Project	**IEEE 802.16 Broadband Wireless Access Working Group**
Title	**Proposed Amendment to 802.16.1pc-00/02: Physical Layer Proposal for the 802.16.1 Air Interface Specification, Addressing Baseband Pulse Shaping**
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Re:	Physical Layer Proposal for the 802.16 Air Interface Specification (IEEE 802.16.1pc-00/02, 1999-12-23). In response to Call for Suggested Improvements and Mergers (IEEE 802.16-99/16, 1999-11-22).
Abstract	Physical Layer Proposal for the 802.16 Air Interface Specification (IEEE 802.16.1pc-00/02, 1999-12-23) identifies baseband pulse shaping rolloff factors that are not consistent across upstream and downstream functional modes. This document highlights these discrepancies and advances recommendations for harmonizing the upstream and downstream specifications.
Purpose	The purpose of this document is to propose a harmonization of specifications for baseband pulse shaping in the downstream and upstream PMD sublayers.
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Background

Baseband pulse shaping for a proposed 802.16.1 Air Interface Specification is described in [1]. The square-root raised-cosine (also called square-root Nyquist—SRN) filter shape is defined for both downstream and upstream PMD sublayers. In addition, the excess bandwidth factor associated with SRN filtering is identified for each transmission mode as summarized in the nearby table.

Summary of Baseband Pulse Shape Rolloff Factors		
Functional Mode	**Transmission Direction**	**Spectral Shaping**
Mode A	downstream	α = 0.15 or 0.35
Mode B	downstream	programmable α = 0.15 to 0.35
Mode C	downstream	programmable α = 0.15 to 0.35
Mode D	downstream	α = 0.25
Mode A	upstream	α = 0.25
Mode B	upstream	programmable α = 0.15 to 0.35
Mode C	upstream	programmable α = 0.15 to 0.35

Qualitative Analysis and Review

The justification for rolloff factors as low as 0.15 is to capture the maximum allowable spectral efficiency while constraining implementation complexity. The justification for rolloff factors as high as 0.35, in addition to enhanced power amplifier efficiency in some circumstances, is to preserve compatibility with low-cost silicon chips that embody the DVB standard for broadcast transmission [2]. It is for this combination of reasons that the baseline downstream transmissions (functional Mode A) are specified to use a rolloff factor of ***either*** 0.15 or 0.35. Programmable values in the range defined by these endpoints is valuable in providing system-level design flexibility to trade spectral efficiency for power efficiency, if no other means is available to facilitate both goals.

On the other hand, the tabular view shows a discrepancy in applying this rationale for the upstream mode. Note in the table that the baseline upstream transmissions are specified to use a ***fixed*** rolloff value set at 0.25, which provides neither bandwidth efficiency nor power efficiency.

A further inconsistency in the table appears under downstream functional Mode D, for which a fixed rolloff value of 0.25 is specified. The primary purpose of functional Mode D appears to be specification of pragmatic TCM, which has no direct relationship to baseband pulse shaping [3].

Recommendations

The discrepancies noted above are the basis for the following recommendations:

1. Harmonize the baseline pulse-shaping specifications (functional Mode A) for upstream and downstream transmissions, in particular revise the specified pulse-shape rolloff factor for functional Mode A upstream transmission to conform to the specification for functional Mode A downstream transmission, either a value of 0.15 or a value of 0.35.
2. Revise the specified pulse-shape rolloff factor for downstream functional Mode D transmission to conform to the specification for downstream functional Mode A transmission, either a value of 0.15 or a value of 0.35.

Additional Comments

These recommendations preserve the capability of optimizing for bandwidth or power efficiency in the baseline functional mode for both upstream and downstream transmissions, while reducing the implementation complexity from a fully-programmable (variable-rolloff-factor) pulse-shaping filter. The comparative complexity of the fixed-coefficient filter (fixed α) is approximately one-fourth that of a fully-programmable (variable-α) filter design [4]. This complexity reduction equates to saving 67,000 gates in a fixed-rolloff-factor filter implementation. This means it is possible to implement a dual-α filter, providing a selection between $\alpha = 0.15$ filtering and $\alpha = 0.35$ filtering in the same chip, and still save 33,500 gates compared to a fully-programmable (variable-α) filter design.

References

[1] 802.16.1pc-00/02: Physical Layer Proposal for the 802.16 Air Interface Specification, 1999-12-23.

[2] ETSI EN 301 421 V1.1.2 (1997-08), "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services."

[3] A.J. Viterbi, J.K. Wolf, E. Zehavi and R. Padovani, "A Pragmattic Approach to Trellis-coded Modulation, *IEEE Communications Magazine*, July 1989, pp.11-19.

[4] "Synopsys Module Compiler™ User Guide," version 1997.08.