IEEE P 802.20™/PD<insert PD Number>/V<insert version number>

Date: <June 24.2003>

Draft 802.20 Permanent Document

<802.20 Requirements Document - Rev. 2>

This document is a Draft Permanent Document of IEEE Working Group 802.20. Permanent Documents (PD) are used in facilitating the work of the WG and contain information that provides guidance for the development of 802.20 standards. This document is work in progress and is subject to change.

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1 Overview

1.1 Scope

For the purpose of this document, an "802.20 system" constitutes an 802.20 MAC and PHY implementation in which at least one subscriber station communicates with a base station via a radio air interface, and the interfaces to external networks, for the purpose of transporting IP services through the MAC and PHY protocol layers. This document defines system requirement for the IEEE 802.20 standard development project. These requirements are consistent with the PAR document (see section 1.3 below) and shall constitute the top-level binding specification for the 802.20 standard. The requirements also include interoperability with other wireless access systems with intra and inter-systems hand-off support.

1.2 Purpose

This document will establish the detailed requirements for the Mobile Broadband Wireless Access (MBWA) systems for which the 802.20 PHY and MAC layers shall form the lower protocol layers.

1.3 PAR Summary

The scope of the PAR (listed in Item 12) is as follows:

> *"Specification of physical and medium access control layers of an air interface for interoperable mobile broadband wireless access systems, operating in licensed bands below 3.5 GHz, optimized for IP-data transport, with peak data rates per user in excess of 1 Mbps. It supports various vehicular mobility classes up to 250 Km/h in a MAN environment and targets spectral efficiencies, sustained user data rates and numbers of active users that are all significantly higher than achieved by existing mobile systems."*

In addition, a table (provided in Item 18) lists "additional information on air interface characteristics and performance targets that are expected to be achieved."

Characteristic	***Target Value***
Mobility	*Vehicular mobility classes up to 250 km/hr (as defined in ITU-R M.1034-1)*

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Sustained spectral efficiency	*> 1 b/s/Hz/cell*
Peak user data rate (Downlink (DL))	*> 1 Mbps**
Peak user data rate (Uplink (UL))	*> 300 kbps**
Peak aggregate data rate per cell (DL)	*> 4 Mbps**
Peak aggregate data rate per cell (UL)	*> 800 kbps**
Airlink MAC frame RTT	*< 10 ms*
Bandwidth	*e.g., 1.25 MHz, 5 MHz*
Cell Sizes	*Appropriate for ubiquitous metropolitan area networks and capable of reusing existing infrastructure.*
Spectrum (Maximum operating frequency) *Spectrum (Frequency Arrangements)*	*< 3.5 GHz* *Supports FDD (Frequency Division Duplexing) and TDD (Time Division Duplexing) frequency arrangements*
Spectrum Allocations	*Licensed spectrum allocated to the Mobile Service*
Security Support	*AES (Advanced Encryption Standard)*

** Targets for 1.25 MHz channel bandwidth. This represents 2 x 1.25 MHz (paired) channels for FDD and a 2.5 MHz (unpaired) channel for TDD. For other bandwidths, the data rates may change.*

2 Services and Applications

The 802.20 Air-Interface (AI) should be optimized for high-speed IP-based data services operating on a distinct data-optimized RF channel. The AI should provide for compliant Mobile Terminal (MT) devices for mobile users, and should enable significantly improved performance relative to other systems targeted for wide-area mobile operation. The AI should be designed to provide improved performance attributes such as peak and sustained data rates and corresponding spectral efficiencies, system user capacity, air- interface and end-to-end latency,

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overall network complexity and quality-of-service management. Applications that require the user device to assume the role of a server, in a server-client model, shall be supported as well.

- **Applications:** The AI all should support interoperability between an IP Core Network and IP enabled mobile terminals and applications shall conform to open standards and protocols.

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- **Always on**: The AI should provide the user with "always-on" connectivity. The connectivity from the wireless MT device to the Base Station (BS) should be automatic and transparent to the user.

2.1 Data Communications Applications

2.1.1 World Wide Web Browsing

2.1.2 Electronic Mail Transmission and Retrieval

2.1.3 Instant Messaging

2.1.4 FTP

2.1.5 Video and Audio Streaming

2.1.6 IP Multicast

2.1.7 Multiplayer gaming

2.1.8 Multi-media messaging services (MMS)

2.1.9 Broadcast Multi-cast services

2.1.10 Location based services

2.1.11 Secure transactions

2.1.12 Virtual Private Networking

2.1.13 Telematics

Telematics is an emerging area that is expected to become a popular application for macro-cellular systems in the next few years. Delivering services to vehicles such as positioning, location based services; electronic toll tags and others are currently proving to be one of the more challenging areas. This section is meant to capture anticipated services and to act as a repository for requirements that may affect the 802.20 specifications.

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2.2 Telecommunications Applications

2.2.1 Voice Services

Voice Services are currently among the most profitable services available to the cellular and PCS service providers. These services are highly optimized to provide high quality at very minimal cost to provide. It is expected that MBWA will need to make some accommodation to provide voice services as an integral part of any service offering.

The MBWA system should accommodate VOIP services by providing the capability to transport a variety of industry standards formats to include but not limited to MCGP(per RFC 2705), SIP (per RFC 2543), SIP+. The codec's to be supported by the PHY/MAC need to include (list), G.726-32, G.729, G.723 with respect to jitter and latency. Budgets for jitter and latency need to be established. The MAC should provide call blocking for supported formats.

2.2.2 Push to talk

2.2.3 Enhanced voice services

Call forwarding, call transfer, caller ID, call blocking, call etc.

2.2.4 E911

2.3 Multimedia Applications

2.3.1.1 Location Services

2.3.1.2 Priority Access

2.3.2 Messaging Services

These services are Data-Like services, but currently are not implemented as true "data services." Examples of these services are the current SMS offerings of GSM and CDMA2000 networks, as well as the "instant messaging" type services provided by independent service providers.

2.3.2.1 SMS Messaging

2.3.2.1.1 Definition and Characteristics

"Classic" SMS messaging was first described for 2G systems such as GSM and IS-95 and currently are implemented directly over the cellular infrastructure, without need of data communication networking infrastructure. Several different variations of these services exist, to be described as part of this section.

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2.3.3 3G Service Application Extensions for MBWA

3 System Reference Architecture

3.1 System Architecture

The 802.20 systems will be designed to provide ubiquitous mobile broadband wireless access in a cellular architecture. The system architecture will be a point to multipoint system that works from a base station to multiple devices in a non-line of sight outdoor to indoor scenario. The system will be designed to enable a macro-cellular architecture with allowance for indoor penetration in a dense urban, urban, suburban and rural environment.

The AI shall support a layered architecture and separation of functionality between user, data and control planes. The AI must efficiently convey bi-directional packetized, bursty IP traffic with packet lengths and packet train temporal behavior consistent with that of wired IP networks. The 802.20 AI shall be optimized for high-speed mobility. The system architecture shall be consistent with the IEE 802.xxx family of standards model and share the upper layers with peer wireless standards (802.11, 802.15, 802.16 etc.). These systems also support interoperability with other wireless access systems with intra and inter-system hand-off support.

3.1.1 System Context Diagram

This section presents a high-level context diagram of the MBWA technology, and how such technology will "fit into" the overall infrastructure of the network. It should include data paths, wired network connectivity, AAA functionality as necessary, and inter-system interfaces. Major System Interfaces should be included in this diagram.

3.1.2 MBWA-Specific Reference Model

To aid the discussion in this document and in the 802.20 specifications, a straw man Reference Partitioning of the 802.20 functionality is shown in Figure 1. This reference partitioning model is similar to those used in other 802 groups.

The 802.20 reference model consists of two major functional layers, the Data Link Layer (DLL) and the Physical Layer (PHY).

The Data Link Layer is functionally responsible for a mobile station's method of gaining access to the over-the-air resource. The Data Link Layer consists of the MAC Sub layer, and the MAC Management Sub layer. The MAC Sub layer is responsible for the proper formatting of data, as well as requesting access to the over-the-air resource. The MAC Management Sub layer is responsible for provisioning of MAC Layer Parameters and the extraction of MAC monitoring information, which can be of use in network management.

The Physical Layer consists of the Physical Layer Convergence Protocol, the Physical Medium Dependent, and the Physical Layer Management Sub layers. The Physical Layer Convergence Protocol Sub layer is responsible for the formatting of data received from the MAC Sub layer

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into data objects suitable for over the air transmission, and for the deformatting of data received by the station. The Physical Medium Dependent Sub layer is responsible for the transmission and reception of data to/from the over-the-air resource. The Physical Layer Management sub layer is responsible for provisioning of the Physical Layer parameters, and for the extraction of PHY monitoring information that can be of use in network management.

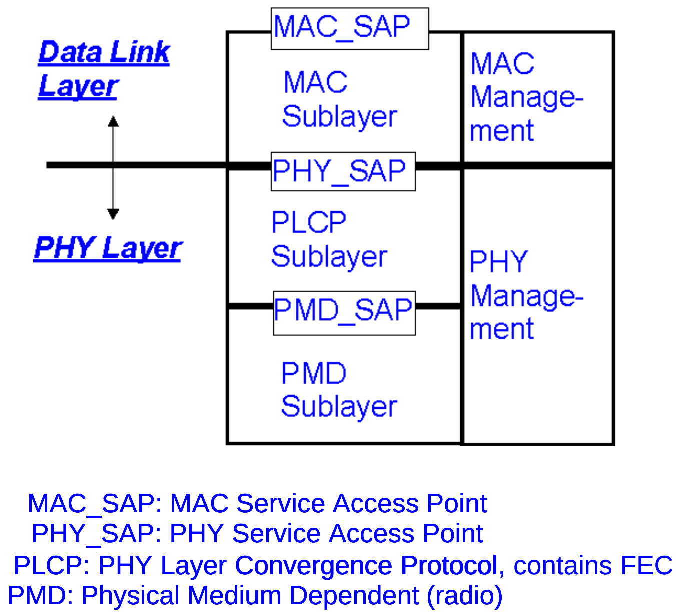

Figure 1 – Reference partitioning

3.2 Definition of Interfaces

Open interfaces: The AI shall support open interfaces between any network entities in the AI that may be implemented by service providers and manufacturers as separate systems, sub-systems, or network entities. IETF protocols shall be considered and adopted in these open interfaces, if appropriate.

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4 System Requirements

4.1 System Aggregate Data Rates – Downlink & Uplink

Consistent with the 802.20 PAR, tables 1 and 2 define the required air interface data rates and capacity characteristics.

Table 1 – Information Data Rates and Capacity Requirements for 1.25 MHz channel.

Description	Downlink	Uplink
Outdoor Peak Data Rate[1]	3 Mbps	3 Mbps
Outdoor Average Data Rate[2]	1 Mbps/Sector	1 Mbps/Sector
Indoor Peak Data Rate[3]	3 Mbps/Sector	3 Mbps/Sector
Voice Capacity	Equivalent of 52 Erlangs/Sector	Equivalent of 52 Erlangs/Sector

Table 2 – Information Data Rates and Capacity Requirements for 5 MHz channel.

Description	Downlink	Uplink
Outdoor Peak Data Rate[1]	9 Mbps	9 Mbps
Outdoor Average Data Rate[2]	3 Mbps/Sector	3 Mbps/Sector
Indoor Peak Data Rate[3] Voice Capacity	9 Mbps/Sector Equivalent of 175 Erlangs/Sector	9 Mbps/Sector Equivalent of 175 Erlangs/Sector

Foot notes to tables 1 and 2:

In an aggregate **1**.25 MHz channel bandwidth, the AI shall support peak aggregate data rate (user payload) per cell in excess of 4 Mbps in the downlink and in excess of 800 Kbps in the uplink. In wider channels, the data rates shall be proportionate. "Outdoor Peak Data Rate" is defined as the maximum instantaneous information data rate available to any given user in a mobile application. **2**. "Outdoor Average Data Rate" is defined as the system-wide average information data rate available per sector in a fully loaded system with all users moving at average vehicular speed. **3**. "Indoor Peak Data Rate" is defined as the maximum instantaneous data rate available to any given indoor user moving at pedestrian speed.

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User Data Rates - – Downlink & Uplink

The AI shall support peak per-user data rates in excess of 1 Mbps on the downlink and in excess of 300 kbps on the uplink. These peak data rate targets are independent of channel conditions, traffic loading, and system architecture. The peak per user data rate targets are less than the peak aggregate per cell data rate to allow for design and operational choices.

4.2 Spectral Efficiency (bps/Hz/sector)

Sustained spectral efficiency shall be in excess of 1 b/s/Hz/cell in a loaded network. Sustained spectral efficiency is computed in a network setting. It is defined as the ratio of the expected aggregate throughput (bits/sec) to all users in an interior cell divided by the system bandwidth. The sustained spectral efficiency calculation shall assume that users are distributed uniformly throughout the network and shall include a specification of the minimum expected data rate/user. Additionally, the AI shall support universal frequency reuse but also allow for system deployment with frequency reuse factors of less than 1 (e.g., using spatial diversity to reuse spectrum within a cell).

The 802.20 PAR indicates that the MBWA technology shall have a much greater spectral efficiency than “existing systems”. This section defines the fundamentals of Spectral Efficiency in terms of “achievable” and “maximum” spectral efficiency and the necessary requirements for the concept of “much greater.”

Spectral Efficiency: Good put

Downlink > 2 bps/Hz/sector

Uplink >1 bps/Hz/sector

4.3 QOS

The AI shall support the means to enable end-to-end QoS within the scope of the AI and shall support a Policy-based QoS architecture. The resolution of QoS in the AI shall be consistent with the end-to-end QoS at the Core Network level. The AI shall support IPv4 and IPv6 enabled QoS resolutions, for example using SBM. The AI shall support efficient radio resource management (allocation, maintenance, and release) to satisfy user QoS and policy requirements.

4.4 Number of Simultaneous Sessions

\> 100 sessions per carrier (definition of simultaneous to be provided)

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4.5 Packet Error Rate

The physical layer shall be capable of adapting the modulation and coding so as to achieve a packet error rate of 10^{-3} or better (based on a 1500-byte packet) for all mobile stations. Use of ARQ shall reduce the packet error rate to 10^{-5} or better.

4.6 Link Budget

The system link budget shall be appropriate for ubiquitous metropolitan area networks and capable of reusing existing infrastructure with cell sizes typical of macro-cellular wireless networks. Smaller cells shall also be supported to accommodate operational, deployment and capacity considerations. System Link Budget in excess of 160 dB for all devices and terminals at the data rates specified in the earlier section.

4.7 Receiver sensitivity

Blocking and selectivity specifications shall be consistent with best commercial practice for mobile wide-area terminals. Air-link reliability

The AI shall support automatic selection of optimized user data rates that are consistent with the RF environment constraints and application requirements. The AI shall provide for graceful reduction or increasing user data rates, on the downlink and uplink, as a mechanism to maintain an appropriate frame error rate performance.

Radio system should have sufficient diversity to provide at least 99.9 AI reliability

4.8 Max tolerable delay spread Performance under mobility

The system is expected to work in dense urban, suburban and rural outdoor-indoor environments and the relevant channel models should be applicable. The system shall NOT be designed for indoor only and outdoor only scenarios.

4.9 Mobility

Support different modes of mobility from pedestrian (3 km/hr) to very high speed (250 km/hr) but not optimized for only one mode. As an example, data rate gracefully degrades from pedestrian to high-speed mobility.

4.10 Mobility and Hand-off

Interoperability (including handoff) with other existing mobile wireless systems. Seamless handoff of voice over IP and other packet data services between 802.20 and existing mobile wireless systems.

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4.11 OTA (Over the air) support including programming and provisioning of end user devices

4.12 Billing to support accounting records

4.13 Always-on" user experience

4.14 Regulatory Support

The standard shall be consistent with regional regulatory requirements such as those described in Part 15, Part 22, and Part 24 of the FCC Rules

4.15 Security

Network security in MBWA systems is assumed to have goals similar to those in cellular or PCS systems. These goals are to protect the service provider from theft of service, and to protect the user's privacy and mitigate against denial of service attacks. Security for these systems is generally broken into Access control, privacy methods, billing and authorization. Provision shall be made for authentication of both base station and mobile terminal, for privacy, and for data integrity consistent with the best current commercial practice.

4.15.1 Access Control

A cryptographically generated challenge-response authentication mechanism for the user to authenticate the network and for the network to authenticate the user must be used.

4.15.2 Privacy Methods

A method that will provide message integrity across the air interface to protect user data traffic, as well as signaling messages from unauthorized modification will be specified.

Encryption across the air interface to protect user data traffic, as well as signaling messages, from unauthorized disclosure will be incorporated.

4.15.3 Billing Considerations

The system will prevent the unauthorized disclosure of the user identity.

4.15.4 Denial of Service Attacks

It shall be possible to prevent replay attacks by minimizing the likelihood that authentication signatures are reused.

It shall be possible to provide protection against Denial of Service (DOS) attacks.

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4.15.5 Key Management

The shared secret (root authentication key) is known only to the terminal and to the authenticating server.

Secondary authentication keys may be shared with visited systems for use in authentication.

The key agreement and key distribution mechanism shall be secure against man in the middle (MitM) attacks.

Privacy keys shall be cryptographically decoupled from the keys used for authentication and message integrity.

Privacy keys may have limited cryptographic strength to comply with regional requirements.

It shall be possible to store all long-term security credentials used for user and network authentication in a tamper resistant memory.

4.15.6 Security Algorithm

The authentication and encryption algorithms shall be publicly available on a fair and non-discriminatory basis.

National or international standards bodies shall have approved the algorithms.

The algorithms shall have been extensively analysed by the cryptographic community to resist all currently known attacks.

The cryptographic strength of the authentication algorithm shall be independent of the cryptographic strength of the encryption algorithm.

4.16 OA&M

4.17 Link Adaptation, Power Control, and Dynamic Bandwidth Allocation

Link adaptation shall be used by the AI for increasing spectral efficiency, peak data rate, and cell coverage reliability. The AI shall support adaptive modulation and coding, adaptive bandwidth allocation, and adaptive power allocation.

4.18 Spectral Requirements

The system shall be targeted for use in TDD and FDD licensed spectrum allocated to mobile services below 3.5GHz. The AI shall be designed for deployment within existing and future licensed spectrum below 3.5 GHz. The MBWA system frequency plan shall include both paired

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and unpaired channel plans with multiple bandwidths, e.g., 1.25 or 5 MHz, etc., to allow co-deployment with existing cellular systems. Channel bandwidths are consistent with frequency plans and frequency allocations for other wide-area systems

The design shall be readily extensible to wider channels as they become available in the future.

4.19 Signaling Requirements

A signaling system for MBWA is key to providing services over the system and tying these services into currently existing 2.5G and 3G infrastructures. This section presents requirements for signaling channels, latencies and other items of interest.

4.19.1 Signaling Sub channels

4.19.2 Signaling Sub channel Reliability

4.19.3 Signaling Sub channel Latency and Data Rates

4.20 Handoff Support

Handoff methods are required in MBWA systems to facilitate providing continuous service for a population of moving Mobile Stations. Mobile stations may move between cells, between systems, between frequencies, and at the higher layer between IP Subnets. At the lowest layers, handoffs can be classified as either soft or hard handoffs, depending on whether there is a momentary service disruption or not. Handoffs to and from 3G technologies are assumed to be important in this context as well, since MBWA is being designed to co-exist with current 3G systems.

4.20.1 Soft Handoff

4.20.2 Hard Handoff

4.20.2.1 Hard Handoff Between Similar MBWA Systems

4.20.2.2 Hard Handoff Between Frequencies

4.20.2.3 Hard Handoff Between MBWA and 3G Systems

4.20.3 IP-Level Handoff

Regardless of the lower layer handoff types required, it is expected that a higher level handoff utilizing a mechanism such as Mobile IP will be required for MBWA systems.

4.20.3.1 Definitions and Characteristics

4.20.3.2 Requirements

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5 Functional Requirements

5.1.1 Duplexing – FDD & TDD

The 802.20 standard shall support both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) frequency arrangements. The MAC and PHY shall exhibit minimal differences between use in the two duplexing cases, with maximum commonality in terms of modulation and coding and in the control messages.

5.1.1.1 RF Channelization

5.1.1.2 Bands of Applicability

5.1.1.3 Spectral Masks

5.1.2 Link Budget

5.1.3 Spectral Efficiency

5.1.4 Channel Characteristics

5.1.5 Timing and Power Control

5.1.6 Adaptive Modulation and Coding

The system will have adaptive modulation in both the uplink and the downlink

5.1.7 Adaptive Coding

5.1.8 Layer 1 to Layer 2 Inter-working

The interface between layers 1 and 2 is not an exposed interface; it may be handled at the implementer's discretion.

5.1.9 Mobility and PHY

The AI shall support various vehicular mobility classes up to 250 km/hr (as defined in ITU-R M.1034-1)

5.1.10 Space-Time Processing hooks Support & Multiple Antenna Capabilities

Support will be provided for advanced antenna technologies to achieve higher effective data rates, user capacity, cell sizes and reliability. Antenna diversity shall not be a requirement of the mobile station.

5.1.11 Encryption

The air interface shall support either block- or stream based cipher with shared secret keys.

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5.1.12 Antenna Configurations

5.2 Layer 2 MAC

5.2.1 MAC Modes of Operation

5.2.1.1 Random Access MAC

5.2.1.2 Polled MAC

5.2.2 Scheduler

The AI specification shall not preclude proprietary scheduling algorithms, so long as the standard control messages, data formats, and system constraints are observed.

5.2.3 Quality of Service and The MAC

Many emerging service concepts such as multimedia applications, video on demand, and others require that data transmission and delivery performance be bounded to provide a good user experience. To achieve this, there are many efforts in progress to define a Quality of Service "framework" and from that framework to define requirements to assure that such services can be offered. This section is meant to capture relevant QoS work, and to derive appropriate requirements for the 802.20 technologies.

5.2.4 Cos/QoS Matched Criteria

5.2.4.1 Protocol field mapping

5.2.4.2 Hardware mapping

5.2.5 CoS/QoS Enforcement

5.2.5.1 Inter-packet delay variation

5.2.5.2 One-way, round-trip delay

5.2.5.3 Prioritization

5.2.5.4 Error correction

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5.2.5.5 Queuing

5.2.5.6 Suppression

5.2.6 ARQ/Retransmission

5.2.7 MAC Error Performance

5.2.8 Latency

5.2.8.1 End to End Latency

5.2.8.2 End to End Latency Variation

5.2.9 Protocol Support

5.2.10 Addressing

5.2.11 Support/Optimization for TCP/IP

5.2.12 Mobility and the MAC

As listed in the PAR, the 802.20 specifications should provide robust communications under vehicular mobility conditions up to 250 Km/hr. This section seeks to parameterize this requirement and to derive MAC layer requirements to meet the goal of a robust air interface in these mobility conditions.

5.2.13 MAC Complexity Measures

To make the MBWA technology commercially feasible, it is necessary the complexity is minimized at the MAC, consistent with the goals defined for the technologies. This section defines complexity measures to be used in estimating MAC complexity. \

5.2.14 Additional IP Offerings

5.3 Layer 3+ Support

5.3.1 OA&M Support

5.4 User State Transitions

The AI shall support multiple protocol states with fast and dynamic transitions among them. It will provide efficient signaling schemes for allocating and de-allocating resources, which may include logical in-band and/or out-of-band signaling, with respect to resources allocated for end-user data. The AI shall support paging polling schemes for idle terminals to promote power conservation for MTs.

5.5 Resource Allocation

The AI shall support fast resource assignment and release procedures on the uplink and Duplexing – FDD & TDD

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5.5.1 RF Channelization

The 802.20 RF channel characteristics should be compatible with existing mobile wireless systems (e.g., support band classes, include guard bands, address interference constraints for coexistence with neighboring radio systems.).

5.5.2 Hybrid ARQ

The system should support incremental redundancy (IR) based soft combining of the physical layer retransmissions. The (re) transmissions of the same information block can use different modulation and coding.

5.6 Handoff

The AI shall provide inter-sector, inter-cell, and inter- frequency handoff procedures at vehicular speeds that minimize packet loss and latency for robust and seamless (i.e., without service interruption) IP packet transmission.

5.7 Latency

The system should have a one-way target latency of 50 msecs from the base station to the end-device.

The AI shall minimize the round-trip times (RTT) and the variation in RTT for acknowledgements, within a given QoS traffic class, over the air interface. The RTT over the airlink for a MAC data frame is defined here to be the duration from when a data frame is received by the physical layer of the transmitter to the time when an acknowledgment for that frame is received by the transmitting station. The airlink MAC frame RTT, which can also be called the "ARQ loop delay," shall be less than 10 ms. Fast acknowledgment of data frames allows for retransmissions to occur quickly, reducing the adverse impact of retransmissions on IP packet throughput. This particularly improves the performance of gaming, financial, and other real-time low latency transactions.

6 References

- 802.20 - PD-02: Mobile Broadband Wireless Access Systems: Approved PAR (02/12/11)
- 802.20 - PD-03: Mobile Broadband Wireless Access Systems: Five Criteria (FINAL) (02/11/13)
- C802.20-03/45r1: Desired Characteristics of Mobile Broadband Wireless Access Air Interface (Arif Ansari, Steve Dennett, Scott Migaldi, Samir Kapoor, John L. Fan, Joanne

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Wilson, Reza Arefi, Jim Mollenauer, David S. James, B. K. Lim, K. Murakami, S. Kimura (2003-05-12))

- C802.20-03/47r1: Terminology in the 802.20 PAR (Rev 1) (Joanne Wilson, Arif Ansari, Samir Kapoor, Reza Arefi, John L. Fan, Alan Chickinsky, George Iritz, David S. James, B. K. Lim, K. Murakami, S. Kimura (2003-05-12))

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Appendix A Definition of Terms and Concepts

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- *Active users* - An active user is a terminal that is registered with a cell and is using or seeking to use air link resources to receive and/or transmit data within a short time interval (e.g., within 100 ms).

- *Airlink MAC Frame RTT* - The round-trip time (RTT) over the airlink for a MAC data frame is defined here to be the duration from when a data frame is received by the physical layer of the transmitter to the time when an acknowledgment for that frame is received by the transmitting station.

- *Bandwidth or Channel bandwidth* - Two suggested bandwidths are 1.25 MHz and 5 MHz, which correspond to the bandwidth of one channel (downlink or uplink) for paired FDD spectrum.

- *Cell* - The term "cell" refers to one single-sector base station or to one sector of a base station deployed with multiple sectors.

- *Cell sizes* – The maximum distance from the base station to the mobile terminal over which an acceptable communication can maintained or before which a handoff would be triggered determines the size of a cell.

- *Frequency Arrangements* – The frequency arrangement of the spectrum refers to its allocation for paired or unpaired spectrum bands to provide for the use of Frequency-Division Duplexing (FDD) or Time-Division Duplexing (TDD), respectively. The PAR states that the 802.20 standard should support both these frequency arrangements.

- *Interoperable* – Systems that conform to the 802.20 specifications should interoperate with each other, e.g., regardless of manufacturer. (Note that this statement is limited to systems that operate in accordance with the same frequency plan. It does not suggest that an 802.20 TDD system would be interoperable with an 802.20 FDD system.)

- *Licensed bands below 3.5 GHz* – This refers to bands that are allocated to the Mobile Service and licensed for use by mobile cellular wireless systems operating below 3.5 GHz.

- *MAN* – Metropolitan Area Network.

- *Mobile Broadband Wireless Access systems* – This may be abbreviated as MBWA and is used specifically to mean "802.20 systems" or systems compliant with an 802.20 standard.

- *Optimized for IP Data Transport* – Such an air interface is designed specifically for carrying Internet Protocol (IP) data traffic efficiently. This optimization could involve (but is not limited to) increasing the throughput, reducing the system resources needed, decreasing the transmission latencies, etc.

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- *Peak aggregate data rate per cell* – The peak aggregate data rate per cell is the total data rate transmitted from (in the case of DL) or received by (in the case of UL) a base station in a cell (or in a sector, in the case of a sectorized configuration), summed over all mobile terminals that are simultaneously communicating with that base station.

- *Peak data rates per user (or peak user data rate)* – The peak data rate per user is the highest theoretical data rate available to applications running over an 802.20 air interface and assignable to a single mobile terminal. The peak data rate per user can be determined from the combination of modulation constellation, coding rate and symbol rate that yields the maximum data rate.

- *Spectral efficiency* – Spectral efficiency is measured in terms of bits/s/Hz/cell. (In the case of a sectorized configuration, spectral efficiency is given as bits/s/Hz/ sector.)

- *Sustained spectral efficiency* – Sustained spectral efficiency is computed in a network setting. It is defined as the ratio of the expected aggregate throughput (bits/sec) to all users in an interior cell divided by the system bandwidth (Hz). The sustained spectral efficiency calculation should assume that users are distributed uniformly throughout the network and should include a specification of the minimum expected data rate/user.

- *Sustained user data rates* – Sustained user data rates refer to the typical data rates that could be maintained by a user, over a period of time in a loaded system. The evaluation of the sustained user data rate is generally a complicated calculation to be determined that will involve consideration of typical channel models, environmental and geographic scenarios, data traffic models and user distributions.

- *Targets for 1.25 MHz channel bandwidth* – This is a reference bandwidth of 2 x 1.25 MHz for paired channels for FDD systems or a single 2.5 MHz channel for TDD systems. This is established to provide a common basis for measuring the bandwidth-dependent characteristics. The targets in the table indicated by the asterisk (*) are those dependent on the channel bandwidth. Note that for larger bandwidths the targets may scale proportionally with the bandwidth.

- *Various vehicular mobility classes* – Recommendation ITU-R M.1034-1 establishes the following mobility classes or broad categories for the relative speed between a mobile and base station:
    - Stationary (0 km/h),
    - Pedestrian (up to 10 km/h)
    - Typical vehicular (up to 100 km/h)
    - High speed vehicular (up to 500 km /h)
    - Aeronautical (up to 1 500 km/h)

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- o Satellite (up to 27 000 km/h).

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Appendix B Unresolved issues

Coexistence and Interference Resistance

Since MBWA technology will be operative in licensed bands some of which are currently being utilized by other technologies, it is important that coexistence and interference issues be considered from the outset, unlike the situation in unlicensed spectrum where there is much more freedom of design. Of particular interest is adjacent channel interference; if MBWA is deployed adjacent to any of a number of technologies, the development effort should evaluate potential effects.

Interference can be grouped as co-channel and adjacent channel interference; evaluation of all combinations of technologies likely to be encountered should be part of the 802.20 processes. Furthermore, 802.20 technology is described in the PAR to encompass both TDD and FDD techniques. These should be evaluated separately, and requirements provided below.

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- 5.1 Coexistence Scenarios
- FDD Deployments
- In this section, scenarios should be developed with 802.20 deployed as FDD, following the FDD "rules" for each of the 2G and 3G technologies likely to be encountered in practice.
-
- 802.20 and AMPS
- 802.20 and IS-95
- 802.20 and GSM
- 802.20 and LMR
- 802.20 and CDMA2000
- 802.20 and WCDMA
- 802.20 and 1xEVDO
- 802.20 and HSDPA
- 802.20 and 1xEV/DV
- 5.1.2 TDD Deployments
- In this section, scenarios should be developed with 802.20 deployed as TDD, following any TDD "rules" for each of the 2G and 3G technologies likely to be encountered in practice. Since the majority of existing technologies are deployed as FDD solutions, some new

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ground is being explored here, and it will be necessary to make sure that the 802.20 technology will not seriously impact the existing services.

- 802.20 and AMPS
- 802.20 and IS-95
- 802.20 and GSM
- 802.20 and LMR
- 802.20 and CDMA2000
- 802.20 and WCDMA
- 802.20 and 1xEVDO
- 802.20 and HSDPA
- 802.20 and 1xEV/DV
- Adjacent Channel Interference
- Definitions and Characteristics
- Requirements
- Co-channel Interference
- Definitions and Characteristics
- Requirements
- TDD Interference in Traditionally FDD Bands
- Since 802.20 is listed as being both TDD and FDD, it should be evaluated in a scenario where TDD 802.20 technology is deployed in a traditionally FDD frequency band. 802.20 should develop appropriate scenarios and requirements so that the new technology meets all necessary coexistence requirements that may be placed upon it.
- Definition and Characteristics
- Requirements

Interworking: *The AI should support interworking with different wireless access systems, e.g. wireless LAN, 3G, PAN, etc. Handoff from 802.20 to other technologies should be considered and where applicable procedures for that hand-off shall be supported.* [Dan Gal

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dgal@lucent.com]: This issue is quite **critical** to the successful deployment of 802.20 systems in existing and future markets worldwide. The purpose of defining Coexistence requirements in this document is to assure that 802.20 systems would not cause interference to or be susceptible to interference from other wireless systems operating in the same geographical area. Detailed quantitative RF emission limits need to be specified as well as received interference levels that the 802.20 receivers would have to accept and mitigate.

2. **Interworking**

[Dan Gal dgal@lucent.com]: Interworking between 802.20 systems and other wireless systems is highly desirable and may give it a competitive edge. Systems that have disparate physical layers can still interwork via the higher protocol layers. Current interworking solutions exist for CDMA2000/802.11b and for GSM-GPRS/802.11b. Multi-mode devices, such as 802.11b+802.11a or more recently, 802.11b/g are now available. Existing applications (such as Windows XP mobility support) provide for transparent roaming across systems, automatically handling the applications' reconfiguration so as to keep sessions working seamlessly.

Building support for interworking in 802.20 – right from the first release of the standard – would add significantly to its market appeal.

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