# Co-existing with IEEE 802.16a

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# IEEE 802.16: Overview

¥ Working group developing interoperable air interface standards for Fixed Broadband Wireless Access Systems (FBWA)

— Known also as WirelessMAN$^{TM}$ group

¥ The base standard published early this year

— MAC and PHY for fixed point-to-multipoint BWA systems

— Tailored for 10-66 GHz licensed bands

# IEEE 802.16: Activity

¥ Three ongoing activities

— TGa — PHY & MAC amendments

¥ Two former task groups (TG3 and TG4) merged together

¥ Addresses both licensed and unlicensed bands between 2-11 GHz

— Original TG4 PAR for unlicensed bands excluded deliberately the 2.4 GHz ISM band

— TG2 — Co-existence group

¥ Recommended practice for coexistence of BWA systems

¥ RP for 10-66 GHz published 2001

¥ Currently addressing 2-11 GHz (primarly licensed bands)

— TGc — Profile task group

# IEEE 802.16a: Overview

¥ Amendment to the base 802.16 standard

— Medium Access Control Modifications and Additional Physical Layer Specifications for 2-11 GHz

— The latest draft D3 available since late March 2002

¥ The resulting standard specifies the air interface of fixed (stationary) broadband wireless access systems and applies to systems operating between 2 and 11 GHz, where such systems are permitted

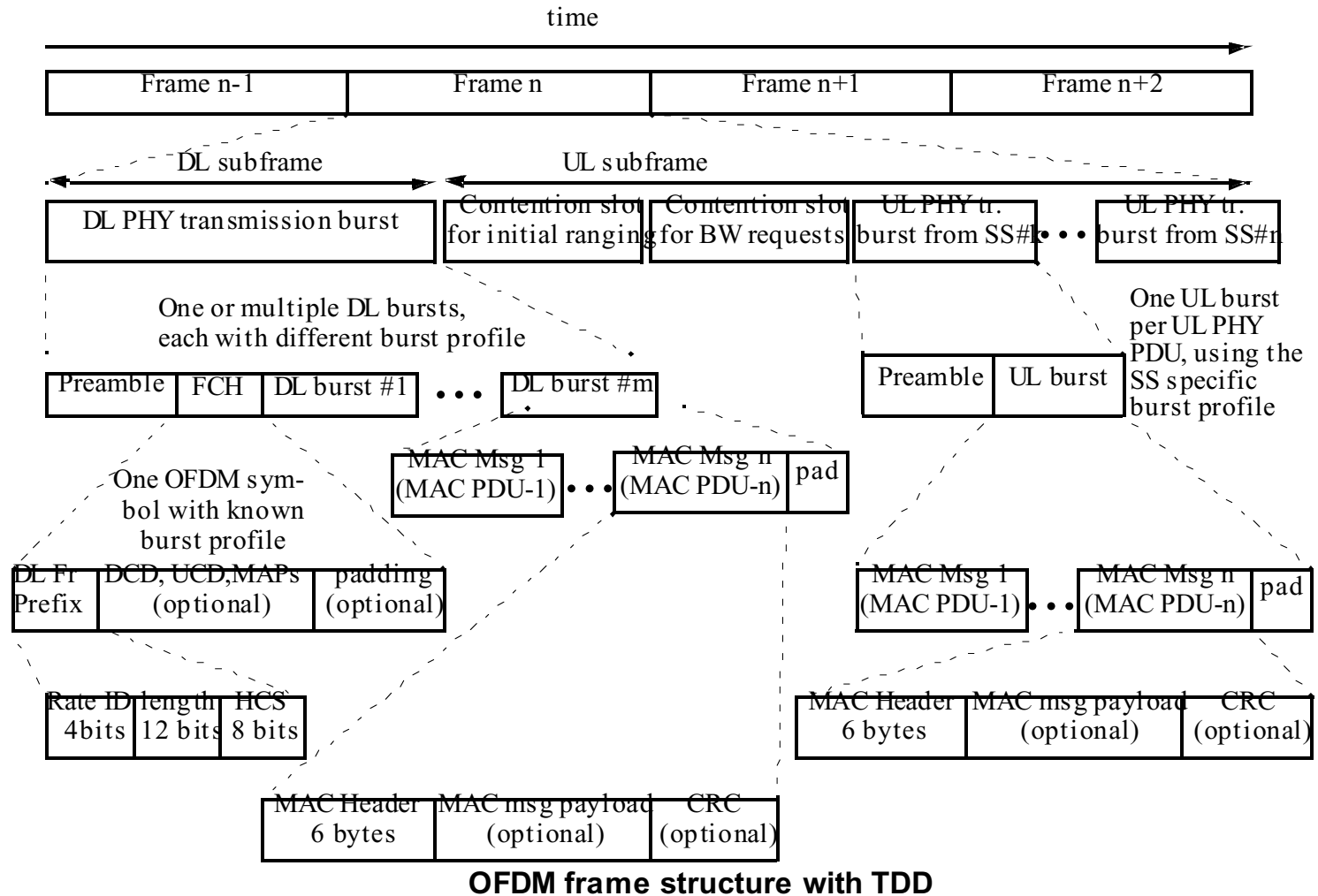¥ Targeted unlicensed frequency bands include 5.25-5.35 GHz and 5.725-5.825 GHz

# IEEE 802.16a: MAC

¥ Exploits the basic MAC of 802.16

 — Common MAC PDU format

  ¥ flexible in size

  ¥ generic MAC header followed by payload and optional CRC

¥ New functionality for better robustness and reliability

 — Messages for transmit power control

 — Per-connection ARQ

 — Optional support for Advanced Antenna Systems

  ¥ Adapt the antenna pattern and concentrate its radiation to each individual subscriber

# IEEE 802.16a: PHY

¥ Only TDD in license-exempt bands

¥ The PHY is based on OFDM

— Can support TDMA as well as OFDMA

¥ 256-FFT OFDM mandatory

¥ 2048-FFT OFDMA optional

— QPSK and 16QAM mandatory sub-carrier modulation schemes, 64QAM optional

¥ Adaptive modulation in both UL and DL for each allocation separately

— Concatenated Reed-Solomon and Convolutional codes to obtain code rates _ and _

¥ Block interleaver

# IEEE 802.16a: PHY

time

| Frame n-1 | Frame n | Frame n+1 | Frame n+2 |

DL subframe                UL subframe

| DL PHY transmission burst | Contention slot for initial ranging | Contention slot for BW requests | UL PHY tr. burst from SS#1 | • • • | UL PHY tr. burst from SS#n |

One or multiple DL bursts, each with different burst profile

One UL burst per UL PHY PDU, using the SS specific burst profile

| Preamble | FCH | DL burst #1 | • • • | DL burst #m |

| Preamble | UL burst |

One OFDM symbol with known burst profile

| MAC Msg 1 (MAC PDU-1) | • • • | MAC Msg n (MAC PDU-n) | pad |

| DL Fr Prefix | DCD, UCD,MAPs (optional) | padding (optional) |

| MAC Msg 1 (MAC PDU-1) | • • • | MAC Msg n (MAC PDU-n) | pad |

| Rate ID 4bits | length 12 bits | HCS 8 bits |

| MAC Header 6 bytes | MAC msg payload (optional) | CRC (optional) |

| MAC Header 6 bytes | MAC msg payload (optional) | CRC (optional) |

**OFDM frame structure with TDD**

# IEEE 802.16a: PHY - Channelization

¥ Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz

Channel center frequency = $5000 + 2.5\ n_{ch}$ (MHz)

¥ 10 MHz and 20 MHz channelization mandatory, 5 MHz optional

— with 20 MHz channelization center carriers: 5280, 5300, 5320, 5745, 5765, 5785, 5805 MHz
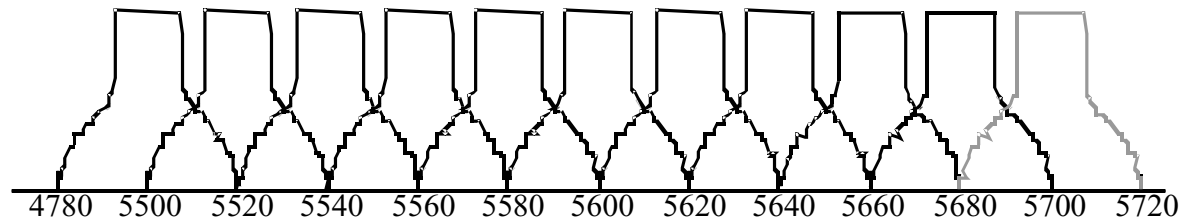
¥ As the draft D3 says:

— Channelization has been defined to be compatible with IEEE 802.11a for interference mitigation purposes, even though this results in inefficient spectrum usage in the middle U-NII band."
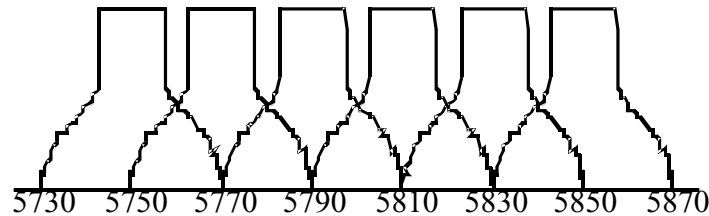
# IEEE 802.16a: PHY — 20 MHz channelization
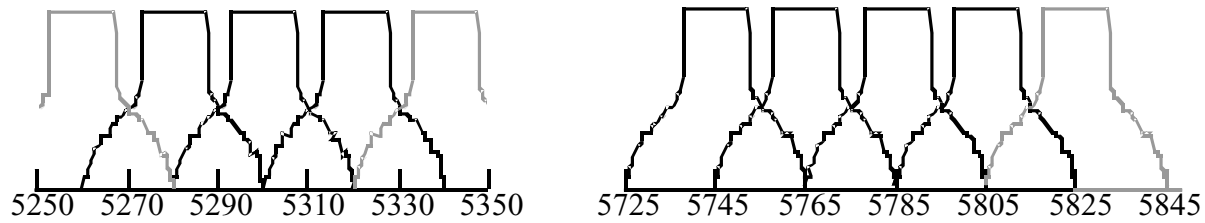


U-NII middle and upper band

CEPT, 5GHz, band B

CEPT, 5GHz, band C
**Channelization, 20 MHz**

# IEEE 802.16a: PHY — 10 MHz channelization

## U-NII middle:

8 channels ($n_{ch}$=106, 110, 114, 118, 122, 126, 130, 134)

## U-NII upper:

8 channels ($n_{ch}$=296, 300, 304, 308, 312, 316, 320, 324)

# Specific Co-existence Methods

¥ The standard shall include Dynamic Frequency Selection (DFS)

— provides capabilities to assess channel quality and communicate that information

— facilitates co-existence

— addresses issues covered by 802.11 TGh

¥ It mandates active transmit power control (TPC) mechanism to facilitate band sharing

— monotonic power level control of 45 dB minimum with resolution of 3 dB

— BS controls Tx power of all subscriber stations (SS)

— DL power control is to both control the cell range and to mitigate interference

# Specific Co-existence Methods

¥ Various channel quality measurements are specified

—BS responsible for making assignments and/or re-assignments based on channel quality assessments

¥ in UL autonomous measurements by the BS

¥ channel quality reports required from SSs

—Measurements and statistics defined:

¥ RSSI mean and standard deviation

¥ CINR mean and standard deviation

¥ uncoded mean BER

# Good to Remember

¥ 802.16a is developing wireless MAN systems for outdoors which results in enough separation in most of the cases to the indoor LAN/PAN devices

— Also the subscriber stations typically outdoor

— Exterior wall attenuation 10-20 dB

— Access radio links typically require engineering and carefull design and deployment

# Summary

¥ Unlicensed part of the TGa is based on the work done by the former TG4

—PAR prepared with care and after consultations with 802.11 and 802.15 => OFDM selected as the basis of the PHY, 2.4 GHz ISM excluded

¥ TGa draft does define mechanisms facilitating sharing in license-exempt bands

—Same channelization as in 802.11a

—TPC with high dynamic range

—DFS with channel assessment reports

—Support for advanced antenna systems and various channel quality measurements

—Robustness within MAC