

Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >	
Title	Proposal for support of FDD in License-Exempt Bands	
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Re:	P802.16a/D4	
Abstract	Rationale for support of FDD in License-Exempt Bands	
Purpose	Support of FDD as well as TDD in all frequency bands in the 802.16a Standard.	
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Support of FDD In License-Exempt Bands

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Proposal

This contribution provides the rationale for, and further discussion on, the support of FDD in the License-Exempt bands in the IEEE 802.16a Standard.

Discussion

The IEEE 802.16a Standard provides for the operation of BWA systems within the License-Exempt bands (5.25-5.35 GHz and 5.725-5.825 GHz) as well as other Licensed bands in the frequency range, 2-11 GHz. It is the recommendation of this author that the standard support both FDD and TDD methods of duplexing within all bands covered by this standard. The rationale is provided below.

The reasons why we need to support FDD in the License Exempt bands generally fall into the following six different categories:

1. **Economics** – BWA equipment suppliers need the ability to provide the most competitive solutions possible. This is best done using FDD in some bands, especially when the bands are “paired.”
2. **Performance** – The performance of certain solutions is optimized using FDD.
3. **Leverage** – FDD systems have been in use for some time. The industry must be allowed to leverage its investment in FDD systems to provide the best solutions possible.
4. **Existing Interference Mitigation Solutions** – Some interference mitigation solutions are already being used, and work equally well with FDD and TDD systems.
5. **Optimized Interference Mitigation Solutions** – A number of different standards groups are working in interference mitigation techniques for equipment operating in the License-Exempt bands. Various IEEE 802 Task Groups are analyzing the best way to achieve interference mitigation solutions among systems operating in the three UNII bands and operating under the FCC Part 15 rules. An ITU-R task group is addressing the interference mitigation solutions for systems used by other primary users in the UNII bands. None of these groups has offered an optimal solution yet. We should not limit innovation at this point in time, and recognize that good solutions are forthcoming.
6. **Simplified Standard** – The standard is simplified by removing yet another special case.

The points below offer more detail and fall into one or more of the six categories listed above.

1. **Use of Common Chipsets** – Some BWA equipment suppliers provide systems today in both the Licensed and License-Exempt bands covered by this standard. It is highly desirable to use the same chipsets as much as possible for equipment that operates in both License-Exempt and Licensed bands to reduce overall BWA equipment costs, especially since some bands have provision for FDD operation and channel pairing.
2. **Use of Both Bands** – The FCC permits the use of both the 5.25 GHz and the 5.725 GHz bands for BWA equipment. The use of one band for downstream transmission and the other one for upstream transmission (i.e. FDD duplexing) provides an efficient use of these bands, especially for applications such as video streaming.
3. **Use of FDD Today** – Most BWA equipment that operates in licensed bands today uses FDD. Suppliers need to be able to leverage this investment.
4. **FDD Chipsets Exist Today** – Chipsets supporting FDD exist, and are being used today, for BWA equipment operating in both Licensed and License-Exempt bands.

5. **Higher Throughput** – Systems that use both bands at the same time, i.e. use FDD, can achieve higher data throughput, especially in situations where there is significant video streaming and where multiple sectors are used.
6. **Better Spectral Efficiency** – FDD systems are more spectrally efficient than TDD systems since less overhead is required for scheduling purposes.
7. **Better Frequency Re-Use** – The use of both bands at once offers better frequency re-use options for the equipment operator, especially in situations where multiple independent sectors are generated from the same geographical location.
8. **FCC Part 15 Requirements** – The FCC rules governing the use of UNII frequency bands allows the use of mixed FDD and TDD systems.
9. **Simplified Standard** – The standard already provides too many options. Supporting both FDD and TDD in the License-Exempt bands removes one more special case.
10. **Minimal Interference with 802.11a Equipment Today** – WLAN equipment operates primarily indoors in the lower 5.15 GHz band today. BWA equipment operating in the UNII bands only operates in the middle band and the upper bands. Thus the interference between WLAN equipment and BWA operating in the UNII bands is minimal to non-existent today.
11. **IEEE 802.11 Co-Existence Work** – The IEEE 802.11 working group has formed a new task group, IEEE 802.11h, to address co-existence issues between 802.11, 802.15 and 802.16a systems. They are defining Dynamic Frequency Selection (DFS) and Transmit Power Control (TPC) mechanisms to mitigate interference between these systems. However, they are NOT addressing co-existence with other primary users of the UNII bands, many of which use FDD-based systems.
12. **Interference Mitigation with other users** – There are multiple primary users of the UNII bands, e.g. radiolocation service, earth exploration-satellite service, etc. in addition to the WLAN and BWA users. All of the other users exhibit very different characteristics (many using FDD) from the WLAN and BWA users. The primary users do not have the EIRP limitations applied to License-Exempt commercial equipment. Effectively they represent the major source of possible interference because of their higher EIRP. Solving the interference mitigation challenge requires addressing all of the users of the UNII bands. The proper solutions are still being determined.
13. **Consideration of Possible WRC 2003 Requirements** – Some of the frequency bands, pending WRC 2003, may have EIRP masks applied to them (such as the 5.25 – 5.35 GHz band). Such masks will be difficult to implement in subscriber terminals, but would be difficult to implement at the larger base stations. FDD would allow downlinks from base stations to be EIRP mask limited, and uplinks to be undertaken in bands not having EIRP mask limitations (such as the 5.725 – 5.825 GHz band). An FDD subscriber terminal could therefore have simple antennas, receiving at 5.25 – 5.35 GHz and transmitting at 5.725 – 5.825 GHz.
14. **ITU-R 8A-9B Task Group Co-existence Work** – The ITU-R 8A-9B Task Group was established to determine sharing arrangements between BWA, WLAN and radiodetermination systems for the purposes of mitigating interference. This group has yet to issue its proposal. Thus the IEEE 802.16a standard must not prematurely exclude the FDD mode of operation in the License-Exempt bands.
15. **ITU-R Preliminary Conclusions** – The ITU-R 8A-9B Task Group has determined that “practical experience may lead to innovative and more efficient means than can be formulated today.” The best interference mitigation techniques for use by systems operating in the UNII frequency bands have not yet been determined. The IEEE 802.16a standard must take this into consideration, and not prematurely exclude the FDD mode of operation in the License-Exempt bands.
16. **FDD Systems Allow Measurements** – It is possible for FDD-based systems to take measurements in both downstream and upstream directions to determine whether interference exists, channel quality, and the frequency of the interferer. These measurements can be used to mitigate interference in FDD-based systems as well as in TDD-based systems.

17. **Indoor/Outdoor Operation** – BWA systems operate outdoors, and are therefore separated from WLAN systems that operate indoors by 10 to 20 dB of attenuation.
18. **Advanced Antenna Systems** – The use of directional antennas can be used to mitigate most of the interference that would otherwise exist between systems operating in the UNII frequency bands.
19. **Interference Mitigation Done at the MAC Layer** – Ultimately, the processing of measurement results and the mitigation of interference must be done at the MAC layer.

Recommendation

It is the recommendation of this author that the IEEE 802.16a Standard support both FDD and TDD methods of duplexing within all bands covered by this standard. This can be achieved by changing the first paragraph of Section 8.3.3.2.2 on page 157 at line 3 of the IEEE 802.16a/D4 Draft Standard to read:

To provision bi-directional operation, the PHY shall support FDD, H-FDD or TDD.