OFDMA PHY proposal for the 802.16.3 PHY layer

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Purpose:

To introduce MAC enhancements to the TG1 MAC for the TG3/TG4 groups.

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MAC Enhancements proposal for TG3

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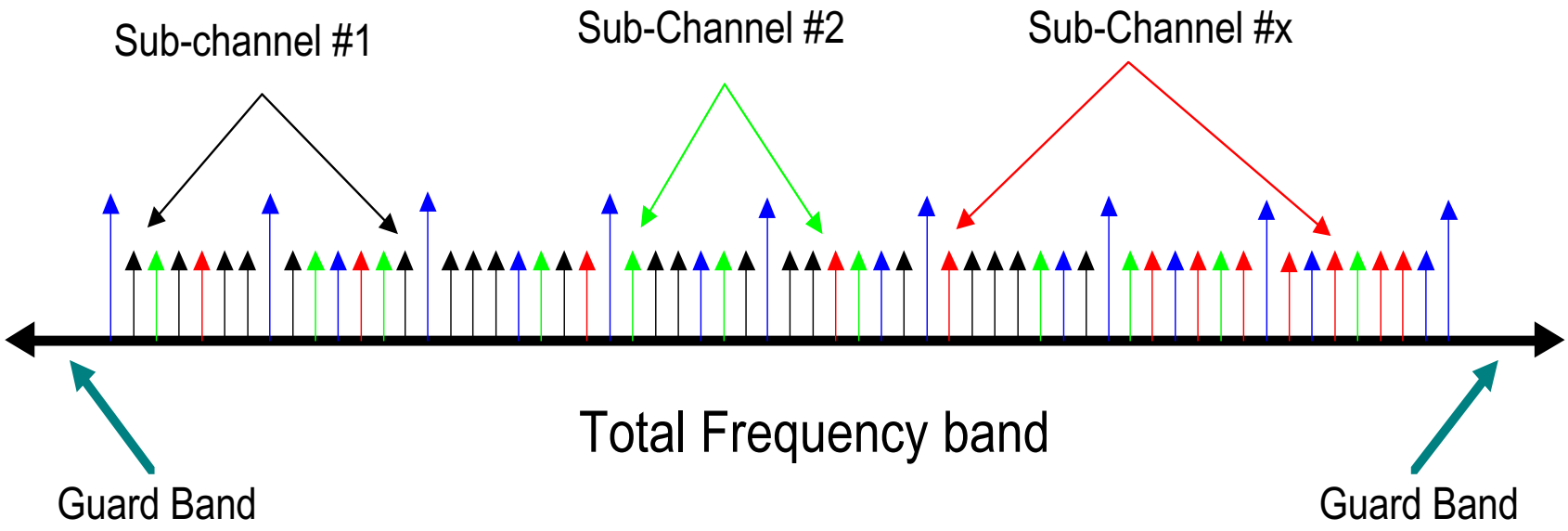
Introduction

- ¥ Proposed Enhancements based on OFDMA PHY proposals (for TG3 & TG4)
- ¥ Already integrated into the DVB-RCT standard (to be approved this April)
- ¥ Based on an existence of Sub-Channels and enhancing existing mechanisms
- ¥ Supports all MAC working modes (FDD-C, FDD-B, TDD)

OFDMA symbol structure

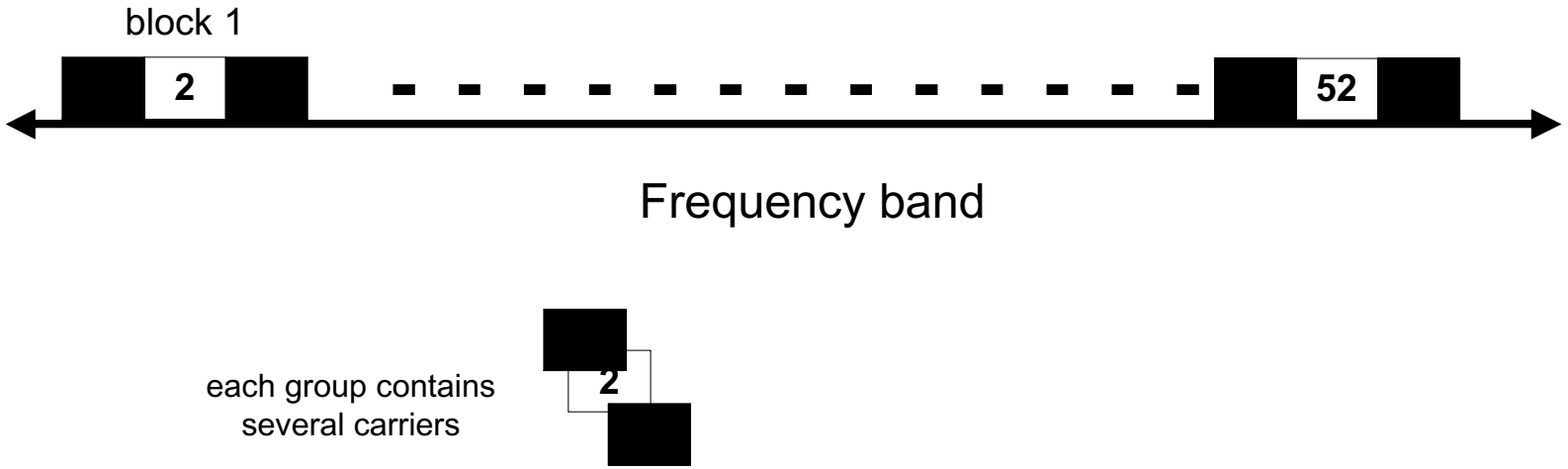
The usable carriers are divided into groups called Sub-Channels.



Using Special Permutations for Carrier Allocation

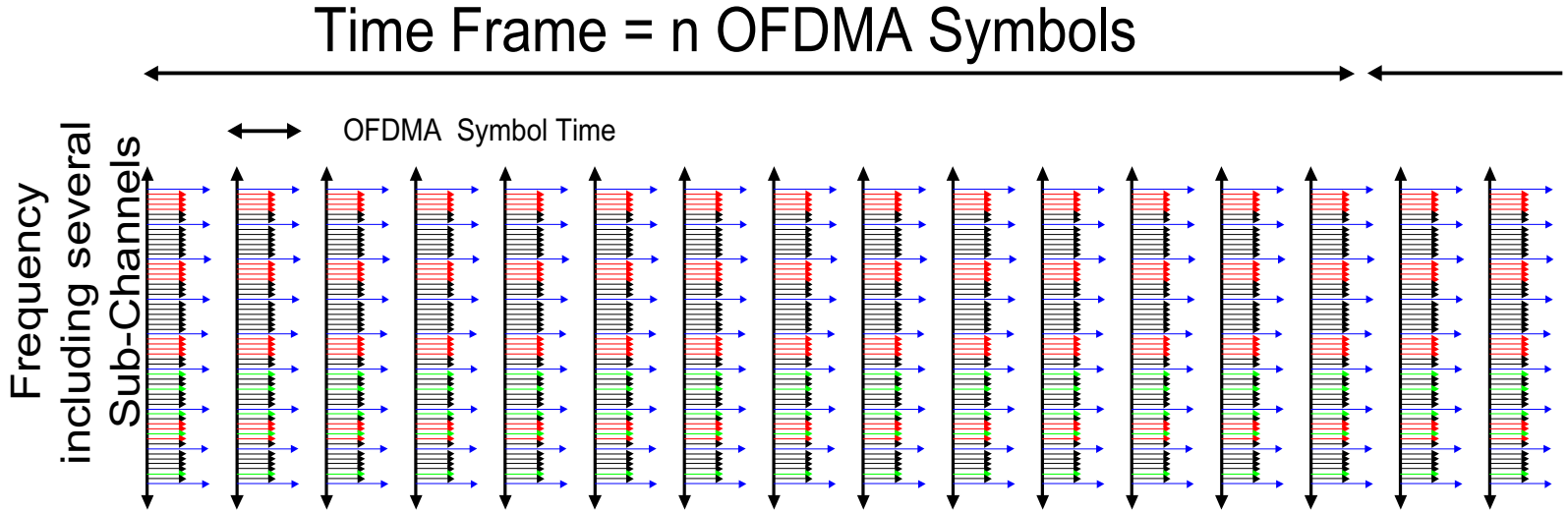
All usable carriers are divided into 53 (or 48) carrier groups named basic group, each main group contains several carriers (depending on the mode used):

- ¥ 32 carriers for the 2k mode
- ¥ 16 carriers for the 1k mode
- ¥ 4 carriers for the 256 mode



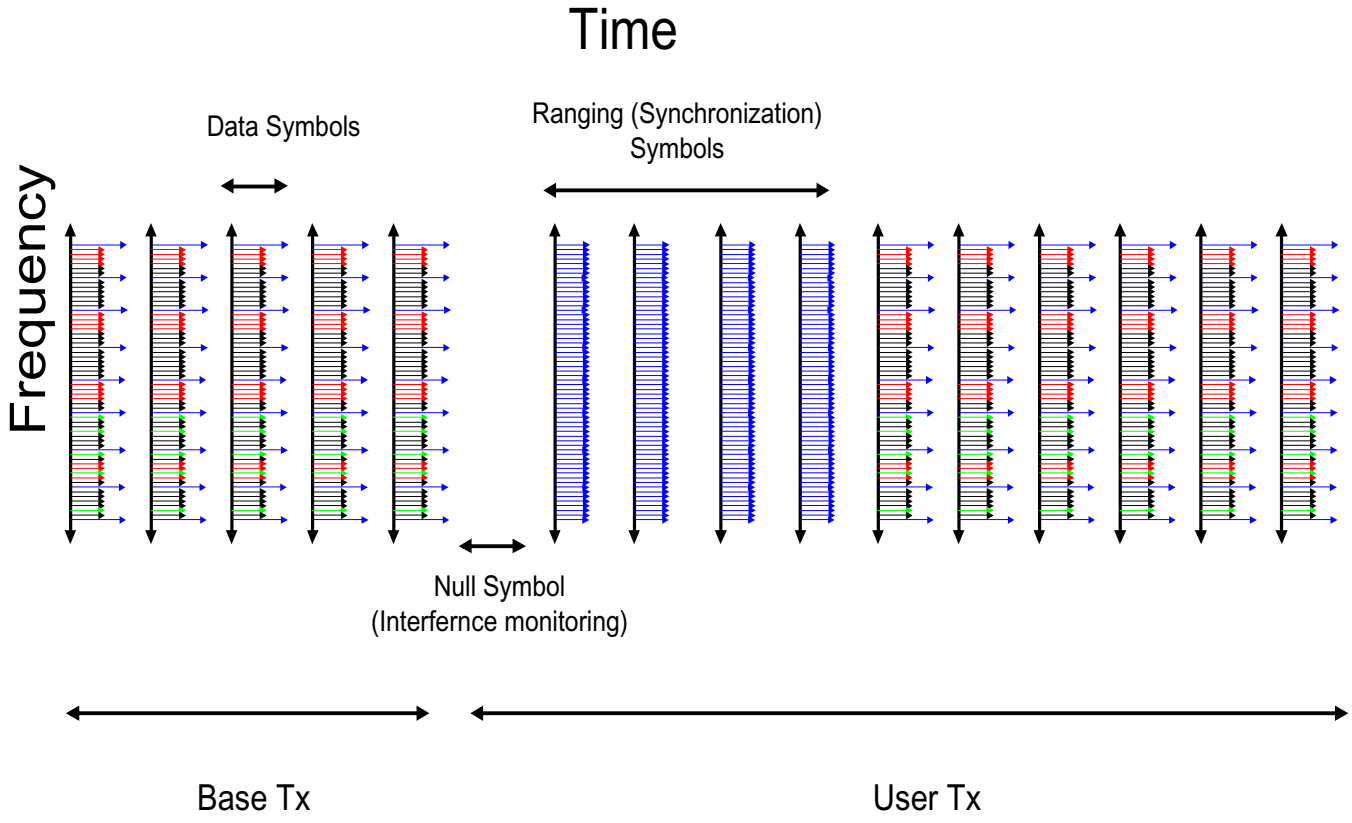
OFDMA/TDMA - Principles

Using OFDMA/TDMA, Sub Channels are allocated in the Frequency Domain, and OFDM Symbols allocated in the Time Domain.



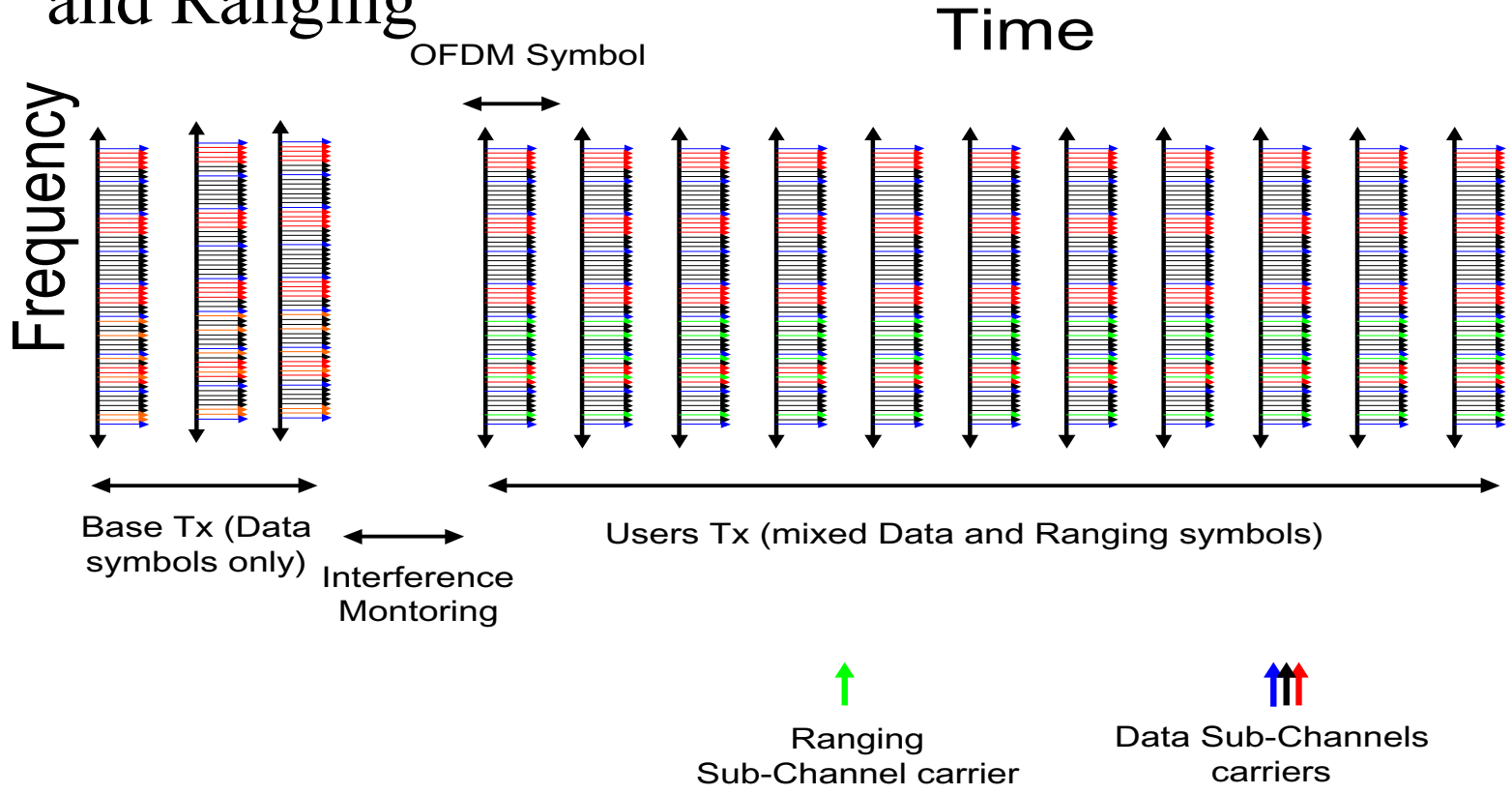
Access method for the 256, 64 modes

All Sub-Channels within a symbol are allocated for data or Ranging only



Access method for the 2k, 1k modes

DS symbols are allocated for data only, US Sub-Channels within a symbol are allocated for data and Ranging



Proposed Ranging Enhancement

Proposed Ranging Enhancement

Terminology:

¥ Ranging Sub-Channels:

—Dedicated Ranging carriers

¥ Ranging Symbols:

—Ranging - Dedicated OFDM Symbols in 64, 256 modes.

—Normal OFDM Symbols in 1K,2K modes

Proposed Ranging Enhancement

Terminology (cont.)

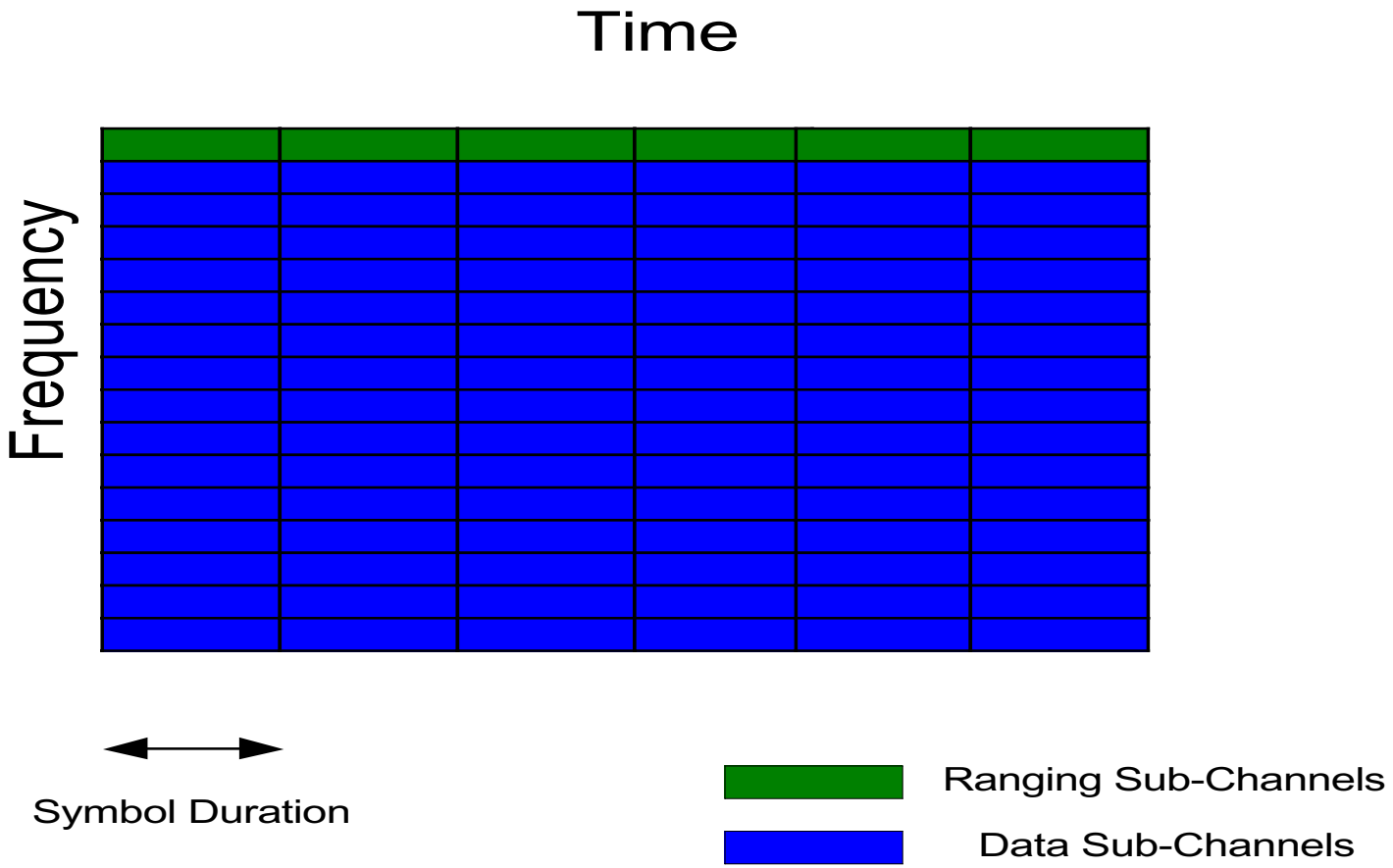
¥ Ranging Slot

—Combination of Ranging Sub-Channel and Ranging Symbol

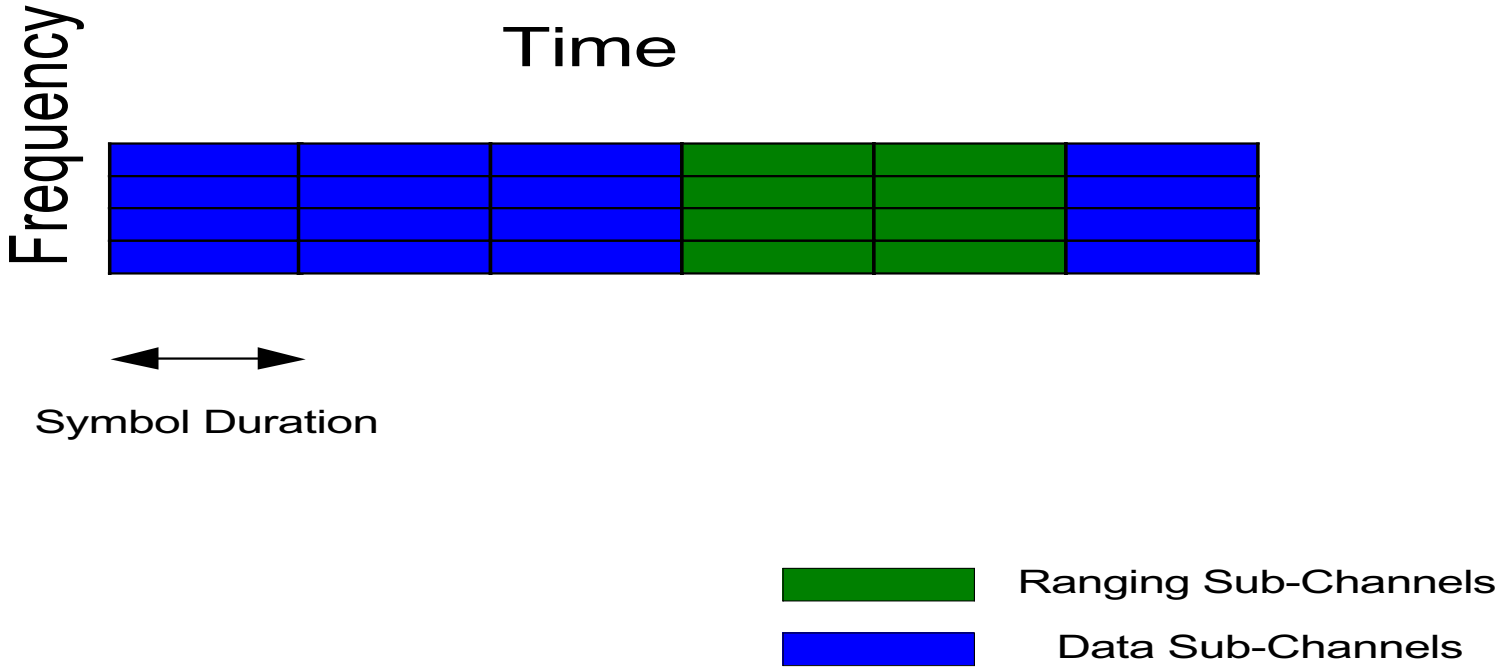
¥ Ranging Code:

—CDMA code sent on the ranging slots

Ranging Sub-Channels



Ranging Symbols



Proposed Ranging Enhancement

- User Selects Randomly Ranging Slot
- User Selects Randomly Ranging Code
- User Sends the Ranging Code to the BS with a pre-defined and robust modulation
- User waits for RNG-RSP message with indication about the sent Ranging Code and Ranging Slot

Proposed Ranging Enhancement

- Advantages:
  - Robust Synchronization Technique
  - Several SS can be Synchronized Simultaneously
  - In the 1K, 2K modes, the ranging is done in parallel to data transmission with small overhead

Proposed Ranging Enhancement

¥ Advantages (cont)

—The SS is the initiator of the initial Ranging process

—The CDMA technique can be used for other purposes.

Enhanced Bandwidth Reservation

Enhanced Bandwidth Reservation

Current Bandwidth reservation techniques:

- ¥ Unsolicited Grants (UGS, UGS-AD)
- ¥ Various Polling technique (rtPS, nrtPS, PM bit)
- ¥ Piggyback
- ¥ Best Effort Bandwidth request (Contention)

Enhanced Bandwidth Reservation

- IP centric environment
  - —Bursty and unexpected traffic
  - —No predictable polling strategy
  - —Small bursty packets (TCP ACKs)
  - —Dense cells

- Need for a fast and safe bandwidth reservation tool with minimal overhead and good statistical multiplexing

Enhanced Bandwidth Reservation

- Three domains of CDMA codes:
  - Initial Ranging
  - Maintenance Ranging
  - BW Requests

- Using the CDMA codes on the Ranging Slots to send bandwidth requests !!

Enhanced Bandwidth Reservation

Advantages

- ¥ No need for best effort access region allocated
- ¥ Reduce the collision risk due to the CDMA technique
- ¥ Several requests can be sent simultaneously
- ¥ No specific allocation to a subset of users

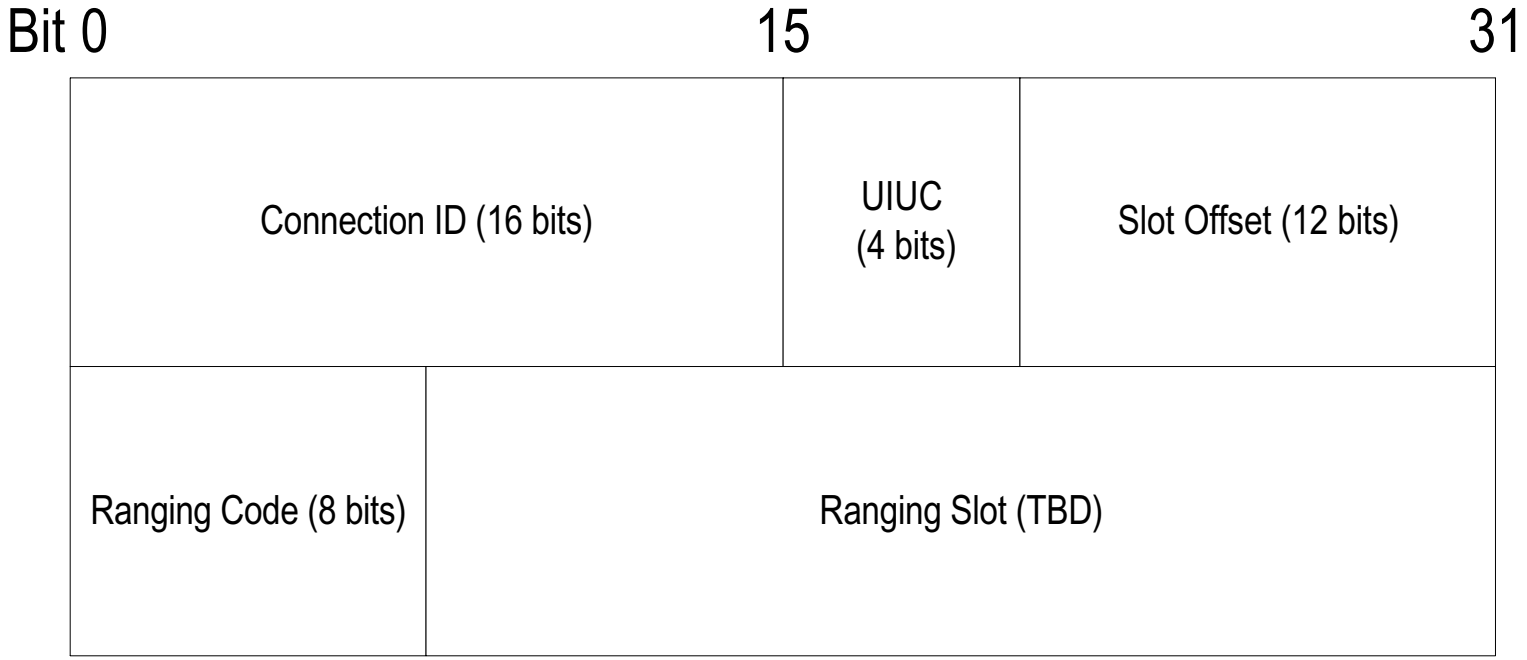
Enhanced Bandwidth Reservation

How does it work?

- ¥ SS randomly selects Ranging Slot and Request Code (uses request backoff window)
- ¥ BS receiving Request Code, allocates a predefined BW
- ¥ SS identify it s allocation by the Ranging Slot and Request Code.

Enhanced Bandwidth Reservation

¥ Proposed Upstream MAP IE for Request Code:



Two Dimensional Allocation

Two Dimensional Allocation

- A OFDMA based PHY introducing the notion of a Sub-Channel or Sub-Carriers allocation.

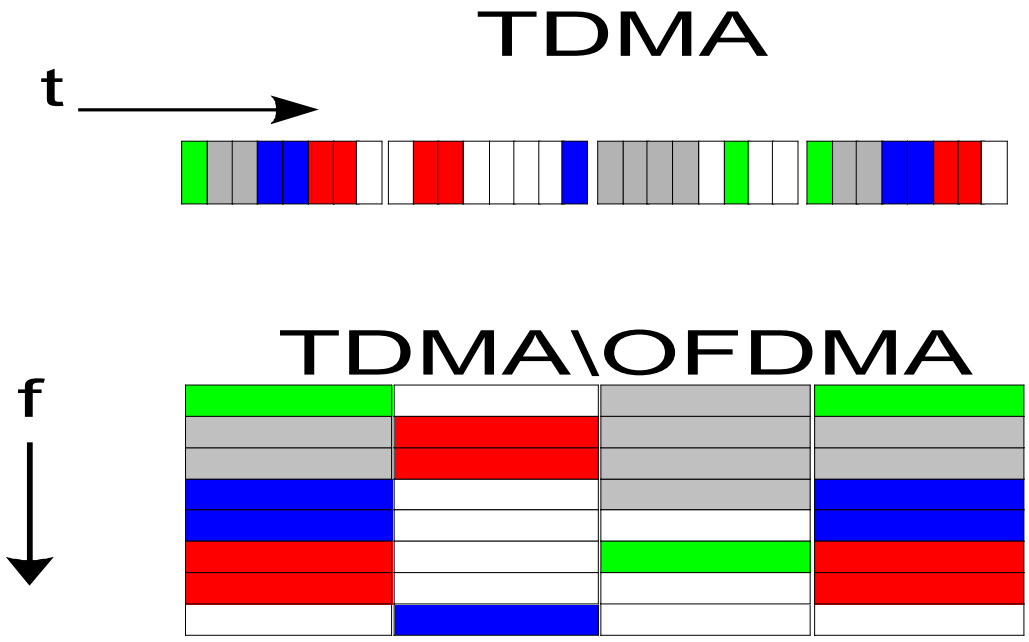
- The upstream (and downstream) allocation expands into a combination of frequency and time.

Two Dimensional Allocation

- Slot = ({N,m} | N = Time Symbol,
  m = Sub-Channel)
- Time tick duration = OFDM symbol duration
- Addition of Sub-Channel reference to the time reference

Two Dimensional Allocation

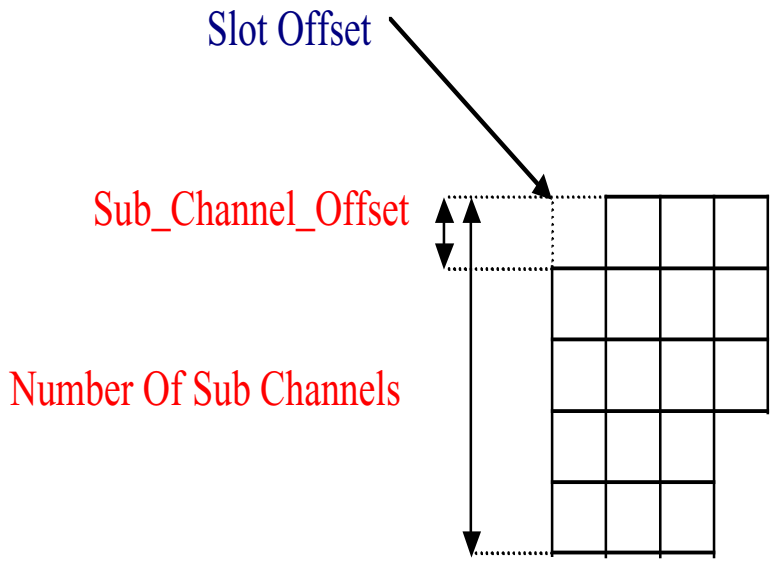
MAC Mapping can stay in the same complexity level as for ordinary TDMA schemes



Two Dimensional Allocation

- The allocation can be optimized to facilitates the two dimensional grid
- Each user will get allocation according to the relevant QoS requirements
- Allocation of a *sub-grid* in the two dimensional resource

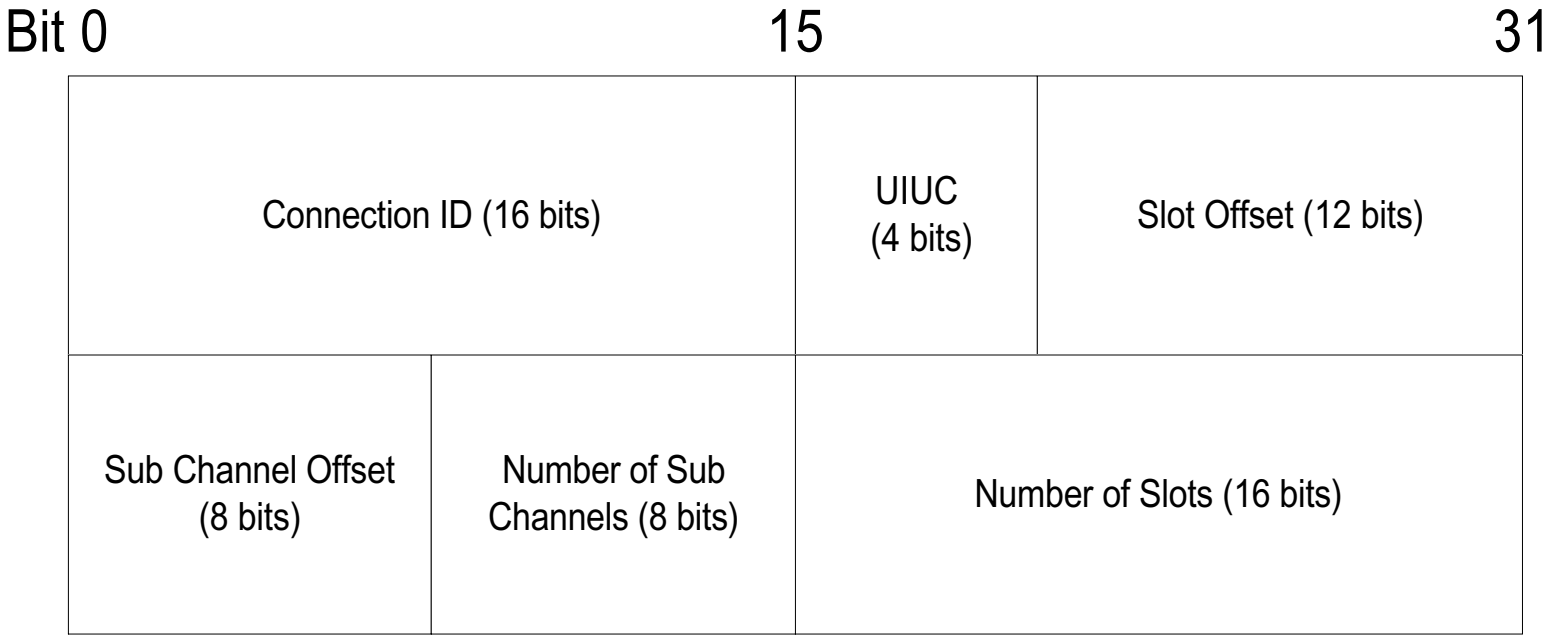
Two Dimensional Allocation



Example of slot pattern with 17 allocated slots

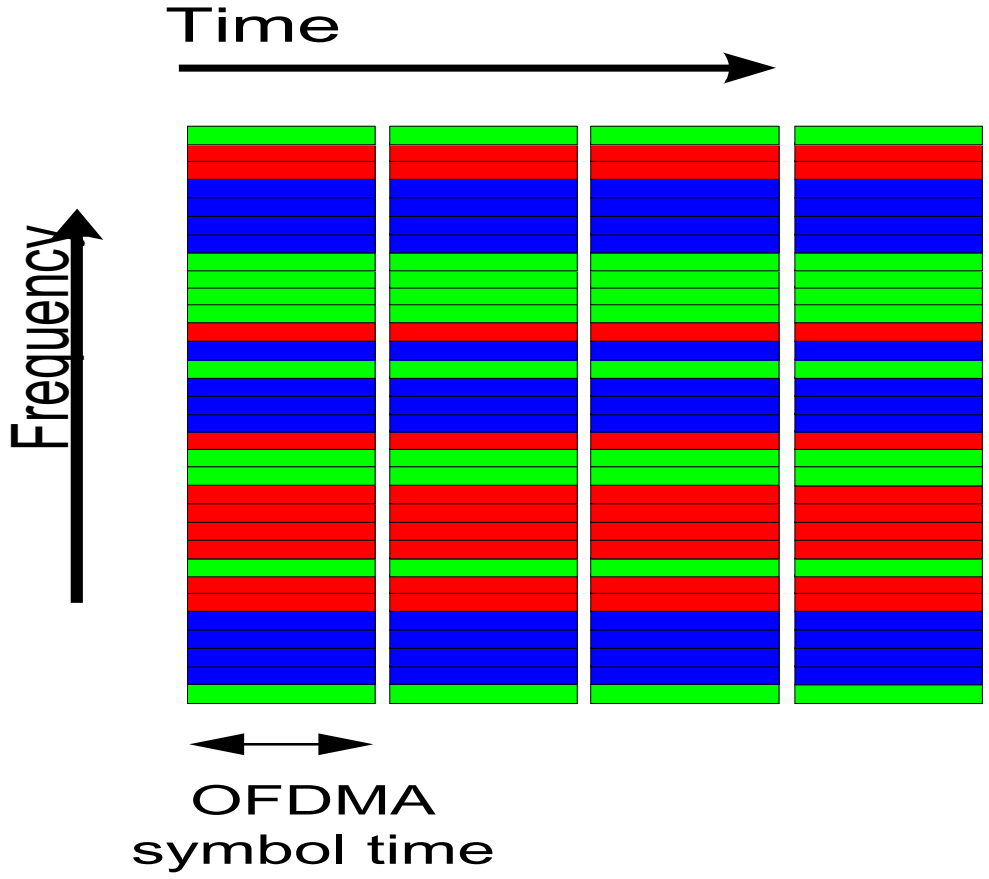
Two Dimensional Allocation

- Possible Map IE structure to support two dimensional allocation:



Two Dimensional Allocation

MAC Mapping maps the down stream Sub-Channels to their specific Usage/Users.



Summary

- ¥ Guidelines for possible enhancements based on OFDMA PHY
- ¥ Efficient utilization of the transmission resource
- ¥ Natural expansion of the TG1 MAC for OFDMA PHY
- ¥ Based on an OFDMA-based standard (DVB-RCT)