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IEEE 802.16s Draft System Requirements Document

May 19, 2016

## Introduction

This document is to summarize the performance requirements for channel bandwidths less than 1.25 MHz. This SRD will act as a guide for the development of an amendment to IEEE Std 802.16-2012 as amended by 802.16p, 802.16n, and 802.16q.

The following terminology is used in this document:

SHALL: This word, or the terms "REQUIRED" or "MUST", mean an absolute requirement of the specification.

SHALL NOT: This phrase means an absolute prohibition of the specification.

SHOULD: This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.

SHOULD NOT: This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.

MAY: This word, or the adjective "OPTIONAL", mean that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.)

# Applications

The following examples are the types of applications that the standard is expected to support.

• Downline automation, Distribution Automation

• Advanced Metering Infrastructure (AMI) – backhaul from collectors

• Advanced Metering Infrastructure (AMI) – communication to/from meter

• Substation Communications (SCADA)

• Distributed Generation (DG), Microgrid control

• Electric Vehicle Communication (Smart Charging)

• Teleprotection circuits

• Replacement for retired copper or leased circuits (facility services, remote access, etc.)

• Security cameras (configured to communicated over reduced bandwidth)

• Remote thermal imaging cameras (configured to communicated over reduced bandwidth)

• Remote access to operational devices (relays, DFRs, etc.)

• Asset health monitoring (e.g. transformer monitoring)

• Mobile Workforce Management, Automatic Vehicle Location

• Distribution Synchrophasors

In general, standard should support applications operating on field area networks, or other critical infrastructure industry applications, that require high reliability and availability.

Note that the standard can support all of these applications by variations in configuration. It may not be possible to support all of them simultaneously with the same network and a single set of parameters.

## 802.16s System Operational Requirements

This section specifies capabilities that must be supported by the standard, as amended by 802.16s, to meet the use cases and market needs described in the 802.16s PAR and CSD.

**Topology:**

PMP LoS and non-LoS shall be supported

**Frequency Range**

The availability of channel BWs less than 1.25 MHz will create opportunities for users to apply small amounts of spectrum that may become available in any specific geographic location or in any frequency band. The standard may support operation in exclusively licensed VHF and UHF frequency bands from 30 MHz to 3000 MHz. The following frequency bands shall be supported:

* 176-220 MHz
* 406-470 MHz
* 746 – 806 MHz
* 895 - 941 MHz (excluding 902 - 928 MHz)
* 1390 – 1395, 1432 - 1435 MHz

**Channel BW Range**

The applicable channel BWs shall be greater than or equal to 100 kHz and less than 1.25 MHz, (100 kHz ≤ Channel BW <1250 kHz)

**UL/DL Ratio**

The UL/DL ratio shall be configurable. The range of configuration should be 10:1 to 1:10

**TDD or FDD**

TDD operation shall be supported. FDD operation is not used.

**Range (DL or UL):**

SHOULD: The base station coverage range should be 60 km (given appropriate frequency band, configuration, and propagation conditions)

The TTG/RTG gaps shall be configurable to optimize efficiency and maximum SS range.

**Modulation and Coding Scheme:**

To maximize spectral efficiency, optional Convolutional Turbo Coding (CTC) 64QAM-5/6 Coding shall be supported in both the DL and UL profiles.

**Mobility:**

Nomadic operation shall be supported. Mobile operation up to 80 km/hr should be supported

**BS to BS Handoff:**

Nomadic operation shall be supported. Handoff during mobile operation up to 80 km/hr should be supported

**One-way Latency:**

One-way latency of <10ms for packet size ≤200 bytes shall be supported. The latency is bidirectional, and the same for UL and DL.

**Operational throughput:**

Delivered throughput at the MAC SAP (aggregate per channel) according to this table (given appropriate frequency band, configuration, and propagation conditions)

|  |  |
| --- | --- |
| Channel Width | Throughput |
| 1 MHz | 1.5 Mbps |
| 500 KHz | 750 Kbps |
| 250 KHz | 375 Kbps |
| 100 KHz | 150 Kbps |

**Permutation:**

Channelization and fractional frequency re-use shall be supported.

**Advanced Antenna Systems:**

2x2 MIMO and 2x1 MIMO shall be supported. Because operation at frequencies below 1 GHz is anticipated, higher order MIMO is less practical.

**Quality of Service**

Systems shall prioritization of packets on the air interface, and conform to IEEE 802.1 QoS standards.

**Cyber Security**

Systems shall implement cyber security that is able to meet the requirements of NERC CIP V6.

## 802.16s Amendment Requirements

Amendment Requirements that must be specified in the amendment in order to meet the operational requirements. These requirements identify the gaps in the existing standard that must be addressed by the amendment in order to attain those capabilities.

**Topology:**

Only Point to Multipoint topologies will be specified in 802.16s.

**Frequency Range**

The standard may support operation in exclusively licensed VHF and UHF frequency bands from 30 MHz to 3000 MHz. The standard shall support the following frequency bands

* 176-220 MHz
* 406-470 MHz
* 746 – 806 MHz
* 895 - 941 MHz (excluding 902 - 928 MHz)
* 1390 – 1395, 1432 - 1435 MHz

**Channel BW Range**

The standard shall support channel BWs shall be greater than or equal to 100 kHz and less than 1.25 MHz, (100 kHz ≤ Channel BW <1250 kHz)

**UL/DL Ratio**

The standard shall support configurable UL/DL ratio. The range of configuration should be 10:1 to 1:10

**TDD or FDD**

The standard shall support TDD operation. FDD operation is not specified.

**Range (DL or UL):**

The standard should support a base station coverage range of 120 km (given appropriate frequency band, configuration, and propagation conditions).

The TTG/RTG gaps shall be configurable to optimize efficiency and maximum SS range.

**Modulation and Coding Scheme:**

To maximize spectral efficiency, optional Convolutional Turbo Coding (CTC) 64QAM-5/6 Coding shall be supported in both the DL and UL profiles.

**Mobility:**

The standard shall support Nomadic operation. The standard should support mobile operation up to 80 km/hr

**BS to BS Handoff:**

The standard shall support handoff during Nomadic operation. The standard should support handoff during mobile operation up to 80 km/hr

**One-way Latency:**

The standard shall support one-way latency of <10ms for packet size ≤200 bytes. The standard shall support configurable frame sizes between 5 and 50mS.

**Operational throughput:**

The standard should support delivered throughput at the MAC SAP (aggregate per channel) according to this table (given appropriate frequency band, configuration, and propagation conditions)

|  |  |
| --- | --- |
| Channel Width | Throughput |
| 1 MHz | 1.5 Mbps |
| 500 KHz | 750 Kbps |
| 250 KHz | 375 Kbps |
| 100 KHz | 150 Kbps |

These values represent the capabilities of the specification, independent of equipment implementation, frame gap variations, frequency of operation, propagation, etc.

These widths are examples, and system profiles should be parameterized to cover a number of incremental channel sizes within these ranges.

Specific profiles within the set may be optimized for certain use cases.

**Throughput maximization, reduction of overhead:**

The standard shall incorporate measures to maximize throughput including:

* Use of higher throughput FEC codes in both the downlink and uplink.
* Reducing 802.16 protocol overhead
* Dynamic Packet Header Suppression (PHS)
* Support for frame concatenation (Packing) and fragmentation.
* Changes to Cyclic Prefix
* Consider making certain mobility features optional to reduce signaling overhead

**Permutation:**

The standard shall provide support for channelization and fractional frequency re-use.

The standard shall support Band AMC permutation in the uplink and downlink. The standard may support operation with optional use of the PUSC permutation. The standard shall permit operation with a single zone using Band AMC for improved efficiency.

**Advanced Antenna Systems:**

<no change to existing MIMO specifications>

**Management / MIB**

New management parameters may be required.