802.16a PHY Proposals - Proposed Improvements and Mergers

Document Number : **IEEE 802.16.3p-01/42**

Date Submitted: **14th March 2001**

Source:

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Venue: IEEE 802.16 Meeting #12, Hilton Head Island, SC

Base Document: **IEEE 802.16.3c-01/42** http://ieee802.org/16/tg3/contrib/802163c-01_42.pdf

Purpose: The Base Document is intended as a framework for reorganizing the proposals into a market driven draft standard. .

Proposal 1 : Merger of Proposals 31 and 32

Contributions 802163c-01/31 and 802163c-01/32 contain significant overlap, both in content and in the list of contributors.

For the purposes of evaluation, these two proposals should be merged and evaluated as a single proposal.

This means that only TWO proposals would be presented and evaluated at Meeting 12, on behalf of two groups of contributors.

Proposal 2 : Improvement in structuring the Draft Standard

The current proposals 802163c-01/31 , 802163c-01/32 and 802163c-01/33 are oriented firstly around modulation schemes etc, rather than characteristics of more relevance to Service Providers, Investors and Regulators.

Proposed Information Structure

PHY Mode A FDD

A1 : Framing, Coding, Modulation, … etc

A2 : Diversity Enhancement Options

A3 : Frequency Reuse Options

PHY Mode B TDD and HFDD

B1 : Framing, Coding, Modulation, … etc

B2 : Diversity Enhancement Options

B3 : Frequency Reuse Options

The following Improvements are aimed at linking the IEEE 802.16a Standard to the business case drivers of potential FWA Service Providers /Investors and the imperative to establish a successful high volume market for systems based on the Standard, especially with respect to residential and SME applications.

Proposal 3 : Duplexing Mode

Service Providers regularly quote **Cost, Spectrum Flexibility and Flexible Payload Asymmetry** among their highest priority requirements. These characteristics favor TDD or HFDD rather than FDD modes

Cost No Duplexer. Simpler / cheaper CPE Electronics. Cheaper Power Amps. Higher volume synergies with license exempt bands. Channel Estimation / reciprocity. Simpler / Cheaper beamforming.

Spectrum Flexibility

- Single or Paired Blocks
- Contiguous or Fragmented Blocks
- Minimal (or zero) block separation

Flexible Payload Asymmetry

- Configurable or Dynamic Uplink / Downlink Ratios
- Does not impact Frequency Blocks / Planning
- Per Cell / Sector and per User Adaptability

Licensed Allocation	Block Structure Structure	Example
5 MHz	contiguous	USA WCS C or D
6 MHz	contiguous	USA UHF, MDS
7 MHz	contiguous	????
	3.5 + 3.5	ETSI
10 MHz	contiguous	????
	5 + 5 PCS	USA, CITEL
	5 + 5 WCS- A	USA
	5 + 5 WCS-Other	USA
	5 + 5 General	USA
12 MHz	contiguous	USA UHF, MDS
	6 + 6	USA UHF, MDS
12.5 MHz	contiguous	USA 3650
	6.25 + 6.25	USA 3650
14 MHz	contiguous	????
	7 + 7	ETSI
18 MHz	contiguous	USA UHF, MDS
	6 + 12	USA UHF, MDS
20 MHz	contiguous	????
	10 + 10	USA WCS, PCS
	5 + 15	USA WCS
24 MHz	contiguous	USA UHF, MDS
	6 + 18	USA MDS
	12 + 12	USA MDS
25 MHz	contiguous	USA 3650 , CITEL
	12.5 + 12.5	USA 3650
	10 + 15	???
28 MHz	contiguous	???
	14 + 14	ETSI
30 MHz	contiguous	USA MDS
	15 + 15	USA PCS
	18 + 12	USA MDS
36 MHz	contiguous	USA MDS
	18 + 18	USA MDS
48 MHz	contiguous	USA MDS
	24 + 24	USA MDS
	18 + 30	USA MDS
50 MHz	contiguous	USA 3650
	25 + 25	USA 3650, CITEL

Proposal 3 : Duplexing Mode

Motion

That TG3 adopt a “Working Assumption” that TDD and Half FDD (HFDD) is the preferred Mode for high volume residential and SME BWA deployments, and shall optimize the Standard accordingly.

- Does not preclude (full) FDD option for lower volume applications, or specific medium / large business applications and the higher frequency bands (e.g. 10.5 GHz)
- TG3 Coexistence group needs to address / resolve potential issues with Regulators and Service Providers for sharing bands with (other) broadcast and (full) FDD technologies.
- Radio Planning tools need to be enhanced to include TDD/HFDD interference scenarios with respect to incumbent Broadcast and (full) FDD deployments.
- The WCA Engineering Committee, TG3 Coexistence group and the proposed TDD Coalition could be asked to handle the Regulatory, Service Provider and Industry Education issues.

Proposal 4 : Benchmark Modulation Rate

Expectations of high volume residential and small business deployments place an over-riding priority on Non LOS operation with predictable, economical and reliable (semi or non-professional) installation procedures.

QPSK, 8PSK Predictable NLOS performance with good field deployment history and experience up to 3.5 GHz

16-QAM Predictable NLOS performance with modern adaptive equalization and multipath mitigation techniques. Some field deployment experience with Second Generation MDS systems / trials

32-QAM Expected to have good NLOS performance with modern / advanced diversity enhancement techniques, especially for the lower frequency bands.

64-QAM Unlikely to have good NLOS performance, but OK in Line of Sight deployments for non-residential or non-SME applications, especially for the higher frequency bands.

Proposal 4 : Benchmark Modulation Rate

Motion

That TG3 adopt a “Working Assumption” that 16-QAM is the Benchmark Modulation Rate for high volume residential and SME BWA deployments, and shall optimize the Standard accordingly.

- Does not preclude QPSK or 8-PSK for specific applications or purposes (e.g. range extension and in / through building propagation) on a configured or adaptive basis per link.
- Does not preclude 32-QAM in appropriate frequency bands or for systems using (optional) advanced diversity enhancement techniques where necessary.
- Does not preclude 64-QAM (or higher) in appropriate frequency bands or for links where LOS deployment is appropriate.

Proposal 5 : System Capacity and Spectrum Utilization Efficiency

In frequency bands below 11GHz, the (limited) spectrum allocations and deployed cost per customer become the driving limitations of economic viability for high volumes of customers and / or payload per geographic area, forcing a Service Provider to reduce cell radius and install higher quantities of base stations to achieve the necessary coverage / capacity profiles.

High frequency reuse factors must therefore play a large part in the resolution of the 802.16a Standard, especially with the requirements of Proposal 4 in mind.

Payload Requirement (Mbps per Cell)	**Payload Efficiency (Mbps per Mhz per Cell)**			
	Spectrum Allocation			
	10 MHz	**50 MHz**	**100 MHz**	**200 MHz**
50	**5**	1	0.5	0.25
100	**10**	**2**	1	0.5
300	30	**6**	**3**	1.5
500	50	**10**	**5**	**2.5**

Proposal 5 : System Capacity and Spectrum Utilization Efficiency

System Payload Efficiency is calculated by multiplying a Frequency Reuse Index by the individual Channel Payload Efficiency rates (in Mbs per MHz). The Frequency Re-use Index is calculated by dividing the Intra-cell Frequency Re-use factor (R) by the Inter-cell Frequency Re-use factor (N), as shown in the example table below

Channel Payload Efficiency	**Intra-Cell Reuse**	**Inter-Cell Reuse**	**Frequency Reuse Index R / N**	**System Payload Efficiency** Mbps/MHz/Cell
3 Mbps per MHz	R = 2	N = 1	**2.00**	**6.0**
		N = 3	**0.67**	**2.0**
		N = 5	**0.40**	**1.2**
	R = 6	N = 1	**6.00**	**18.0**
		N = 3	**2.00**	**6.0**
		N = 5	**1.20**	**3.6**
	R = 10	N = 1	**10.00**	**30.0**
		N = 3	**3.33**	**10.0**
		N = 5	**2.00**	**6.0**

Proposal 5 : System Capacity and Spectrum Utilization Efficiency

Motion

That TG3 adopt a "Working Assumption" that a System Payload Efficiency of 2 – 10 Mbps per Cell per MHz of (allocated) spectrum is to be achieved at the benchmark modulation rate for high volume residential and SME BWA deployments, and shall optimize the Standard accordingly.

- Does not preclude the use of (optional) advanced frequency reuse techniques for the higher efficiency rates, especially for the smaller frequency allocations.
- Concerns for base-station costs (per customer) and the probable geographic dispersion of customers around the base station location probably favor adaptive beamforming rather than sectored antenna techniques for high volume residential and SME deployments.