Digital Radio Technologies for Better Mobile Services

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Abstract

Digital mobile communications is one of the great success stories of recent years, offering people levels of mobility and services never available before. The new 3G services will push mobile even further, opening up opportunities for true broadband mobile services. This is not the end of the road for mobile, however. On the contrary, we are still only at the beginning of the mobile revolution. Already the requirements for the next generation of mobile and wireless communications technology are emerging. Future systems must put user needs centre stage - seamlessly integrating the many different communication systems we see emerging today so as to deliver personalised enhanced services to users. In addition, they will require open interfaces and architectures to allow different players to inter-work and offer new services. Such an open approach will be essential for players to compete in a market where users are increasingly mobile and their requirements continually changing. Digital rights management and content management will also be important considerations.

Index terms— digital mobile communication, 3G services, mobile and wireless networks, winner.

1 Introduction

nalogue Private Mobile Radio (PMR) has enjoyed great success in Europe for many years, and serves a very broad community of users. Available for both licensed and unlicensed spectrum use, PMR applications extend from low-cost walkie-talkies aimed at the consumer market through to public safety and mission-critical systems. A comparable technology known as Specialized Mobile Radio (SMR) exists in the United States. Changes to the professional environment have meant that the operational requirements placed on communication equipment have evolved, and the traditional analogue service is no longer able to meet the users' needs completely. A demand for more sophisticated services has raised a need for a technology enhancement and inevitably this has led to a redefinition of PMR based on digital technology.

The concept will comprise the optimized combination of the best component technologies, based on an analysis of the most promising technologies and concepts available or proposed within the research community. The initial development of technologies and their combination in the system concept will be further advanced towards future system realization. Compared to current and evolving mobile and wireless systems, the WINNER system concept will provide significant improvements in peak data rate, latency, mobile speed, spectrum efficiency, coverage, cost per bit and supported environments taking into account specified Quality-of-Service requirements.

The success of future mobile and wireless communications systems depends on meeting, or exceeding, the needs, requirements and interests of users and society as a whole. It seems likely that this will require an increase in spectral efficiency to allow high data rates and high user capacities far beyond those of second or third generation systems. Moreover, flexible resource allocation will play a key role in future mobile radio networks. In recent years, much research has been carried out in increasing the performance and efficiency of various air interface components like coding or detection. Also new air interface concepts based on either single carrier or multi-carrier transmission have been proposed which show promising performance results. To design the next generation mobile radio systems, a clear understanding of the requirements on these systems is necessary and a comprehensive overview of new air interface technologies is required to really choose between the best available technologies. These new and integrated radio access technologies are being addressed as part of IST's research for Mobile and Wireless Systems and Platforms Beyond 3G.The work aims to arrive at a consolidated European approach to technology, systems and services, including location based services, and contributions to standards. It also aims towards a clear European understanding of spectrum requirements and novel ways of optimizing spectrum usage for "systems beyond 3G". Experimental Details a) Requirements for Future Radio Systems Future mobile radio systems will have to meet exacting requirements. Data rate per user is expected to increase significantly, but could also vary substantially between the peak vs typical. With data traffic dominating over voice transmissions, the demands in data rate between downlink and uplink are becoming asymmetric. Quality of service -a complex parameter which can be defined in several ways -is of particular interest to mobile users. And with many future services likely to be location based, mechanisms will be necessary to derive the user's location or other context.

Although hidden from the user, one of the most important issues is the integration of packet-switched and IP-based traffic. Network operators have made significant investments in building IP core networks based on internet system architectures. Further efforts are needed to optimize these and ease the integration of fixed and wireless networks.

Frequency spectrum and bandwidth allocation will be important considerations. Radio spectrum is scarce, and therefore expensive and hence future systems will have to be very efficient in how they use the limited spectrum available. Alternative methods of spectral allocation and use could also be considered. The system must be able to dynamically change the allocated resources as users' requirements and available capacities change.

Particular attention should be paid to how the air interface might affect terminal, base station and other infrastructure costs. Also regulatory authorities are specifying mandatory limits for the maximum power consumption and radiation for both the base station and the mobile terminal.

2 b) WINNER Overview

The key objective of the WINNER project is to develop an innovative concept in radio access in order to address high flexibility and scalability with respect to data rates and radio environments. The future converged wireless world requires in the long-term perspective a ubiquitous radio system instead of disparate systems for different purposes (cellular, WLAN, short-range access etc.).

The vision of a ubiquitous radio system concept is providing wireless access for a wide range of services and applications across all environments, from short range to wide-area, with one single adaptive system concept for all envisaged radio environments. It will efficiently adapt to multiple scenarios by using different modes of a common technology basis.

The concept will comprise the optimized combination of the best component technologies, based on an analysis of the most promising technologies and concepts available or proposed within the research community. The initial development of technologies and their combination in the system concept will be further advanced towards future system realization.

Compared to current and evolving mobile and wireless systems, the WINNER system concept will provide significant improvements in peak data rate, latency, mobile speed, spectrum efficiency, coverage, cost per bit and supported environments taking into account specified Quality-of-Service requirements.

3 III.

4 Objectives of Winner i to iii in A Phased Approach

The WINNER vision results in the overall objectives for all the WINNER Phases as follows:

? To develop a ubiquitous scalable radio access system based on common radio access technologies that will adapt to and be driven by different user needs and scenarios, by utilizing advanced and flexible network topologies, physical layer technologies and frequency sharing methods. ? To base the design of the WINNER I and II radio system on a horizontal integration for different radio environments and spectrum conditions in terms of frequency range and carrier bandwidth with respect to spectrum availability. ? To make efficient use of the radio spectrum in order to minimize the cost-per-bit by utilizing and combining the technologies researched within WINNER I and II in an efficient way. ? In recent years tremendous advances have been made in radio technology research. The design of new radio systems provides the unique opportunity to combine the best of the recent advances in order to maximize their benefits from the perspective of defining new and improved radio interfaces using a systematic investigation and development approach and to feed the results into the international standardization and regulatory process. The combination of new technologies, which are mutually optimized, is the key for significant performance leap. The ubiquitous WINNER radio system will be realized through a phased approach (Figure 2-2), each Phase is characterized by a major milestone and a basic objective. These are described below. The expected duration of all Phases is six years. Each of the three Phases with a specific focus will has a duration of two years to allow an adaptation to actual developments in technology, international standardization, regulation and the political environment. This Annex I is addressing Phase II. In Phase I a scenario analysis was performed to capture the user requirements. Additionally, a set of technical assessment criteria was defined, which will serve as a basis for the assessment of potential enabling technologies and the selection of the most promising ones, as well as the definition of suitable building blocks. From this assessment, a first concept for a ubiquitous system was defined with respect to the deployment and propagation conditions in the potential target frequency ranges, and its basic performance has been evaluated in Phase I.

Phase II is focused on the detailed system design, optimization, validation (through limited trials) and preparation of further trials in Phase III. This translates into the following WINNER II objectives: G1-To design and optimize the new ubiquitous radio access system, whose parameters can be scaled or adapted to the requirements of a comprehensive range of mobile communication scenarios. From a coverage area point of view wide-area, metropolitan and short-range scenarios have to be supported. The radio access system should be capable of supporting variable bit rates, with peak data rates of up to approximately 100 Mb/s for medium to long-range heavy traffic areas with high mobility, and up to approximately 1 Gb/s for hot spots and short-range scenarios.

G2-To continue the identification and analysis of challenging user scenarios and corresponding usage scenarios in concordance with all WWI IPs based on WINNER I. To derive requirements for the WINNER II radio interface and to evaluate and refine the scenarios based on the evaluated radio interface performance and other external developments.

G3-To define the detailed radio interface technologies needed for the ubiquitous radio system concept, including the following items: adaptive transmission schemes, duplex schemes, multi antenna concepts, and enhanced radio protocols, including Medium Access Control (MAC)/ Radio Resource Management (RRM) protocols for multi antenna configurations in order to develop a system specification.

G4-To develop in detail radio network topologies and deployment concepts capable of providing a ubiquitous radio coverage area, for example by the use of fixed or mobile relays, feeder systems, adhoc networking. The definition includes the functionality and external interfaces of the different network elements, communication protocols for information exchange between them and Radio Resource Management (RRM) algorithms to assign the available radio resources to the corresponding elements. This will be part of the system specification.

G5-To define the detailed radio level cooperation mechanisms between different Radio Access Networks (RAN).The choice of mechanisms will include, but will not be limited to, handover between new RANs or between new and legacy ones, combined Radio Resource Management (RRM) and concurrent/ complementary use of different RANs. This will be part of the system specification.

G6-To investigate missing cases for the propagation conditions and to continue from WINNER I the development of related channel models including path loss, multipath propagation and direction of arrival models in the identified potential target frequency ranges. G7-To define functionalities that implement efficient and flexible spectrum use and sharing as part of the system specification.

G8-To contribute to the international standardization and regulatory process -in particular to the development of the necessary reports and recommendations in ITU-R in the preparatory phase of WRC 2007 -and where appropriate to other international bodies, where WINNER II can provide technical input. One example might be the 3G evolution study item in 3GPP on special topics depending on the detailed work plan in 3GPP.

G9-To perform limited trials in Phase II in order to proof the concept of basic functionalities of the WINNER II system. G10-To prepare the trial campaign in Phase III by the selection of the hardware and software platform of the trial system and preparatory activities towards the application of a frequency test license.

G11-To disseminate results via international conferences, reputable journals and the organization of workshops as part of a global harmonization process. WINNER III will be focused on system refinement, key components and validation in trials. Therefore, the following focus areas will be addressed in the following Phase III:

? Adaptation to external developments such as upcoming specification and standardization activities, e.g. after the potential identification of new spectrum in WRC 2007.

? Dissemination and external promotion of the WINNER II results and specifications in an international harmonization process as part of prestandardisation and standardization activities. ? Validation and proof of system in more extensive trials of key components in the intended Phase III.

IV.

5 Achievements of Winner

The overall objective of Phase I was to develop a system concept adaptable to meet a wide range of scenario requirements. This objective was achieved and a flexible system concept has been proposed based on the combined results from activities mainly conducted within the following five principal areas:

? Definition of Requirements: The WINNER I system concept is user centric. To reflect this system concept, requirements defining the overall design and performance goals of the WINNER II air interface and radio access network were defined based on both technical and user oriented system requirements. The former type of requirements were based on physical limitations and the anticipated state-of-the-art performance of systems beyond IMT-2000 whereas the latter type of requirements were derived based on fundamental results obtained from user scenario analysis.

? Significant contributions to the international regulatory process: WINNER I has contributed significantly to the work of ITU-R WP8F. A concept on how to mesh base stations and fixed relay stations into an existent cellular system in a plug and play manner has also been developed. Furthermore, a framework for cooperation architectures between WINNER I RAN and legacy RANs, including the cooperation architecture entities and the mapping of the cooperation functionalities (mobility management, admission control, location based handover, scheduling / load control and QoS management) in these new entities has been defined. As spin-off of the activities in this area, a large number of scientific papers has been prepared and submitted to international conferences and magazines.

? Assessment of key technologies and system concept proposals: The justification of identified and selected key technologies and system concept components was a central activity in Phase I. Such assessments were conducted both on the link and system levels as well as on the network levels. To support those activities different channel models were developed. Initially channel models based on existing models were selected and adapted for early assessment use. In parallel, acquisition of measurement data for diverse outdoor and indoor environments at both 2 GHz and 5 GHz frequency ranges considering an RF bandwidth of 100 MHz were conducted in order to provide wide-band channel models for final assessment use. ? Feasibility studies: The implications of the technology concepts chosen for the WINNER I system concept have been studied in terms of feasibility and complexity. The feasibility of multiband width transmission was verified. It has also been established that fixed (L1/L2/L3) relays are useful in both, short-range/hot area and widearea scenarios to increase the capacity of a radio cell substantially as well as to increase the range of coverage of a base station substantially. Moreover, sharing, co-existence and flexible spectrum use have also been studied and analyzed extensively and suitable ways how to employ by the WINNER I system concept to improve the overall spectrum efficiency, ease the possible spectrum identification and deployment of the networks has been proposed.

V.

6 Conclusion

Future systems must put user needs centre stage -seamlessly integrating the many different communication systems we see emerging today so as to deliver personalized enhanced services to users. In addition, they will require open interfaces and architectures to allow different players to inter-work and offer new services. Such an open approach will be essential for players to compete in a market where users are increasingly mobile and their requirements continually changing. Digital rights management and content management will also be important considerations.

The key objective of the WINNER project is to develop an innovative concept in radio access in order to address high flexibility and scalability with respect to data rates and radio environments. The future converged wireless world requires in the long-term perspective a ubiquitous radio system instead of disparate systems for different purposes (cellular, WLAN, short-range access etc.). [1]

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Figure 1: EFigure 1 :

[1]EDigital Radio Technologies for Better Mobile Services

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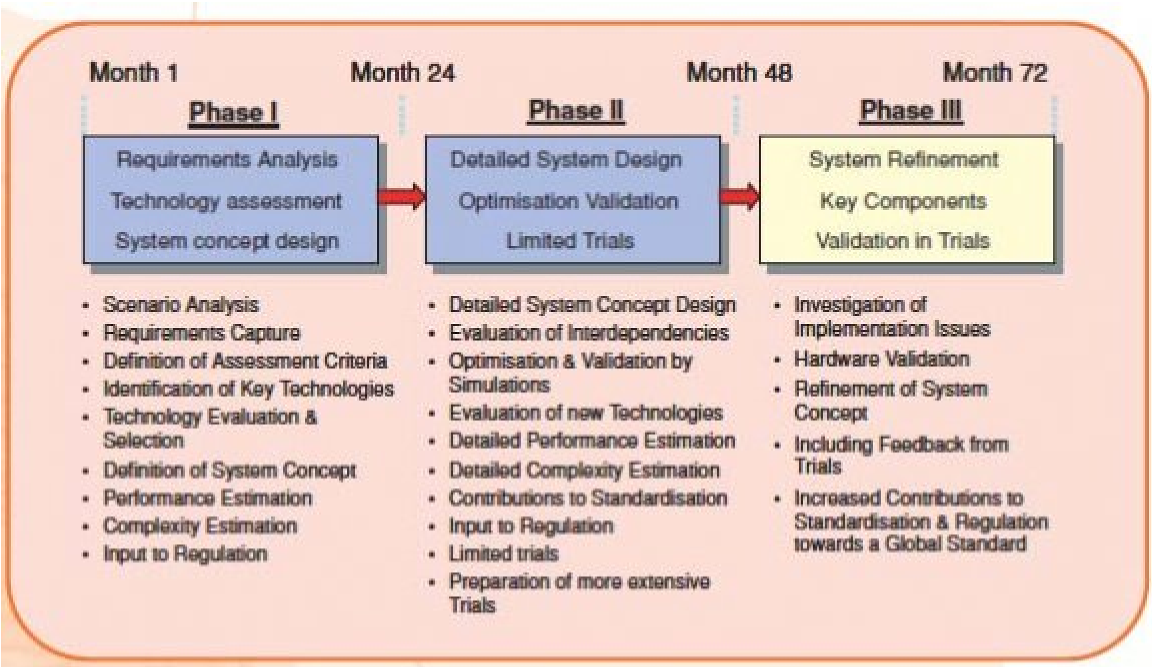
Month 1
Month 24
Month 48
Month 72
Phase I
Requirements Analysis
Technology assessment
System concept design
Phase II
Detailed System Design
Optimisation Validation
Limited Trials
Phase III
System Refinement
Key Components
Validation in Trials
• Scenario Analysis
• Requirements Capture
• Definition of Assessment Criteria
• Identification of Key Technologies
• Technology Evaluation & Selection
• Definition of System Concept
• Performance Estimation
• Complexity Estimation
• Input to Regulation
• Detailed System Concept Design
• Evaluation of Interdependencies
• Optimisation & Validation by Simulations
• Evaluation of new Technologies
• Detailed Performance Estimation
• Detailed Complexity Estimation
• Contributions to Standardisation
• Input to Regulation
• Limited trials
• Preparation of more extensive Trials
• Investigation of Implementation Issues
• Hardware Validation
• Refinement of System Concept
• Including Feedback from Trials
• Increased Contributions to Standardisation & Regulation towards a Global Standard

Figure 2: 2 E

[Digital Radio Accessibility Developments with digital radio technology for people with disabilities the Australian Communicatio ‘Digital Radio Accessibility Developments with digital radio technology for people with disabilities’. *the Australian Communications and Media Authority*, august 2010.

[EBU Viewpoint on the Future of Digital Radio] *EBU Viewpoint on the Future of Digital Radio*,

[Technologies for digital radio services in regional Australia Discussion paper (2010)] *Technologies for digital radio services in regional Australia Discussion paper*, November 2010.