Connected Cars: Role of Connectivity and Evolution

VATM 5G Masters

5G@Automotive

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Agenda

1. Status of 4G/5G deployment in automotive

2. Next steps – Non-terrestrial networks (NTN)

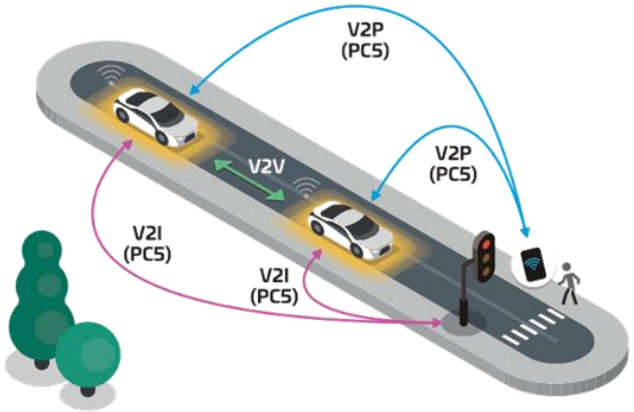
Connected cars: Cellular–V2X (C-V2X)

Complementary communication modes

C-V2X Direct Communications

V2V, V2I, and V2P operating independent of cellular network

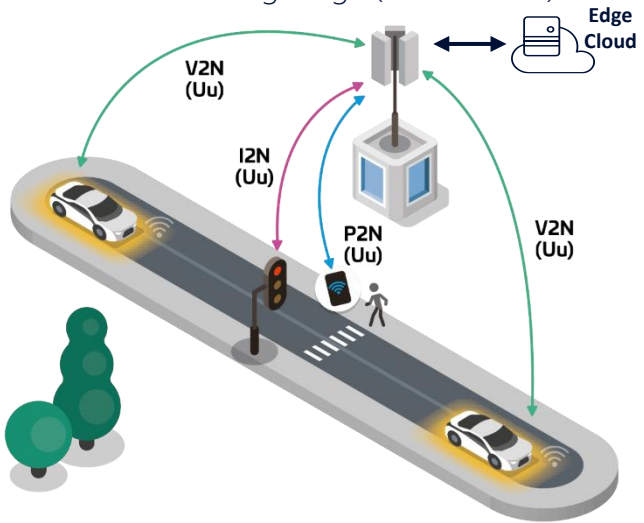
- Short range (<1 kilometer)



C-V2X Mobile Network Communications

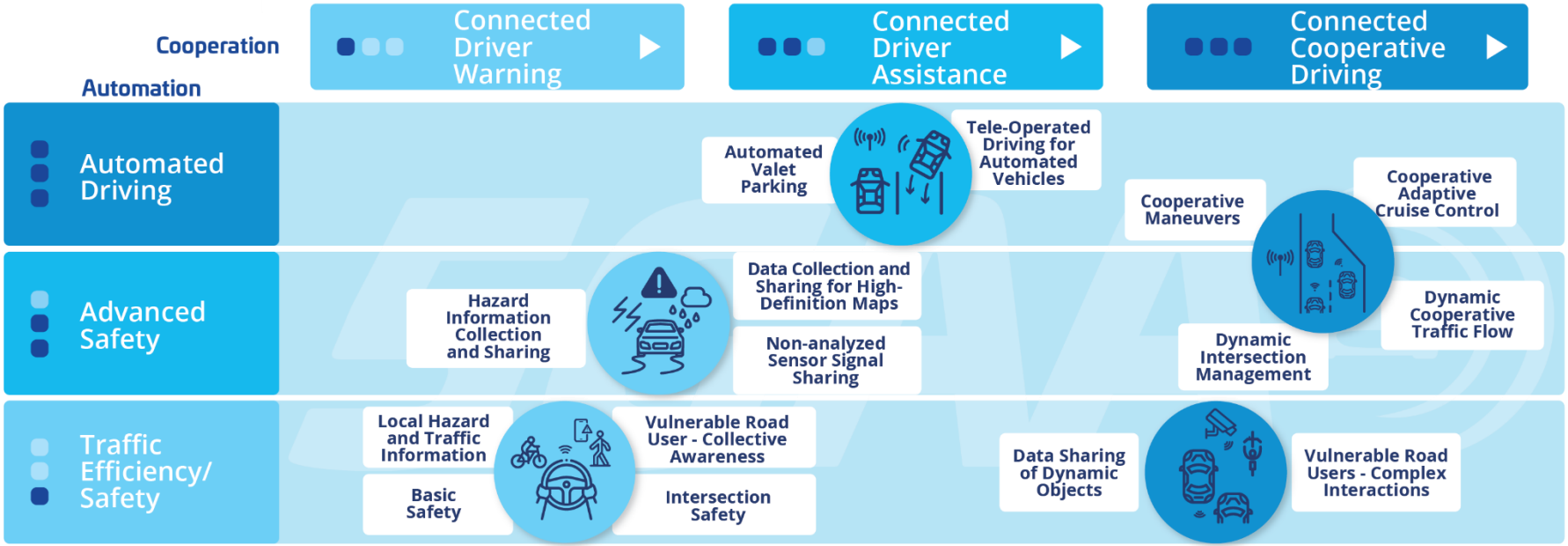
V2N/I2N/P2N in licensed spectrum bands designated for mobile network communication

- Long range (>1 kilometer)



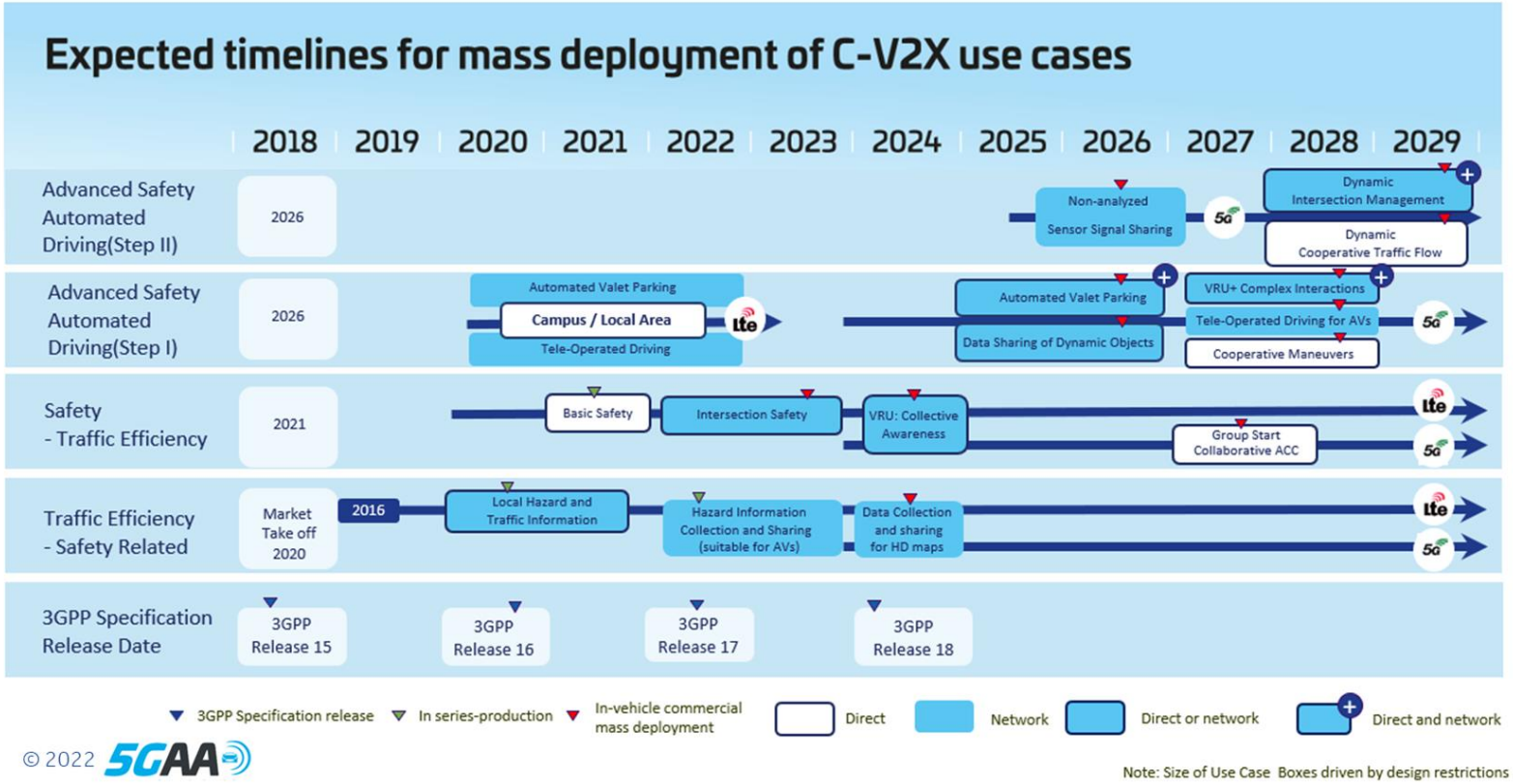
Source: Adopted from 5GAA

Evolution of use cases towards connected cooperative driving



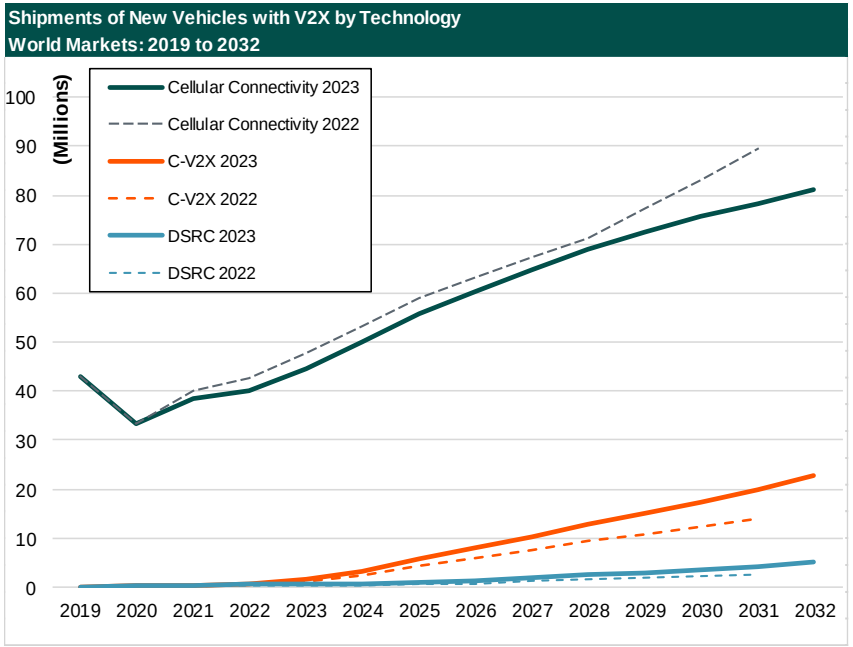
Source: 5GAA, Nov. 2022, https://5gaa.org/content/uploads/2023/01/5gaa-white-paper-roadmap.pdf

5GAA's visionary roadmap



Source: 5GAA, Nov. 2022, https://5gaa.org/content/uploads/2023/01/5gaa-white-paper-roadmap.pdf

Number of connected vehicles & impact



Source: ABI Research 3Q2022, 3Q2023

Today, approx. 15% of the total EU fleet is equipped with C-V2X 4G-LTE:

- Up to 70% of the new vehicles sold in the EU are now equipped with 4G-LTE
- 30% of the total EU fleet should be connected with 4G-LTE by 2025 and 40% by 2027
- By 2025, one out of five connected cars sold in the EU should also be 5G equipped (and remain interoperable with 4G-LTE models)

Source: https://www.counterpointresearch.com/connected-car-shipments-for-europe-hit-expressway/

Source: Adopted from 5GAA

To start getting real benefits at least 30-40% of the total EU fleet needs to be equipped (regardless of the direct communication technology) – *Source: Ricardo*

Challenge for V2V direct communications – a snapshot

How long does it take to get an impactful penetration rate ?

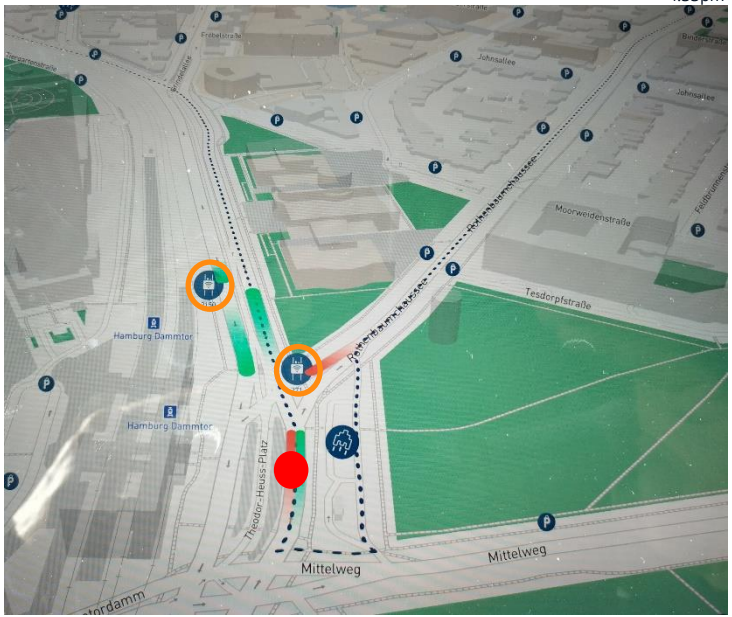
Hamburg City center, April 26th 2023, during rush hour

Exception !

4:32pm

Normality !

4:33pm



V2V enabled car

RSU

Location of bus

Source: Pictures taken from a tablet during a Bitkom bus tour through the Hamburg test/deployment field built for ITS world Congress 2021 and evolved since then.

C-V2X status in the US, Europe and China

USA:

- Focus on deployment of LTE V2X direct complemented with 4G/5G V2N
- US FCC granted waivers to allow deployment of C-V2X in upper 20 MHz of 5.9 GHz (5905-5925MHz): Audi, Ford, JLR, approx. 17 state DoTs and local/city authorities, approx. 11 equipment manufacturers
- Preparation of RSU deployments (day1 use cases, profiles, …)
- FHWA started to work on digital infrastructure strategy

FAQ on FCC Waiver

EU:

- ITS directive amendments close to approval
- Technology neutral approach
- Strong focus on scope and timeline of data to be provided at national access points (NAPs)
- Alignment of NAP via NAPCORE, Data for Road Safety initiative on SRTI data
- VW deploys ITS G5 in ID.3, ID.4, ID.5, ID.Buzz, …
- French PFA committed to move to 5G V2X and skip prior V2X short range radio technologies

China:

- 20 MHz in 5.9GHz spectrum allocated for commercial deployment of LTE-V2X
- All major Chinese OEMs committed to launch C-V2X (LTE V2X PC5 & 4G/5G V2N)
- Many models already in the market (FAW, GM/SAIC, Ford, NIO, Great Wall, …)
- 7 national pilot areas, 17 national demonstration areas & 16 Smart Cities
- More than 6200 RSU installed
- LTE-V2X protocol conformance certification available

Deployment of 5G: still at the beginning

"First 5G enabled car on the road", 25.12.2020

"BMW iX with 5G connectivity via two network operators", 02.09.2021

" … advanced vehicle connectivity innovations in 5G and cellular vehicle-to-everything (C-V2X) on HiPhi X — Human Horizons' first super sports utility vehicle (SUV) in mass production" 22.03.2021

"ARCFOX α-T, a high-end brand of BAIC New Energy, officially opened its pre-sale. … The company calls it a '5G smart electric car'. " 26.08.2021

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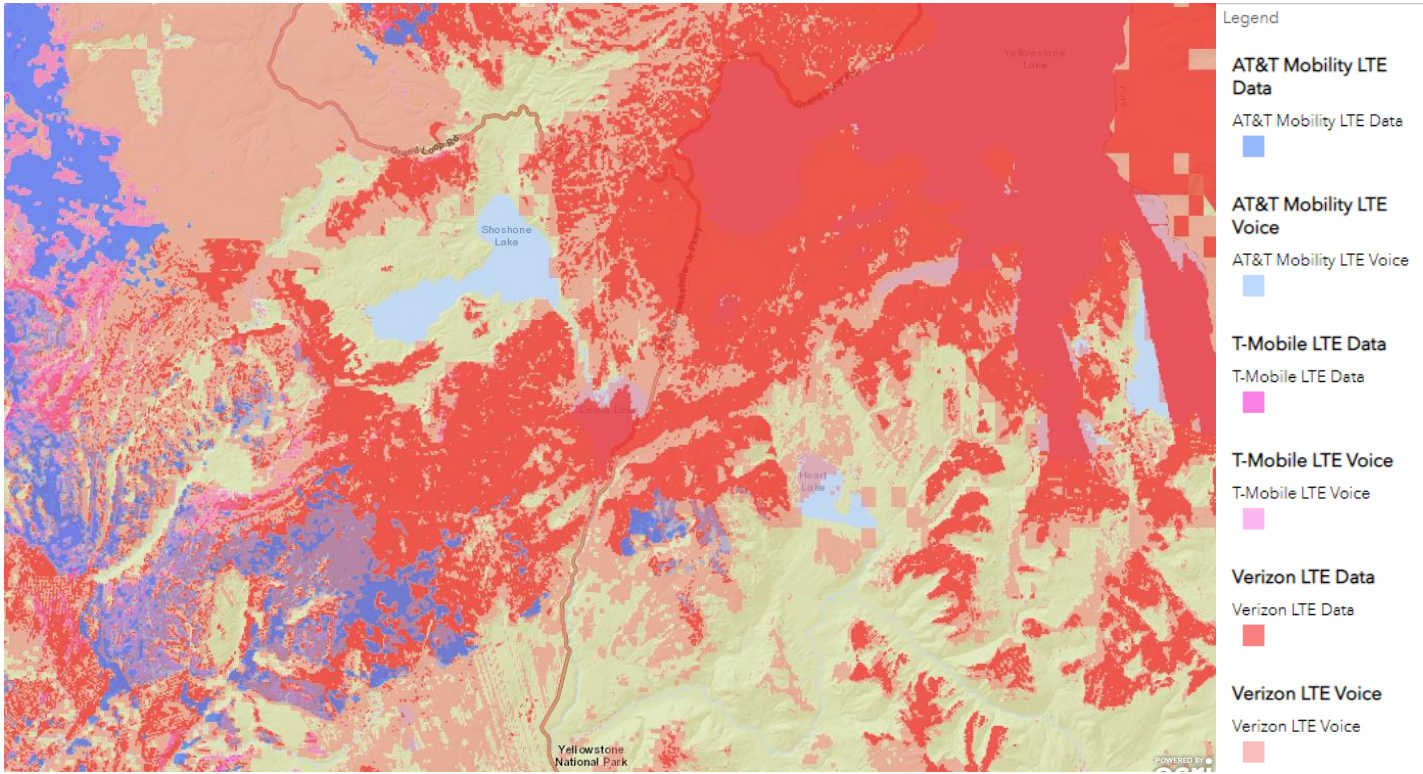
1. Status of 4G/5G deployment in automotive

2. **Next steps - NTN**

Challenge: Ubiquitous 4G/5G Connectivity

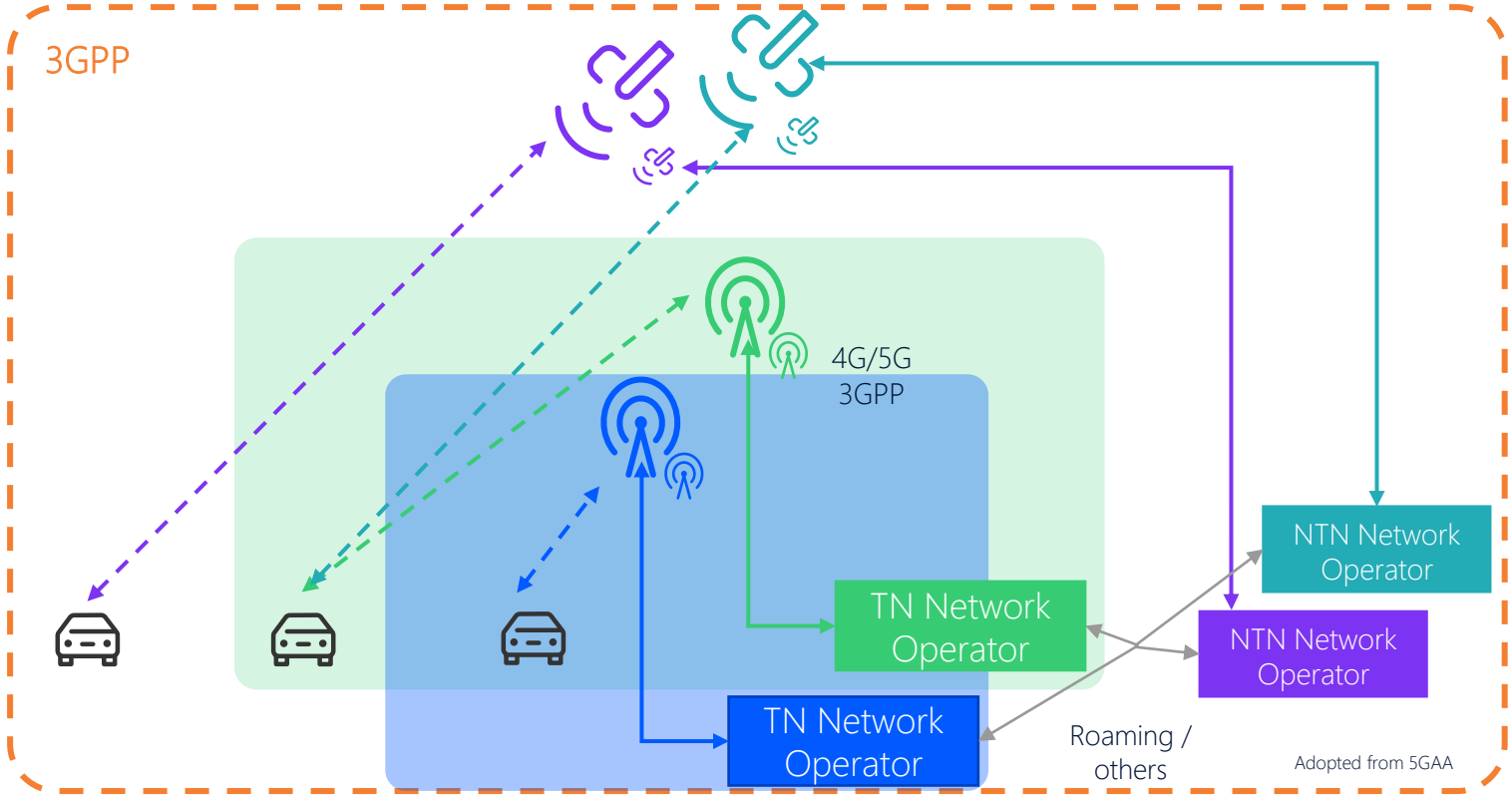
An example: 4G Coverage as of May 15, 2021, US area of Yellowstone National Park



Source: US FCC: https://fcc.maps.arcgis.com/apps/webappviewer/index.html?id=6c1b2e73d9d749cdb7bc88a0d1bdd25b

Motivation: NTN for Automotive

Ubiquitous coverage



Non-coverage areas

Tunnel / Park house * ....

* Selected tunnels, parking areas, ... are covered by TN

Automotive NTN use cases: 1st phase with narrow band data rates

Ubiquitous coverage is a necessity for connected cars

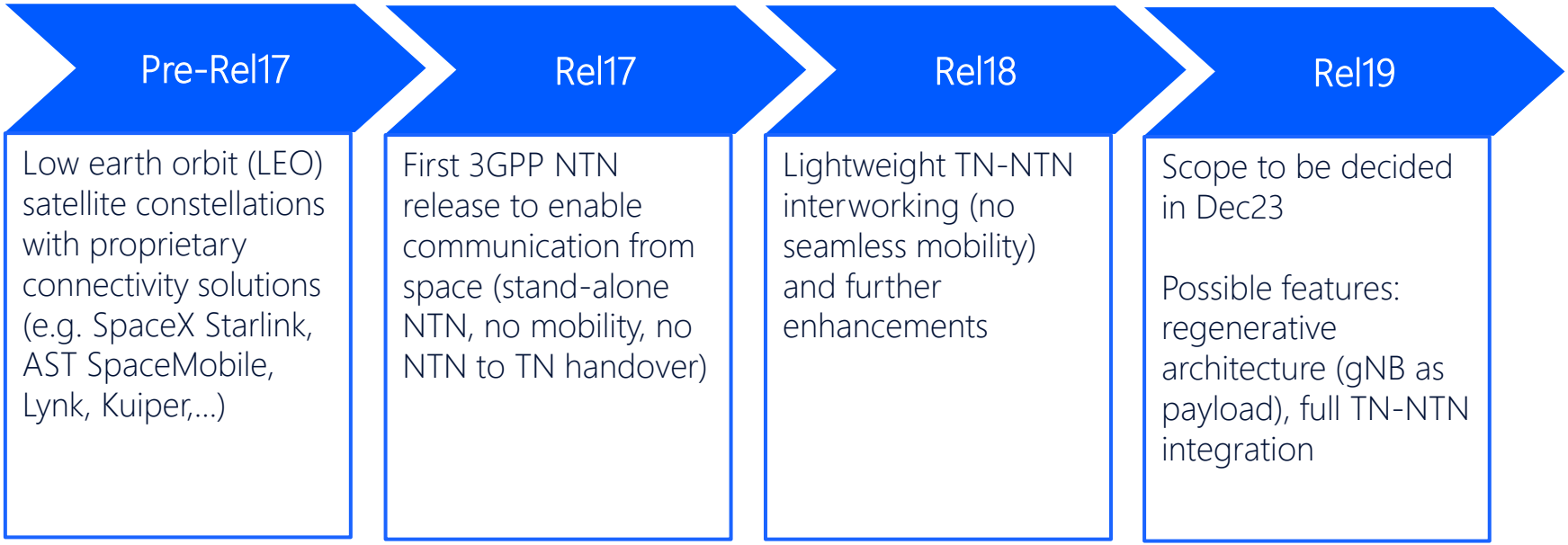
What if emergency calls (eCall) stop working when you are out of network coverage ?

Road hazard warning (e.g. black ice) is only working if network coverage is available to receive warnings from other vehicles.

Remote unlocking of shared cars is only working if network coverage is available

NTN Evolution - 3GPP Releases

From NTN stand-alone towards integrated TN-NTNs

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