IEEE 802.16m for IMT-Advanced: The Next Step in WirelessMAN Evolution

Andreas Mäder, Michael Einhaus, Xavier Pérez-Costa
NEC Laboratories Europe
Network Research Division
Heidelberg, Germany
Email: andreas.maeder@neclab.eu

Linghang Fan
NEC Laboratories Europe
Network Research Division
London, United Kingdom
Email: linghang.fan@eu.nec.com

***Abstract*—The next step in the evolution of the IEEE WirelessMAN project is IEEE 802.16m. Building upon IEEE 802.16e mobile WiMAX, this standard in development is one of the contenders in the IMT-Advanced programme of the ITU. Designed for high data rates and low packet latencies, IEEE 802.16m has the potential to become a key enabler of the future wireless Internet. We provide a comprehensive overview of the current status, development plan and main technical features, including advanced concepts like Femtocells, relays and self-organizing networking.**

I. Introduction

The successful deployments and reception of wireless Internet services like the UMTS-enhancement High Speed Packet Service (HSPA) demonstrates the ever-growing demand for high-capacity mobile wireless Internet. Within the IMT-Advanced programme, the International Telecommunication Union (ITU) searches for candidate technologies for the next generation in mobile wireless networks [1]. In [2], a concrete set of requirements for future IMT-Advanced candidates was published, with peak data rates over 1 Gbps in wideband carriers and packet latencies below 10 ms.

In response, the IEEE 802.16 Working Group started in January 2007 the development of IEEE 802.16m with the purpose to fulfill aforementioned requirements. 802.16m aims for transparent provisioning of high data rate connections optimized for IP connections, while maintaining backward compatibility to existing WiMAX deployments. IEEE 802.16m is designed as all IP network with a flexible MAC scheme which enables adaptation to requirements of future Internet services in a timely manner with minimum effort.

II. Status and Work Plan

IEEE 802.16m is formulated as an amendment to the existing IEEE 802.16e standard [3] and as such aims for reuse, backward compatibility and enhancement of the current technology.

The system requirement document (SRD) [4] describes the specific requirements on the future standard based on the IMT-Advanced guidelines. Any performance evaluation should be based on the 802.16m Evaluation Methodology Document (EMD) [5] which provides reference scenarios, parameters and evaluation modeling guidelines.

IEEE 802.16m is a standard in development. Figure 1 shows that according to the work plan, the final proposal in form of an amendment document should be completed at the end of September 2009. This ensures that the submission to ITU until end of October 2009 has draft status, such that only minor changes on the overall structure and contents of the document are to be expected.

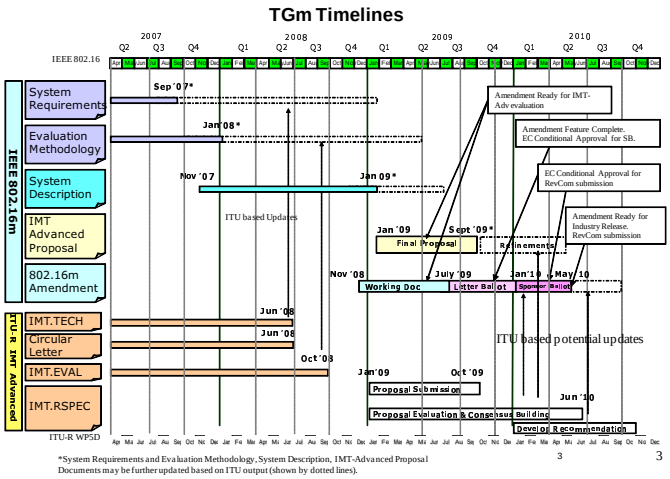

Fig. 1. IEEE 802.16m work plan [6]

III. Technical Overview

Like its predecessor, IEEE 802.16m implements OFDMA as multiple access scheme, with support for TDD, FDD and half-duplex FDD. The basic concept of WiMAX is untouched in IEEE 802.16m. In order to meet the IMT-Advanced requirements, several technical features are standardized, which aim for higher efficiency in MAC and PHY, wide carrier frequencies and environment-optimized deployments.

- On *PHY* layer, advanced multi-antenna techniques (beamforming and MIMO) are used. In both uplink and downlink, open-loop and closed-loop MIMO in single-user and multi-user configuration (SU-MIMO and MU-MIMO) are supported. MU-MIMO enables the concurrent utilization of radio resource units by spatial multiplexing. Adaptive Modulation and Coding is supported

with 16 different modulation and coding schemes to enable a fine granularity of the link adaptation mechanism. *Multi-Carrier* operation is defined in order to enable "virtual" carriers up to 100 MHz wide and for deployments in carrier scenarios other than 5, 10 and 20 Mhz.

- On *MAC* layer, IEEE 802.16m defines persistent and group resource allocations for efficient transport of traffic with recurrent transmission patterns (like voice over IP) and for users with similar QoS requirements. The frame structure supports different time zones (LZone for legacy and MZone for 16m access) in order to enable mixed deployments in brownfield scenarios. Co-existence with other radio access technologies like UTRAN LTE is facilitated by the flexible frame concept. Furthermore, adaptation of QoS flow parameters, Hybrid ARQ for mitigation of channel fading (synchronous in uplink and asynchronous in downlink) and advanced power management mechanisms to increase battery lifetime in mobile station are supported.
- *Femtocell* base stations are small-scale and cheap devices which are installed in the premises of subscribers. This enables very high data rates due to the close distance of the mobile devices to the base stations. The control of the radio functionalities and QoS provisioning to the user is enabled by core network connections over DSL. A number of features for femtocells will be supported in the standard, including a low-duty mode on base station side for interference mitigation and energy efficiency.
- *Self-organizing networking* (SON) is explicitly supported by features for neighbor discovery, interference mitigation and load balancing. SON is especially useful in Femtocell deployment scenarios where proper network planning is nearly impossible.
- *Relays* increase coverage by closing "blind areas" in unfavorable radio environments. Relay stations are downscaled, low-cost base stations with repeater functionality and otherwise very limited capabilities.

Figure 2 provides a schematic overview of different functional entities and protocols defined in IEEE 802.16m. The control plane is subdivided into a radio resource control and management which contains network and interference related functionalities, and Medium Access Control which contains scheduling, QoS and PHY control functionalities. Located on the data plane side are service flow management functionalities like ARQ, fragmentation and encryption. The convergence sublayer enables transparent adaptation to Layer 3 protocols like IP.

IV. Conclusion

IEEE 801.16m is an emerging standard which enables next generation applications and services by high data rates, low latency and innovative deployment concepts. As such, IEEE 802.16m is a key enabler for future wireless internet services. With the standard document finalized in 2010, deployment of this next generation wireless communication technology can be expected after 2011.

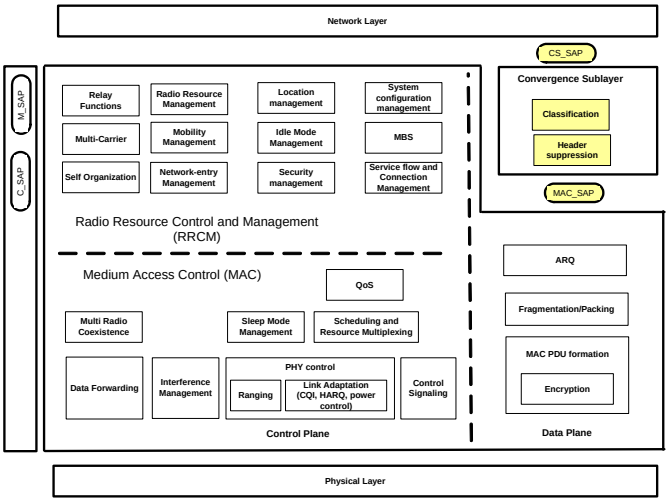

Fig. 2. IEEE 802.16m system overview [7]

References

[1] ITU-R, "Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000," ITU, Tech. Rep., Jun. 2003.

[2] ——, "Report M.2134, Requirements related to technical performance for IMT-Advanced radio interface(s)," ITU, Tech. Rep., Dec. 2008.

[3] IEEE, *Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems, Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands, and Corrigendum 1*, IEEE Computer Society and the IEEE Microwave Theory and Techniques Society Std., Jan. 2009.

[4] IEEE 802.16 Broadband Wireless Access Working Group, "IEEE 802.16m System Requirements," IEEE, Tech. Rep., Jan. 2009.

[5] ——, "IEEE 802.16m Evaluation Methodology Document," IEEE, Tech. Rep., Jan. 2009.

[6] IEEE 802.16 Working Group, "IEEE 802.16m-09/0019, Work Plan for IEEE 802.16m Standard & IMT-Advanced Submission," IEEE, Tech. Rep., Jan. 2009.

[7] IEEE 802.16 Broadband Wireless Access Group, "IEEE 802.16m-08/003r7, The Draft IEEE 802.16m System Description Document," IEEE, Tech. Rep., Feb. 2009.