Interactive ultra high multimedia	High quality video conference Collaborative work	WiMAX is currently the only system able to approach such high peak data rates.	Symmetric 50 Mbps // Symmetric (70/2) Mbps OTC	20-100 ms // 100 ms	LM & SR // Any mobility & range.	*WiMAX is a WMAN system. Difficulty could it cope up with the aggregated demand for this service class in a WWAN scenario.
8. Simple telephony and messaging	Voice telephony Instant messages Bets and gambling	GPRS / UMTS mobile communications systems // Existing devoted systems.	Symmetric 64 Kbps // Symmetric 384 kbps	100-200 ms // ~200 ms	Any mobility & range // Any mobility & range.	
9. Data and media telephony	Audio streaming Video telephony (medium quality) Multiplayer games (high quality)	UMTS system // Videoconference can be hold currently e.g. at 384 kbps in UMTS.	Symmetric 512 Kbps // Symmetric 384 kbps	100-200 ms // ~200 ms	Any mobility & range // Any mobility & range.	*UMTS features up to 1920 Kbps OTC in optimal -rate on real network operation-conditions.
10. Geographic datacast	Localised datacast/beacons Audio streaming	UMTS system // MBMS supporting 128 kbps broadcast channels	Asymmetric 512 Kbps // Asymmetric 128 kbps	100-200 ms // ~200 ms	GM & SR // Any mobility & range.	*UMTS features up to 1920 Kbps OTC in optimal -rate on real network operation-conditions.
11. Rich data and media telephony	High quality video telephony Standard data call	This high data rates can be approached with HSDPA/ HSUPA systems in optimal network conditions.	Symmetric 5 Mbps // DL 14, UL 6 Mbps OTC	100-200 ms // ~100 ms	Any mobility & range // LM & SR for the highest rates	*HSDPA/HSUPA throughput at common network conditions equals 1/10 ideal one. . *No high mobility support.
12. LAN access and file service	Database, filesystem server	Next WLAN standard (802.11n) based on MIMO technologies.	Symmetric 50 Mbps // Symmetric (100/2) Mbps	100-200 ms // ~100 ms	LM & SR // LM & SR	*WLAN a 100 Mbps link only in short range. *Severe penalization on range and mobility. *Expected commercialization/spreading on 2006/2007.
13. Multimedia messaging	Messaging (data /voice /media) Authentication (m-payment, m-wallet, m-ticket, m-key etc.)	GPRS / UMTS // Applications based on GPRS systems have been already developed to enable mobile payment on taxis.	Asymmetric 64 Kbps // Symmetric 384 kbps	> 200 ms // ~200 ms	Any mobility & range // Any mobility & range.	

14. Lightweight browsing	Access to corporate database (lightweight) Web browsing Internet radio	UMTS // WAP or WML-based protocols (even application of HTML in future) enable browsing over UMTS. This high data rates can be approached with HSDPA/HSUPA systems in optimal network conditions.	Symmetric 512 Kbps // Symmetric 384 kbps	> 200 ms // ~200 ms	Any mobility & range // Any mobility & range.	*UMTS features up to 1920 Kbps OTC in optimal -rare on real network operation-conditions.
15. File exchange	Access to databases and file systems Video download /upload P2P file sharing	This high data rates can be approached with HSDPA/HSUPA systems in optimal network conditions.	Asymmetric 5 Mbps // DL 14, UL 6 Mbps OTC	> 200 ms // ~100 ms	LM & GR // LM & SR for the highest rates	*HSDPA/HSUPA throughput at common network conditions equals 1/10 ideal one.
16. Video streaming	Video streaming (normal)	This high data rates can be approached with HSDPA/HSUPA systems in optimal network conditions.	Asymmetric 5 Mbps // DL 14, UL 6 Mbps OTC	> 200 ms // ~100 ms	Any mobility & range // LM & SR for the highest rates	*HSDPA/HSUPA throughput at common network conditions equals 1/10 ideal one. *No high mobility support.
17. High quality video streaming	Video streaming (archival)	WiMAX is currently the only system able to approach such high peak data rates.	Asymmetric 50 Mbps // Symmetric (70/2) Mbps OTC	> 200 ms // ~100 ms	LM & GR // Any mobility & range.	*WiMAX is a WMAN system. Difficulty could it cope up with the aggregated demand for this service class in a WWAN scenario.
18. Large files exchange	High rate data transfer (upload/download)	WiMAX is currently the only system able to approach such high peak data rates.	Asymmetric 50 Mbps // Symmetric (70/2) Mbps OTC	> 200 ms // ~100 ms	LM & GR // Any mobility & range.	*WiMAX is a WMAN system. Difficulty could it cope up with the aggregated demand for this service class in a WWAN scenario.

Table 2-3 : WINNER service classes Vs existing systems

Summary of used acronyms in the table:

LM & GM: respectively Low and General mobility.

SR & GR : respectively Short and General Range.

GPRS: Global Packet Radio Service, **UMTS:** Universal Mobile Telecommunication System, **HSDPA/HSUPA:** High Speed Downlink/Uplink Packet Access, **WLAN:** Wireless Local Area Network, **WiMAX:** certification mark for products to 802.16 standard, **DVB-T:** Digital Video Broadcasting -Terrestrial, **WAP:** Wireless Application Protocol , **WML:** Wireless Markup Language. **WMAN:** Wireless Metropolitan Area Network. **WWAN:** Wireless Wide Area Network, **OTC:** Offered throughput per cell.

2.5 Conclusion

In this chapter, the identified generic applications and service classes are highlighted as a very mature result of WP1 work during Phase I. The variety of generic applications and service classes emphasizes the WINNER system versatility and capability to serve many applications and type of services in various user scenarios. In this deliverable, service classes have been better contextualized by showing the relation of generic services to service classes as a function of the end-user perceptual quality and by also giving a more precise correspondence of the overlapping with current services and systems. Lastly, differences on requirements among WINNER service classes and WINNER air interface have been pointed out.

3. Traffic models

3.1 Traffic Models Summary

This chapter summarizes the models identified as reference traffic models during the activity of WP1. The models have been harmonized as much as possible and are presented according to a common structure. Besides, the Video Streaming model has been improved and End to End traffic issues have been addressed. The purpose of the Traffic Models activity has been to identify and propose reference traffic models according to different typologies of applications. Where possible, an effort to align traffic model parameters according to evolution of application emerging from WP1, has been done.

3.1.1 Internet/Browsing

Characteristics

The Internet represents the largest existing WAN offering a broad spectrum of information resources in form of technical reports, product information, software, images, audio and video sources and electronic commerce services. The popularity among larger user groups to use these resources was driven by the introduction of the WWW. In the WWW, global naming conventions, protocols and object formats are used. An object can be a text file, an Audio source, an image file or even the code of a program that can be interpreted and executed on the user's terminal (Java applet).

A WWW browser displays WWW pages that are composed of one or more WWW objects Figure 3-1 shows a WWW page displayed by a WWW browser. It contains several different objects such as text and images. Within one page *links* can be defined that are connected to an identifier of a WWW resource, a URL. When the user chooses a link, a new object or page is displayed. By the direct specification of a URL in the text field of the WWW browser, a specific page or object can be chosen by the user (see Figure 3-1). Every object of the WWW has a unique URL.

The presentation of a WWW page is described by the HTML. In an HTML file the appearance and the URL of the contained objects are specified. An HTML page can also contain text that is displayed at the related position of the page. An HTML page itself is also a WWW object that is analysed by the browser. Further WWW objects are specified in the HTML file as part of the page that are requested and transmitted.

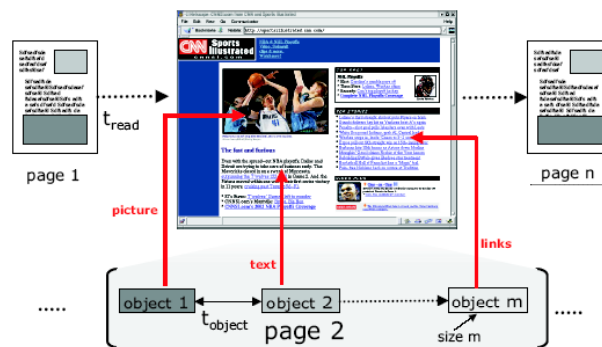


Figure 3-1: Structure of a WWW page

The WWW is characterized by a client-server architecture. A WWW browser represents a client that poses requests to a WWW server concerning the transmission of WWW objects that are stored on the server. The communication between client and server is controlled by HTTP. HTTP is an application oriented protocol that uses the TCP for end-to-end transport. In the initial version of HTTP a new TCP connection is set-up for each requested object. The client transmits a request for a certain object to the server. The request contains the URL of the object, data format parameters and parameters for access control. The server processes this request and transmits the requested object to the client. Then the TCP connection is released. In newer HTTP versions, e.g., HTTP version 1.1, TCP connections can be reused by the following objects (persistent TCP connections) and several TCP connections can be set-up in parallel used for the pipelined transmission of several different objects (pipelined TCP connections). Figure 3-2 depicts the sequence of a WWW session.

Traffic Model Description

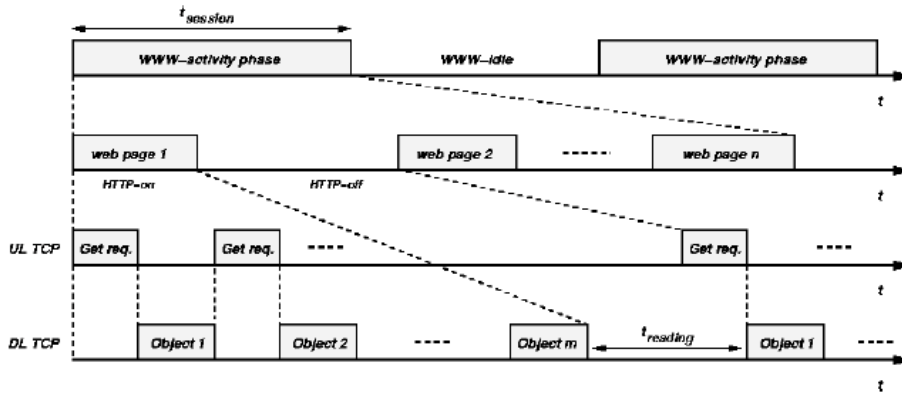


Figure 3-2: Sequence and parameters for a WWW session

Choi's behavioural model is representative for WWW browsing performed on 2 PC connected to the fixed Internet. As mentioned above WWW sessions consist of requests for a number of pages. These pages consist of objects, each with a certain object size. Another characteristic parameter is the delay between two pages depending on the user's behaviour to surf around the Web. Figure 3-1 gives an overview of the Mosaic WWW traffic parameters.

Choi's traffic model is an on/off-model with alternating phases of packet generation and silence (see Figure 3-3). An on-phase starts after the arrival and acceptance of a web request. During this phase, the objects of a WWW page are requested. The off-phase represents a silence period after all objects have been retrieved. Thus, the on and off-phases equal the page loading times and page viewing times, respectively. During the on-phase the page's objects are downloaded.

We distinguish two types of objects: the main object containing the document's HTML code and inline objects, such as linked objects, images or Java applets. To fetch all those inline objects modern browsers open several TCP connections in parallel after the successful retrieval of the main object. In Table 3-1: WWW traffic model parameters and distributions, the random variables for the object sizes, the number of inline objects and the length of the viewing time are listed. The mean values that are listed below are a little different from those that was used by Choi. We have reduced the mean viewing time as a user of a mobile device usually will spend less time to read a page that one at his home or his office using a desktop PC. We have increased the rest of the values as we guess that future Internet sites, will be heavier than today's ones.

Traffic Model Parameters and Distributions

WWW Parameter	Distribution	Mean	Variance
Viewing time [s]	Weibull	25	8.57.10 ³
No. of inline objects per page	Gamma	7	130.0
Size of main object [kB]	Log-Normal	13	625.0
Size of inline objects [kB]	Log-Normal	10	1.59.10 ⁴

Table 3-1: WWW traffic model parameters and distributions

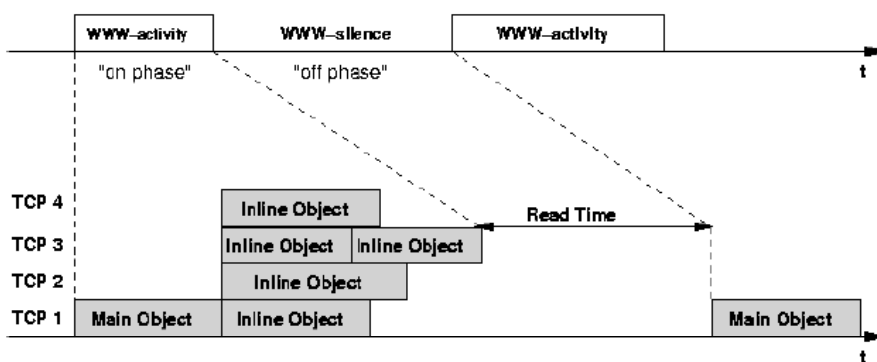


Figure 3-3: Choi's Behavioral Model

The amount of data S that is generated during the on-phase is given by

$$S = s_{Main} + \sum_{i=0}^{n_{Inline}} S_{Inline,i}$$

which is a combination of three random variables. The random variable S represents the payload to be transmitted by the HTTP protocol.

3.1.2 Conversational Voice Model

This model, and its description, is modified from the VoIP model presented in [26]. The underlying traffic models are assumed to apply to all conversational voice applications, regardless of bearer (e.g. IP, circuit switched etc.)

Characteristics

Voice activities can be considered as alternating between two states: talkspurt and silent. Data is generated during talkspurt only, and no data is transmitted during silence, thereby making statistical multiplex gain possible. Paul T. Brady discovered that both talkspurt and silence periods of digitized voice are exponentially distributed [Brady69].

Within WINNER we consider 3 different rates of conversational voice traffic, corresponding to 8, 32 and 64 kbit/s constant bit rate (during talkspurt), depending on whether we intend the voice to be intelligible to people, intelligible to machines, or pleasant to listen to. During talkspurt, data is generated in regular speech packets, according to the use of a codec. An example codec G.723 is detailed in [3].

Traffic Model

The commonly accepted model for a speaker in a voice call is a continuous-time, discrete-state Markov chain. The holding time in each state is assumed to be exponentially distributed with mean $1/\lambda$ and $1/\mu$, respectively (see below).

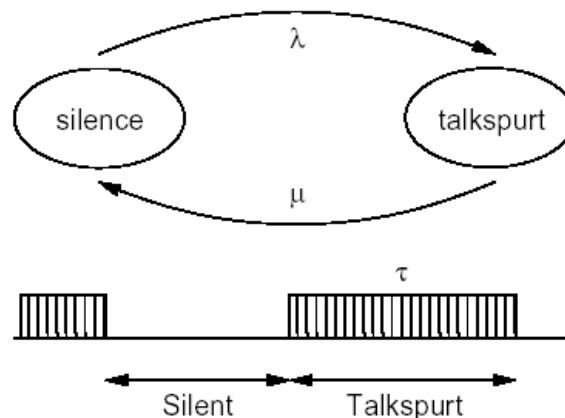


Figure 3-4: Single Speaker Model

The commonly used values are $1/\lambda = 650$ ms and $1/\mu = 352$ ms. These values are often referred to as the *Traditional Packet Voice Model*. Values of $1/\lambda = 742$ ms and $1/\mu = 435$ ms were measured from actual telephone traffic with silence detector of high sensitivity [Yat82].

The fundamental basis of all packet voice performance studies for the past is the classic model of exponential distributions by Brady. This model, however, was based on digitized voice statistics. Its applicability to packet voice with different audio content has not been examined before.

Packetization, may change the traffic characteristics of packet voice, since both the techniques and implementations are different. In addition, while digitized voice in the traditional model was mainly concerned with telephone conversations, packet voice will be used for a wider range of new applications that may affect the traffic model too. For instance, a significant amount of applications will be for information or entertainment distribution.

Traffic Model Parameters and Distributions

The proposed traffic models for conversational voice (see table below) are based on the Single Speaker Model as described above.

During talkspurt periods, the codec generates a speech packet every 30ms. For low quality voice this speech packet is assumed to be 30 bytes, for medium quality it is 120 bytes, and for high quality voice it is 240 bytes. Directly after the transition to silent state a 4 byte frame for comfort noise generation is sent.

	Single-speaker model for digitized speech [Brady69]	Traditional Packet Voice [Deng95]	Packet Voice [Deng95]
Talkspurt	1.34s	0.352s	7.24s
Silence	1.67s	0.65s	5.69s

Table 3-2: Parameters for Voice modelling with Exponential Distribution

The mean call duration for a speech service is 120s. The call duration is negative exponentially distributed.

3.1.3 Video Streaming

Characteristics

Video streams usually exhibit a heavy-tailed probability density function (pdf) and an autocorrelation function with a mix of Short Range Dependence (SRD) and Long Range Dependence (LRD) characteristics. It is incorrect to simply adopt traditional Poisson model, which is widely used for voice traffic modeling. Among many earlier researches on MPEG-1 video traffic modeling, some models have been proposed that consider both SRD and LRD. These include FARIMA models [6], a model based on Hosking procedure [7], scene-based models [8], the Markov modulated processes [9], a frame level model based on wavelet transform [10]. Among them, scene-based models and Markov models have some difficulty in accurately defining and segmenting video traffic into different scenes and states, this is due to the dynamic and stochastic nature of the video traffic; FARIMA models and the model based on Hosking procedure suffer high computational complexity and need unacceptable time to generate model data, thus are not suitable for real-time traffic data generation; The frame level model based on wavelet transform captures both SRD and LRD feature of MPEG-1 video traffic in wavelet domain, but it needs many parameters to independently construct the AR models of wavelet coefficients in 16 time scales. [11] presents a GOP level model based on wavelet transform for MPEG-4 video. It models the size of a GOP in wavelet domain, and the frame size is decomposed from the GOP size with fixed ratios. Though this model is simple, the first and second order statistical characteristics of model data in frame level are inaccurate.

MPEG-4 standard provides very efficient video coding schemes that cover a wide range from the very low bit rates used for wireless communication to high bit rates and quality levels beyond HDTV. MPEG-4 is object-based. Each scene is composed of Video Objects (VOs) that are coded individually. Each VO may have several scalability layers, which are referred to as Video Object Layers (VOLs) in MPEG-4 terminology. Each VOL in turn consists of an ordered sequence of snapshots, referred to as Video Object Planes (VOPs). For each VOP the encoder processes the shape, motion, and texture characteristics. The encoding process of each VOP is very similar to other frame-based standards such as MPEG-1 and H.263, with motion and texture encoding applied to each VOP.

There are three type of frames, I, B and P, in MPEG-4 video. There is only intra-frame coding in I frame. P frame is predicted from the previous I or P frame. While B frame is bidirectionally predicted from the previous I or P frame and the next I or P frame. They are arranged in a periodic pattern referred to as Group of Pictures (GOP), i.e. IBBPBBPBBPBB.

Traffic Model Description

After analyzing the first and second order statistics of typical trace files, it is found that MPEG-4 video data exhibit a heavy tailed probability density function (pdf) and an autocorrelation function with a mix of LRD and SRD and the autocorrelation function shows periodic spikes. Based on these statistical analyses, a model based on Hadamard transform, which efficiently exploits the frame pattern of MPEG-4 video is proposed [12]. It only needs half parameters as needed in the wavelet-based frame level model, and it can accurately match the statistical features of real trace data. Furthermore, the performances of the model data are in very good consistency with those of real trace data in all model evaluation tests.

This model consists of two parts, parameters estimation part and real-time traffic data generating part. The first part estimates the model parameters. The second part generates real-time and stochastic MPEG-4 traffic data with arbitrary length using the obtained parameters.

Parameter Estimation

MPEG-4 video is composed of GOPs, and a GOP consists of 12 frames in the order of IBBPBBPBBPBB. Since I, B and P frames adopt different encoding methods, they usually exhibit obvious differences in statistical properties. This should be taken into consideration when modeling. Thus we divide each GOP into one IBB sequence and three PBB sequences.

Using the 3 frame sizes of IBB sequence and one padded zero a 1×4 column vector denoted as $y(l)$ is constructed, . Using the same method the three PBB sequences is converted into three column vectors, denoted as $z(3l-2)$, $z(3l-1)$, $z(3l)$ respectively, where l is the index of GOP.

It has been demonstrated that it is difficult to accurately match SRD and LRD features simultaneously with a model constructed only in time domain. So some orthogonal transform to y and z is applied before further processing. The model proposes the usage of the Hadamard transform. Applying Hadamard transform to y and z respectively the following is obtained:

$$\hat{y}(l) = W_4 y(l)$$

$$\hat{z}(n) = W_4 z(n)$$

$$n=3l-2, 3l-1, 3l$$

where W_4 is the 4-dimension Hadamard matrix; $l=1, \dots, L$;

$L = \lceil N/12 \rceil$ is the GOP size; N is the length of actual video frame size sequence $x(k)$.

The coding methods of MPEG-4 determine that the I, B and P frames in the same GOP have dependence. While the continuity and correlation of images and coding methods determine that there is dependence between adjacent GOPs.

Those dependences should also be exhibited on the Hadamard transform coefficients of neighboring IBB and PBB sequences.

The method relies on the evaluation of:

- 4 diagonal matrixes $A_{y^{\wedge}}$, $B_{y^{\wedge}}$, $A_{z^{\wedge}}$ and $B_{z^{\wedge}}$ (each has four parameters to be determined) that express the dependence of I, B and P frames from previous one in the same GOP (see [7] for optimal estimate of such matrixes).
- $E(y^{\wedge})$ and $E(z^{\wedge})$ respectively the column vectors means of $y^{\wedge}(l)$ and $z^{\wedge}(n)$
- $\varepsilon_{y^{\wedge}}(l)$ and $\varepsilon_{z^{\wedge}}(n)$, four-dimension column vectors, which are composed of four independent normally distributed random values.

Real-time Traffic Data Generation

The video traffic model is based on a IBB and PBB producing blocks, as shown in Fig. 5.4.

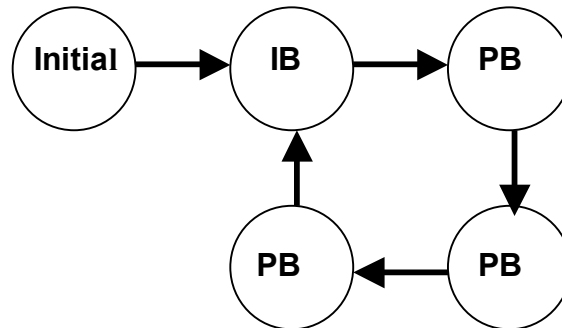


Figure 3-5: Video Traffic Model: IBB and PBB blocks generation flow.

In the initial step $y^{\wedge}(0)$ is set to $E^{\wedge}(y)$.

IBB producing block works according to the following steps:

- 1) Randomly generate four independent normally distributed values denoted as four-dimension column $\varepsilon'_{y^{\wedge}}(l)$;
- 2) Based on previous IBB sequence coefficient $y^{\wedge}(l-1)$, produce current IBB sequence coefficient $y^{\wedge}(l)$ with the following formula:

$$y^{\wedge}(l) = A_{y^{\wedge}}(y^{\wedge}(l-1) - E(y^{\wedge})) + B_{y^{\wedge}} \varepsilon'_{y^{\wedge}}(l) + E(y^{\wedge})$$

- 3) Compute Hadamard inverse transform of $y^{\wedge}(l)$ and obtain the random frame size sequence $y(l)$ which is normally distributed;
- 4) Select the first three elements of $y(l)$, implement the marginal match [11] with the following formula, and obtain the final IBB frame size x' :

$$x'(12(l-1) + i) = F_X^{-1}(F_{y^{\wedge}}(y'_i(l))); \quad i = 1,2,3$$

where $F_{y'z'}$ is the composite cumulated distribution function of the random frame size sequence y' and z' generated by IBB and PBB producing blocks.

Similarly, PBB producing block works according to the following steps:

- 1) Randomly generate four independent normally distributed values, denoted as a four-dimension column vector $\varepsilon'_{z'}(3l-3+j)$ where j means that it is the j th time to invoke PBB producing block in this GOP;
- 2) Based on the IBB sequence coefficient $y'(l)$ in this GOP, obtain current PBB sequence coefficient $z'(3l-3+j)$ with the following formula:

$$z'(3l-3+j) = A_z(y'(l) - E(y')) + B_z \varepsilon'_{z'}(3l-3+j) + E(z')$$

- 3) Compute Hadamard inverse transform of $z'(3l-3+j)$ and obtain the random frame size sequence $z'(3l-3+j)$ which is normally distributed;
- 4) Select the first three elements of $z'(3l-3+j)$, implement the marginal match with the following formula, and obtain the final PBB frame size x' :

$$x'(12(l-1)+3j+i) = F_X^{-1}(F_{y'z'}(z'_i(3l-3+j))); \quad i = 1,2,3$$

Traffic Model Parameters and Distributions

Traffic model parameters are derived from previous section while estimates for mean size of frames and of bit rate (Video Broadcasting model with sequence IBBPBBPBBPBB and MPEG-4 coding) is derived from D1.3 [3].

Video Streaming Parameter	Distribution	Mean	Variance
IBB Frame Size [kbit]	Normal	180.266	-
PBB Frame Size [kbit]	Normal	180.266	-
Bit Rate [Mbit/sec]	-	1.730	-

Table 3-3: Video traffic model parameters and distributions

3.1.4 Streaming of audio

Characteristics

Audio traffic in the internet has been steadily gaining ground over the last few years mainly due to the widespread of applications such as live audio transmissions and internet radio stations. According to a recent study [27], popularity of audio streaming applications surpasses the spread of video viewing over the internet, while according to earlier research video traffic was slightly ahead of audio [28].

There are significant traffic parameters differentiating audio traffic from usual internet traffic among which the most distinguishing are the following: in contradiction to web traffic, audio is sent at consistent bitrates at medium time scales (10s of seconds) and examined in smaller time scales. An audio traffic generator behaves as a bursty on-off source [29]. Furthermore, there are specific influential factors regarding audio traffic, such as geographical and time of the day. Another important aspect differentiating audio streams from other kinds of web traffic is the highly unidirectional traffic pattern. The outbound rate in an audio server can be 50 times higher than the inbound rate. In addition, the packets carrying audio data maintain consistent lengths (300/500 bytes corresponding to 16 and 20kbps respectively), and stable interdeparture rates, that follow a normal distribution [29].

Regarding specific figures that describe audio traffic over the internet, according to [28] most of the audio files are currently streamed to a mean rate of 20kbps, so as to accommodate even for modem dial up users.

Traffic Model Description

There is currently an ongoing effort for specifying a reliable statistical model that describes audio streaming traffic. Most proposals suggest an adoption of a low bit rate video traffic model so as to depict the characteristics of the relevant traffic regarding audio applications. In the following table we summarize a few data rates regarding streaming of audio.

Traffic Model Parameters and Distributions

Audio Streaming Parameter	Distribution	Mean
Session Duration (sec)	Pareto (a =1,6)	2400
Session Interrival Times (sec)	Exponential	$1/\lambda = 3600/0.16*k$ (k = average number of streaming audio connections performed by a user in a day)
Packet Size (bytes)	-	300/500 (16 and 20kbps respectively)
Bit Rate (kbps) (compressed audio/ low quality)		20
Bit Rate (kbps) (compressed audio/ FM radio quality)		32
Bit Rate (kbps) (compressed audio/ high quality)		128-256
Bit Rate (kbps) (uncompressed audio)		1411

Table 3-3: Audio traffic model parameters and distributions

3.1.5 File transfer

Characteristics

File Transfer refers to the very general activity of transferring a file from one place to another, within a certain time period, and with a given accuracy. For pure file transfer, other concerns, such as interpacket arrival times, or variation of data transfer rate during the process, are not of interest to the end user – these related to other activities, such as streaming of files. Hence, the major characteristics of file transfer are: size of the file, transfer time and accuracy (error rate).

The size obviously depends on the type of the file (picture, video, map, etc), while the transfer time depends on the particular usage scenario behind the file transfer. The required accuracy will be a function of both the file type, and the usage.

In the following pages the major file transfer characteristics from the user perspective are presented. In addition, an FTP traffic model is described at a high level

Traffic Model Description

As mentioned in the previous section, the major file transfer characteristics are the size of the file, the transfer time and the transmission accuracy. It is also of value to create extended models, which take into account the usage of file transfer activities.

According to the scenarios studied within WINNER, we have identified a number of different types of files used within the services and applications. For these types of files, we have estimated typical file sizes, or ranges of file sizes, taking into account evolution in user expectations, and also data formats.

Further analysis of the scenarios provides estimates on the required transfer times and accuracy for the different types of files.

When coupled with analysis on service usage, which will be carried out in later phases of the project, a model can be produced showing how often files of each type are requested, and what characteristics the transfer should possess.

Traffic Model Parameters and Distributions

Regarding size, files are grouped into categories according to their type:

<u>Messaging</u>		<u>Internet</u>	
Voice message	0.5-2.5M	Browsing (Download web-page)	0,1-1M
Simple SMS	5K	eCommerce (secure)	0,1-0,5M
Advanced SMS	100K	Transfer of files	0,1-300M
Email	10K	Intranet access	0,1-1M
Email with attachment	1-10M		

<u>Multimedia</u>		<u>Software package</u>	
MM message	0,1-2M	Small	10K
Uncompressed song	50M	Large	1G
Individual song (compressed)	3-5M	Map	1-50M
Album (compressed)	50M	Augmented map	1-50M
30 min. radio program	30M	3D map	1-50M
Photograph	0.1-5M	VR map	1-50M
		Tourist guide	1-5M

<u>Video</u>			
Mpeg4 movie	1G	Long clip	500 M
Mpeg2 (DVD) movie	5G	3D video clip	300M
TV program	2G/hour	Drawing	0.5-5M
HDTV	10G/hour	Ebooks	1M-1G
Short clip message	10M	Presentation	1-50M
Short clip (high quality)	150M		

Table 3-4 File size table

Other parameters will be part of the future work, as they require a more in-depth study of the user behaviour and requirements.

3.1.5.1 File Transfer Protocol (FTP)

As described above, File Transfer is a very generic process, which may be triggered by many different usage models, such as user initiated browsing, peer to peer activities, messaging, push services, machine to machine communications, agent or ambient intelligence based background activities ...

One common usage model for use of file transfer capabilities within the current wired Internet is the File Transfer Protocol, which is described below.

Characteristics

FTP is an Internet protocol for the transfer of files, based on a simple structure of (assumed) circuit switched connections. The objectives of FTP are 1) to promote sharing of files (computer programs and/or data), 2) to encourage indirect or implicit (via programs) use of remote computers, 3) to shield a user from variations in file storage systems among hosts, and 4) to transfer data reliably and efficiently.

When used by a user, an FTP session typically consists of navigating and browsing through one or more filesystems, interspersed with requests for transfer of individual or groups of files.

Traffic Model Description

An FTP session consists of one control connection, and one or more data connections. The control connection is used for the exchange of commands and replies in simple ASCII format. Each command and reply typically consists of 20-40 bytes. The exchange of commands and replies over the control connection is periodic in nature triggered by user requests. A unique data connection is established for each file transfer or directory listing transfer, and is terminated after the transfer. The closing of the data connection indicates the End of File (EOF). Thus the number of data connections in an FTP session is equivalent to the number of transfers performed. Each data connection follows one of the two modes, active or passive depending on whether the server or client initiates the connection, respectively. In the active mode, the client sends a PORT command to the server indicating the IP address and the port number to which the server should establish the data connection.

FTP provides the transfer of multiple files based on an expression given by the user, for example, using “mget *”. The files are transferred independently and no form of connection information is shared between each file’s transfer. Each transfer requires the client to send PORT, SIZE and RETR (or equivalent) control commands. The total number of data connections consumed for a multiple file transfer request is (n+1): one to transfer of the name list of files, and n for n file transfers.

Traffic Model Parameters and Distributions

C802.20-03.43 [21] has a detailed description of an FTP model which is based on [22] . The basic model is included here for illustration. See also [23]

In FTP applications, a session consists of a sequence of file transfers, separated by *reading times*. The two main parameters of an FTP session are:

S : the size of a file to be transferred

D_{pc} : reading time, i.e., the time interval between end of transfer of the previous file and the user request for transfer of the next file.

The underlying transport protocol for FTP is TCP. The parameters for the FTP application session are described in Table 3-5. Note that the parameters given here are for existing and past FTP usage, and do not reflect changes in usage for the WINNER timescales. The completed WINNER File Transfer model will provide relevant statistics for future usage.

Component	Distribution	Parameters	PDF
File size (S)	Truncated Lognormal	Mean = 2Mbytes Std. Dev. = 0.722 Mbytes Maximum = 5 Mbytes	$f_x = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{(\ln x - \mu)^2}{2\sigma^2}\right], x \geq 0$ $\sigma = 0.35, \mu = 14.45$
Reading time (D_{pc})	Exponential	Mean = 180 sec.	$f_x = \lambda e^{-\lambda x}, x \geq 0$ $\lambda = 0.006$

Table 3-5 FTP Traffic Model Parameters

Based on the results on packet size distribution 76% of the files are transferred using an MTU of 1500 bytes and 24% of the files are transferred using an MTU of 576 bytes. For each file transfer a new TCP connection is used whose initial congestion window size is 1 segment (i.e. MTU). The packet arrival process at the base station is described by the TCP model.

3.1.6 Interactive activities

3.1.6.1 Internet Gaming

Characteristics

Among network games, action games are the most popular and within this genre the most popular game is Counter-Strike® followed by Quake®. A network game model for Counter-Strike is proposed in Network Game Traffic Modelling [17], which is an evolved model based on the network game model for Quake proposed in Source Models of Network Game Traffic [15]. Quake is a fast-action game in which a number of players each control a single character. The player traverses a highly graphical maze filled with weapons, ammunition and opponents. The goal for each player is to eliminate the other players as many times as possible. When players die, they are out of the game until they press a key and are resurrected. In Counter Strike, players join one of two teams and attack or defend against the other team. It is a very fast paced game where a player's life usually ends within a few minutes. The game communication model of both games follows the client/server approach and uses UDP packets for the exchange of small update information to maintain fairness of the game and player synchronization. The server sends game state information to each client where packets are read and processed. Clients synchronize the server game state with their local game state, process player commands, and return update packets with the players' movement and status information.

Network game traffic generates a significant share of today's Internet traffic. In [18] it is reported that 3-4% of all packets in a backbone could be associated with only 6 popular games. A high market potential, increasing usage as well as sharp real time requirements make this kind of traffic interesting for Internet service providers and manufacturers. In order to profit from the high popularity of online gaming, networks are enhanced for gamers, i.e. components and protocols are optimized for game traffic. [14] [16] [19] [20] [21]

Traffic Model

[15] provides a simple traffic model for fast action multiplayer games. Although multiplayer game traffic shows strong correlations due to a shared game state it has been shown in section Traffic Characteristics that the variance is small, i.e. these dependencies only lead to slight traffic changes. Thus, the game traffic can be modelled by independent traffic streams from each client to the server and a burst traffic stream from the server to the clients. Therefore the approach assumed in [15] is:

- (1) clients behave independent of each other,
- (2) server traffic per client is independent of the number of clients and
- (3) client traffic is independent of the corresponding server traffic.

Based on the scope of the evaluation the modelled traffic only reflects active game phases without interruptions due to change of scenario or game options. During game interruptions client and server traffic may pause for a short time after which larger update packets are transferred to synchronize all clients. Note, that this traffic is not time critical. Those

dynamics are out of the scope of this work and have to be modelled on a higher level if desired. The game traffic model proposed consists of only two independent modules, the client traffic model and the server traffic model with a burst size equal to the number of clients participating in the simulated traffic. For a mathematical description of the distribution functions for inter-arrival time or packet size it is necessary to find a function of similar shape and fit its parameters to the empirical data. As Borella [16] has identified the Extreme Value distribution to fit best for Quake traffic, also in [14] this function has been chosen for better comparison. Similar functions as shifted Lognormal or shifted Weibull lead to acceptable fits as well.

The Extreme Value distribution is given by the following expressions:

$$F^c(X) = e^{-e^{-\frac{X-a}{b}}}$$

$$f(X) = \frac{1}{b} e^{-\frac{X-a}{b}} e^{-e^{-\frac{X-a}{b}}}, \quad b > 0$$

Server – Model

The inter-arrival time for the server denotes the burst inter-arrival time. Within a burst packet is sent to every client as soon as possible. Packet sizes are generated independently for each destination. Table 3-6 shows traffic characteristics of the observed data as well as the suggested distribution [14]. For matches with a small number of players, it has been found that inter-arrival times of server bursts show four clear peaks comparable to client inter-arrival times, i.e. at 50 ms, 55 ms, 60 ms and 65 ms instead of a continuous distribution function as obtained for matches with many players. It has been assumed that this behaviour is caused by the server nearing its performance limit in games with many clients.

Client-Model

As the distribution functions of client packet inter-arrival times is characterized by one to three peaks a multimodal distribution is suggested. Significant peaks are identified at 34 ms, 42 ms, 50 ms and 60 ms. As most observed clients show their peak at 42 ms it has been suggested a deterministic distribution for this inter-arrival time (see Table 3-6) [15].

Traffic Model Parameters and Distributions

Gaming Parameter	Distribution	Mean	Peak
(Burst) interarrival (Server per Client) [ms]	Extreme (a=55, b=6)	62	55
Packet Size (Server per Client) [Bytes]	Extreme (a=120, b=36)	127	-
(Burst) interarrival (Client) [ms]	Deterministic (40ms)	41.7	42
Packet Size (Client) [Bytes]	Extreme (a=80, b=5.7)	82	-

Table 3-6: Internet Gaming traffic model parameters and distributions [15]

3.2 End-to-end Traffic Models issues

The traffic models analysis activity, for which this chapter represents the final summary for Phase I, has been carried out through the following steps:

- state of art models search;
- revision of models proposed in the literature and selection of the most representatives ones;
- alignment of current models with future user requirements as much as possible on the basis of qualitative evaluations (taking into account the obvious consideration that future networks and future data traffic measurements are not yet available).

It has to be underlined that the models proposed in the previous section do not represent the outcome of an exhaustive analysis work since the complexity and the variety of the traffic models field would have placed such objective out of WP1 reach. Hence, there is definitively room, in Phase II, for a validation of the proposed models and for further research on the basis of the literature references reported that already in itself represent a valuable result in such complex technical context.

The traffic models introduced up to now address a single specific service, typically validated on real data traffic measurements carried out on existing networks.

In order to build up a complete end-to-end traffic model for WINNER two issues need to be addressed:

1. Multiservice User Traffic Source Model Definition
2. Validation of models taking into account the characteristics and impact of the future IP packet based networks.

Multiservice User Traffic Source Model

Traditional models describe the traffic in single-service telecommunication networks and are not suitable to describe the behaviour of a multiservice IP packet network.

In IP networks several services coexist with a wider variety of characteristics in terms of call arrival rate, holding time, mean bandwidth, burstiness, etc., and this requires the development of new sophisticated models taking into account additional functions and associated logical level (connection, action and transmission). The connection level describes the behaviour of a traffic source on the call basis (how often the service is used and for how long). The call set-up and call clear events that delimit a call duration, are the most macroscopic behaviour of a traffic source. The action level describes the behaviour of an active user, i.e. its statistical behaviour. The on-off characteristics of the cell generation process are modelled in this level. The transmission level describes the behaviour of cell generation at the lowest level. Finally, there is the need to describe the behaviour with new models of data traffic for a multi-service user system, i.e. capable of generating and using more services at the same time. Such models should accommodate user transitions from one service to another and respect the different duration of calls depending both on the specific service as well as the particular user. The models should describe services with widely accepted traffic parameters; e.g., peak and mean transmission rates, call rates, duration of an active period, burst rate, inter-burst time, etc.

Models Validation on future networks

Some of the models proposed in this chapter include modelling of the underlying network. In fact the statistical distributions and parameters of the traffic models are tuned in order to be able to reproduce, from a statistical point of view, real traffic measurements. Data traffic measurements typically include both data traffic generation and underlying network behaviour. The latter includes the description of network overload conditions, characteristics and priority of contemporary supported data transmissions and services, impact of overhead of used network protocols, etc. Now the WP1 approach has been to pursue the validation of existing models on the basis of the foreseeable traffic requirements evolution in terms of data increase, delay, etc. Such evolution of traffic characteristics is due to the change of user requirements in terms of service types, data volumes, characteristics of information to access, etc. While it has been relatively easy to estimate future volumes of data to be transmitted, it is much more complicated to envisage the impact on performances of the future IP based networks architecture.

Furthermore networks performances may depend also on feedback control mechanisms that can be implemented by means of which sending nodes can estimate which packets are likely to be discarded if transmitted. Such control mechanisms would allow transmission only of traffic that has a high probability of reaching its destination hence improving average received bit rates and overall performances.

Control strategies can be devised based on knowledge of the status of each link throughout the system or more simply on the private information exchanges between pairs of terminals (or nodes) that are engaged in two-way conversation with each other. In these schemes information about the effect of the network on a particular sender's traffic is provided by a "feedback" communications path (data transmissions via the net) from the receiver.

3.3 Conclusion

The traffic models analysis, performed in WP1 during Phase I, provides a good basis for models identification and selection taking into account the various typologies of models and the relevant literature in the references. On the other hand, such analysis has not to be considered exhaustive and conclusive. In WINNER Phase II, it should be appropriate to continue the activity on traffic models started in Phase I by validating and refining the proposed models and extending the research on technical literature. Two major issues need to be tackled in Phase II: the definition of aggregated Multi-service user data traffic model and the validation of such models on Future Networks including behaviours due to new network characteristics and/or network control mechanisms.

4. Case Study: a day in a life of a young person

4.1 Introduction

This part details one of the scripts described in D1.1 [1].

It aims at showing through an example how you can use work done in WP1 (except the work concerning economic analysis and business analysis) to analyze a use scenario. This is the first step in order to get the system requirements: traduce the scenarios into applications and service classes and then get the associated system requirements.

We chose to show also the traffic model associated to the application and the main requirements from a user point of view. For a more detailed requirements description, please refer to the requirements of the service classes.

4.2 The case studies

Name: Peter
 Sex: Male
 Age: 18 years
 Occupation: Student
 Place: An urban area in a developed country of Europe
 Date: A spring Saturday in 2015

Time: 8.05 am

Location: His bedroom

Peter is woken up by a video call from his mother. Peter threatens that he will remove her from the Emergency List if she calls him again so early in the morning without a good excuse. The Emergency List is a service provided by the operator that enables someone to list the persons permitted to call them even when they have their mobile device (UT User Terminal) in the not-disturb mode. Peter switches his UT to the normal mode, and receives a video message from his friend Gilda, who he was supposed to meet at 10 at the shopping mall in the city centre, to postpone their meeting for an hour. He replies positively with a video mail. With the remote control he turns on the coffee machine and gets up to take a shower.

Extract of the case study	Generic Application	Application-oriented services	Service Class	Comments	Main requirements (user point of view)	Traffic models
<i>video call</i>	1 Telephony / Conference / Chat	2 Video telephony	9 Data and media telephony	Assuming this does not require a high quality for professional applications (Service class 11 for data rate > 512kbps) Home application allowed by the screen (better screen)	User requires real-time video and a good resolution, Delay should be kept very low. <200ms Data rate up to 512 kbps	Video streaming
<i>Hidden appli for the emergency list – identification of a user to the network, so they can be checked against the emergency list</i>	5 Secure Connection	10 M-payment and secure authentication	13 MM messaging	Secure short message sent to the network to give the caller's id	User takes it for granted that the MM message is transferred securely. Low delay required <200ms	File transfer model
<i>video message/video mail</i>	2 Messaging	6 MM message	14 Lightweight browsing		Transfer time < 5sec	File transfer model
<i>remote control</i>	9 Remote control	24 Control	3 Short control messages and signalling		User expects accurate usage of the UT as a remote control. Interactive, delay <500ms	Interactive activity

NB : The emergency list is described as a network service from the operator and thus does not require anything for the air interface.

Time: 8.45 am

Location: His home backyard
 The day is very hot for the season so he decides to take his breakfast in his backyard. He has a lot of time until his meeting with Gilda so he decides to do some work. With his notebook he connects to the Internet, logs in to his college network, and retrieves the results of a complicated simulation that he had left running on his laboratory cluster. The results are very good, which makes him very happy because he does not have to work any more during the weekend. He browses some music sites and is informed of new songs and the top-10 list. With his UT he prepares a playing list to listen to in his car on the way to the shopping mall.

<i>Extract of the case study</i>	<i>Generic Application</i>	<i>Application-oriented services</i>	<i>Service Class</i>	<i>Comments</i>	<i>Main requirements (user point of view)</i>	<i>Traffic models</i>
<i>connects to the Internet/browse s...</i>	6 LAN/Web access	12 Internet Style Browsing	14 Lightweight browsing		data rate ~1Mbps	Internet/browsing
<i>logs in to his college network</i>	5 Secure Connection	19 Intranet access	14 Lightweight browsing		High integrity	Internet/browsing
<i>retrieves the results of a complicated simulation</i>	5 Secure Connection	20 Database Access	15 File exchange		Very high data-rates up to 10Mbps	Internet/browsing, File transfer model
<i>With his UT he prepares a playing list</i>	5 Secure Connection	14 Secure browsing and transfer	14 Lightweight browsing		High data-rates	Internet/browsing, File transfer model

Time: 10.35 am

Location: In his car on the way to the shopping mall
 He gets in the car without the use of a key, as Peter's digital ID, existing in his UT, wirelessly authenticates him to the car security system. His UT sets up the songs playing list to the car's audio system and the audio system starts downloading the songs from the common wireless song distribution network used by all the big music companies in order to distribute their songs. Peter's e-wallet is charged automatically for the songs that he hasn't already bought listening licenses for. The car's navigation system traces the optimal way to the shopping mall according to the traffic load of the roads. On the way the system identifies a road that is suddenly heavily traffic jammed, probably because of a car accident, so it interrupts the audio system to alert Peter of the situation. Then it informs Peter of the best alternative way to the shopping mall. In order to inform Gilda that he is going to be late, Peter sends a voice message to Gilda.

<i>Extract of the case study</i>	<i>Generic Application</i>	<i>Application-oriented services</i>	<i>Service Class</i>	<i>Comments</i>	<i>Main requirements (user point of view)</i>	<i>Traffic models</i>
<i>wirelessly authenticates him to the car security system</i>	5 Secure Connection	10 M-payment and secure authentication	13 MM messaging but with a low delay (< 1sec)		User would accept only minor delay, (~1sec) however security (including encryption) is taken for granted	Internet/browsing, File transfer model
<i>UT sets up the songs playing list to the car's audio system</i>	5 Secure Connection	14 Secure browsing and transfer	14 Lightweight browsing		Identification of the user profile Security is taken for granted.	Internet/browsing, File transfer model
<i>the audio system starts downloading e-wallet is</i>	10 (former 2) Transfer of files	18 Transfer of files	14 Lightweight browsing	We could also consider SC 15 (for its higher data rate)	High mobility High data rate (~512kbps)	Internet/browsing, File transfer model
	5 Secure	10 M-payment and	13 MM messaging		High security and high	Internet/browsing, File transfer

	Connection	secure authentication and guidance	4 Simple interactive applications	Application for the sending of maps	integrity	model
<i>charged automatically car's navigation system traces the optimal way</i>	8 Navigation/guidance	21 Navigation and guidance	4 Simple interactive applications	Application for the sending of maps	transfer time <60s, amount of data up to 50MB	Internet/browsing, File transfer model
<i>according to the traffic load</i>	2 Messaging	5 Short data message	8 Simple telephony and messaging	Assuming an ad-hoc network is created between cars along the road in order to send informations such as localization, mean speed...	High interactivity, fast partner discovery and setup	Internet/browsing, File transfer model
<i>according to the traffic load</i>	8 Navigation/guidance 2 Messaging	22 Navigation and guidance 4 Voice messages	10 Geographic datacast 8 Simple telephony and messaging	Assuming a local network sends local datacast info (for traffic) according to sensors along the road	broadcast+data rate up to 512kbps	Internet/browsing, Interactive activity
<i>voice message</i>	2 Messaging	4 Voice messages	8 Simple telephony and messaging		Same requirements as voice call	Conversational voice model

NB : We suggest here 2 different ways to deliver the traffic load information

Time: 11.15 am

Location : At the shopping mall

On his arrive at the shopping mall he sends a request to Gilda in order to allow him to use the location system to locate her and lead him to the place she is. He meets her at a store at the fifth floor. Some time later he makes a video call to his father to show him an expensive leather jacket he wants to buy and to persuade him to transfer money to his e-wallet in order to buy it.

<i>Extract of the case study</i>	Generic Application	Application-oriented services	Service Class	Comments	Main requirements (user point of view)	Traffic models
<i>he sends a request to Gilda</i>	2 Messaging	5 Short data message	8 Simple telephony and messaging	SMS application		Internet/browsing, File transfer model
<i>use the location system to locate her</i>	8 Navigation/guidance	21 Navigation and guidance	4 Simple interactive applications	We could also consider another appli for the datacast of the map of the mall	User requires real-time response. Indoor localisation	Internet/browsing, Interactive activity
<i>video call</i>	1 Telephony / Conference / Chat	2 Video telephony	9 Data and media telephony		Delay should be kept very low. <200ms Data rate up to 512 kbps	Video streaming, Conversational voice model
<i>transfer money to his e-wallet</i>	5 Secure Connection	10 M-payment and secure authentication	13 MM messaging		User would accept only minor delay. (below a few sec), secured messaging and high integrity	Internet/browsing

Time: 4:00 pm

Location: His bedroom

Now, it is time to play. One of his favourite activities is playing Virtual Reality games. His new favourite game is called "The Planet" and it is played in a Virtual Reality distributed environment with other remote players. Peter joins a group of players, some of whom are regulars, for another round of "The Planet". He is now using his VR glasses, one of UT's accessories. The 3-D sound effects together with the VR image quality make for a very exciting gaming environment.

<i>Extract of</i>	Generic Application-	Service Class	Comments	Main requirements	Traffic models
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<i>the case study</i>	<i>Application</i>	<i>oriented services</i>			<i>(user point of view)</i>	
<i>Virtual Reality distributed environment with other remote players</i>	4 High interactive applications	5 Network games	1 Real time collaboration and gaming		Very high data rate (up to 20Mbps) Highly interactive (delay < 20ms) Network application	Game traffic model
<i>Extract of the case study</i>	<i>Generic Application</i>	<i>Application-oriented services</i>	<i>Service Class</i>	<i>Comments</i>	<i>Main requirements (user point of view)</i>	<i>Traffic models</i>
<i>videoconference</i>	1 Telephony / Conference / Chat	3 Video conference	1 Real time collaboration and gaming		Low delay (< 200ms) Data rate up to 512kbps Adaptation of the resolution and rate according to the device	Video streaming
<i>watching film trailers (video streaming)</i>	7 Streaming applications	16 Streaming media	16 Video streaming	Assuming anyone from the "group" can control (jump back, fast forward...) the film trailers so as for the whole group to see them in a synchronized manner	Delay should be kept very low. (~100ms) Multicast appli Data rate up to 1Mbps	Audio & Video streaming
<i>watching film trailers (control of the play)</i>	9 Remote control	24 Control	3 Short control messages and signalling		User would accept only minor delay (~100ms) and accurate commands from the UT.	Interactive activity
<i>informed by the operator</i>	1 Telephony / Conference / Chat	1 Voice telephony	8 Simple telephony and messaging	Audio message/announcement		Conversational voice model
<i>she joins by being able to talk and listen only</i>	1 Telephony / Conference / Chat	1 Voice telephony	8 Simple telephony and messaging	Simple audio call		Conversational voice model
<i>receives a multimedia message advertising</i>	2 Messaging	6 MM messages	13 MM messaging	Messaging is better appropriate than Advertising application which was defined for Streaming Ad.	Push service, delay not so important, amount of data up to 10MB	File transfer
<i>shares the multimedia material with the others</i>	3 Broadcast	13 Information sharing	5 Interactive high multimedia		User requires real-time video and a good resolution, which depending on the device used can result in the data	File transfer

Time: 5.45 pm

Location: His bedroom

The game is interrupted by an alert from his UT that he has an incoming call for videoconference with two friends of his, Jim and Marlin. He accepts the call. They try to arrange to go to the cinema, while watching film trailers and reading film criticisms. They call Gilda to join the videoconference but they are informed by the operator that Gilda does not have an appropriate connection for a videoconference so she joins by being able to talk and listen only. After a moment Jim, who has subscribed to the "Funs of Rock" community, receives a multimedia message advertising a rock concert. He shares the multimedia material with the others and they decide to go to the concert instead. They continue their conversation and later they play a networked game.

						rate. Delay should be kept low. (5 sec)	
<i>networked game</i>	4 High interactive applications	9 Network games	1 Real time collaboration and gaming			High data rate (up to 2Mbps) Highly interactive (delay < 20ms) Network application	Game traffic model

Time: 9.15 pm

Location: At the concert

Upon their arrival at the concert place they receive a request for their UTs to download and install plug and play software that enables them to request songs and take part in e-polls and e-auctions during the concert. At the end of the concert Peter goes to take an old audio CD on which he has bided successfully.

Extract of the case study	Generic Application	Application-oriented services	Service Class	Comments	Main requirements (user point of view)	Traffic models
<i>receive a request for their UTs to download and install p'n'p software</i>	3 Broadcast	7 Broadcast and Public Info	SC6 Geographic interactive multimedia broadcast	This is a context awareness application. This is considered as a broadcast of data to a region (the SW is broadcast)	Broadcast with data rate up to 5Mbps	File transfer
<i>e-polls and e-auctions</i>	5 Secure Connection	14 Secure browsing and transfer	13 MM messaging		User would accept only minor delay. (< 500ms) High Security and integrity	Internet/browsing, File transfer model

Time: 11.45 pm

Location: At a dance club

After the concert the group decides to go to a big dance club. Another software installation request arrives at their UTs when they get in the club. Amongst other things, the new software enables you to describe your profile and the profile of your ideal date. Then the program uses the club's wireless network in order to locate potential dates or let other users of the service locate you. Peter thinks about using the service for a moment, but a previous bad experience prevents him. Instead he makes a request for a song to the DJ.

Extract of the case study	Generic Application	Application-oriented services	Service Class	Comments	Main requirements (user point of view)	Traffic models
<i>software installation request</i>	9 Remote control	24 Control	3 Short control messages and signalling	This is considered as a machine-to-machine communication		Interactive activity
<i>potential dates</i>	6 LAN/Web access	11 LAN Access	12 LAN access and file service	Assuming the match of profiles is done by a SW appli in the LAN	Less than half-minute. Med-High integrity	Internet/browsing
	2 Messaging	5 Short data message	8 Simple telephony and messaging	A SMS is sent to the matched date as a request to accept/reject the localization		Internet/browsing
<i>let other users</i>	8	21 Navigation and	4 Simple interactive	We could add AOS21 SC6 if we consider that	User requires real-time	Internet/browsing,

<i>of the service locate you.</i>	Navigation/guidance	guidance	applications	the map of the club is sent to the whole club before the customized localisation	Indoor localisation	Interactive activity
<i>a request for a song</i>	2 Messaging	5 Short data message	8 Simple telephony and messaging	Request for the song via a SMS		Internet/browsing

Time: 2.15 am

Location: His bedroom

For a moment Peter thinks to update his Emergency List by removing his mother, but he changes his mind at the end. He turns off every wake alarm in the house with the remote control, switches his UT to the not-disturb mode, and goes to bed.

<i>Extract of the case study</i>	<i>Generic Application</i>	<i>Application-oriented services</i>	<i>Service Class</i>	<i>Comments</i>	<i>Main requirements (user point of view)</i>	<i>Traffic models</i>
<i>turns off every wake alarm in the house with the remote control</i>	9 Remote control	24 Control	3 Short control messages and signalling		User would accept only minor delay. High integrity, secured appli	Interactive activity

4.3 Case study conclusion

This part illustrates, using a scenario example, the analysis of typical WINNER future applications within service classes. This gives the reader a practical mean to link applications, service classes, and user requirements. WP1 used the same kind of approach in order to categorize all WINNER applications within a minimized set of 18 service classes, with the analysis of many different scenarios, as depicted in [1].

5. WINNER System Concept Analysis

The goal of the WINNER project is to define a single new ubiquitous radio access system concept. The first phase of the research activity in WINNER is about to finish. Although some research outputs still need finalization and the final deliverables are currently under preparation in some of the work packages involved in the process of definition of the overall System Concept, a vision of such System Concept is emerging.

In the first part of the WINNER project a wide range of Layer 1, 2 and 3 technology concepts has been addressed with focus on novel concepts creation and definition rather than on a coherent and detailed system design.

In the second part of Phase I of WINNER, the main objective has been harmonization of the identified novel concepts into a coherent system vision. Such objective is pursued via an analysis of the various technical solutions identified and a selection process leading to a system that exploits most of the most performing novel concepts in order to meet the foreseen system performance requirements but remaining simple enough not to increase the system complexity too much; complexity would be an obstacle for a system that plans to reach, although in the long term, the status of commercial system.

Such analysis and selection process has led to the definition of fundamental features and hence to a first outline of the WINNER System Concepts.

This chapter will propose:

- a summary of the WINNER System Concept as emerging from documents available or under preparation in the project [4] [5];
- an analysis of the WINNER System Concepts from the User Requirements point of view.

5.1 WINNER System Concept

The definition of the WINNER System Concept is the main objective of D7.6: “WINNER System Concept Description” (WP7) [5]. The main outcome of such deliverable is the Functional Description. The System Concept is hence here described as a set of “services” attributed to the system layers, which offers specific functionalities to the layers above to which they provide a “service”. The services, here defined as “layer service” and not as classical user service, are further broken down into service components that are described by state machines. By this, the external behaviour and the execution flow of each service of each layer is shown. Such functional description represents the WINNER System Concept.

Besides that, Architectural and System Modes are being defined. These belong more to the implementational part of the WINNER System Concept but definitively contribute to the clarification and specification of the System Concept.

The activity of the WINNER project during the first phase, in the various specialist work packages, has progressed by revising classical concepts and generating novel ones. Various types of Specific Concepts have been derived: Physical Layer Concepts (WP2), Deployment Concepts (WP3), Network Topology Concepts (WP3), Flexible spectrum usage (WP2,WP6), Co-existence Strategies, Inter-System Handover, CCRM (WP4). The wide and valuable brainstorming occurred in the project has permitted to create the conceptual basis, the “toolboxes”, for the definition of a truly advanced B3G mobile communication system. After the exploration and identification of improved or novel techniques the main objective of the project in the second part of Phase I has been the attempt to rationalize and harmonize the huge and varied typology of concepts in order to fit them into a unique, versatile, coherent and consistent system.

The Specific Concepts identified can be combined in order to define a System Mode, which is a combination of parameters and algorithms (concepts) that make sense in the context of a particular situation (i.e.: radio environment, usage scenario, economic model, etc.). The variety of concept identified brings to several System Modes; some of these may be the best one in a certain context (ex.: radio environment) but may result in difficult implementation under other perspectives (ex.: economical model).

Therefore, there is a need to converge from the multiplicity of Specific Concepts and System Modes to a selected basis of Concepts and Modes that optimize the behaviour of the system under different point of views. The selection process has started at the level of the specialized WPs by proposing a first selection of concepts and is finalized at the System Engineering level (WP7) with a final analysis and selection of the resulting System Modes: the final selection of System Modes will represent the WINNER System Modes that together with the specification of the Generic or Architectural Modes and the Functional Description [5] contribute to the definition of the final WINNER System Concept.

In fact the System Concept is an overall description of the WINNER system made up of basic system building blocks belonging to the following categories:

- Functional Description
- Generic or Architectural Modes
- System Modes.

The selection process of the basic Concepts level contributing to the definition of the System Modes is mostly completed although some modifications are still possible until the end of Phase I.

The WINNER System Modes need to be validated across a range of test scenarios to understand their performance under different conditions. The proposed test scenarios do not represent the whole of circumstances in which the WINNER system may operate but only the contexts of usage considered more representative and challenging. The Functional Description is given in [5] . We provide here below a summary of the Architectural Modes and System Modes definition status.

5.1.1 Architectural Aspects

Architectural or Generic aspects are those aspects that apply in all cases and represent a common characteristic for all system modes and in turn of the WINNER System Concept. They contribute to define the overall Network and Protocol Architecture, that is the Architectural Mode.

The following aspects have been identified as generic to the whole system:

- Multi-mode Protocol Architecture Reference Model
- The set of logical nodes
- Security and trust aspects
- Logical and transport channels

Potential other generic aspects are:

- Control and user plane functionalities
- L2/L3 procedures
- CRRM
- Inter-system handover

5.1.2 System Aspects

The System Aspects are the system specific parameters and algorithms that may be combined to form System Modes. The following aspects have been identified as specific of the system:

- Co-existence strategies
- Flexible Spectrum Usage technologies
- Interference Management Techniques
- Network Topologies
- Deployment Concepts
- Physical Layer Concepts (Spectrum, Multiple Access, Resource Partitioning, Modulation, Duplexing, Coding)

As the Physical Layer concepts is defined through the combination of a wide number of fundamental different aspects, it is possible to refer to them as to Physical Layer Modes (PLM).

5.2 WINNER System Modes

It is deemed that at least the Deployment Concepts and the Physical Layer Concepts are required to form a System Mode. Consequently the WINNER System Mode is currently defined on the basis of Deployment and Physical Layer Concepts.

5.2.1 Deployment Concepts

The Deployment Concepts proposed for inclusion in the WINNER System Mode are:

- Single-hop (SB)
- Fixed Homogenous Multi-hop (FHoMH)
- Moveable Homogeneous Multi-hop (MHoMH)
- Fixed Heterogeneous Multi-hop (FHeMH)
- Co-operative Multi-hop (CMH)
- Peer-to-peer (P2P)

As compared to the initial Deployment Concepts proposed, the only concept dropped is the Mobile Homogeneous Multi-hop although it has been clarified that such concepts can be useful in the case of “Moving Networks” (i.e. nodes located on moving platform as Trains, Ships, etc.).

In the proposed Deployment concepts the User Terminal (UT) connects to classical Base Stations (BS) as well as to new nodes called Rely Nodes (RN). The RNs have forwarding capabilities from/to BS to/from UT.

A set of RNs may be directly connected to the BS and dynamically share the radio resources with it.

Each RN is connected to one but not more BSs. Some or all UTs may communicate directly with the BS. If RNs are present, some UTs may transmit to/receive from these RNs. Thus, the RNs essentially control separate sub-cells.

Both heterogeneous and homogenous relaying is under consideration, where the most challenging case is the one of homogenous relaying, where RNs and BS use the same PLM and share spectral resources.

Relaying via user terminals is not considered in case of UTs being hand-held terminals (mobile phones). The total time-frequency resources are partitioned into parts used by the BS, shared parts, and parts used by RNs.

5.2.2 Physical Layer Concepts

Several concepts have been analysed in WP2 for the Physical Layer. The following table represents the final summary of the selected Physical Layer Concepts. One of the new features as compared to the previous version reported in D1.3 [3] is TDD and FDD convergence. Indeed, WINNER air interface, both FDD and TDD modes, is designed to work in shared spectrum scenarios. In scenarios where dedicated spectrum is available higher spectral efficiency can be provided. Also both FDD and TDD have in principle the same scalability with respect to bandwidth.

They can be aggregated in coherent and different Physical Layers Modes represented by the two columns in the following table: FDD and TDD modes.

	FDD	TDD
Spectrum Freq	0.175 - 6GHZ	
Spectrum BW	1.25 to 100 MHz	
Spectrum Type	design and support for shared spectrum, enhanced capacity for dedicated spectrum	
Multiple Access	non-frequency adaptive transmissions: DL: MC-CDMA+SDMA including TDMA and FDMA as special cases UL: Hybrid TDMA/FDMA+ SDMA	
	frequency adaptive transmissions: chunk-based TDMA/OFDMA /SDMA	
Modulation	GMC based on CP-OFDM	
Modulation Scheme	adaptive <i>M</i> -QAM	
Duplex	FDD, supporting half-duplex FDD terminals	TDD
Coding	CC/PCCC/LDPC	
Multi-antenna technology	multi-user spatial domain link adaptation based on <ul style="list-style-type: none"> • (linear) dispersion codes, • per stream rate control, • multi-user precoding, • beamforming. 	

Table 5-1 : WINNER Physical Layer Modes

5.2.3 System Modes

At this stage of the project, heading towards the end of Phase I, both the Generic/Architectural Concepts and System Concepts are converging towards a final restricted set of proposed concepts. Such final set of concepts, although their definition is still partially in progress and will stabilize only with the conclusion of Phase I and the delivery of last reports, represents the emerging basis of fundamental concepts on which to build up and implement the WINNER System Concept. Since the final set of concepts is not fully stabilized yet, it has been chosen to define the System Modes on the basis of the Deployment and Physical Layer Concepts (initial System Modes). A more complete definition of the Generic/Architectural and System Concepts/Modes will be possible at the beginning of Phase II.

These System Modes have been defined in order to provide a WINNER system that is applicable to a range of situations:

- Able to operate across a range of radio propagations scenarios
- Support a range of traffic densities
- Take advantage of different spectrum options
- Support different deployments - from cellular infrastructure to low-cost minimal deployments

System Mode	Deployment Concept(s)	Physical Layer Mode(s)
1	SH	FDD
2	SH	TDD
3	FHoMH (CMH)	FDD
4	FHoMH (CMH)	TDD
5	FHeMH	FDD + TDD
6	MHoMH	TDD

Table 5-2 : WINNER System Modes

From Table 5-2 it can be seen that system modes 1 and 2 are sub-sets of modes 3 and 4 respectively.

5.3 User Scenarios vs. System Concept Analysis

It is deemed that an appropriate method for performing an analysis of User Scenarios vs. the emerging WINNER System Concept is to concentrate the attention on the innovative feature that the new WINNER system will exhibit and that are likely to make the difference for the user as compared to current systems. Such innovations, as identified in deliverable D7.6 “WINNER System Concept Description” (WP7) [5], belong to four main areas: Physical and MAC layers, Protocols and Resources, Deployment Concepts and Architecture, Co-operation.

Physical and MAC layers

The principal innovations as for Physical and MAC layers are:

- A radio interface based on self-organised synchronisation
- Integration of transmitters with single-carrier waveforms with OFDM transmission
- Enabling technologies for adaptive transmission
- Low radio interface delay
- Multi-antenna transmission that is adaptively tuned per flow
- Aspects of spatial processing solution
- Self-Organising Radio Resource Management

All these technical innovations refer to a higher flexibility and efficiency of the new radio interface. This translates in turn to a higher spectral efficiency. In fact the spectrum resource is limited and scarce and this particularly applies to the NLOS frequencies part of the spectrum. One of the main challenges of mobile radio communications evolution is to exploit to the maximum extent the NLOS portion of the spectrum. All the new features introduced have this objective. On the other hand most of the future user scenarios foresee new services with higher data rates. Hence, the positive impact of higher spectral efficiency systems on the final user is quite straightforward since he will benefit from higher throughput performances and hence from more attractive services. However, when considering services with very low

delay requirements, the scope for adaptation may be limited, so there is a tradeoff between delay performance and high aggregate data rates and spectral efficiency.

Further studies and performance evaluation of these innovative techniques will verify that they have the potential to support all the future services defined in this document, above all the most demanding one in term of data rate (i.e. interactive ultra-high multimedia or large file exchange service classes, section 2.1.1).

Protocols and Resources

The principal innovations as for Protocols and Resources are:

- Multi-mode protocol stack and Mode Convergence Manager
- Re-transmission protocols
- Two layered scheduling, namely service level controller and resource scheduling
- Multi-Mode transmission
- Packet based system design: flow concept
- Spectrum sharing

The innovations at Protocols and Resources level aim at introducing a greater system flexibility and in turn enable ubiquitous broadband service in a wide variety of scenarios. Again, this flexibility may be reduced when considering low delay services.

The future user scenarios identified in WP1 are relevant as for different typologies and as for new challenging conditions. Most of them outline the need for the user to be able to access services in a variety of situations and environments. Hence the progress of the mobile radio systems toward higher efficiency at protocol and resources management element is another key element for the support of future mobile user services.

However, it should be kept in mind, during the specification of these innovations at protocols and resources level, that QOS requirements for the WINNER service classes can be very demanding, and that imply implementation of efficient IP based QOS control mechanisms.

Deployment Concepts and Architecture

The principal innovations as for Deployment Concepts and Architecture are:

- Multi-Hop relaying
- Scalable architecture

Multi-Hop relaying of user data represents an integral part of the WINNER system concept although the integration of relay nodes does not rule out the possibility of conventional single-hop deployments usage. Such a new deployment concept result in a new radio access in wide area and local area/metropolitan scenarios that may improve in terms of:

- deployment flexibility (deployment of RNs, reduced restrictions on placement)
- deployment fastness (no wired infrastructure has to be deployed for the RNs other than power)
- cost efficiency
- network optimization and efficiency

Hence, besides further improvement from the point of view of the network architecture and consequently of the system spectral efficiency, further optimization may be possible from the point of view of deployment flexibility and cost efficiency. These improvement address another key point that is the ability to provide an enhanced system but without cost increase or even with cost decrease.

Also the feature of “Scalable Architecture” is coherent with the objective of costs control or reduction. Indeed, an ubiquitous radio system is supposed to support a great range of deployment scenarios and data rates. The feature related to the scalability of the architecture permits to address several user scenarios basically with the same system resulting in overall improvement of the scale economy.

Co-operation

The main innovations in this area are:

- Cooperation with legacy RANs
- Location Based Inter-System Handover

The possibility for WINNER system to cooperate and inter-work with legacy RAN and to exploit Inter-System Handover goes in the direction of providing higher availability and flexibility in the access to mobile radio services for

the users. As such, these innovations address one of the main future challenges which is the support of ubiquitous broadband mobile services. In practical terms, such cooperation may also aid economic deployment and real world take-up of WINNER systems.

Indeed, section 2.4 has identified that some service classes are already partially covered by legacy systems, so cooperation and inter-system handover are key elements to ensure the success of the future WINNER system.

5.4 Conclusion

An overview analysis of User Scenarios vs. the emerging WINNER System Concept has been performed focusing on the principal innovations of the new WINNER System as identified in D7.6 “WINNER System Concept Description” (WP7) [5]. The analysis performed, taking into account the background of the future user scenarios, has highlighted that such innovations, and hence the WINNER System, address the most important challenges derived so far from the future user requirements such as access flexibility, network efficiency, cost efficiency, availability, etc. Hence, it is deemed that the new WINNER System Concept is suitable to respond to the main challenges posed on future mobile systems by future user requirements.

6. Business and Economic Analysis

In this section a method for WINNER business analysis is described. In D1.3 [3] a first introduction of the WINNER business analysis was made. Below a more detailed description of the generalised business framework, and its use, is made together with three example domains.

6.1 The Generalised Business Framework

In WINNER we have developed a variety of usage scenarios (D1.1 [1], D1.2 [2], D1.3 [3]), operating for diverse scopes (commercial, corporative, promotional, educational, supportive, etc), and used by multiple user groups having different motivations, independently of the technologies and business domains which may provision the scenarios. The WINNER business framework aims to support all those multiple scenarios by introducing a single generalised business framework of abstract *Actors* and *Relationships*. Abstract Actors and abstract Relationships become more specific when the generalised framework is applied to a particular domain and further tend to become less abstract when an exact scenario is mapped to the framework.

The generic framework depicted in the following figure identifies in an abstract yet descriptive way the business analysis approach that will be adopted within the context of WINNER project. The three fundamental concepts on which the specific analysis has been based upon, i.e. the domains, the actors and the relationships between parties involved in the value chain, have been identified in a way that primarily accommodates all the applications, target groups of users and markets that are of relevance to WINNER.

In the following paragraphs we will give a brief overview of these concepts and provide linkage to each ones functional role in the business areas that are addressed by the specific project.

The description follows a layered approach, being based primarily upon actor description, having their roles identified within the context of specific examples - domains. In each of these examples we also try to discriminate the relationships that are established between actors, in terms of money and information flow.

We note that the purpose of the approach undertaken in the specific study is not to service as an exhaustive market research, since all relevant ventures should also be accompanied with analytical qualitative and quantitative analysis of the provisioned e-services in the scope of the evolution of the related technological frameworks.

6.2 Using the Business Framework

It is not the role of WINNER to impose, or constrain itself to, a single business structure. Nor is it intended to develop business models, or “operations handbooks” on behalf of any particular actors.

Rather, the approach taken is to identify the multitude of current business structures (domains) which may support some or all of the types of services being considered, the key actors within those domains, the roles played by those actors, and the types of relationships needed between those actors.

In order to perform an analysis of a particular scenario or use case, the following actions should be performed.

- Identify all business domains within which it may be possible to support the scenario (not only those traditionally or currently used)
- For each domain:
 - Identify which specific actors would be involved in supporting the scenario
 - Identify what relationships would exist between these actors, and what constraints or requirements would be placed on these relationships, from the viewpoints of the different actors

- o Compare the requirements on the relationships from the different viewpoints to identify compatibilities or inconsistencies. e.g. if a user is only prepared to pay 1 euro for a service, but it costs the service provider 5 euro to provide that service
- Identify whether there exists one or more domains within which it is possible to resolve any inconsistencies. In this case, there is a realistic possibility to provision the scenario. If there are no domains within which it is possible to resolve the inconsistencies, it should be considered that the scenario is not viable within the identified domains.

A domain may be characterised as being a combination of actors and their relationships which enable the provision of an instance of a service to a user, or which enable a user to provide an instance of a service. Generally this implies a commercial business structure, although not for profit domains also exist, and there may be not for profit actors in some domains. Even in these cases, actors and relationships exist, although the nature of the relationships (or the requirements on the relationships) may vary.

The following list identifies those domains which are clearly relevant for study of WINNER services and scenarios. For each studied service/scenario, a domain specific instance of the business framework should be developed for each of these domains: Traditional mobile telecommunications; MVNO mobile telecommunications; Fixed telecommunications; WISPs and commercial hotspot operators; "Value add" hotspot operators (e.g. Coffee shop); Free hotspot providers (community and general members of the public); Broadcasting – network operation / content provision; End user service/content provision (GNU software, freeware, P2P, for money, etc.); Content retail (not networked/download); Financial transactions.

Further details on these domains can be found in deliverable D1.3 [3]. Other domains may exist, or may develop in the future, and can also be included in the analysis.

For the purpose of business and economic analysis, the main type of relationship which must be considered is that of money flow – between which actors does money flow? in which direction(s)? and how much?

Other types of relationships can also exist, and may be interesting or beneficial to study. For example: Information flows (other than content and direct application data – e.g. context information); Trust; Contractual (similar to money flows, but not necessarily the same. e.g. with some freeware there is no obligation or contract to provide any payment in return for a service, but is it possible to do so should you wish to show your appreciation for what has been provided); Legal (company) ownership; User / profile "ownership".

6.2.1 The Generalised Business Framework

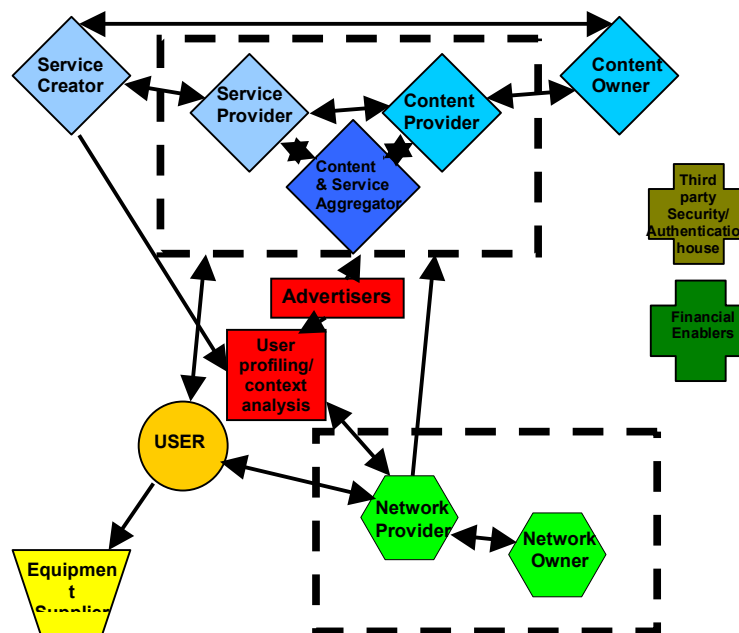


Figure 6-1 : Generalised Business Framework

6.2.2 Actors

It would be possible to identify hundreds of different actors who have some involvement in the different domains (particularly considering hardware, which consists of multiple components which can be traced back to raw materials, via a chain of manufactures, sales organisations, logistics companies etc.). Such detailed analysis would not be useful –

the variabilities in estimations would be bigger than the role of many actors, and the resource needed to develop the complete framework would be excessive.

In the following list we have identified the most important actors, from the perspective of the business framework.

Depending on the particular service and domain being considered, some of these actors will not be relevant in all cases, and at other times there may be multiple instances of a single type of actor.

6.2.2.1 Network owner (site owners, infrastructure owners)

Network owner's contribution includes the physical networking infrastructure mostly in terms of bandwidth provision either for wired/fixed connectivity (e.g. fixed telephony & internet) or for wireless connectivity (e.g. transmitter/receiver sites). It may also include ownership of radio frequency licenses.

6.2.2.2 Network / connectivity provider

The main role of the network/connectivity provider is to contextualize the networking infrastructure into realistic connectivity. Its functional role is strongly affected by the network owner and the market needs formed by end user demands.

The network provider may be the network owner, or may lease network capacity (mainly bandwidth) from one or more network owners in order to provide network level services to end users or service providers.

6.2.2.3 Equipment suppliers

Equipment suppliers are key actors of the business framework, since the hardware sophistication is substantially influential in regard to the overall service provision process, affecting cost, speed and quality of the final product the customer experiences. It is important to be able to predict and analyze the role of equipment supplier into a generalized business framework that tracks down the evolutions of end user demands, networking techniques and hardware sophistication.

6.2.2.4 Service creator

The service creator is the actual application developer, his tasks being limited most of the time to service design, development, testing and maintenance. Although traditionally, service creators have been performing their part of the role in a service value chain within a pure technical context, new user-centric approaches to services dictate a more thorough interaction with other actors of the framework, especially the end-user that becomes progressively a determinant factor in the overall service design and implementation procedure.

6.2.2.5 Service provider

The main role of the service provider is to provide high level services to end users. The service provider holds a similar role in relation to the service as the content provider to the supplied content. In some cases, the service provider acts as the common reference point in the service supply chain, maintaining interactions with the majority of actors involved, such as the advertiser, the end user, the content provider, the service creator and the network owner/provider - with which it may form a single business entity.

6.2.2.6 Content provider

The content provider may undertake the role of the intermediate and act as a liaison between the content owner and the rest of the value chain described in a business domain. The role of the content owner usually encompasses involvement into both technical (content storage, format transformation) and business/economical aspects (digital rights management).

Among others content provider paradigms may include:

- A record label for musical content exploitation
- A film production company
- A specialized intermediary company

6.2.2.7 Content owner

In a business domain, the content owner is the actor who acts as the primary source of the final content that is to be delivered to the end-user. The content format may undergo transformation regarding its digital representation throughout the service integration procedure, so as to be readily served on a variety of different platforms and terminal devices.

Typical examples of content owner in real value chains include:

- A library, for an e-learning platform
- An artist or his manager, for an online digital music platform

6.2.2.8 Content and Service aggregators

This is another strategic role depicted in WINNER business framework, reflecting the current status and trends of electronic services market. As it is self-evident, this business entity may be formed as a direct consequence of the interplay between the content and service creators/providers or may be held by anyone of these four parties.

6.2.2.9 Advertisers

Advertisers maintain their traditional role in the business framework described by WINNER, forming a substantial source of revenues and in many cases even having the role of a driving force behind a service creation initiative. The role of advertiser can be undertaken either by specialized advertisement companies or by the service providers.

6.2.2.10 End users (including machines)

The end user role in the generalized business framework adopted by WINNER has been realized with a futuristic visionary aspect, so to include in technical, business and economic terms the range of user behavior, needs and demands, as these affect and are affected by an ever-changing market. End users represent the final service consumer, with the only distinctions being based upon economical criteria, i.e. whether the customer is a single physical person or an entire company. This constitutes a major influential factor of the service aggregation and management strategies, that has a substantial impact on the way today's and future services are being delivered.

Typical instantiations of an end user include

- Physical persons
- Large/Medium/Small Companies
- Institutions
- States
- Machines

New groupings of customers are constantly emerging: i.e. a family is now seen as a single end-user entity by many service providers. In any case, it is the usual practice to try to reflect social structural foundations to form target groups of customers.

Increasingly, end users may also take on the role of other actors within a domain.

6.2.2.11 Financial enablers / institutions

The role of financial enablers and the respective institutions is focused in the facilitation of the economical transactions that usually take place among parties involved in a business domain. It is needless to emphasize the critical role implemented by the security/authentication actor in all levels and instantiations of financial exchanges. In any case such forms of interactions usually appear in any potential relationship depicted in the business platform.

6.2.2.12 Third party security / authentication house

The complexity of relationships that emerge in a business framework and also the need of safeguarding private and protected data may require a common ground for all involved parties, used for authentication purposes, intrusion detection and data protection. The security aspect should be an inherent attribute of all kinds of transactions implemented within the business domain, and this is clearly stated by placing the role of the actor in to a more abstract level in relation to all other actor roles existing in the domain.

6.2.2.13 User context analyser and profile manager/owner

This role is primarily based on the task of monitoring aspects directly related to user habits, preferences, economic and social categorization, that lead to the extremely valuable outcome of user profiling. The versatility of new services is highly dependent of this concept, since service customization and customer satisfaction are highly correlated. User contextual analysis is a task that affects significantly many aspects of the framework, since there may be also advertisement adoption to user target groups, service and content selection to satisfy diverse customer needs, and network resources provision based on specific user's demands.

6.3 Example Domains

6.3.1 Traditional Mobile Telco Domain

Since its emergence as an available commercial service, the traditional mobile telecommunications business domain has been constantly evolving regarding both the infrastructure (in terms of implemented hardware and algorithm sophistication) and the variety and complexity of the available services. When trying to identify the driving force of this evolution, the role of the interplay between industrial/business drives and enabling technologies comes forth.

It is therefore important to delineate a business domain that underlines these two main key players in the field of traditional mobile communications: the service/content provider and the network provider. This situation is clearly depicted in Figure 6-2, alongside with other enabling parties regarding this domain, i.e. the user/consumer, the security/authentication authorities and the third party financial enablers. Figure 6-2 depicts what is the result of the adjustment of the generalized business framework previously introduced, into the idiosyncrasies of the specific domain under examination.

Within this example we only consider the traditional domain and structure, where the user only access services offered via the network provider. Already in the real world we see an evolution of this domain somewhat towards that of other domains, such as the fixed internet domain, where the user has much more freedom and flexibility to also create relationships directly with other actors.

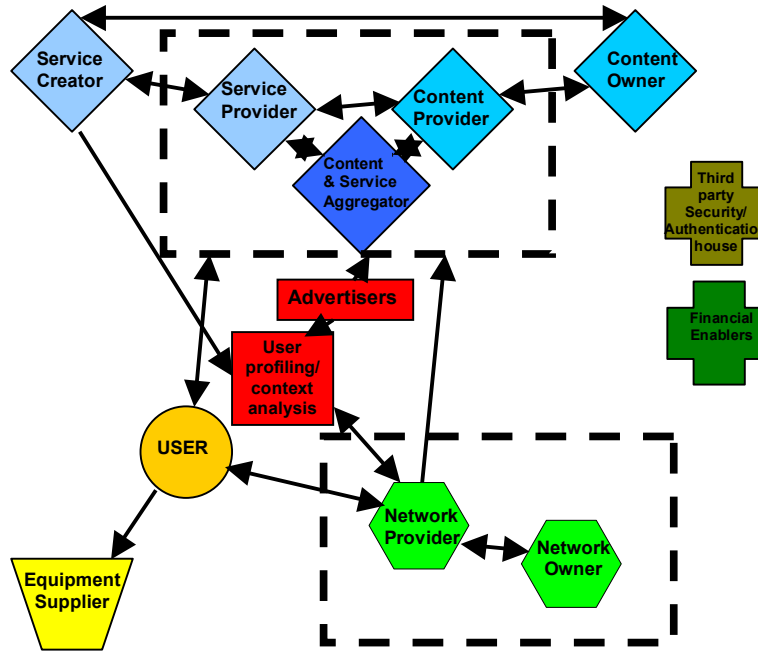


Figure 6-4 : Fixed Internet domain

The fixed internet business domain is clearly the most complicated of the example domains, and it expresses an effort to conceptualize the variety of service scenarios and financial relationships that this domain encompasses.

The traditional web browsing feature has been enhanced with a variety of services such as e-commerce, e-banking, streaming multimedia, e-learning platforms, context aware services, etc. Most of the aforementioned applications include interactions among all the actors of the specific business domain creating a rather complex scenery of both types of relations, i.e. financial and technical.

6.4 Summary

In this section we have presented and analysed a generic business framework as a useful tool for analysis in terms of economical and business aspects all applications that are in scope of WINNER. There has been a relatively extensive list of actors incorporated in this framework, their roles have been contextualized and there has been an effort to identify the most significant interactions that emerge within the service provision process.

7. Conclusions

7.1 D1.4 conclusion

In chapter 2, the identified generic applications and service classes are highlighted as a very mature result of WP1 work during Phase I. The variety of generic applications and service classes emphasizes the WINNER system versatility and capability to serving many applications and type of services in various user scenarios. In this deliverable, service classes have been better contextualized by exemplifying the relation of generic services to service classes as a function of the end-user perceptual quality and by also giving a more precise correspondence of the overlapping with current services and systems. Also differences on requirements among WINNER service classes and WINNER air interface have been pointed out.

Chapter 3 presents the traffic models analysis performed in WP1 during Phase I. It provides a good basis for models identification and selection taking into account the various typologies of models and the relevant literature in the references. On the other hand, such analysis has not to be considered exhaustive and conclusive. In WINNER Phase II, it should be appropriate to continue the activity on traffic models started in Phase I by validating and refining the proposed models and extending the research on technical literature. Two major issues need to be tackled in Phase II: the definition of aggregated Multi-service user data traffic model and the validation of such models on Future Networks including behaviours due to new network characteristics and/or network control mechanisms.

Chap 4 illustrates, using a scenario example (the case study), the analysis of typical WINNER future applications within service classes. This gives the reader a practical mean to link applications, service classes, and user requirements. WP1 used the same kind of approach in order to categorize all WINNER applications within a minimized set of 18 service classes, with the analysis of many different scenarios, as depicted in [1].

In chapter 5, an overview analysis of User Scenarios vs. the emerging WINNER System Concept has been performed focusing on the principal innovations of the new WINNER System. The analysis performed, taking into account the background of the future user scenarios, has highlighted that such innovations, and hence the WINNER System, address the most important challenges derived so far from the future user requirements such as access flexibility, network efficiency, cost efficiency, availability, etc. Hence, it is deemed that the new WINNER System Concept is suitable to respond to the main challenges posed on future mobile systems by future user requirements.

Chapter 6 presents and analyses a generic business framework as a useful tool for analysing in terms of economical and business aspects all applications that are in scope of WINNER. There has been a relatively extensive list of actors incorporated in this framework, their roles have been contextualized and there has been an effort to identify the most significant interactions that emerge within the service provision process.

7.2 General conclusions on WP1 work for WINNER phase 1

This deliverable ends the phase I of WINNER WP1 relative to usage scenarios. Four different deliverables have been written during those 2 years of work.

D1.1 [1] proposed the methodology used to get WINNER user requirements. Some key user groups have been identified and their main motivations for using mobile communications were described. For all these motivations, some scenario elements have been extracted from external references. First they were grouped by generic application type and later, a synthesis of this table leads to the preliminary list of service classes. Moreover, some initial scripts have been derived, by regrouping the scenario elements around one day in the life of a person or a location.

D1.2 [2] introduces a new major valuable part of WP1 work related to traffic models. Indeed, one of the other purposes of WP1 was to give the new and updated traffic models which should cover all needs identified for WINNER future applications while describing service classes.

D1.3 [3] gives the final usage scenarios after refinement work where feedback from other groups and internal iteration has been taken into account. Moreover, it introduced a preliminary part on business and economic analyses linked to our new requirements.

Finally, this document (D1.4) gives the final view of WP1 on service classes, traffic models, and business analysis. It also gives guidelines to discriminate service classes' characteristics, showing how you can obtain the service classes starting from qualitative criteria and underlines the differences between service classes' characteristics and air interface requirements. A case study, practical illustration of the use of service classes to analyse usage scenarios, is also developed.

WP1 Usage scenarios proposed an original methodology for getting the requirements for WINNER future applications. Analysing and crossing many inputs linked to usage scenarios such as user groups, user motivations, external references scenarios, scenarios elements, we proposed a reduced classification of 10 generic applications and 18 service classes. Each service classes are described with their main user requirements that should help to fill the gap between applications and system requirements. This work has been done independently from technical issues and choices while trying to stay as exhaustive as possible.

Moreover, in order to give and update all elements relative to the new user requirements for WINNER, we proposed 6 traffic models, including new and updated formulas according to our service classes' proposal.

Lastly, a preliminary analysis on business and economic aspects has been proposed by WP1 and should be continued during WINNER phase 2.

8. References

WINNER deliverables

- [1] WINNER deliverable D1.1 "First Economic and Technical Evaluations per Scenario"
- [2] WINNER deliverable D1.2 "Final requirements per scenario"
- [3] WINNER deliverable D1.3 "Final usage scenarios"
- [4] D7.3 "Initial System Concept Description" (WP7)
- [5] D7.6 "WINNER System Concept Description" (WP7)

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