3GPP RAN #68
June 2015

RP-150626

LTE-based Vehicle to Vehicle Communications

QUALCOMM®

Background: V2V Requirements

SA1 to RAN

- LS from SA1 to RAN #66
  - Providing a set of requirements for V2V
  - See 3GPP TR 22.885
  - Table below also provides an informative set of possible parameters

Worst case scenario driving requirements

	Effective Range	Absolute Velocity of a UE supporting V2X Services	Relative Velocity between 2 UEs supporting V2X Services	Maximum tolerable Latency	Minimum application layer message reception reliability
#1 (suburban)	200	50 kmph	100 kmph	100 ms	90 %
#2 (freeway)	320	160 kmph	280 kmph	100 ms	80 %
#3 (autobahn)	320	280 kmph	280 kmph	100 ms	80 %
#4 (NLOS / urban)	100	50 kmph	100 kmph	100 ms	90 %
#5 (urban intersection)	50	50 kmph	100 kmph	100 ms	95 %

LTE-D2D framework selection for V2X

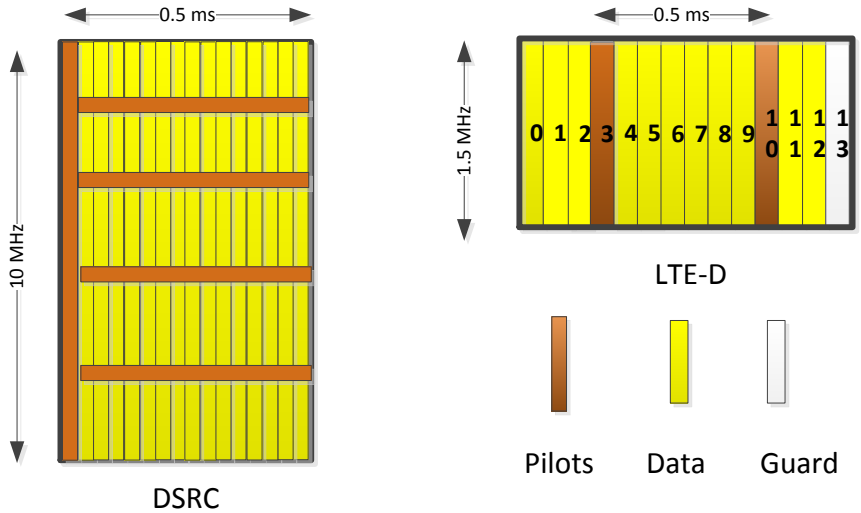
- Both D2D discovery and D2D Communications frameworks can be extended to satisfy V2X use cases
- D2D Discovery
  - Needs longer message sizes
  - Needs faster duty cycles
  - It is not ideal model for variable size messages
- D2D Communications
  - Handles large and variable size messages
  - Supports fast duty cycles
  - Needs better handling of half duplex and collisions
  - Needs more flexible retransmission configuration

Main issues to be addressed

- **Proposal: Extend D2D communications framework for V2X**

LTE-D2D & DSRC

Qualitative comparison



	DSRC	LTE-D2D
Waveform	OFDM +: Freq. selective channels	SC-FDM +: PAPR - : RS flexibility
RS/Pilots	+: Dense in time - : Sparse in Freq - (Except for preamble)	+: Dense in Freq -: Sparse in time
Coding	Convolutional w/o interleaving +: iterative decoding possible	Turbo w interleaving +: robust to time variation

Main issue to be addressed

Air Interface Enhancement for LTE V2X

Discussion Points (1/2)

- a) Doppler-related enhancement
  - DMRS densification should be the baseline solution to deal with high Doppler and high frequency offset. Other enhancements can be considered if they show significant benefit over DMRS densification.
- b) Latency-related enhancement
  - If LTE-D communication framework is used, then no enhancements are needed. Can consider enhancements to align SA/Data period with latency requirements for 3GPP SA1 for further optimization.
- c) Resource allocation-related enhancement
  - Following enhancements to Rel-12 LTE-D comm framework can be considered
    - Variable number of re-transmissions (smaller than 4 HARQ/packet which is what Rel-12 supports)
    - Randomization of re-transmission pattern (T-RPT)
    - Sensing mechanisms for collision avoidance
- d) Synchronization issues
  - GPS or equivalent solution should be considered as a practical solution for synchronization especially when outside network coverage. Some extension of GPS or equivalent solution can be defined.

Air Interface Enhancement for LTE V2X

Discussion Points (2/2)

- e) Congestion control issues
  - Extension of random access mechanism to incorporate sensing mechanisms should be considered
- f) System information broadcasting issues
  - R-12 mechanisms of SIB broadcast or pre-configuration can be used
  - If needed, R-13 mechanism of sending resources on another carrier frequency can be used
- g) Evaluation Methodology
  - Link level models can be reused from Rel-12 D2D with minor changes to parameters
  - For system level studied, outdoor drop models from Rel-12 can be reused as a starting point.

3GPP

Work-planning – Rel-13

- We support LTE D2D enhancements to address some V2V use cases
  - Approve **a new LTE V2V work item that builds on R-13 LTE D2D**

- We anticipate the following could be accomplished in Rel-13
  - Normative Specification for:
    - Link level: additional DMRS to deal with high Doppler (RAN1)
    - System level: changes to resource allocation algorithms for
      - dealing with half duplex constraint (RAN1)
      - capacity enhancements (e.g. more intelligent resource selection, variable number of transmissions per MAC PDU) (RAN1)

3GPP (cont.)

Work-planning – RAN & SA Rel-14

- Rel-14 should address all of the remaining scenarios identified by SA1
  - RAN
    - Backward Compatible Enhancements to R-13 V2V
    - V2I and V2P
  - SA2/SA3/CT
    - System level / upper layers / security enhancements to the ProSe architecture to support V2V & V2X
    - Note that Service Layer should not be reinvented in 3GPP, as it has already been defined by automotive community (i.e., IEEE,SAE and ETSI network, facilities and applications layers)
  - Note that SA1 is already planning to complete the V2X service requirements in Rel-14 as per normal process

Conclusions

- Qualcomm supports enhancing LTE to address the V2V & V2X opportunity
- We believe LTE, with proper enhancements, can address the related requirements
  - Wherever DSRC may be ahead in integration (eg because of mandates), a LTE solution can complement DSRC
- We support approving a related Work Item for Rel-13 in RAN #68

Thank you

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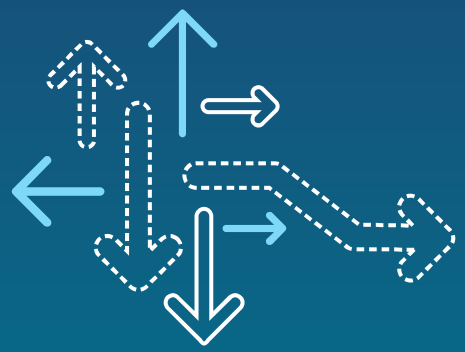
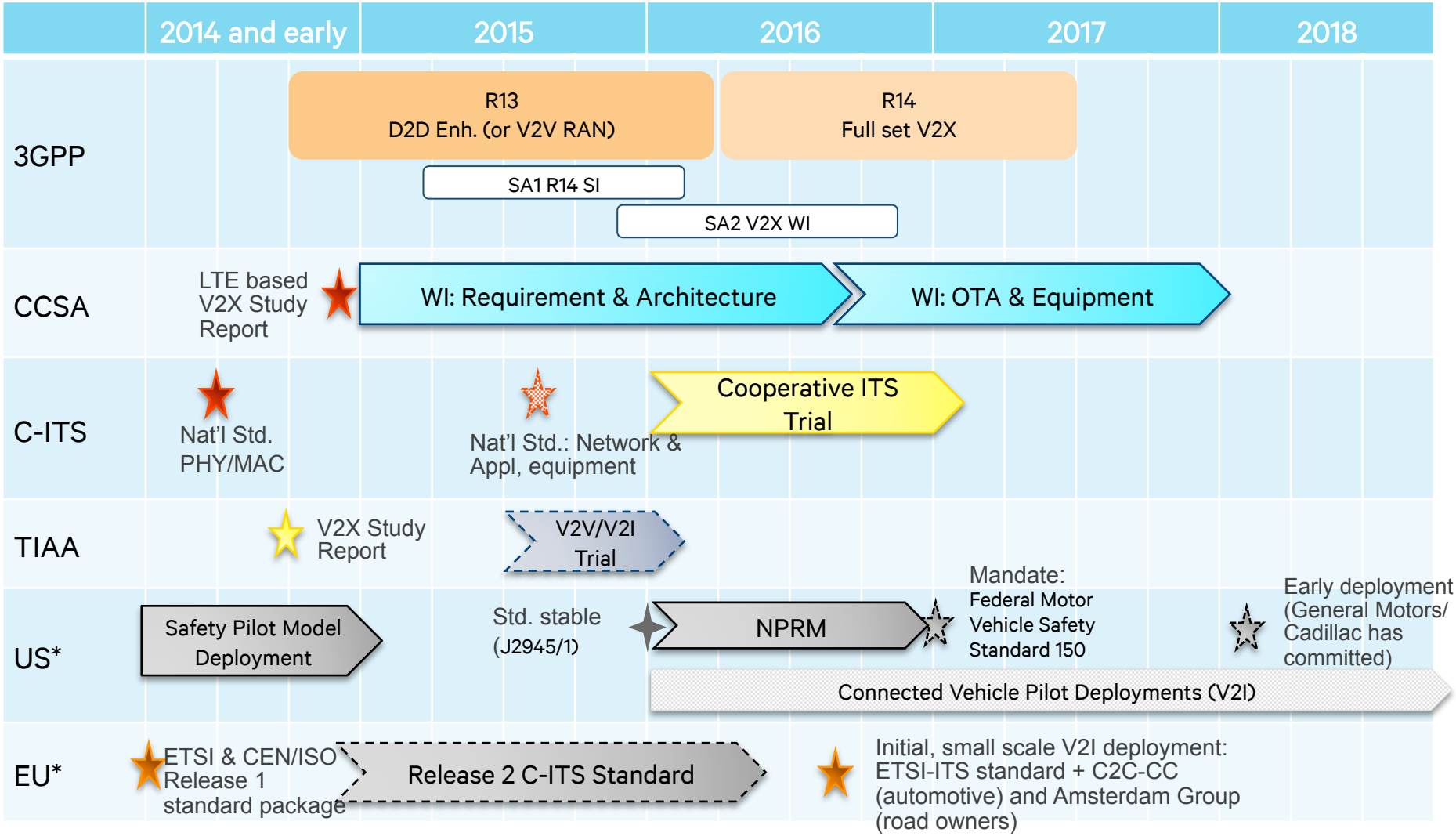


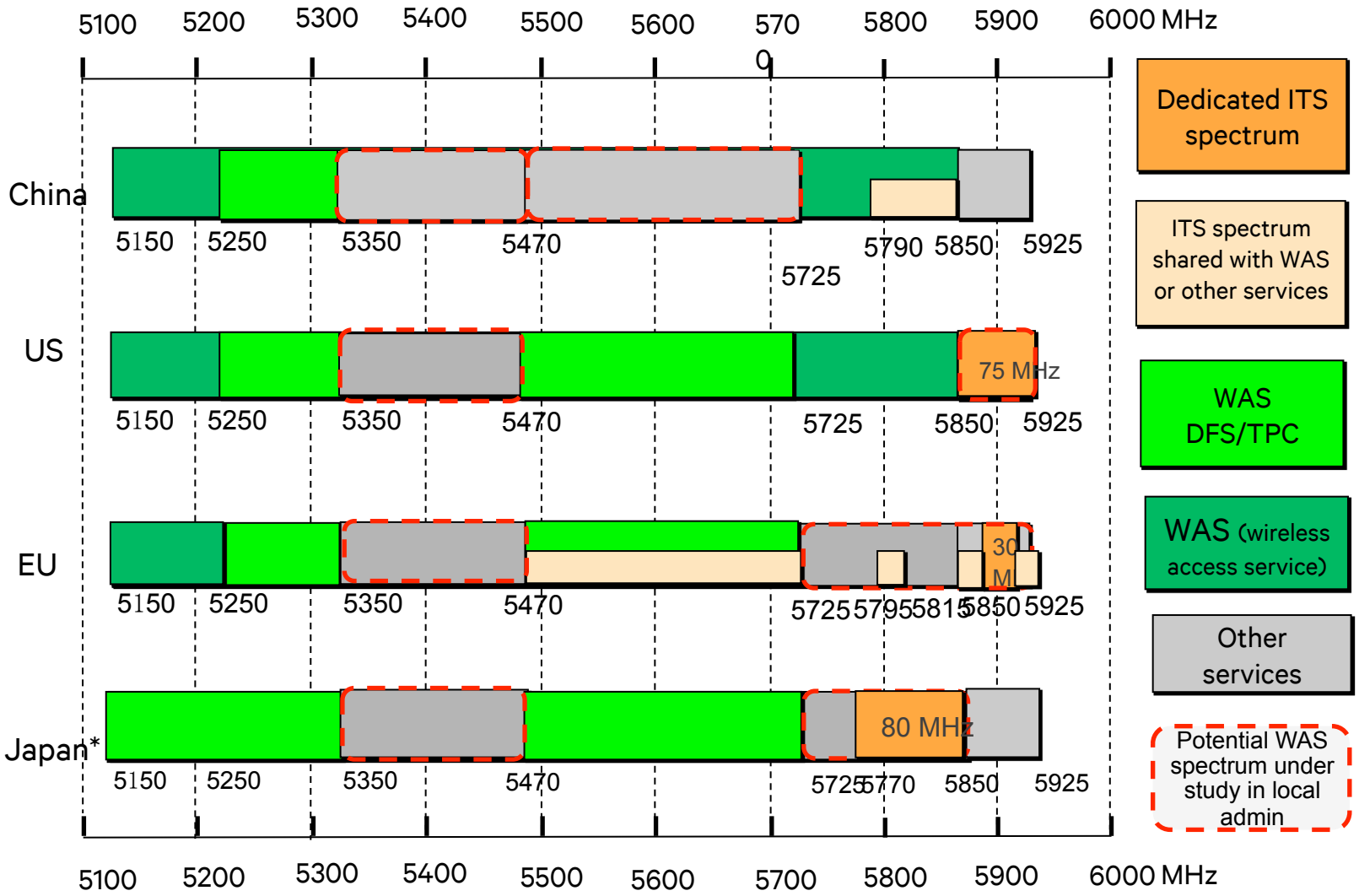
Annex: Regulatory Aspects

V2X Standardization and Deployment Timeline



* US allocated dedicated spectrum 5850-5925MHz in 2003, EU allocated 5875-5905MHz in 2008

5GHz ITS Spectrum



*Japan also allocated 715-725MHz as V2X safety spectrum. It makes Japan an isolated case.