3GPP TSG RAN Future Evolution Work Shop
2 -3 November 2004, Toronto, Canada

Compendium of Abstracts

Contents

1 Introduction

This document contains the summaries of the contributions that will be presented at the Work Shop on RAN Evolution taking place in Toronto, Canada, 2 – 3 November 2004.

The full length contributions will be available in the following folder:
ftp://ftp.3gpp.org/workshop/2004_11_RAN_Future_Evo/

2 Requirements guiding the evolution

2.1 Operators views

2.1.1 REV-WS002: Requirements for long-term RAN Evolution, Vodafone

UMTS is now a reality in today's mobile networks. Major effort has been spent on improving the performance of UMTS, with 3GPP Release 5 and Release 6 containing features like HSDPA, Enhanced Uplink and MBMS.

The evolution of RAN beyond Release 6 should be a major step in 3GPP System performance and deployable from around 2010. The aims are to reduce cost; to facilitate support for revenue increasing services; and to improve O&M and service provisioning.

A potential new radio technology should provide a major step forward in terms of spectral efficiency, user throughput, and round trip time. Robustness, flexible bandwidth allocation, cost-effective backhaul and the support for multiple Radio Access Technologies are essential to meet these aims.

Reduction of system complexity (particularly with regards to interfaces) and efficient Radio Resource Management need to be addressed to serve easy deployment and operation.

The facilitation of roaming, multi vendor operation and open interfaces with minimised options shall be maintained as the underlying principles.

2.1.2 REV-WS003: Requirements for the RAN long term evolution Workshop, Orange

Orange consider that the evolution of 3GPP RAN should provide a smooth migration path to technical and economic performance levels that are equal or superior to other emerging technologies. This leads us to the following requirements.

Re-use existing infrastructure
Incremental cost in OPEX and CAPEX has to be considered on infrastructure side, as well UE cost. More generally a dramatic reduction of cost per bit delivered has to be achieved, without decreasing service quality as perceived by the end-user (e.g. voice quality).

Technology Competitiveness & time to market
Competitive environment has to be taken into account. 3GPP RAN must keep ahead of emerging radio access technologies that are likely to offer competition in the future in terms of mobility management (roaming, handover), spectral efficiency and quality of service to differentiate delivery by service and by customer segment (minimum/maximum bandwidth, for example).

Performance requirement:
The evolved radio interface and RAN architecture must generate significant performance benefits in terms of: Spectral efficiency , throughput, DL/UL ratio, QoS control, e2e delay, seamless mobility whilst maintaining backwards compatibility with existing UE's.

Spectrum
New 3GPP radio interfaces must work in all UMTS spectrum allocations.
The channel bandwidth should be flexible and scalable to support different bandwidth allocations and peak bit rate requirements .

Architectural Evolution
Make most efficient use of growing base of packet oriented transmission technologies.
Support seamless service provision between different access technologies.

Services
A wide range of services must be accommodated, so flexibility is required to support, application with very different traffic profiles. Real-time communications services shall be of highest priority also for the future evolution of services and applications over 3GPP, secondly non-real time communications and thirdly other services such as, web browsing, entertainment services, office applications and machine to machine services.

2.1.3 REV-WS004: Requirements on UTRAN evolution, TIM

Introduction

The Workshop on UTRAN Evolution is focused on defining the evolution of UMTS radio access beyond release 6. TIM believes that UTRAN evolution represent a great opportunity for the future, but a number of guidelines and requirements shall be taken into account in order to improve the customer satisfaction and to better exploit current assets (e.g. 3G licenses and networks) and/or future assets (e.g., new bands).
This document presents some guidelines and requirements from an Operator point of view.

Guidelines for UTRAN evolution

A number of guidelines shall be taken into account in creating new Study Items and/or new Work Item and in revisiting the scope of already approved SI's or WI's.

First of all, the e**volution** must be **driven by**

- service and market requirements
- cost reduction

The technology must not hinder the service accessibility from a customer point of view.

Secondly, the operators need to **exploit** their **investments**, therefore the following points must be considered

- Coverage
  - Techniques to improve coverage have to be investigated
  - New radio schemes should provide at least the same coverage as release 99/release 5 (at the same bit rate)

Finding new sites is more and more difficult. Coverage shall not be reduced by new solutions (at least at the same bit rate) and possibly techniques for improving coverage should be exploited.

- Improvements and cost saving shall justify architectural changes
- Integration of different radio access technologies
  - Current radio technologies (GSM, EDGE, W-CDMA) shall interwork with the evolving technologies and be able to share the same frequency bands.
  - Possibility to optimally allocate radio resources on a service basis

In many networks different radio access techniques already coexist. Evolutions of radio interface shall make coexistence still possible. Moreover solution to provide optimal resource allocation (within a given RAT or managing multiple RATs as one network) shall be provided[1]

- 3G licences are a valuable asset

New radio technologies shall not reduce the value of 3G licenses (i.e., avoid early obsolescence of 3G networks)

Optimal use of spectrum by the capability to

- Exploit old and new bands
- Global roaming and economy of scale

New solutions shall facilitate economy of scale global roaming

- Minimise the information delivery time

Solutions shall be envisaged to simultaneously provide access to services to very large numbers of customers

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[1] Common Radio Resource Management was already investigated but the topic was dismissed due to lack of contribution. The increase in the number of Radio Access Technologies makes this requirement more important than in the past and solutions (for example new interfaces and architectures between RATs) shall be enabled.

Availability of equipment

- Interoperability and testing

Interoperability and testing will always be crucial issues and time consuming activities. Therefore it is important to minimise complexity and unnecessary options to easy interoperability and testing and to design the system considering the need of efficient testing process and monitoring. In addition, timely specification of performance and test case need to be ensured.

Requirements

Based on the above guidelines the following requirements have to be considered

Radio access technologies

- Integration between enhanced/new and existing GSM/EDGE/W-CDMA radio access.

New solutions shall be integrated as much as possible with already deployed networks. Common resource management shall be enabled

- Use technical “variants” to cover different operational scenarios with one technology

E.g. wide area coverage at moderate bit rates and high speed movements, spot coverage at very high bit rates– mass market and large numbers are drivers for cost reduction. The possibility to cover different operational scenarios (bit rate, mobility, …) with variants of the same technology will imply a larger scale in production and lower complexity in the terminal. Moreover, the number of radio access technologies to be integrated in one terminal shall be minimised.

- minimise complexity and unnecessary options
- timely specification of performance and test cases

Spectrum

- Capability to operate in existing and new bands for the new technologies
- Coexistence with previous technologies within one band
- Scalable use of the spectrum in different phases with different “variants”

Possibility to exploit evolutions in multiples of 5MHz.

- Variable duplex frequency
- Asymmetric allocation of up and downlink

It shall be possible to allocate multiple channels (multiples of 5MHz) to downlink (uplink) in correspondence of a single channel in uplink (downlink) with variable duplexing.

Quality of service vs System efficiency

- Techniques enhancing coverage and system efficiency shall be considered from the first phase.
- minimise the overhead on radio

Open interfaces and new architecture

- New interfaces shall be open
- Allow Common Radio Resource Management between different RATs
- Introduce an open interface between base band at node-B (BTS in Geran) and a remote radio head (RET, power amplifiers, antennas, …).

2.1.4 REV-WS005: View on 3G Evolution and Requirements- 3G Long-term Evolution Scenario: Super 3G, NTT DoCoMo

From a 3G operator's point of view, long-term evolution of the 3G systems is essential for 3G systems to keep a highly competitive position in the world market even in the 4G era, although HSDPA is competitive enough for a mid-term evolution. Additionally, 3G long-term evolution can provide a smooth migration path towards 4G [1].

Towards 3G long-term evolution, the following technology and market trend should be taken into account;

- Need for broadband in mobile communications is growing as well as in fixed networks.
- Research and development for variety of new radio technologies are progressing.
- It is anticipated that 4G1 will be launched in 2010s.

In the workshop, the position and requirements of DoCoMo's long-term evolution concept, "Super-3G", will be presented.

As for Super-3G's requirements, not only improved data rate and capacity, but also reduced latency is important since we have some restriction in the current radio systems due to latency. Smooth migration with reasonable CAPEX and OPEX are, of course, important requirements for Super-3G. First-rate technology for broadcast/multicast services shall be taken into account as well as point to point services. Channel transmission bandwidth should be scalable with N times 5 MHz up to 20 MHz.

Super-3G stands for the 3G long-term evolution concept that utilizes the 3G spectrum, and specifications for Super-3G should be developed in 3GPP. Although Super-3G is a long-term evolution, it is the time now to initiate discussions and development of the specifications.

[1] 4G stands for new capabilities of systems beyond IMT2000, defined in ITU-R M.1645. Note that it is not our intention to discuss 4G issues in 3GPP.

2.1.5 REV-WS006: Views on the study of OFDM-HSDPA, China Mobile

To meet the rapid development of data services, we need the high rate packet network. Now it is the proper time to discuss the issue of the UTRAN evolution. We think HSDPA based on R5 is important in the coming years, but with the increase of requirement we will need more efficient solutions in 3GPP several years later. We think OFDM will be one of the most promising technologies in the future.

We suggest setting up a work item to standardize OFDM in 3GPP as early as possible, the reasons are as follows:

- The data services will have a tremendous and fast increase in a long-term view, and the market change is unpredictable. So the more efficient technology will be needed to meet the requirement, and the standard work should start earlier.
- The conclusion of the technical report [1] shows that the performance and the complexity of OFDM-HSDPA outperform those of WCDMA-HSDPA with “advanced” receiver. Furthermore, it also shows that there are no indications that the introduction of OFDM in UTRAN is not feasible for the downlink.

References

[1] 3GPP TSG RAN WG1, OFDM TR 25.892 v2.0, “Feasibility Study for OFDM for UTRAN enhancement”.

2.1.6 REV-WS007: Requirements on RAN Future Evolution, T-Mobile Intl

From a T-Mobile perspective the evolution of the 3GPP RAN should build upon what operators have available. Existing networks, both GERAN and UTRAN, as well as their ongoing enhancements represent large investments. Their roaming capabilities provide service to customers everywhere.

The evolution should also recognise that non-3GPP specified radio technology exists, is being used by operators –T-Mobile is the biggest WLAN hotspot operator in the world- and sets benchmarks for the evolution of RAN. Interworking with non-3GPP technologies has to be provided.

T-Mobile considers that the focus of evolution should be on data, where lower latency, higher data rates and throughput, also by going to higher bandwidths, improved spectral efficiency and lower cost per bit are essential.

Alternative air interfaces are to be considered, where OFDM is a very promising technology.

The evolved RAN furthermore needs to be easily deployable on diverse available frequency spectrum.

2.1.7 REV-WS008: UTRAN as a part of a multi-access network, TeliaSonera

Today there are a multitude of radio access techniques (RAT) available for supplying mobile services. Using a combination of several inter-working access types, operators may optimise coverage, capacity and performance at a low infrastructure cost. UTRAN will be an important part of such a multi-access network, evolving toward systems beyond 3G. In this presentation, we will look at viable improvements of the UTRA radio interface and support in UTRAN for Common RRM and inter-working with other RATs in the multi-access network.

Traffic patterns are changing. The current GPRS UL/DL ratio is much higher than the UMTS Forum prediction for UMTS traffic; it is even higher for WLAN networks. Therefore, an improvement of today's 64 kbps in the UMTS UL is of paramount importance, whilst still avoiding the terminal complexity associated with the highest data rates. These could be supplied in local areas by other (inter-working) technologies. Alternatively, would these rates be supported by a 3GPP version of OFDM?

Another important problems are inter-working and Common Radio Resource Management (C-RRM) with other RAN such as GERAN. C-RRM will provide an efficient use air interface resources in available RANs for the support of mixed services of different QoS classes. But where would the C-RRM functionality be located? Standardised at all? What would be a suitable split between C-RRM function and the RRM of UTRAN (and other RANs)? Some initial ideas from the EU 6th Framework Programme Project EVEREST studying C-RRM will be presented.

2.1.8 REV-WS009: 3GPP Actions to Support Evolving Market Needs, Cingular

- 3GPP needs to assess how the technology capabilities and specifications under its purview need to be improved to meet newly identified market needs in the immediate term.
- Furthermore, shortened time to market intervals for the near to medium term future should cause 3GPP to reassess not only the specific market needs of each region of the world for 2007-2008, but also to critically examine its working methods to determine how specifications can be more rapidly produced with higher quality and greater assurance of proper functioning of deployed product.

2.2 Manufacturers' views

2.2.1 REV-WS010: Requirements for an Evolved UTRAN, Siemens

Siemens' requirements for an Evolved UTRAN are guided by the market's increasing demands for high-quality data services. Siemens expects that people's day-to-day perception of broadband data access in fixed-line networks will foster high expectations to UTRAN.

Evolution of UTRAN air interface shall provide the means to follow these growing demands, not excluding new radio access technologies. A suited radio access option shall be fully inter-operable with the existing UMTS radio access, providing enhanced ps-connectivity near the end of the decade. The air interface shall be highly adaptive to the various frequency and bandwidth allocations of different Network Operators.

It is expected that the evolved UTRAN will be optimised for TCP/IP traffic with respect to latency and enhanced data throughput.

In the progress of UTRAN Evolution in 3GPP, service (application) requirements needs to be taken into consideration, especially when discussing optimisation of radio protocols. Based on 3GPP's comprehensive expertise in services and their requirements for mobile networks, Evolved UTRAN will sustainedly address users' and operators' growing demands.

2.2.2 REV-WS011: Factors Impacting UTRA Evolution Requirements – Infrastructure and Terminal Perspectives, Motorola

This document considers a Release 6+ RAN evolution path from the perspective of both network and terminal. First, the current status, capabilities and performance of the UTRA RAN are briefly considered, and compared to contemporary deployed and emerging wide area systems. Potential opportunities for UTRA enhancements are then identified which could primarily enhance a) the user experience, b) the value of services offered by UTRA networks, and c) the economics of UTRA network deployment and operation. Further, emphasis is placed on requirements which could realistically be addressed in the period 2006+ timeframe, and which would be suited to existing and emerging spectrum resources. Finally, specific evolutionary requirements in terms of timeframe, technical features and quantitative performance goals – are offered to assist in identifying a way forward from the Workshop.

2.2.3 REV-WS012: Requirements for UTRAN evolution, Qualcomm Europe

It has taken several thousands of man years to define, implement, test and deploy the UTRAN platform. The 3GPP evolution workshop provides an opportunity to discuss the future of the platform and in particular the guiding principles driving its evolution. As a 3GPP member, which is significantly contributing a fair amount of resources towards the success of the UMTS platform, QUALCOMM is fully supportive of a **strong evolution path for the UTRAN platform.** This has been apparent through our commitment to work items such as HSDPA, MBMS and EUL. As this first major set of enhancements comes to a successful completion in 3GPP, it is time to initiate work on the next major set of enhancements to address the ever growing demand in data services already experienced in some regions of the world.

A large fraction of the effort associated with setting up the UTRAN platform was related to the "one size fits all" and the "toolbox" philosophies. We believe that the high level principle of addressing a broad range of services with the same platform should be maintained; however the evolution of the UTRAN platform should consider **service and scenario specific enhancements** in order to address even more closely and more quickly the user demand. In the same way, the "toolbox" approach has had and still has a number of benefits with respect to the platform evolution; however, going forward the use of the toolbox should be defined on a per service basis rather than left open to any possible combination thus becoming exponentially complex.

Although increasing the spectrum efficiency is a key motivation whenever discussing the UTRAN evolution, one should keep in mind that the **broader and most critical goal is and shall always remain improved user experience**. Early deployments of UMTS are showing that the user experience depends as much on the system delays as it depends on the spectral efficiency. In order to ensure that users will indeed benefit from any future improvements in spectral efficiency and related increases in peak transmission rates, enhancing the network architecture, protocols and procedures with delay reduction in mind is a critical requirement which should be addressed as part of the 3GPP evolution activity.

Finally, the spectrum landscape is changing in a number of regions, **progressively introducing new bands for IMT systems and a higher level of flexibility for spectrum utilization**. These changes will allow for UMTS deployments in new bands as well as open new opportunities for enhancing the UTRAN platform. In the long term, these changes may however result in a greater fragmentation of the bands in which UMTS will be deployed. The evolution work should take these changes and associated consequences into account so that UMTS can fully benefit from the evolving spectrum situation.

2.2.4 REV-WS013: Requirements guiding evolution (manufacturer view), Nokia

For the RAN long term evolution competitiveness with the challenging technologies is needed, especially considering systems to be introduced before 4G radio access solutions. In order to be competitive it will be necessary to reach downlink data rates (peak) of up to 200 Mbps and in the uplink in the order of 100 Mbps with the maximum of 20 MHz bandwidth. Besides considering larger bandwidth, also the bandwidth flexibility is important and thus the long term evolution should accommodate possibility to go down to smaller bandwidths, such as down to 1.25 MHz carrier spacing to reach frequency bands down to 450 MHz.

As such modifying only the modulation is a dead end and thus substantial work will be needed with the layer 2/3 and architecture evolution to reach round trip delays clearly smaller than 30 ms. The term round trip delay here referring the delay between the terminal and the first server in the internet, thus in case of two terminals in different parts of the network total delay round trip delay between two terminals should meet 50 ms.

The long term evolution can focus on the PS domain connectivity but should not compromise the strong points of WCDMA technology, such as

- Mobility
- Security

For the terminal power consumption as such the outcome should be further improving the WCDMA level of power consumption. Also the achievable amplifier efficiency and uplink range for a given data rate should be bear in mind when concepts are developed.

From the practical point of view it will be also utmost importance that long term evolution will not hinder progress of the existing technology track with 5 MHz carrier spacing and thus especially in the beginning it should be ensured that groups dealing with the on-going or to be initiated shorter term items can have sufficient focus on the development.

2.2.5 REV-WS014: Proposal for 3GPP RAN evolution, LG

1 Introduction

3G mobile systems are routed in widespread use of the previous 2G systems for increased data rate and global roaming. Considering the current market trends that mobile users and wireless multimedia service grow rapidly, an evolved UMTS should support much higher data rate and better spectral efficiency than the current one. Furthermore in the aspect of service and enabling technology, the evolved 3GPP RAN should be competitive compared with other B3G-like standard systems and other worldwide frameworks. A general guideline on 3GPP evolution was made in TR 21.902 in 2003, where the target requirements require peak data rate in the order of 20-30 Mbps in short to mid-term, and 100 Mbps in full mobility and 1Gbps in low mobility in long-term. In this contribution, we propose discussions of an efficient migration path towards Beyond 3G as follows.

2 Physical layer structure

A challenging technical issue on the air interface is how to provide a wireline-like multimedia quality for future users on the move. There are two possible ways to provide such service requirements. One is based on an enhancement of current CDMA-based technology that guarantees better backward compatibility with the existing system. In this approach, we discuss its feasibility about how to accommodate much wider bandwidth in a cost-effective way with very high spectral efficiency. The other way is to introduce a revolutionary technology, although some backward compatibility is sacrificed. A possible technique can be multi-carrier transmission technology such as OFDM in order to overcome ISI problem, which is a critical factor in the case of the transmission of a much higher symbol rate. In our view on this technique, many attractive features are explained to justify its validity as a candidate solution. In addition, we suggest the adoption of advanced techniques such as FEC coding, high dimension modulation, and multi-antenna technologies for achieving high spectral efficiency.

3 Protocol and Signalling

Signalling and data routing technology need to be evolved to satisfy End-to-End QoS requirements with more various parameters including bandwidth, round-trip delay, Jitter, and packet loss, etc. As possible scopes, dynamic resource allocation and scheduling, traffic and mobility control, advance MAC technology have to be optimised. In addition, inter-working with other networks is one of efficient expansion methods in the aspect of coverage and service.

4 Architecture

The RAN architecture should be also evolved to accommodate future IP-based networks, which allow a common transport even in different access networks, simple resource management, and easy heterogeneous inter-working. For this architecture, current network nodes such as RNC, Node B, and core nodes are simplified in order to achieve a high quality seamless connection with intra and inter networks where users can conveniently access with a high quality service continuity. Additional interfaces and a re-ordering of the functionalities should be considered in order to support the evolution towards higher bit rates on the air interface. We suggest some technical issues to drive IP technologies into the radio access network.

5 Conclusion

For discussion, we propose short term and long term work items from our considerations.

2.2.6 REV-WS015: The long-term 3G evolution – Requirements and Targets, Ericsson

During the last three years, extensive work has been carried out within 3GPP/RAN and the corresponding working groups to finalize enhanced packet-data support. With the *High Speed Downlink Packet Access* (*HSDPA)* and *Enhanced Uplink* features, the 3GPP radio-access technology is now at a stage where it will be highly competitive for at least the next five years.

However, the demands and expectations of the end-user, in terms of performance and capabilities of the radio-access network, are continuously expanding. Thus, it is already now necessary to initiate discussions and plan the work on the *long-term evolution* of the 3GPP radio-access technology, an evolution necessary to ensure a competitive 3GPP radio-access technology in an, at least, ten years time perspective. The fundamental focus of this radio-access evolution should be the provision of improved services at a reduced cost for both service providers and end users.

In parallel to the evolution of the radio-access technology (UTRA) there should also be a corresponding long-term evolution of the 3GPP radio-access-network (UTRAN) architecture. This is needed, among other reasons, to allow for flexible cost-efficient deployment of future 3G system as well as to ensure that the capabilities of the 3GPP radio-access technology, including its long-term evolution, can be fully exploited.

In this paper, we will present the Ericsson view on the requirements and targets of this long-term UTRA/UTRAN evolution.

2.2.7 REV-WS016: Requirements for future RAN evolutions, Alcatel

In the future, a variety of different radio access technologies providing high speed IP packet based access will compete for user acceptance. The key success factor will be the provision of packet switched services at a reasonable price. A major challenge for the radio access network is its ability to evolve from today's architecture, which was originally inspired by circuit switched services, towards a highly flexible packet switched architecture supporting different radio technologies. At the same time the complexity of the network has to be reduced in order to reduce the price for the service and to simplify network deployment and operation. Therefore, the usage of soft handover shall be strongly reduced in the network as it contributes significantly to the overall complexity.
A cornerstone for the evolution will be the introduction of IP technology all the way from the network edge down to the base station. This will lead to more powerful base stations taking over part of the radio functions carried out by the base station controller in today's architecture while coordination functions can be added in the base station controller.
In order to provide improved bandwidth new air interfaces have to be integrated in the RAN architecture. As in general, not all radio access technologies integrated in a radio access network have identical coverage, a smooth handover between the different radio access technologies is required in a heterogeneous access world. Moreover, a multistandard radio resource management providing smart load balancing is essential to optimise the resource usage of all radio access technologies and to improve the user service quality. From a terminal perspective, new air interfaces shall provide high bandwidth at low complexity in order to decrease computation requirements and power consumption for reception. Promising candidates are OFDM based access technologies.

2.2.8 REV-WS017: Requirements of the UTRAN Evolution, Samsung

3G technologies have pursued enabling high speed data services as well as enhanced quality for voice service. For enhanced packet switching (PS) based data services, 3GPP has standardized new technologies such as HSDPA, MBMS and E-DCH.

UTRAN has been developed to support general PS based services, but it is not optimized for real-time services such as IMS services, e.g., VoIP. However, current UTRAN solution for supporting IMS in RAN level is not enough to guarantee the similar level of service quality to CS calls. Call set up delay and user plane overhead are the key issues which should be addressed.

To make the 3G service successful, UTRAN should continue to evolve to support higher data rate, which will open new service areas. Higher peak data rate can be achieved by introducing new radio transmission technologies and wider bandwidth. To this end, Samsung believes OFDM is a promising solution in terms of complexity and performance, compared to DS-CDMA.

The direction of UTRAN evolution can be categorized into two phases as below.

- Short term evolution: optimization of UTRAN to support current Packet services (e.g., VoIP)
- Long term evolution: support of higher data rate , e.g., around 30 to 50 Mbps to create new services. There may also be a need for supporting even larger than 50Mbps in some limited area e.g., airport, which could be called hot spot area.

Short term evolution could be made through regular WG meetings for new Rel-7 Work Items while long term evolution could be made through separate ad hoc meetings in parallel for efficiency.

The requirements of Short term evolution are;

- IMS call should be supported with the similar level of service quality to CS call in terms of call setup delay and user plan overhead.
- The solution should be backward compatible and result in minimal change in H/W

The requirements of long term evolution are;

- Higher peak data rate should be supported
- A smooth migration from the current UTRAN system

Samsung believes that the UTRAN evolution is essential for continual success of 3G service and business.

2.2.9 REV-WS018: OFDM a promising technology for UTRAN evolution, Wavecom

The Study Item "Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement" stated in its conclusion that the performances of the 70's version of the OFDM (called OFDM textbook) are better than those of the W-CDMA-HSDPA with Rake receiver and are at least as good as the intractable complex MMSE receiver. Other contributions concerning complexity showed the relative simplicity of the OFDM structure (for both transmission and reception) comparing to the MMSE receiver.
In order to have a like-to-like comparison, the study context was restricted to W-CDMA-HSDPA context concerning signalisation and data resources. Yet this resources allocation consists in the best scheme for W-CDMA-HSDPA, it turns out to be under-scaled for the OFDM link since it can support more data rate transmission by fully uses of the system frequency bandwidth. Moreover, OFDM access technology can use many of simple up-to-date techniques in order to enhance performances (IOTA, diversity by rotated constellation, channel estimation, etc.).
For all these reasons, we believe that OFDM is a very promising technology for UTRAN enhancement.

2.2.10 REV-WS019: Views on the OFDM-HSDPA, Huawei

Because of its nature advantage, as one of radio techniques, OFDM has been and is being standardized in many wireless communication systems. On one hand, OFDM makes AMR works very well in wireless channel, which makes that OFDM has higher spectra efficiency than CDMA. A high-rate data system with higher spectra efficiency will cheer the operators. On the other hand, OFDM works very well in high delay channel. A high-rate data system that works well in complicated environment shall cheer our customer. For the sakes of the operator and customer, we propose that RAN accelerate the standardization of OFDM-HSDPA.

2.2.11 REV-WS020: UTRAN Evolution to higher chip rates, IPWireless

The huge growth in fixed-line broadband is creating a growing user expectation for the support of mobile broadband. Existing and new entrant mobile network operators are ideally positioned to satisfy this expectation. The requirement to support mobile broadband can be satisfied either by an evolution of UTRAN or by mobile network operators adopting competitive technologies. We believe that a UTRAN evolution to higher chip rates is ideally positioned to satisfy this need.

There is a clear performance benefit from the use of higher UTRAN chip rates. A higher chip rate increases the system capacity, increases the number of users that can be supported per cell, increases the peak throughput that can be provided to users and reduces latency. In order to remain competitive with other technologies, UTRAN must embrace the use of higher chip rate technology.

Unpaired spectrum exists in multiple frequency bands and multiple geographies. Depending on the spectral allocation and local regulatory issues, the ideal chip rate differs between bands and geographies. UTRAN should thus support a range of chip rates in the same manner that competitive technologies support a range of bandwidths.

Higher chip rates for UTRAN allow for more cost effective deployments due to the greater levels of integration that are possible both in terms of manufactured equipment and operational aspects.

An evolution of UTRAN to support higher chip rates must be backwards compatible with current 3GPP technologies. This backwards compatibility is elegantly provided by TD-CDMA technology where multiple chip rates can be supported either at different frequencies or in different timeslots. Adoption of higher chip rates should impact predominantly the physical layer, and therefore there are not expected to be architectural changes to higher layers.

2.2.12 REV-WS021: View on requirements for RAN evolution, NEC

The document presents NEC's view on requirements for RAN evolution in the medium and long term. HSDPA and EUDCH enhance RAN capabilities to meet emerging demands in the medium term. In order to meet ever-increasing user demands, the 3GPP RAN standard should continue to evolve considering the following requirements and keep its leading position for mobile systems.

- Broadband access capabilities beyond HSDPA and EUDCH
- Flexible and efficient spectrum use including wider and scalable channel bandwidth use
- MBMS capability enhancement
- Low latency and distributed network architecture
- Smooth migration from the current system

2.2.13 REV-WS022: Access Network Architecture (R)evolution, Vodafone

Current and future advances in 3GPP radio technology mean that the data rates supported by a base station site are increasing rapidly. However, the economic models and technologies for the 3GPP backhaul transmission are not evolving at the same rate. Additionally, increases in the peak data rate to a site are unlikely to be matched by corresponding increases in the average data rate to the site.

Given that operators' backhaul costs are already huge, this situation is undesirable.

Indeed, it can be questioned whether it is worth 3GPP evolving the Radio Interface technology unless 3GPP also performs equivalent work on the Access Network architecture.

The presentation highlights some of the areas where 3GPP may need to perform studies and specification work in order to provide an Access Network Architecture suitable for the anticipated evolutions in the Radio Interface Technology .

3 Proposals for evolution

3.1 REV-WS023: Proposal for 3GPP Evolution, Motorola

The cellular business is focused on deploying and evolving 3G UMTS. Following HSDPA deployment in 2005 and completion of HSUPA specification and potential deployment in early 2005 and late 2007 respectively, further 3GPP UMTS evolution is needed to achieve competitively higher data rates, increased spectral efficiency (lower cost per bit), better user experience, and improved coverage. This contribution provides a brief overview of the possible components and strategy of a successful next generation 3GPP network and air-interface, which we refer to as 'Evolved-UMTS' (E-UMTS) in this contribution. Section I considers supported channel bandwidths for E-UMTS specification and addresses bandwidth expansion and deployment aspects, along with backward compatibility issues with respect to the current UMTS system. In Section II, the main system features for E-UMTS including VoIP, broadcast support etc. are discussed.. Section III gives a brief overview of uplink and downlink air-interface options for E-UMTS. The network architecture and deployment scenarios for E-UMTS are highlighted in Section IV. Finally, in Section V, some suggestions for 3GPP E-UMTS work prioritization and options for working group structure are outlined, along with a conceptual time-line for the work.

3.2 REV-WS024: RAN long term evolution, Nokia

The presentation focuses on the RAN long term evolution by looking aspects other than the obvious OFDM based downlink modulation, though some remarks are made showing that with 5 MHz allocation the current WCDMA downlink with HSDPA is within 1-2 dB of the Shannon limit and thus wider bandwidth (or more antennas) would be needed for significant steps in bit rate and capacity. The main technology consideration in this presentation is for the uplink and for the Layer 2/3 and radio network architecture work.

With the uplink side the use of OFDM as in the downlink is not obvious solution to pursue due to possible problems with the peak to average properties of the OFDM signal, thus single-carrier technology (even the reuse of the forthcoming HSUPA technology along with enhancements to achieve the improvements in terminal power consumption as well as capacity and data rates) should be regarded as an alternative.

From the Layer 2/3 point of view, the current thinking with the RAB set-ups will need a serious rework in order to reach faster reactions times and call set up times. The concept of always connected needs to be improved with such protocol design that allows terminal to be connected and not needing extensive signalling between the state transitions from active to non-active state and vice-versa. This thinking would also enable attractive operating times for user devices compared to existing solutions.

The outcome from the architecture point of view should allow early PS user plane and control plane separation to accommodate possibilities for different kind of treatment of user plane and control plane signalling, thus enabling better scalability and small delay values.

3.3 REV-WS025: Proposals for 3G Long-term Evolution - Technologies for Super 3G, NTT DoCoMo

New technical features must be incorporated in order to satisfy the requirements we raised for 3G long-term evolution. In the workshop, we propose the following features to be addressed as part of 3G long-term evolution.

- Radio Transmission Technologies
- New elements for scalable and wider bandwidth, e.g. VSF-Spread OFDM for DL, VSCRF-CDMA for UL
- MIMO
- Shorter TTI ? 0.5 ms
- Simple and low overhead channel structure
- Signaling optimization

Technologies for UTRAN

- Optimum routing based on IP technologies
- Loss-less, low-latency and low complexity inter-Node B and Inter-RAT HO
- Functional distribution and C/U separation
- Plug-in RAN

3.4 REV-WS026: Physical layer considerations on 3G evolution, ETRI

The main issues in 3G evolution can be considered two categories. One is service and network issue and the other is the radio access issue. In rel. 6 of UMTS, the circuit domain core network will be replaced by IMS phase II with packet domain core network , which provides new feature services such as high speed downlink packet service and MBMS. After rel. 6, all IP concept will be adopted resulting in accelerating the unification of Node-B and RNC(radio network controller). All IP network is actually first harmonization between 3GPP and 3GPP2 which can be the essence of the next generation mobile communication. As its important services, we can think the converged service of broadcasting and communication and high speed up/downlink packet service.

For uplink high speed packet service, CDMA technology could be still good. However, it has some drawbacks in downlink high data rate because its multipath interference becomes dominant performance degradation factor. In order to overcome this disadvantage, advanced receivers can be considered, however it increases severely mobile terminal complexity. As an alternative, OFDM technology is under discussion. It can be better for the broadcasting and communication converged service as well as the high speed downlink service. Moreover, the next generation system needs more than 100 Mbps data rate in mobility case. To provide this high rate, multi-band and/or multi carrier technology is more suitable than a single ultra-wide band one in terms of accommodating multiple users served with various kinds of multimedia services. Moreover, the extra bands of 2.5GHz and 2.6GHz are to be reserved for the higher data rate services.

So, this document describes as follows:

1. 3G evolution direction in terms of network, service, and radio access technology.
2. OFDM general
3. OFDM advantage for downlink high speed communication
4. OFDM advantage for broadcasting and communication converged service
5. Multi-band/multi carrier system for 2.5G-2.6GHz usage

3.5 REV-WS027: The long-term 3G evolution – Technology considerations, Ericsson

During the last three years, extensive work has been carried out within 3GPP/RAN and the corresponding working groups to finalize enhanced packet-data support. With the High Speed Downlink Packet Access (HSDPA) and Enhanced Uplink features, the 3GPP radio-access technology is now at a stage where it will be highly competitive for at least the next five years.

However, the demands and expectations of the end-user, in terms of performance and capabilities of the radio-access network, are continuously expanding. Thus, it is already now necessary to initiate discussions and plan the work on the long-term evolution of the 3GPP radio-access technology, an evolution necessary to ensure a competitive 3GPP radio-access technology in an, at least, ten years time perspective. As mentioned in a companion paper, the fundamental focus of this radio-access evolution should be the provision of improved services at a reduced cost for both service providers and end users. Furthermore, the evolution should not only cover the radio-access technology itself but also the 3GPP radio-access network (UTRAN) architecture.

In this paper, we will discuss what we think are technologies that should be considered as components of this long-term UTRA/UTRAN evolution. We will also describe how we believe these technologies should be combined into a “unified” package, rather than being introduced as separate more or less independent technology updates to the specifications.

3.6 REV-WS028: UTRA evolution based on OFDM over a wide bandwidth, Samsung

In the presentation, we propose to adopt OFDM with a wide transmission bandwidth of 10~20 MHz in downlink as an alternative to WCDMA for the UTRA evolution. We address key component technologies required for the OFDM based enhancement and show our preliminary study results. Increasing user demands for high data rate services in mobile environments call for an increase in the current 5 MHz bandwidth. However, DS-CDMA will show limitations in implementation and performance for very wide-band applications. Lately, OFDM is emerging as a key radio transmission technology over the wide bandwidth in various applications. We believe that the evolution would better be made in the way to enable a smooth migration from the current UTRAN system. In those aspects, adopting OFDM over the wide bandwidth in downlink as a first phase would be a good way-forward for the evolution.

3.7 REV-WS029: OFDM air interface for 3G broadband evolution, Alcatel

OFDM for HSDPA downlink traffic has been a Study Item in RAN WG 1. In RAN WG 1 #37 the final version 1.2.0. of the SI report has been approved. The study was explicitly restricted to so called "textbook" OFDM, which means a basic OFDM system without any advanced features like, e.g., pulse shaping for higher spectral efficiency, frequency scheduling, and interference avoidance measures at the cell borders. The SI report basically states that OFDM is feasible as an additional air interface for HSDPA traffic.

Several contributions show that an OFDM air interface offers a higher spectral efficiency and an enhanced throughput. Further contributions point out that an OFDM air interface can provide a substantially wider cell coverage for high rate HSDPA services than WCDMA.

Nearly all current approaches worldwide towards new broadband air interfaces for Beyond 3G / 4G system use OFDM or some derivative of it (like MC-CDMA). The main reason is the ability of OFDM to cope with strong intersymbol interference (ISI) as generally experienced in broadband transmission and the moderate implementation complexity, especially at the receiver. Examples are WWI WINNER and proposals discussed in the WWRF. The IEEE 802.16 (WiMAX) standard also includes an OFDM air interface, as does DVB-h (Digital Video Broadcasting for Handhelds).

In our contribution we want to highlight the potential of OFDM for the evolution of 3G. OFDM offers advantages compared to WCDMA with respect to spectral efficiency, cell throughput performance, and complexity, especially when the air interface is to be scaled to higher bandwidths. Furthermore, OFDM with non-rectangular pulse forms like the IOTA approach discussed in the SI achieves even higher gains, albeit with a complexity increase.

The additional degree of freedom gained by the division of the frequency band into many narrowband subcarriers allows for scheduling in time and frequency with high flexibility and fine granularity. In addition, it offers the possibility to avoid or at least control Intercell Interference (ICI) in a system layout with a frequency reuse of 1.

One of the problems encountered with OFDM is the large Peak-to Average Power Ratio (PAPR) of the transmitted signal, causing nonlinear distortions when passing through the Power Amplifier (PA). We demonstrate a concept for PA linearisation and point out that the amount of distortions of an OFDM signal after clipping and PA linearisation is comparable to that of a multicarrier WCDMA signal with reasonable efficiency.

The integration of a broadband OFDM air interface for downlink packet traffic is a way to open the road from 3G towards a "Beyond 3G" system with high flexibility and as much backward compatibility as possible.

3.8 REV-WS030: Proposal on the standardization of OFDM-HSDPA, Huawei

On one hand, OFDM has been and is being standardized in many wireless communication systems because of its nature advantage. On the other hand, OFDM-HSDPA is beneficial for both operators and customers. Huawei thinks it should have a clear and pressing schedule in 3GPP RAN, so that the OFDM-HSDPA can be standardized by the mid or end of 2006.

3.9 REV-WS031: Proposal for an Evolved UTRAN: Data Overlay, Siemens

In order to fulfil the requirements for an Evolved UTRAN, Siemens is proposing to define a complementary Data Overlay structure. Whilst this overlay is fully integrated in the existing UTRAN network, the corresponding cells shall be characterised by the following specifics:

- Usage of OFDM based air-interface (at least in DL), adaptable to a multiplicity of carrier bandwidths for deployment in today's and upcoming IMT-2000 frequency bands
- Optimisation of radio protocols for TCP/IP traffic: Reliable high-rate data throughput with low latencies
- Optimisation of function split in the network for TCP/IP traffic by support of direct Cell-to-CN interface

To allow for economic implementation of supporting UEs, the need for a number of features (e.g. macro-diversity, highly flexible transport formats or RRC protocol options) needs to be reviewed in the light of a high-quality data overlay with typically focussed mobility. Moreover, the feasibility of a specialised Data Overlay UE and the aspect of integrated control of the Data Overlay cells should be addressed.

3.10 REV-WS032: Advanced iterative receivers for single carrier MIMO HSDPA, France Telecom & Orange

Recently a Work Item was launched to compare the respective benefit of dual receive diversity and advanced receiver for HSDPA. However, only non-iterative receivers such as LMMSE chip equalizer are considered until now. We believe that the combination of MIMO and advanced iterative receivers offers a huge potential to increase the spectral efficiency of the WCDMA radio-interface. This is the case independently of the access technique, i.e., multi-carrier[1] or single-carrier. However, the requirement of backward compatibility in the existing allocated UMTS bands motivates the improvement of single-carrier HSDPA type of transmission.

From an information theory point of view, MIMO spatial multiplexing gain has to be exploited by the MIMO transmission schemes to increase significantly the spectral efficiency. This can be achieved by BLAST like techniques at the transmitter (code-reuse).

In this paper, we will provide some link level simulations to demonstrate the potential of the combination of MIMO and advanced iterative receivers to design spatial modulation and coding schemes that are both spectrally and power efficient while keeping single-carrier HSDPA type of transmission.

[1] Another complementary contribution of France Telecom & Orange investigates MIMO OFDM in UTRAN

3.11 REV-WS033: MIMO OFDM for WCDMA evolution, France Telecom & Orange

A Study Item on the feasibility of the introduction of OFDM in UTRAN was closed in June 2004 by the RAN. The aim of this study was to evaluate the performance of a new radio interface (using OFDM modulation) to provide high bit rate in downlink. The scope was very restrictive: only "textbook" OFDM considered for performance evaluation. This Study Item wasn't conclusive. It was proposed by several companies at last RAN plenary meeting that OFDM should be further studied at 3GPP.

As already suggested during the OFDM SI, they are different ways to improve textbook OFDM performances. One of them is the introduction of advanced OFDM waveforms as IOTA (see section 4.2 of 3GPP TR 25.892 for details). Another possible enhancement is to combine OFDM with MIMO techniques. Note that MIMO techniques and the IOTA waveform do not exclude each other for the enhancement of OFDM.

As MIMO technique, STBC improves link level performances by increasing diversity order. However STBC exploits Tx diversity only (e.g. employed in Alamouti 2x1) and becomes conflictual with Max C/I scheduling algorithm. System level performances are not so improved because for slow varying channels (i.e. when the channel coherence time is larger than the 2 ms packet duration of HSDPA) the Max C/I scheduling algorithm does not benefit of the opportunity: the modulus of the channel response of the best user is not improved (if the number of user is large enough, i.e. > 10) whereas each user has long term SNR improved. Thus it should be preferable to use BLAST techniques or any STBC scheme also exploiting Rx diversity. Anyway, more advanced MIMO schemes should be evaluated in this context to improve link-level and more specifically system-level performances.

In this paper we will provide link level simulation results both for textbook OFDM and enhanced OFDM techniques such as OFDM/IOTA or OFDM combined with simple MIMO schemes. Multi-cellular issues in OFDM downlink will be discussed in this paper with first results at link level. We will also provide basic system level simulation results.

Anyway we believe that further studies are still needed on OFDM to take multi-cellular effects into account.

3.12 REV-WS034: MATRICE, Multicarrier CDMA TRansmission Techniques for Integrated Broadband CEllular Systems, CEA-LETI

This presentation gives an overview of the work performed within the MATRICE project, an IST (Information Society Technologies) project of the European Union 5th Framework Program.

MATRICE goal is to design the broadband air interface of a cellular system providing high bit rate services with high mobility capabilities. To comply with a complement-type scenario as defined by the ITU, compatibility with the UMTS air interface has been ensured. A spectrum requirement of 50MHz has been assessed, making the 5GHz band a good candidate. More precisely, target peak data cell throughputs are as follows:

- up to 100 Mbps in indoor environments, with users moving at 3 km/h
- up to 20 Mbps in urban environments with users moving at 60 km/h
- up to 10 Mbps at 300 km/h in rural environments, with users embedded in trains at 300km/h.

However, the physical layer can be easily adapted to a larger or lower bandwidth provided that it remains a multiple of 5MHz, the peak throughput being changed accordingly.

MATRICE interface is based on MC-CDMA, a modulation combining the simplicity of OFDM and the robustness of CDMA versus inter cell interference. The project has investigated advanced layer 1 techniques, such as: multi-user detection, pre-equalization, 2D chip mapping, beamforming and MIMO, also synchronization and sensitivity to RF impairments. Algorithm complexity has been evaluated. In addition, a system level simulation platform has been developed, based on 3GPP methodology for HSDPA. The objective is to study the effect of real IP traffic on system capacity. The project also investigates Dynamic Resource Allocation (DRA) schemes exploiting the MC-CDMA resource allocation flexibility (code/time/frequency), and based on the joint design of Hybrid ARQ (Chase Combining/ Incremental Redundancy), Adaptive Modulation and Coding, and advanced scheduling algorithms taking into account users QoS requirements (delay).
Finally a layer 1 hardware demonstrator has been built as a proof of concept.

MATRICE website : www.ist-matrice.org, coordination Sylvie MAYRARGUE CEA-LETI, France

3.13 REV-WS035: UTRAN Evolution to higher chip rates, IPWireless

The huge growth in fixed-line broadband is creating a growing user expectation for the support of mobile broadband. Existing and new entrant mobile network operators are ideally positioned to satisfy this expectation. The requirement to support mobile broadband can be satisfied either by an evolution of UTRAN or by mobile network operators adopting competitive technologies. We believe that a UTRAN evolution to higher chip rates is ideally positioned to satisfy this need.

There is a clear performance benefit from the use of higher UTRAN chip rates. A higher chip rate increases the system capacity, increases the number of users that can be supported per cell, increases the peak throughput that can be provided to users and reduces latency. In order to remain competitive with other technologies, UTRAN must embrace the use of higher chip rate technology.

Unpaired spectrum exists in multiple frequency bands and multiple geographies. Depending on the spectral allocation and local regulatory issues, the ideal chip rate differs between bands and geographies. UTRAN should thus support a range of chip rates in the same manner that competitive technologies support a range of bandwidths.

Higher chip rates for UTRAN allow for more cost effective deployments due to the greater levels of integration that are possible both in terms of manufactured equipment and operational aspects.

An evolution of UTRAN to support higher chip rates must be backwards compatible with current 3GPP technologies. This backwards compatibility is elegantly provided by TD-CDMA technology where multiple chip rates can be supported either at different frequencies or in different timeslots. Adoption of higher chip rates should impact predominantly the physical layer, and therefore there are not expected to be architectural changes to higher layers.

3.14 REV-WS036: Enhanced UTRAN support for MBMS, Qualcomm Europe

Support for point to multipoint (PtM) data delivery has been introduced in Release-6 as part of the MBMS work item. Although the functionality introduced in Release-6 results in greater PtM spectral efficiency (up to 512-768 kbps in 5 MHz) than what is currently possible with Release-5 functionality (in the order of 128 kbps in 5 MHz), further enhancements should be considered in order to support a broader range of content delivery services on the UMTS platform.

The existing downlink multiplex structure has been optimised for single cell point to point data delivery and assumes the existence of a return link. These assumptions differ very much from the ones associated with multi-cell point to multipoint content delivery. As such, we believe that there is significant room for further increasing the efficiency of the radio support for MBMS.

PtM data delivery is primarily a DL transport mechanism. Noting that the typical traffic symmetry is at best balanced (conversational) but most likely dominated by the DL (actual users typically absorb more data than they can ever produce), it is apparent that using a duplex band for PtM delivery may typically result in under utilization of UL spectrum resource. Unpaired spectrum for DL transmission thus represents an attractive alternative.

We will describe a proposal to significantly enhance 3GPP support for multi-cell point to multipoint content delivery which consists in the definition of a new DL multiplexing structure compatible with deployments in the unpaired spectrum identified for IMT-2000 services. More generally we propose that 3GPP-RAN identifies enhanced support for multi-cell point to multipoint content delivery as a focus area in the evolution of UTRAN.

3.15 REV-WS037: Flexible DL for UTRAN evolution, Qualcomm Europe

It is generally accepted that future mobile services will result in a large range of traffic characteristics and requirements for the uplink as well as the downlink.

These services will benefit from increased downlink peak data rates that the combination of several UTRA FDD downlink carriers can offer. Increased rates will reduce delay for many applications plus enhance QoS. Such an increase will also be beneficial for traditionally symmetric services, such as video-telephony. At the same time, it may be beneficial to support certain specialized services with a more optimised downlink structure. For example, a special component for broadcast/multicast can provide these services more efficiently. This is introduced in a separate paper.

Additionally, the bandwidth of existing and contemplated allocations as well as new regulatory policies (spectrum trading, spectrum liberalization) will make flexible and scalable downlink configurations an appealing evolution path for UTRAN.

We examine the aspects that will be affected by the flexible downlink configuration. These include signalling, system acquisition, selection and inter-system/inter-frequency handover and measurement aspects.

As a conclusion, we suggest to introduce a more flexible downlink configuration in the UTRAN platform. Specifically, we propose to consider a multicarrier CDMA downlink structure, which, due to its scalability and compatibility, appears particularly attractive.

3.16 REV-WS038: TD-CDMA: One Air-Interface Two Duplexing Methods, IPWireless & UTStarcom

When supporting broadband services in the mobile domain the access technology has to be capable of meeting a similar set of requirements as those defined for fixed line technologies. The user expectation has been set by fixed line technologies and this must be maintained when the user is mobile. The basic requirements for mobile broadband are low latency, high throughputs, including average and cell edge, and inherent support for a large set of active users. All three requirements are tightly coupled and depend on many factors.

UTRA TDD (TD-CDMA) meets all these requirements. High throughputs are achieved through the use of multiuser detection (MUD) on both uplink and downlink, low latency and a large active user base is simultaneously achieved as there are no fundamental requirements for support of dedicated channels.

In 3GPP there are two duplexing modes supported, Frequency Division Duplex (FDD) and Time Division Duplex (TDD). The air-interface selected for FDD mode is Wideband Code Division Multiple Access (W-CDMA) and the air-interface selected for TDD mode is Time Division Code Division Multiple Access (TD-CDMA).

The main advantages of using TDD mode as a duplexing method are:

1) Exploitation of channel reciprocity.
2) Single carrier operation enables deployment in heavily fragmented spectrum.
3) Variable switching point.

Whilst these are desirable features, it's mainly the TD-CDMA air-interface that achieves the requirements for mobile broadband and not the TDD duplexing method. The fundamental building blocks of TD-CDMA are essentially independent of the duplexing mode: TD-CDMA is equally applicable to FDD mode. Fundamental restrictions in WCDMA in terms of MUD and support of dedicated channels means that significant changes to the technology are required to meet the requirements for mobile broadband. From a timescale perspective this is not feasible given the emergence of other mobile wireless technologies such as WiMAX.

An evolution of UTRAN to support TD-CDMA in both duplexing modes means that mobile broadband is possible in paired spectrum, using technology that has already been proven in the field. We will show that the requirements for UTRA FDD (TD-CDMA) are relatively straightforward requiring minimal changes to the specifications and more importantly to legacy infrastructure. We believe that UTRA FDD (TD-CDMA) provides a path to rapid commercialisation of mobile broadband in paired spectrum.

3.17 REV-WS039: Efficient Support of Packet Switched Services by UTRAN, IPWireless

The increase in the number of mobile broadband users will follow the uptake of fixed-line broadband. The services required by these mobile broadband users will be similar to the services that they require on fixed-lines. Mobile radio offers a great number of advantages over fixed-line channels. A mobile radio network is a significant capital investment, due in part to licensing issues, and must therefore be used to maximum capacity.

The internet uses packet switched rather than circuit switched technologies. A consequence of this packet switching is that it allows a large number of users to be statistically multiplexed onto internet resources. In many cases, UTRAN does not make use of these statistical multiplexing gains even though it controls a much scarcer resource.

In order to more efficiently support background and interactive services, UTRAN has previously evolved to support HSDPA and HSUPA features. These features go some way towards the goal of an all packet switched UTRAN, however the 3GPP standards maintain the requirement to support dedicated channels when HSDPA / HSUPA are used.

There exist persuasive arguments for the requirement to support dedicated channels in FDD (WCDMA) mode due to the fundamental nature of FDD (WCDMA) operation. There are no fundamental requirements for the support of dedicated channels with TD-CDMA technology.

To remain competitive with other technologies, UTRAN must evolve to an all packet switched air-interface. This evolution requires a fundamental rethink regarding whether dedicated channels are specified as mandatory for all services. At a high level, 3GPP should set a requirement that packet service techniques should not need to be reliant (from a standards perspective) on the existence of dedicated channels. This requirement will allow mobile network operators to compete both in traditional circuit switched markets, such as voice, and emergent markets, such as mobile broadband.

3.18 REV-WS040: Proposal for RAN evolution, NEC

The document presents NEC's proposal for the RAN evolution requirements discussed in the agenda item 2.2. The followings are main candidate technology features.

For UTRA Radio Interface evolution

- OFDM based transmission technology for bandwidth beyond 5MHz
- MIMO
- Shorter TTI Packet

For UTRAN evolution

- IP-based distributed UTRAN architecture with C/U separation

3.19 REV-WS041: Introducing OFDM in UTRAN, Nortel Networks

RAN1 concluded the Study Item “Analysis of OFDM for UTRAN enhancement” in a positive way, last March. The main conclusion resulting from the Study was that OFDM can be introduced in UTRAN to support HSDPA traffic at reasonable complexity.

The framework of the Study conducted by RAN1 was however quite restrictive, it assumed 5MHz spectrum allocation and a “text book” version of the OFDM modulation in the downlink only for data applications. The OFDM DL carrier was paired with UL and DL WCDMA carriers.

A number of questions arise when considering a further step in the introduction of OFDM in UTRAN:

- Can OFDM be introduced as a standalone cell?
- Can OFDM be used in the uplink as well?
- Which type of services should be supported: data-only or speech as well?
- Which spectrum is most suitable?
- Which type of OFDM is best suited to a mobile environment? Several variants have been shown in publications and other standards which could be considered for UTRAN as well e.g. MIMO-OFDM, CDMA-OFDM
- Which type of mobility should be supported?

This paper proposes a framework for RAN Future evolution discussions based on OFDM introduction in UTRAN, and provides some tentative replies to this long list of questions. This framework preferably builds on the existing UTRAN architecture rather than requiring a complete new deployment and also takes advantage of the flexibility of OFDM in terms of deployment in diverse frequency allocations. It complements the alternatives defined by e.g. WLAN integration in GERAN or UTRAN and e.g. UMTS interworking. It also provides some opinion on how this work should be conducted in 3GPP so as to leverage the expertise already built, and how this work could be seen as a natural continuation of current RAN activities.