Title: Spectrum sharing in License Exempt bands – protocol proposal

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Purpose: Make possible a certain level of QoS in LE bands

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Spectrum sharing in License Exempt bands – protocol proposal

Marianna Goldhammer

ALVARION

Problem to resolve: inter-system interference

- Between co-located or almost co-located Access Points using un-synchronized MAC Frames
  - general TDD problem
    - un-coordinated transmit and receive intervals
- Between not co-located Access Points
  - ST working in the nearby of another Access Point will be strongly interfered
    - Adjacent channel interference problem
  - Different operators having partially overlaid cells and using the same channel
    - Co-channel interference problem
- Indoor ST is in the relative vicinity of a WLAN network

Interference scenarios
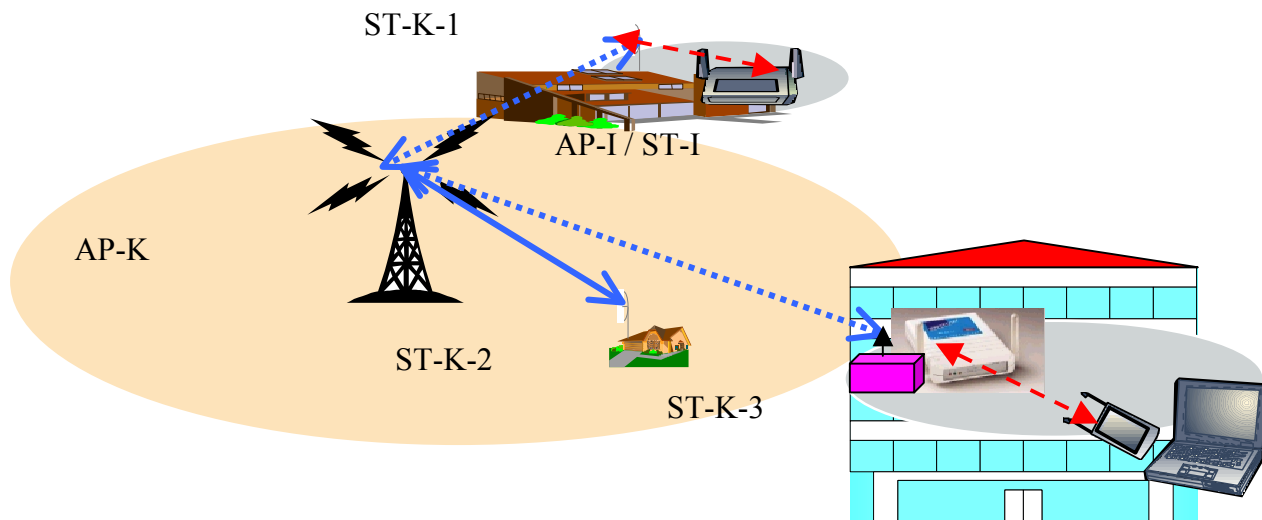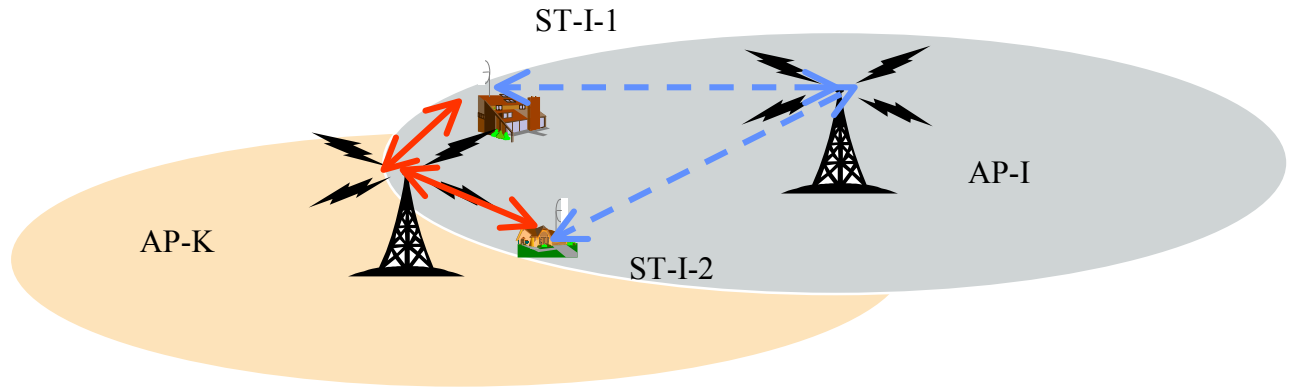
Perception

- Operators
  - LE spectrum should not be used – no QoS possible
- Regulators
  - Should "listen before send" be imposed in LE bands?
    - Will not work with scheduled protocols
    - 802.16 should have an interference avoidance mechanism

Solution

- Create "interference – free" periods
- Use minimum signaling
  - Only 2 signals are defined here!
- Assumptions
  - Operators shall co-ordinate
    - MAC Frame durations
    - Tx / Rx intervals
  - All the systems have equal right to spectrum

Rotating wheel principle

- A system may be experience adjacent channel and / or co-channel interference

- Create a rotating wheel of MAC Frames:
  - Every system will have control of one of the MAC frames, to create interference-free slots

AP 1
MAC Frame 1

AP 2
MAC Frame 2

AP 3
MAC Frame 3
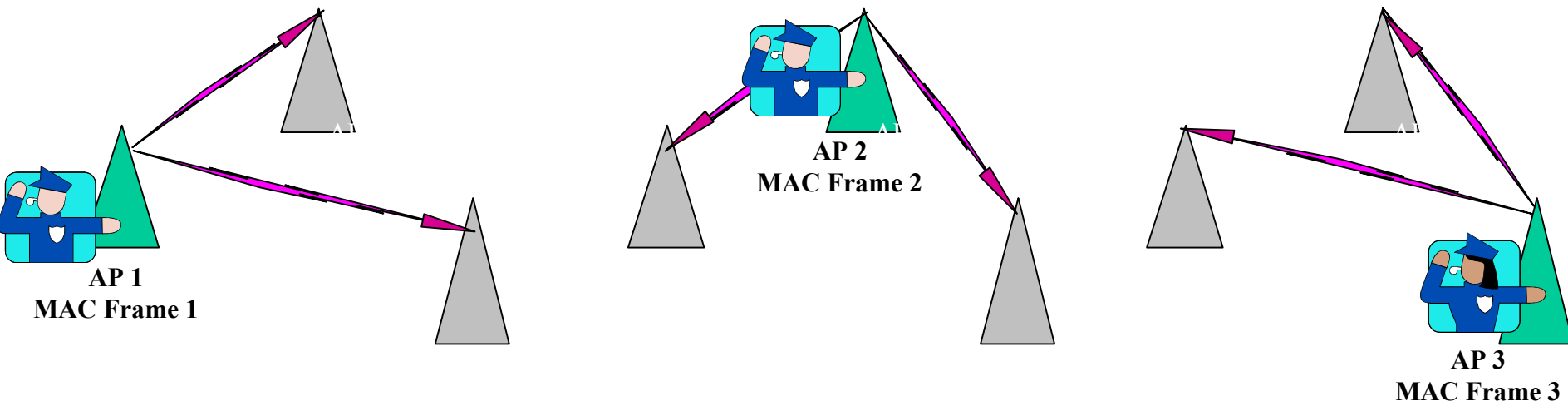
3 states wheel: basic structure
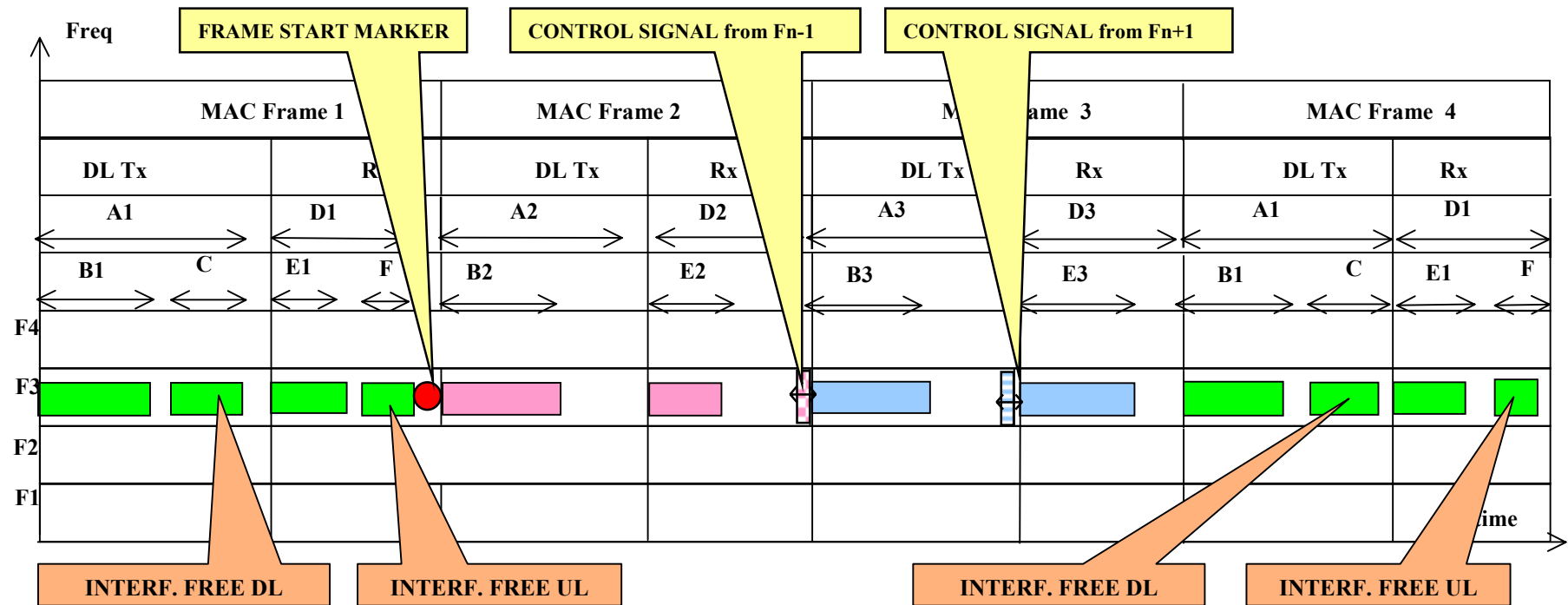
Example: 3 states wheel

Resolves: 2 adjacent channel interference
- Frame control
- systems on F3, F6 in MAC Frame 1
- systems on F2, F5 in MAC Frame 2
- systems on F1, F4 in MAC Frame 3
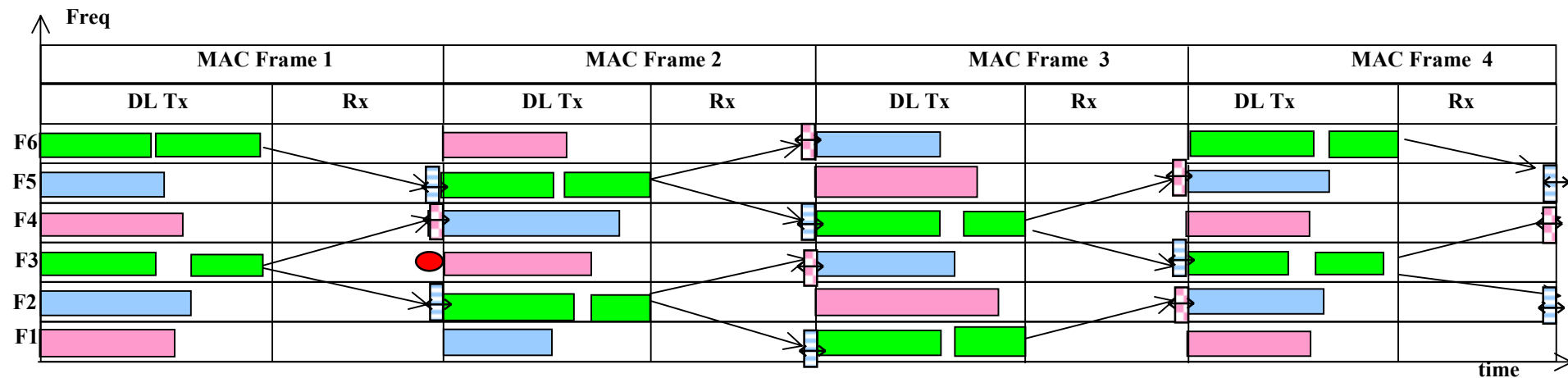
Example: 4 states wheel

Resolves: 2 adjacent channel interference, 1 co-channel interference
- Frame control
- System 1 on F3, system 1 on F6, in MAC Frame 1
- co-channel control for system 2 may be also inserted
- Systems on F2, F5 in MAC Frame 2
- System 2 on F3, system 2 on F6, in MAC Frame 2
- co-channel control for system 2 may be also inserted
- systems on F1, F4 in MAC Frame 4
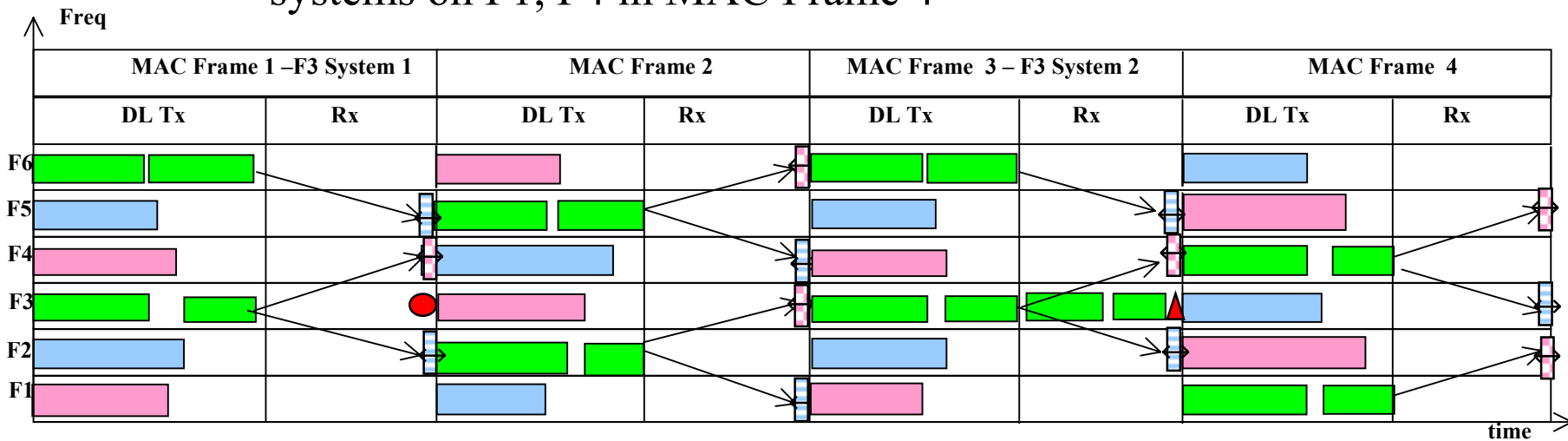
Example: creating up-link interference free slots
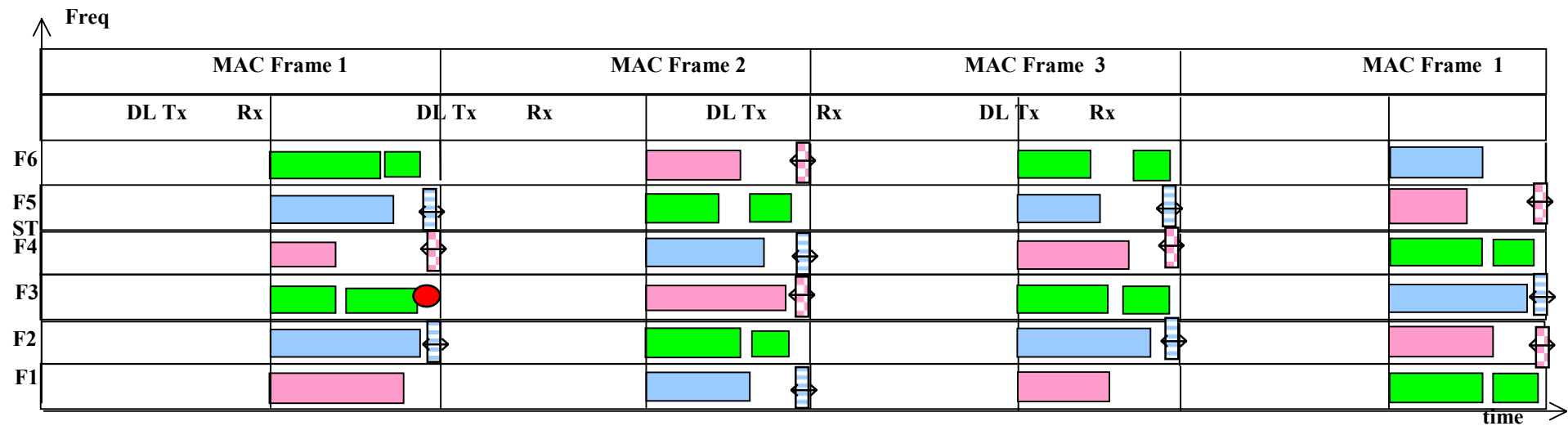
Markers signals

- Markers
  - PHY only
  - One symbol duration
  - Defined place in MAC frame
    - Before the frame start
    - AU or SU can place them at the right time

Possible marker signals

Channel split in 32 bins; bins between 6…26 are used

Sub-band number	6	8	10	12	14	18	20	22	24	26
SYNC_MARKER Type 1	y			y	y				y	
		y			y	y				y
	y		y			y	y			
SYNC_MARKER Type 2		y		y			y	y		
			y		y			y	y	
				y		y			y	y
SYNC_MARKER Type 3	y				y		y			y
		y	y			y		y		
			y	y			y		y	

Controls – MAC or PHY

- Common
  - Control: for DL or UL, increase or decrease Tx or Rx, with STEP 1 or STEP2
  - STEP1 = 2%, STEP2 = 5%, faster adjustment
- MAC Message
  - PHY dependent, to be used by WirelessMAN-OFDM mode
  - Implies a roaming procedure
- PHY signaling
  - PHY independent, usable by all 802.16 modes, eventually by 802.11a
    - Insert energy in sub-bands
    - One symbol duration
    - Defined place in MAC frame, AU or SU can place them
    - Before the frame start

Control message format

Table 1 – TLV for Ext-Act-Ctrl

Name	Type	Length	Value
SHFT_FREQ		1	Frequency shift of channel to be controlled
Control		2	Use the OR function 0h80: Restraint downlink transmission, use IME_STEP_1 0h40: Restraint downlink transmission, use TIME_STEP_2 0h20: Restraint up-link transmission, use TIME_STEP_1 0h10: Restraint up-link transmission, use TIME_STEP_2 0h08: Increase downlink transmission, use TIME_STEP_1 0h04: Increase downlink transmission, use TIME_STEP_2 0h02: Increase up-link transmission, use TIME_STEP_1 0h01: Increase up-link transmission, use TIME_STEP_2

Control Signal Format

Message	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Bin 10	Bin 11	Bin 12
	Decrease DL	Decrease UL	Increase DL	Increase UL	STEP1 DL	STEP2 DL	STEP1 UL	STEP1 UL	DL Bin Check		UL bin Check	
									D1	D0	D1	D0
Decrease downlink transmission, use TIME_STEP_1	y				y				y			
Decrease downlink transmission, use TIME_STEP_2	y					y					y	
Decrease up-link transmission, use TIME_STEP_1		y					y				y	
Decrease up-link transmission, use TIME_STEP_2		y						y				y
Increase downlink transmission, use TIME_STEP_1			y		y				y			
Increase downlink transmission, use TIME_STEP_2			y			y					y	
Increase up-link transmission, use TIME_STEP_1				y			y					y
Increase up-link transmission, use TIME_STEP_2				y				y			y	

Conclusions

- Avoiding interference between 802.16 systems in LE bands
  - Possible
  - ONLY 2 SIGNALS
    - MAC Frame SYNC_MARKER
    - CONTROL
- Work
  - Adopt the proposal
  - Close the details through the re-circulation process