

Now, Near and Far: The Case For CV2X

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Technology evolution is inevitable

Time from concept to application is rapidly shrinking.



The question is not “will it happen” but how to **deal with the speed of change** and how to **ride the wave rather than be submerged by it**

Important cellular radio technology enhancements were codified in Release 14 of 3GPP (2017)

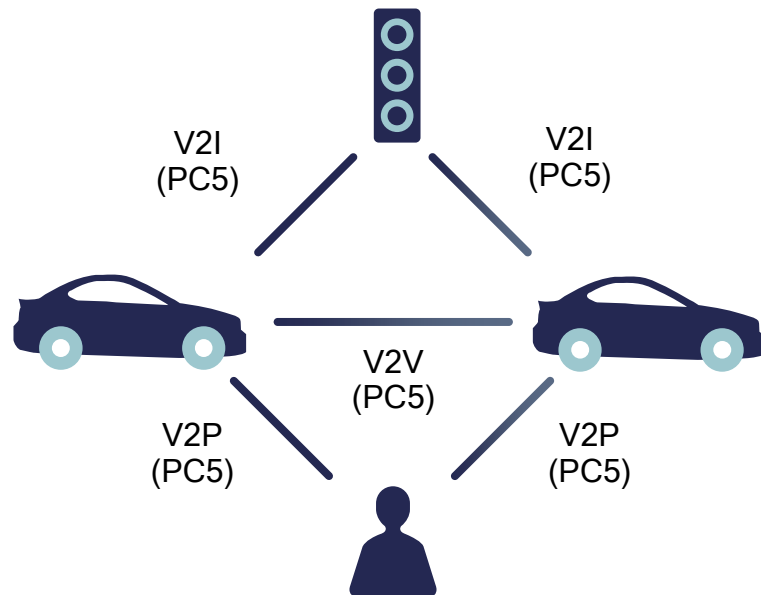
Before	Now
Devices using cellular technology required infrastructure support.	Cellular V2X devices can communicate directly without any network support.
Low latency communication was not possible with cellular solutions.	Cellular V2X technology supports low-latency needs for V2V.
Cellular solutions required use of (costly) licensed spectrum.	Cellular V2X technology can operate in the ITS 5.9Ghz band.
Cellular solutions lacked mechanisms to address privacy issues.	Cellular V2X operates w/out SIM cards and enables anonymity on par to DSRC
DSRC was the only technology available to support V2V.	Cellular technology is a viable alternative to meet and exceed V2V requirements.



C-V2X has two complementary communication modes

Direct

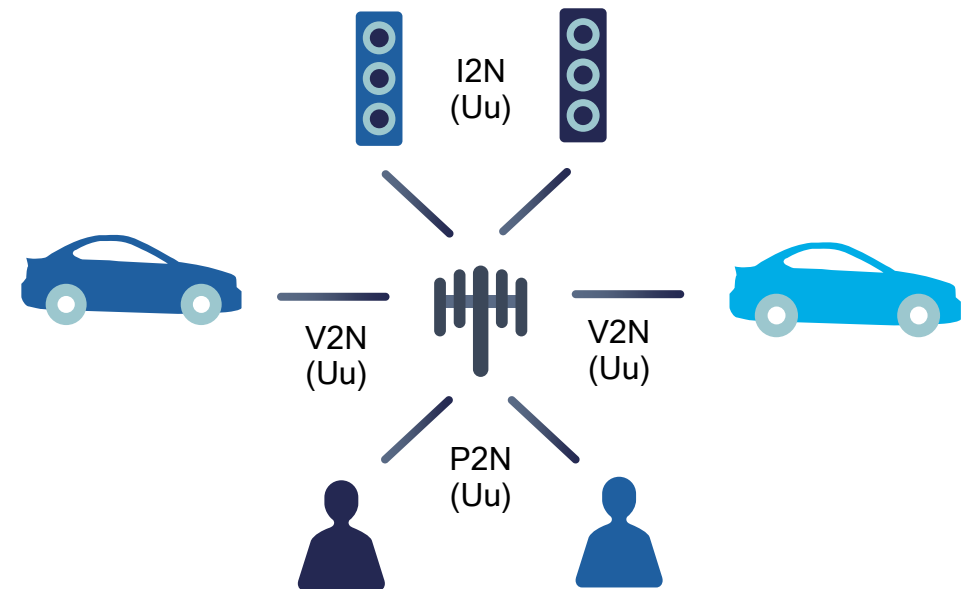
V2V, V2I, and V2P operating in ITS bands (e.g. ITS 5.9 GHz) independent of cellular network



Short range (<1 kilometer), location, speed
Implemented over “PC5 interface”

Network

V2N operates in traditional mobile broadband licensed spectrum



Long range (>1 kilometers). e.g. accident ahead
Implemented over “Uu interface”

Why is this important?

- A. Performance:** C-V2X delivers superior performance and reliability by leveraging the latest advances in radio technology
- B. Implementation Efficiency:** C-V2X can be implemented by utilizing the cellular technology platforms that automakers are already deploying
- C. Readiness:** Commercial C-V2X products are available for deployment as early as 2019
 - supported by a broad ecosystem reflected in the diversity of 5GAA membership



Why is this important?

- D. Reuse:** C-V2X leverages a very significant portion of the V2X work already done
 - Benefits from existing V2X transport layers and application protocols: safety Apps developed for DSRC will work unchanged with CV2X radios
 - Learnings from past V2X research are reusable
- E. Global Footprint:** C-V2X will be deployed consistently and predictably across the world in the same way that other cellular technologies such as LTE have been
- F. Evolution:** C-V2X is the first step towards 5G that will leverage future improvements in cellular radio technology while remaining backward compatible



Extensive testing to validate CV2X radio performance initiated in 2017 will be completed by this summer in Ann Arbor, San Diego, Aberdeen and Shanghai.

Range	Lab Cabled Tx and Rx Tests
	Field LOS Range Tests
	Field NLOS Range Tests
Interference	Lab Cabled Tx and Rx Test with Simulated External Interference
	Lab Cabled Near-Far Test
	Field Co-existence with Wi-Fi 80 MHz Bandwidth in UNII-3
	Field Co-existing of C-V2X with Adjacent DSRC Carrier (CH172 and CH174)
Congestion	Lab Cabled Congestion Control
	Field Congestion Control Field Test: Multi-Lane Line-of-Sight Highway

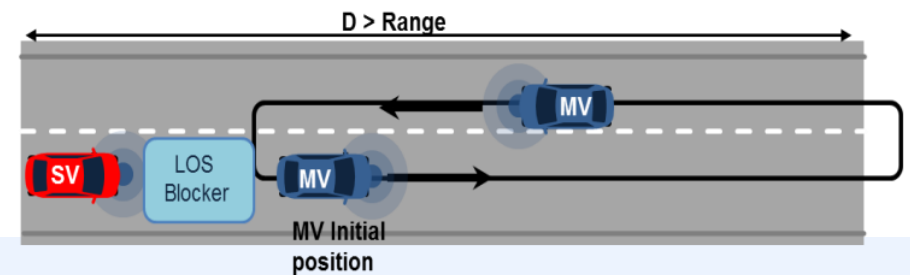
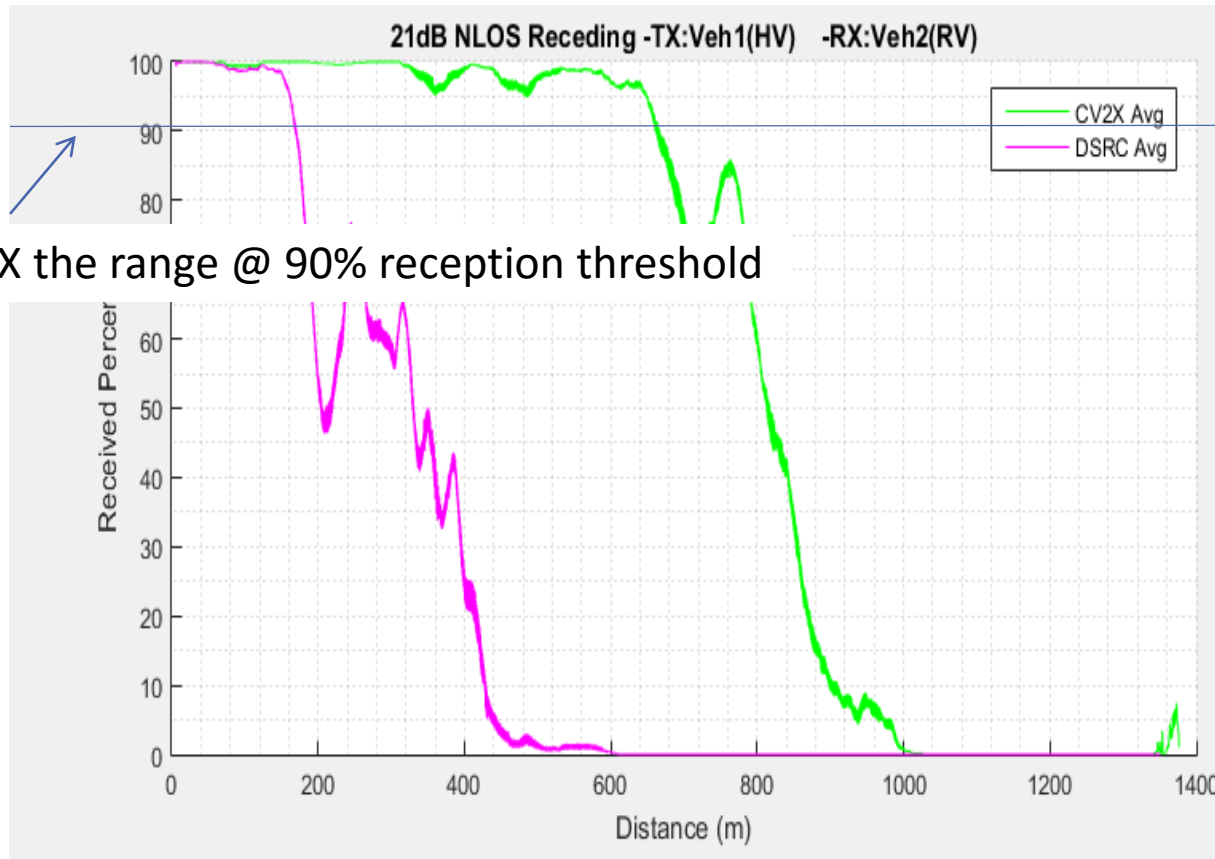


Testing

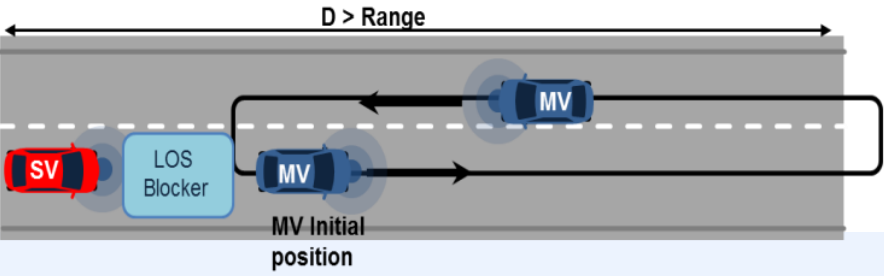
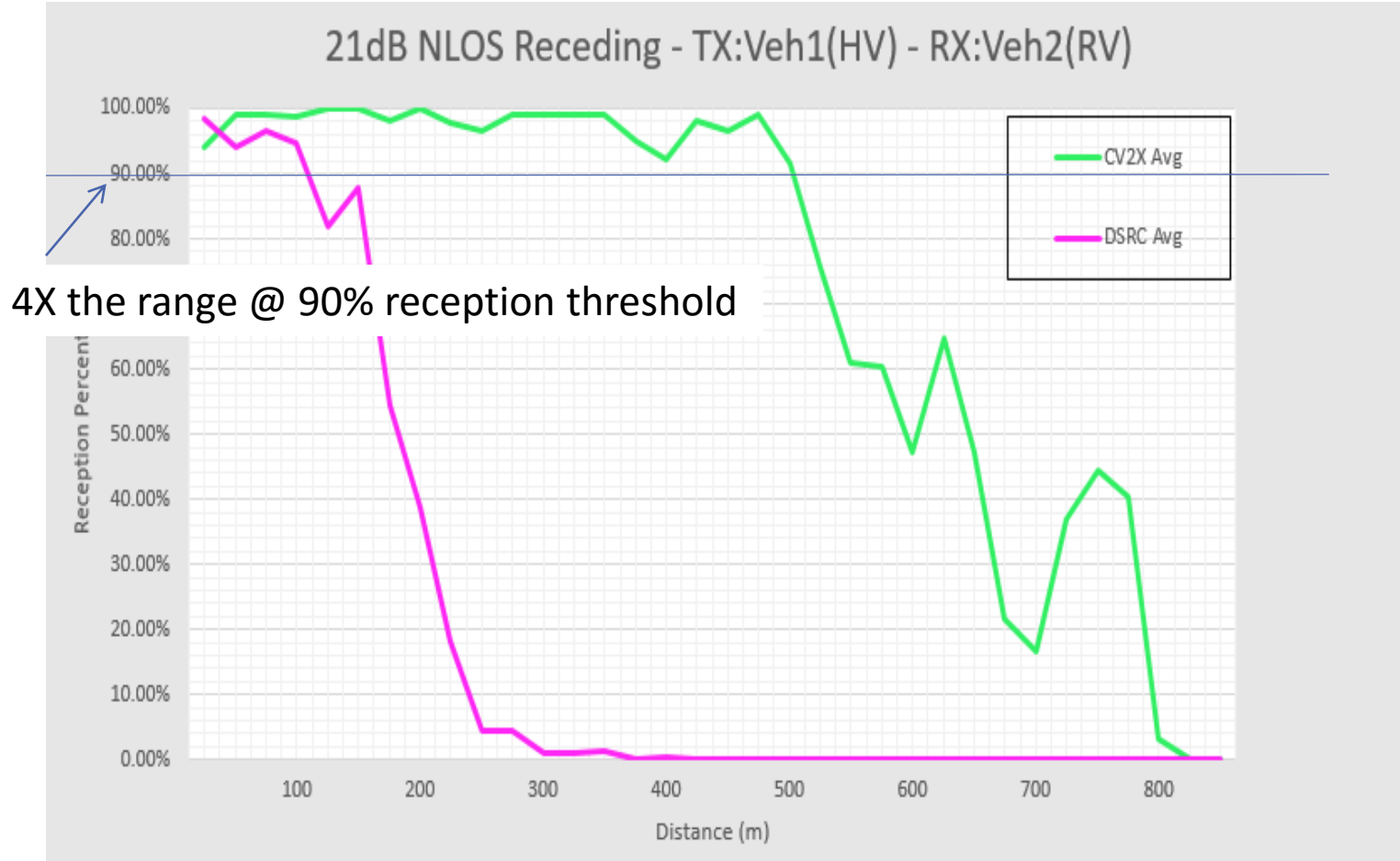
- Ford in partnership with Qualcomm (in US) and Datang (in China) has been testing C-V2X devices since 2H17. Work will be completed in 2H18.
- Test procedures have been documented and are now being harmonized in 5GAA to ensure global uniformity.
- Initial results are consistent and very encouraging. They support our beliefs in the benefits of the technology.



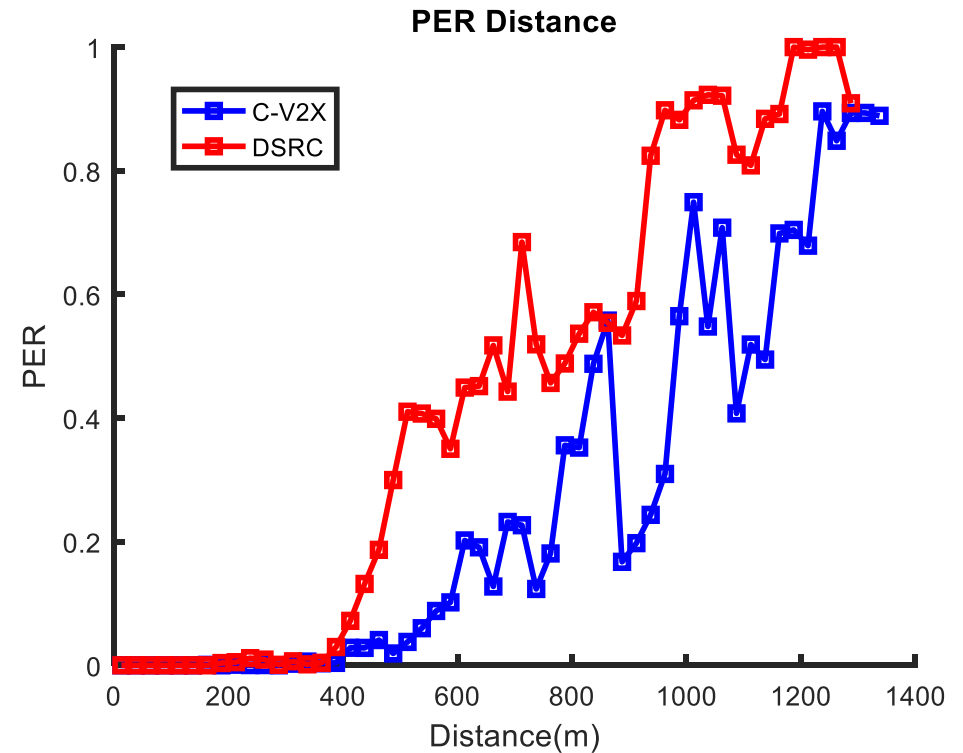
Obstructed Non-Line-of-Sight (NLOS) Range/Reliability Road Test in Fowlerville, Michigan



Obstructed Non-Line-of-Sight (NLOS) Range/Reliability Road Test in Miramar, San Diego

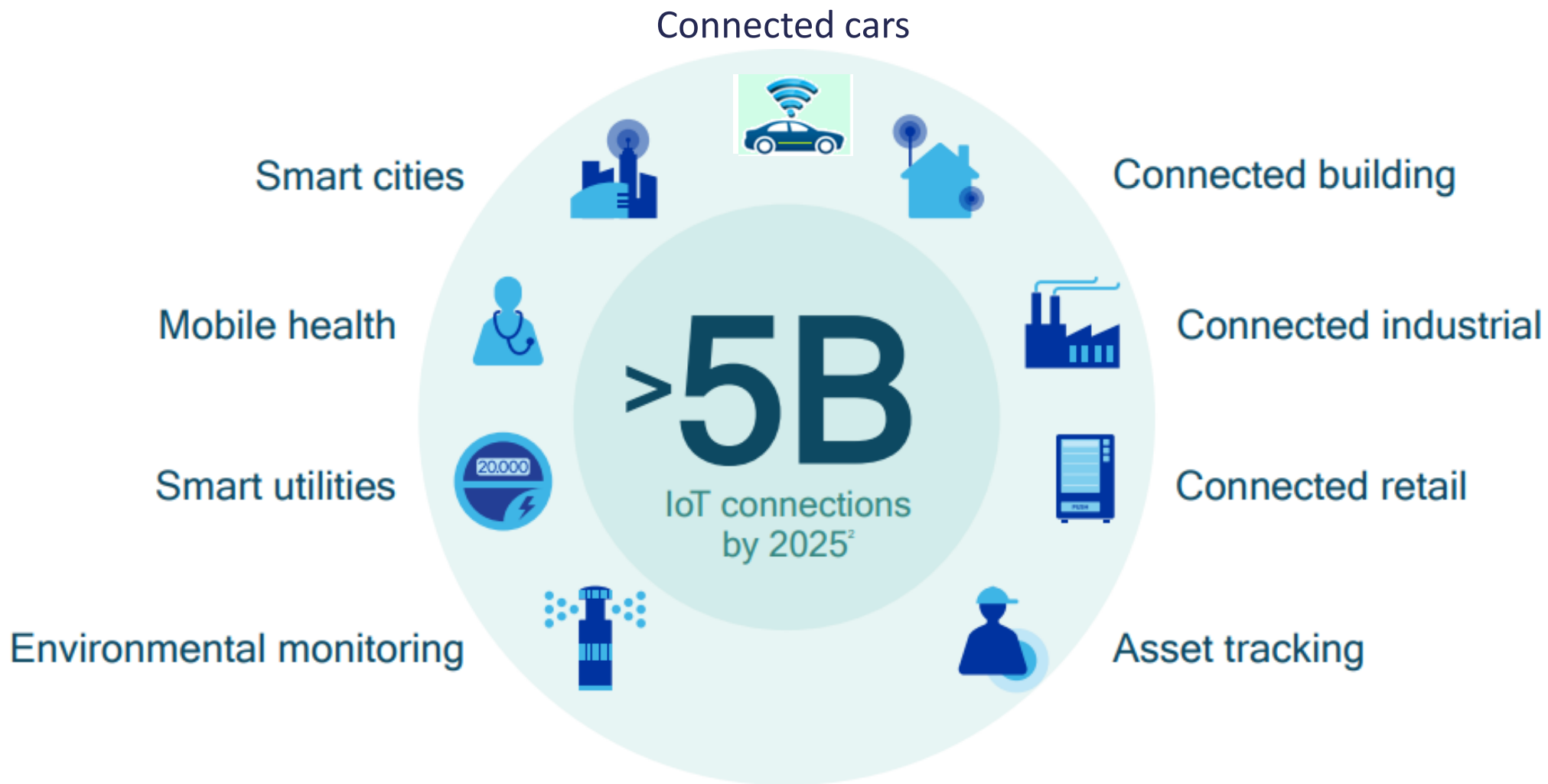


Highway Testing Near Beijing



- Vehicles driven at 80 km/h, 100 km/h and 120 km/h
- Both cars slowly separating until no packet received, then closing gap, three times
- Distance maintained at 200m, 400m, 600m etc. for 5 min

CELLULAR TECHNOLOGIES AND EVOLUTION TO 5G ENABLE THE CONNECTED FUTURE



2. Including cellular and LPWA M2M connections, Machine Research, May 2017

Thank You!

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