

Initial/Handover Ranging for IEEE 802.16m System

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Re: [IEEE 802.16m-08/016r1](#) – Call for Contributions on Uplink Control Structures

Base Contribution:

C802.16m-08/448r1

Purpose:

Propose to be discussed and adopted by TGM for the use in Project 802.16m SDD

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<<http://standards.ieee.org/guides/bylaws/sect6-7.html#6>> and <<http://standards.ieee.org/guides/opman/sect6.html#6.3>>.

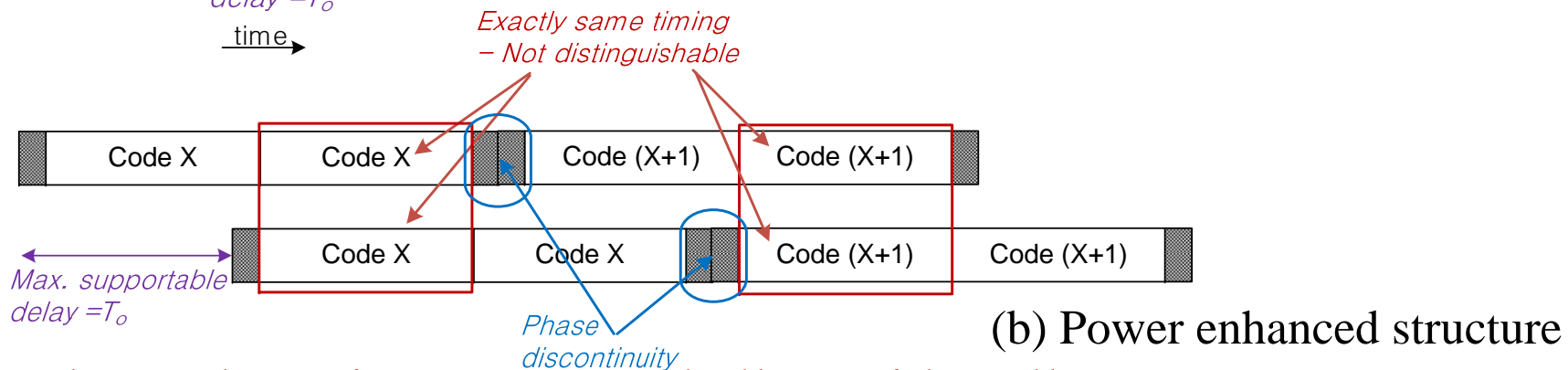
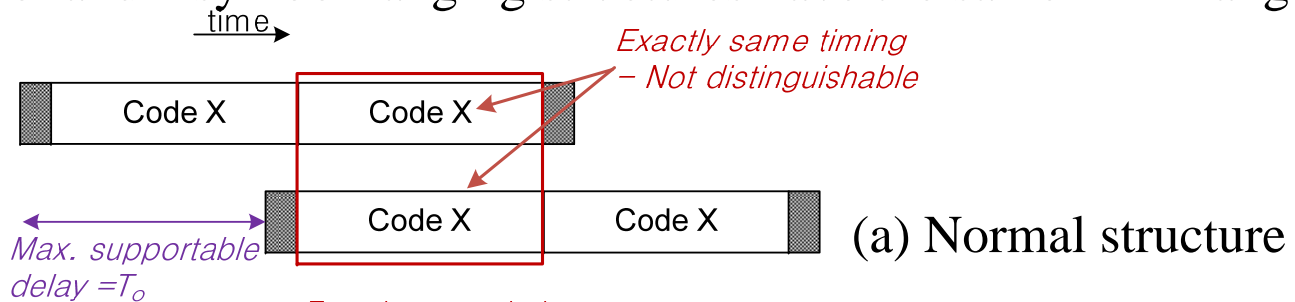
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Issues of Legacy Ranging Structure

- SRD Coverage Requirement Related
 - Limited Coverage for Timing Estimation
- Detection Performance Related
 - Insufficient Link-Budget for Maximum Cell Coverage
 - Poor Correlation Property
 - Poor PAPR/CM
- Structural Problem
 - Interference to Data subcarriers
 - Resource Utilization

Limited Coverage for Timing Estimation

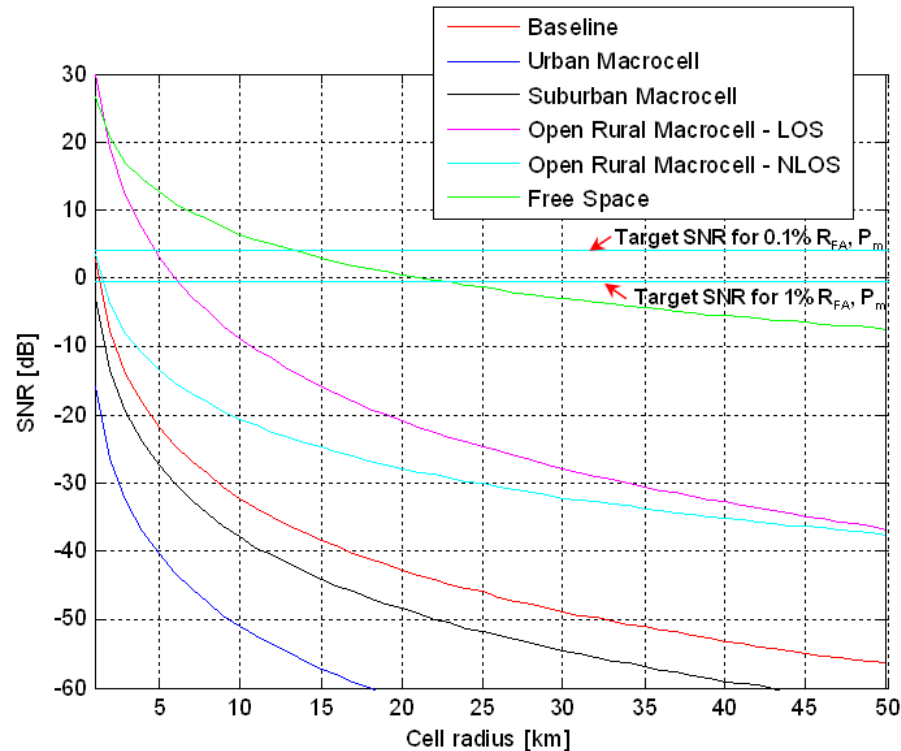
- Current SRD specifies cell-size up to 50km
- Legacy ranging channel
 - Non-ambiguous supportable cell-size is limited by one OFDM symbol (=91.43 μ s RTD)
 - 2 symbol and 4 symbol ranging structures have the same RTD range



Enhanced ranging structure shall provide cell coverage up to 50km (333.36 μ s RTD)

Insufficient Link-Budget for Maximum Cell Coverage

- Legacy ranging structure of 4 OFDMA symbols (no interference)



- Maximum cell coverage under ideal free-space model
 - only 13.5 km (or 22.7 km) cell radius for 0.1% (or 1%) target probability

👉 The additional energy margin (11.4dB or 4.5dB) is required even for free space propagation

Poor Correlation Property

- Legacy ranging codes have poor correlation property
- The peak difference of auto-correlation and cross correlation (The sequence power is normalized)
 - It represent the robustness to noise and interference
 - 16e codes (144 length), AMC : 12.04 dB
 - 16e codes (144 length), PUSC : 11.05 dB
 - ZC codes (139 length), AMC : 21.43 dB
 - ZC codes (701 length), AMC : 28.46 dB

👉 The ranging sequence shall show low cross correlation for better detection performance.

Poor PAPR/CM

- In order to fully utilize Power Amp (better link budget or less distortion), the ranging preamble should have the low PAPR and CM value
- The legacy codes have large PAPR/CM.

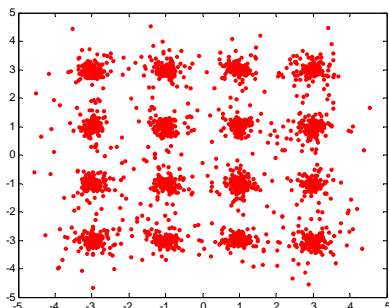
	PUSC for legacy codes		AMC for legacy codes		AMC for ZC sequences (139 length)		AMC for ZC sequences (701 length)	
	PAPR	CM	PAPR	CM	PAPR	CM	PAPR	CM
Min.	4.81	2.57	3.42	2.12	1.82	-0.48	1.73	-0.67
Max.	12.48	4.64	10.21	5.19	4.53	2.01	4.97	2.20
Avg.	6.93	3.38	5.76	3.26	2.99	0.93	3.00	0.97

* [dB]

👉 The ranging sequence shall show low PAPR and CM for better link budget.

Interference on Data subcarrier

- Inter-subcarrier interference to data traffic
 - RTD makes OFDMA symbol boundary mismatch among ranging and data
 - ISI on data (distributed mode > localized mode)



< ISI impact to constellation for 16-QAM >

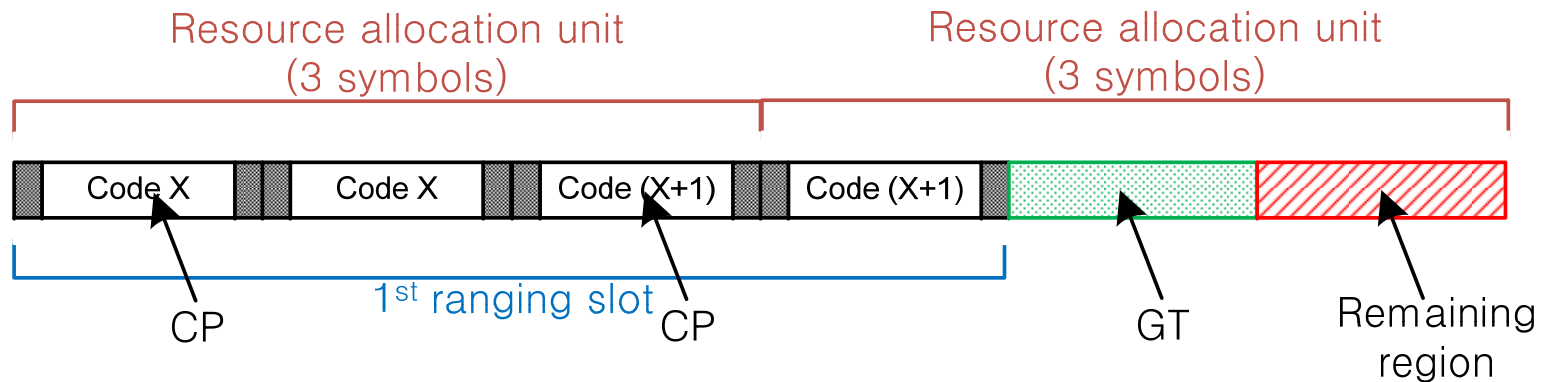
< Data performance degradation due to ranging channel >

	QPSK	16-QAM	64-QAM
1 ranging MS	0.2 dB	0.7 dB	4.2 dB
2 ranging MS	0.4 dB	1.5 dB	Large
4 ranging MS	0.9 dB	4.3 dB	Large

☞ The localized frequency allocation is preferable.
(including guard band at edge of ranging bands)

Resource Utilization

- Legacy ranging structure
 - OFDMA symbol CP is attached for each preamble
 - Every length should be constructed by OFDM symbol granularity
 - No optimization
 - In-efficient ranging CP implementation in 4-symbol structure
 - 2 OFDMA symbols



👉 The ranging structure shall utilize radio resource in an optimized manner.

Time Domain Criteria of Ranging Structure

- **CP (cyclic prefix)**
 - Enable frequency domain detector of low complexity
- **GT (guard time)**
 - Prevent the inter-symbol interference to next OFDMA symbol
- **Preamble Length**
 - Configure enough power gain to cover a large cell (up to 50 km)
 - Provide ranging opportunity
 - Support maximum mobility (up to 350km/h)
- **Preamble sequence**
 - Possibly zero auto-correlation
 - low cross-correlation
 - low PAPR/CM

Frequency Domain Criteria of Ranging Structure

- **Localized Frequency Region**

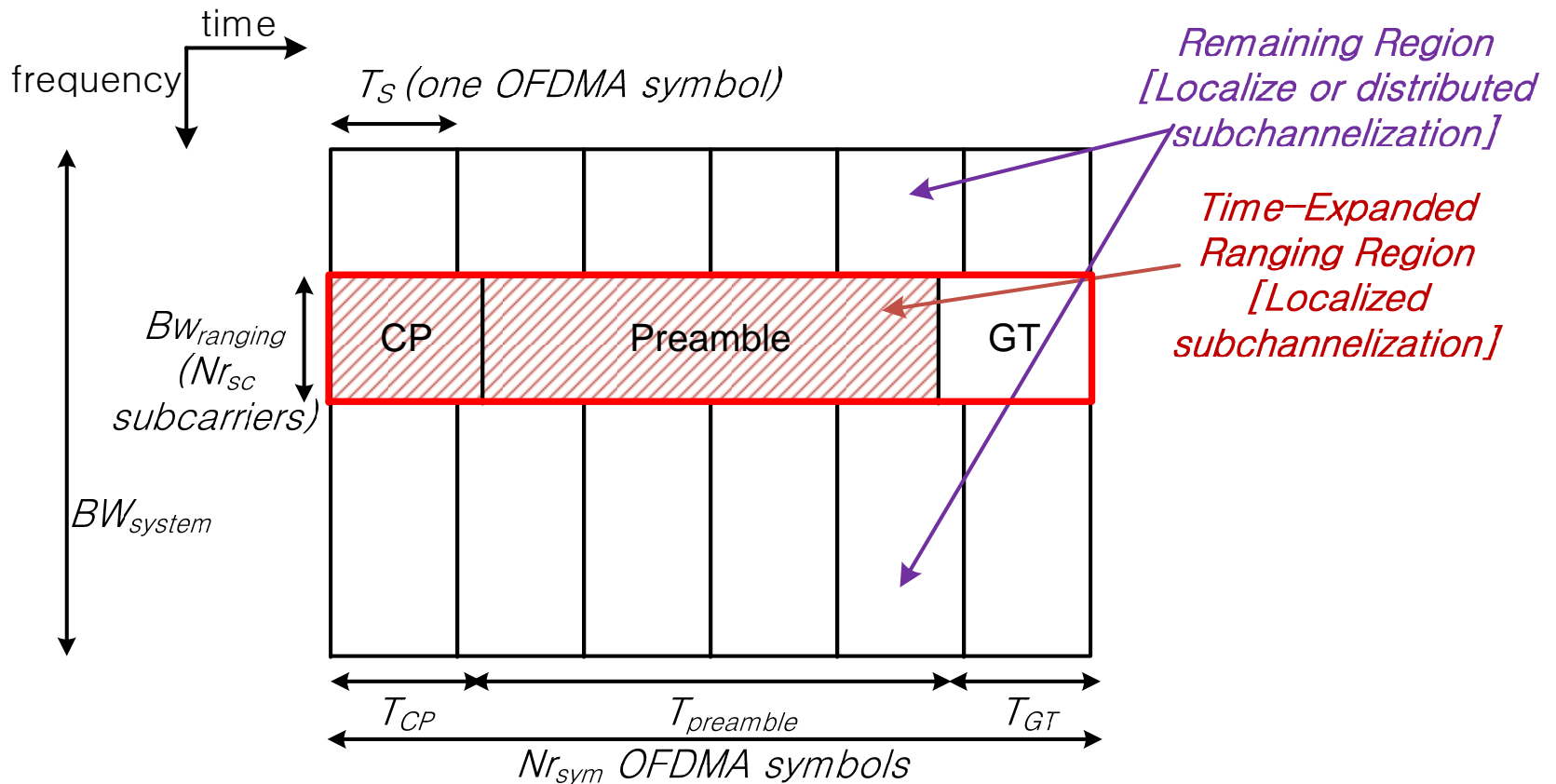
- Efficiently prevent the interference to adjacent channels (guard subcarriers)
- Increase number of available codes while constrained by Doppler frequency
- Increase detection performance [12]

- **Ranging Bandwidth**

- UL symbol timing accuracy shall be smaller than $(T_b/32)/4$ in [9]
- Ranging bandwidth shall be $\geq 1.4\text{MHz}$ (e.g., 144 subcarriers)

Proposed Ranging Structure

- Time Domain : Nr_{sym} consecutive OFDMA symbols
- Frequency Domain : Nr_{sc} consecutive subcarriers
- Continuous resource in both time and frequency domain



Proposed Text for SDD

11. Physical Layer

11.y. Uplink Control Channel

11.y.a. Initial/Handover Ranging

The enhanced ranging channel consists of three parts; 1) cyclic prefix (CP), 2) Preamble, and 3) guard time (GT) as shown in Figure 11.y.a.1. The resource allocation should be Nr_{sc} consecutive subcarriers by Nr_{sym} consecutive OFDMA symbols. Some subcarriers of ranging channel should be reserved for a guard band. The details of the each length of three parts and its configurations are FFS.

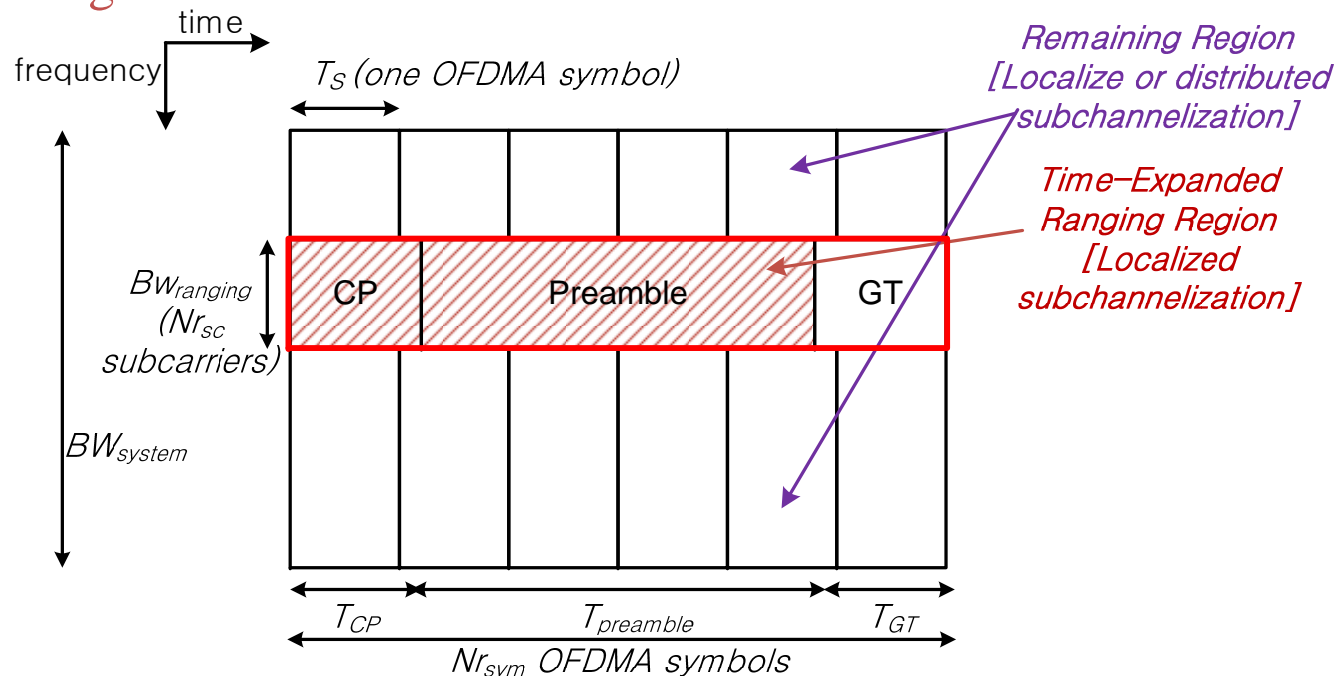


Figure 11.y.a.1 Enhanced Ranging Structure for IEEE 802.16m System