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| **Radiocommunication Study Groups** |  |
|  | IEEE L802.16-10/0097 |
|  | **\*\*\*DRAFT\*\*\*** |
| Received: xxxxx 2010 | **Document 5A/xxxx** |
| **November 2010** |
| **English only** |
| IEEE | |
| Input towards working documents on Objectives and requirements for mobile wireless access systems for communications to a large number of ubiquitous sensors and/or actuators scattered over wide areas in the land mobile service | |
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1. **Introduction**

IEEE 802.16 Working Group (WG) has reviewed with great interest the working documents from ITU-R Working Party 5A on “Mobile Wireless access systems providing telecommunications for a large number of ubiquitous sensors and/or actuators scattered over wide areas in the land mobile service” contained in Annexes 15 and 16 of WP 5A Chairman’s report (5A/513).

The IEEE would like to inform WP5A about our related project on enhancements to the IEEE 802.16 radio interface to support machine-to-machine (M2M) communications[[1]](#footnote-1). Developing M2M capability in broadband wireless access networks will accelerate implementation of the “Internet of things” vision.

The IEEE 802.16 WG started the M2M project as a result of an IEEE tutorial in March 2010 on the challenges and potential technology opportunities in future 802.16 networks[[2]](#footnote-2). The tutorial identified M2M services and applications as a key area for development and as an opportunity to enable service providers to create new revenue streams. This initiated a study group in March 2010 with the objective of identifying M2M usages and applications, M2M features that are common across multiple applications, M2M system architecture, and potential optimizations to the IEEE 802.16 radio interface[[3]](#footnote-3). While the study group wrote a comprehensive report on the scope and standards implications for a broad range of M2M applications, it was recommended that the IEEE 802.16 working group consider a phased approach to address M2M requirements. Specifically, near term requirements would be addressed as part of the initial project scope to enable basic M2M capability to quickly enable the deployments, and longer term advanced requirements would be addressed in a follow-on project.

Based on recommendations from the M2M study group, a project scope was drafted which was submitted to the IEEE 802 Executive Committee for approval in July. The new project, IEEE 802.16p, was authorized by the Executive Committee and work has begun on drafting system requirements[[4]](#footnote-4).

Another relevant project recently authorized by IEEE is the IEEE 802.16n project which focuses on the network reliability issues that are typical of, amongst other applications, M2M communications.

1. **IEEE 802.16p Project**

The objective of this project is to enable a range of M2M applications that are automated rather than human-controlled, which require Wireless Wide Area Network (WWAN) communication in licensed bands. These applications have network access requirements that are significantly different from those used to support standard cellular connections. Some of the M2M applications of interest include secured access and surveillance, tracking, tracing and recovery, public safety, vehicular telematics, healthcare monitoring of bio-sensors, remote maintenance and control, smart metering, automated services on consumer devices, and retail digital signage. The current IEEE 802.16 standard does not address the unique requirements posed by these usages, such as very low power consumption, large numbers of devices, short burst transmissions, robust device integrity, high reliability, staged access priority, time tolerant operation, time controlled operation, low/no mobility, extremely low latency, and others.

The 802.16p project will specify enhancements to the IEEE 802.16 medium access control (MAC) and *minimal* modifications to the IEEE 802.16 Physical Layer (PHY), which is based on orthogonal frequency division multiple access (OFDMA). Minimal PHY changes are required to avoid hardware changes to base station/device equipment that may otherwise prevent quick entry into the M2M market. In this first stage of M2M optimizations, the following features will be supported: low power consumption at the device, support of extremely large numbers of devices, efficient small burst transmissions, and improved device authentication. While these features are not all-encompassing to the M2M applications space, they are common to several key applications, such as smart metering, remote maintenance and control, etc.

Figure 1 shows the basic system architecture that is assumed for IEEE 802.16 based M2M communications. In this figure, the IEEE 802.16 M2M device is an IEEE 802.16 mobile station with M2M functionality. The M2M server is an entity that communicates to one or more IEEE 802.16 M2M devices. The M2M server also has an interface which can be accessed by an M2M service consumer. The M2M service consumer is a user of M2M services (e.g. a utility company). The M2M server may reside within or outside the Connectivity Service Network (CSN) and can provide M2M specific services for one or more M2M devices. An M2M application runs on the M2M device and the M2M server.



Figure 1. High-level M2M service system architecture

The M2M service system architecture in IEEE 802.16 supports two types of M2M communication: a) communication between one or more M2M devices and an M2M server, and b) point-to-multipoint communication between M2M devices and the BS. An IEEE 802.16 M2M device can act as an aggregation point for non IEEE 802.16 M2M devices. The non M2M devices typically comprise one or more sensors and a low power, low cost connectivity solution such as IEEE 802.11, IEEE 802.15, etc. The aggregation functionality will be critical to M2M deployments since not all devices will be able to afford cellular connectivity, and the aggregation device will provide an efficient and cost-effective means of supporting a large number of localized devices/sensors.

1. **802.16n Project[[5]](#footnote-5)**

Recently introduced legislation in U.S. and other countries encourages and funds a wide range of activities in communications technologies supporting Smart Grid applications such as monitoring and control of generation, transmission, distribution and consumption of energy resources. This project is expected to support the higher reliability that may be required in M2M communication including Smart Grid applications.

High data rates and long range are required for some of these applications. IEEE 802.16 technology is uniquely suitable for these purposes, due to its inherent longer range and high data rate capability compared to other wireless technologies. The benefit of this particular project is to facilitate applications for those new deployments.

This greater reliability is specified to be achieved by MAC and PHY enhancements that will enable establishment of alternate paths as well as maintain coverage under adverse propagation conditions.

1. **Discussion**

In general, IEEE 802.16 is aligned with ITU-R WP5A on the wireless system features needed to enable machine-to-machine usages. There are, however, some items for which we have comments, and some that require further clarification:

* Long-term connectivity of the network interface: It needs clarification whether longevity requirement is 5 to 10 years or several decades. One of the implications of this requirement is that the system has to be designed with excess bandwidth.
* Communication range: The text calls for space diversity techniques to improve coverage. However, several other architectures and enabling technologies can be considered that can improve coverage, such as femtocell networks, multi-RAT networks, relays, coordinated MIMO, and others.
* Accommodation capability: In our view, a video camera for surveillance applications may be regarded as a sensor. In this case, the data generated may be large, and can potentially challenge system capacity available. In our view the system should be optimized for small data bursts but also accommodate large data transmissions.
* Suppression of interference: In addition to the techniques used for interference mitigation, smart resource scheduling (time/frequency resources) and/or MIMO techniques can also be extremely effective.
* New network topologies: These are required to provide the extra reliability required for some M2M applications.
* Security: Since the M2M device may be deployed remotely over long time periods, the network should provide support for the device to report if there is tampering or damage to the device. New security procedures are also necessary for new network topologies
* Under service applications, Smart Grid usage should include all aspects of monitoring and control of generation, transmission, distribution and consumption of energy resources. Thus for example it includes the monitoring and control of the electrical grid itself and load management.
* The application example provided in the WP 5A working document seems hand tailored to low data rate and very long range application. The system itself doesn’t seem to be spectrally efficient and may not scale well to bandwidth requirements growth with years. This is particularly problematic as devices are expected to stay in the field for many years without possibility of upgrade.

The IEEE is looking forward to continued cooperation with ITU-R WP5A on the development of the two working documents and exchange of information on status and progress given our common goals.

IEEE is planning to submit more specific comments on the contents of the two working documents in time for WP 5A’s next meeting in May 2011.

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1. IEEE 802.16ppc-10/0003r9, Machine to Machine (M2M) Communication PAR Form and Five Criteria, May 2010. [↑](#footnote-ref-1)
2. IEEE C80216-10\_0016r1, “Future 802.16 network: Challenges and Possibilities,” IEEE 802 Call for Interest Tutorial, March, 2010. [↑](#footnote-ref-2)
3. IEEE C80216-10\_0002r7, “Machine to Machine (M2M) Communication Study Report,” IEEE 802.16 Contribution, May, 2010. [↑](#footnote-ref-3)
4. IEEE C80216-10\_0011r1, “IEEE 802.16p Machine to Machine (M2M) System Requirements Document (SRD),” IEEE 802.16 Contribution, September, 2010. [↑](#footnote-ref-4)
5. IEEE 802.16n Communication PAR Form and Five Criteria in <http://wirelessman.org/gridman/P802.16n.pdf> [↑](#footnote-ref-5)