5G-ADVANCED RAN ENHANCEMENTS FOR VERTICALS

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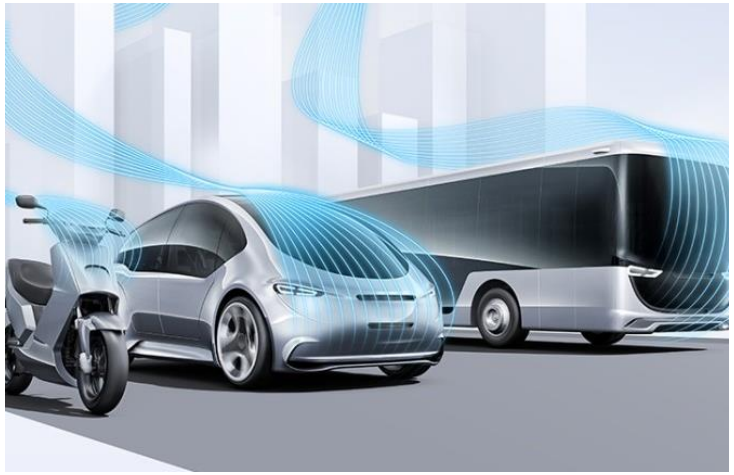
Bosch focus areas for 5G-Advanced



Connected mobility

Connected Industries, I4.0

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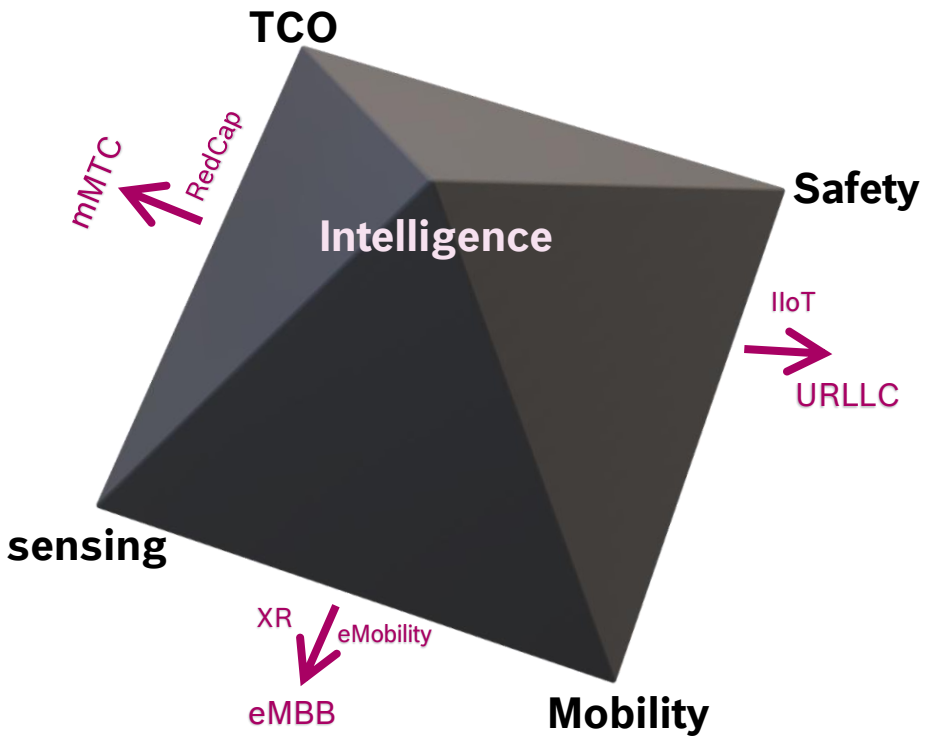
5G-Advanced RAN Enhancements for Verticals

Operational and Functional requirements for Verticals

- **Mobility:** different mobility requirements for Bosch various IoT products impacting 5G-Advanced roadmap
- **Safety communication:** more functional safe QoS requirements need to be monitored, predicted and controlled in communication layers
- **Sensing:** enhancing sensor sharing capability and allow more wireless sensing capability (e.g., enhanced positioning, JCS**, etc.)
- **Reduced TCO*:** further reduced cost, complexity, energy, and simplified operation for verticals
- **Intelligence:** sensing fusion, safety decision, and Mobility predictive requirements require AI-enabled RAN at both network sides UE and gNB[3*]



* Total cost of ownership
** JCS: joint communication and sensing
3* 5G Advanced RAN should enable a terminal-based AI and a network-enabled AI

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5G-Advanced RAN Enhancements for Verticals
Agenda

- Vertical enhancements in Rel-18
  - Automotive enhancements (including sidelink)
  - Industrial IoT
  - Building/smart-home technology

- Cross verticals enhancements:
  - RAN-assisted functional safety

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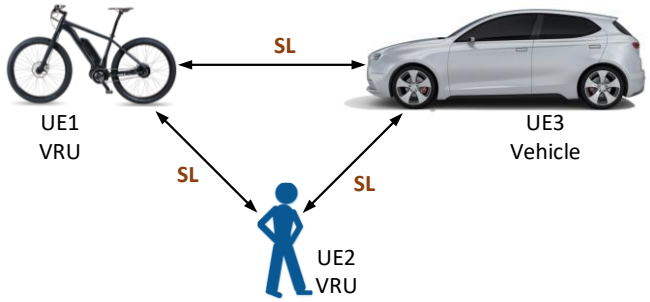
5G-Advanced RAN Enhancements for Verticals
Sidelink enhancements for new advanced use cases

- Use cases and requirements:
  - Automated valet parking (AVP): Sidelink for Wake-up, go-to-sleep and assisting maneuver
  - Different VRU+ types (eBike, pedestrian, 2-wheeler,…) with different sidelink capabilities
  - Light-weight vehicles and reduced cost mobility, scaling RedCap devices for V2X

- Possible enhancements for Rel-18 (based on Rel-17 outcome):
  - For AVP: further enhance sidelink power saving for, e.g., Wake-up, go-to-sleep, adaptive DRX, adaptive BWP/search-space, etc.
  - For VRU+ and reduced cost mobility: enhance sidelink capability to include:
    - Support of reduced capabilities (RedCap) UE with sidelink for, e.g.,
      - e-Bike or µ-mobility uses on-board modem
      - light-weight vehicles and reduced cost mobility
    - Support of configurable UE sidelink capabilities for power saving, e.g., if pedestrian UE handset is used connected to e-Bike/µ-mobility (i.e., in battery charging mode)



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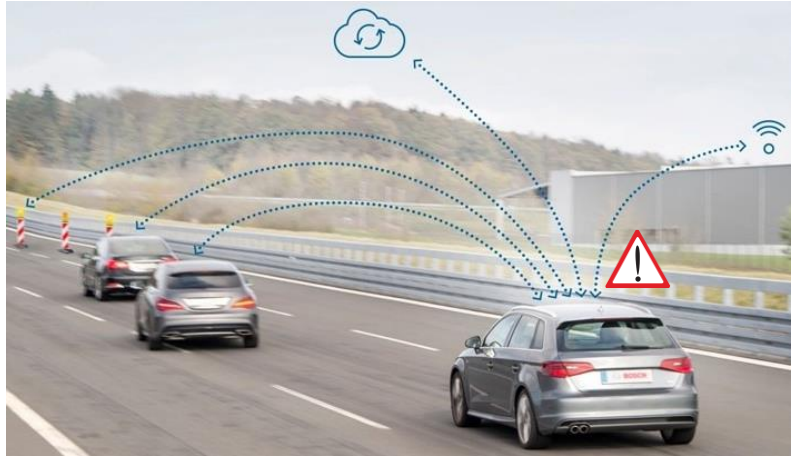
3GPP Rel-18 and Beyond Discussions
Vertical enhancements: automotive enhancements

- Further Rel-18 sidelink enhancements for advanced use cases:
  - Further sidelink enhancements for functional safety:
    - Introduce survival time evaluation and/or burst distribution to handle consecutive packet loss
    - Enhance QoS parameters handling to support predictive QoS (pQoS)
    - Support RLC enhancements for groupcast, e.g., support AM for NACK-only and ACK/NACK options*



  - Enhanced periodic reservation (Mode2 / Mode1) for the varying V2X messages (i.e., actual size/period of CAM/CPM are variable in size and periodicity):
    - Support adaptive/flexible reservation period and size, i.e., support adaptive configured grants/SPS-like

* Sidelink groupcast is the main cast type for several V2X functional safe communication/use cases, e.g., lane-change maneuver, lane merge, platoon coordination, etc.. Therefore, a reliable communication is crucial for sidelink groupcast.

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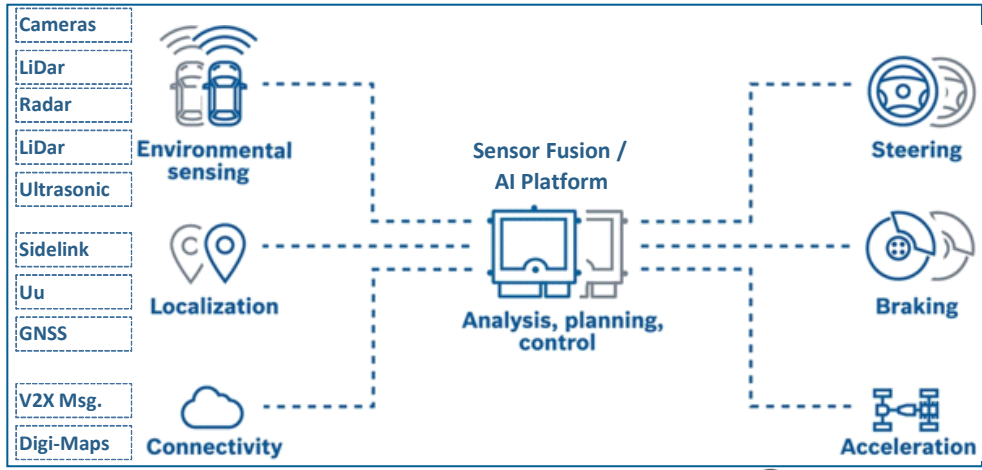
5G-Advanced RAN Enhancements for Verticals
Sidelink positioning in all coverage scenarios

- Motivation for sidelink positioning:
  - a native choice for relative positioning in many V2X use cases
  - Sidelink positioning enhances localization accuracy when fused together with other on-board sensors (including Uu and GNSS)
  - steppingstone towards joint communication and sensing (JCS)

- Possible enhancements (based on Rel-17 TSG RAN SI):
  - Support sidelink positioning for all coverage scenarios: in-coverage, partial coverage, and out-of-coverage
  - In in-coverage scenario: support sidelink positioning at least for:
    - computing relative positioning directly using sidelink
    - enhancing Uu positioning, e.g., if the required accuracy is not met
  - Support sidelink positioning for Mode 1 and Mode 2 resource allocation



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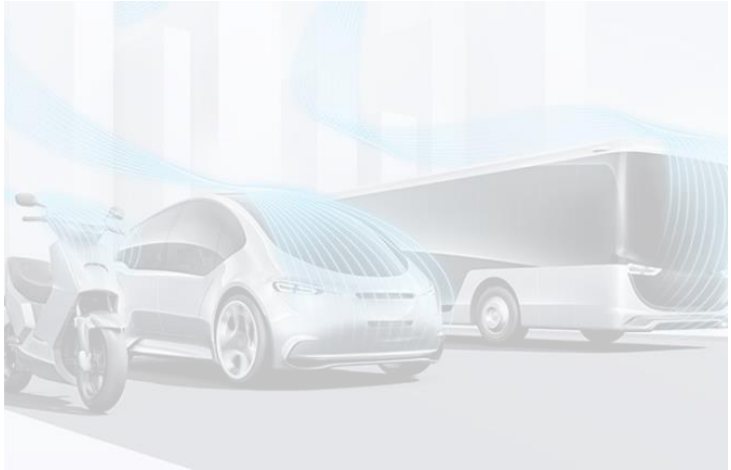
Bosch focus areas for 5G-Advanced



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3GPP Rel-18 and Beyond Discussions
Industrial IoT and Connected Industries

- Further enhancements for Industrial IoT:
  - Support for XR in IIoT:
    - Extend XR to cover IIoT use cases (e.g., remote industrial monitoring)
    - Traffic-aware RAN (e.g., UE traffic characteristic, periodicity, rate, QoS, etc.)
    - Enhanced power saving for XR
  - Cost reduction:
    - Enhanced positioning scheme with a lower infrastructure cost (via, e.g., low cost 5G infra structure nodes)
    - Support RedCap devices with low latency and higher reliability (i.e., sub-slot design, HARQ enhancements, etc.) for light weight IIoT (e.g., AGVs)
  - Enhancements for safety communication: e.g.,
    - Further enhanced survival time and burst distribution evaluation in L2 and L1
    - Support identifying QoS loss via, e.g., periodic keep-alive-messages/heartbeats signaling (see FuSa slide)

Maintenance tasks can even be executed remotely with data glasses and augmented reality

Cost reduction of automated guided vehicle (AGV) connectivity is important for massive deployment

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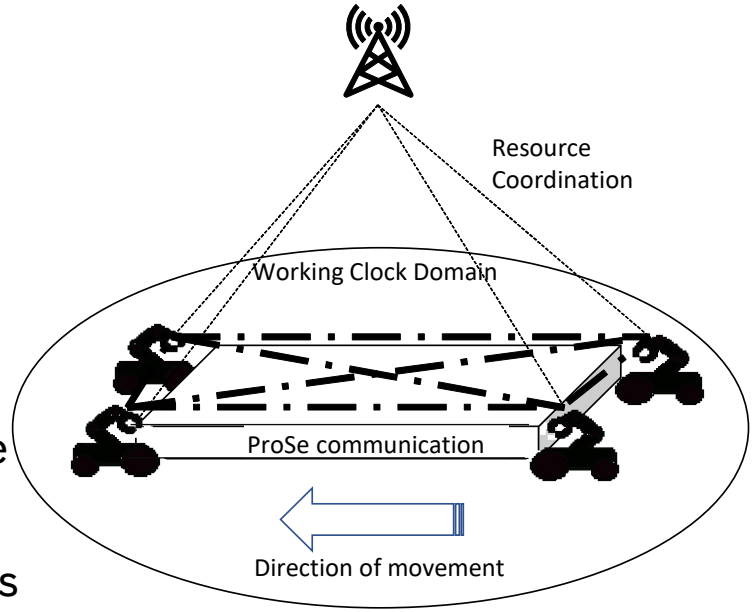
3GPP Rel-18 and Beyond Discussions
Industrial IoT and Connected Industries

- Further enhancements for Industrial IoT:
  - Sidelink for IIoT (machine-to-machine and PLC-to-Machine)
    - Introduce lower latency capability to sidelink via, e.g., sub-slot scheduling
    - Further enhance inter-UE coordination for the synchronized access use cases (e.g., ProSe for cooperative carrying use case [TS 22.104])
    - Support sidelink positioning (relative and absolute) for industrial IoT Ues
      - Absolute may rely on fixed 5G (sidelink capable) nodes
    - Support Mode 1 + Mode 2 cooperation or common mode for IIoT
    - Support Sidelink for IIoT in unlicensed bands and FR2



ProSe communication setup for mobile robots/AGVs carrying a work piece [TR 22.832]

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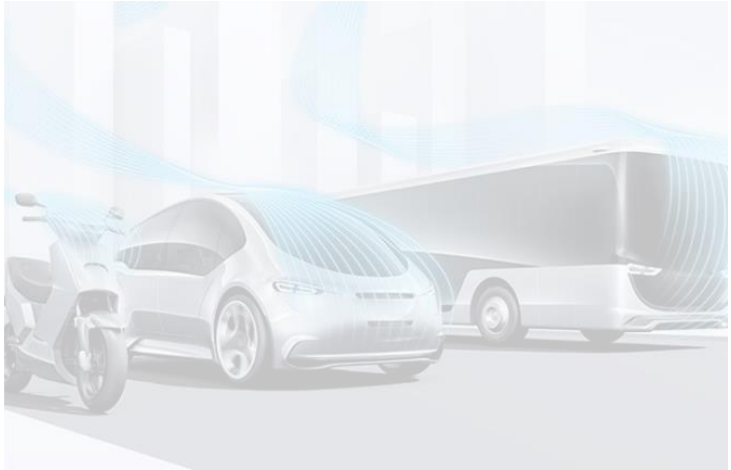

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5G-Advanced RAN Enhancements for Verticals

IoT services for Smart Buildings/Homes

- Sensing and Media (Audio/video)
  - Support further enhanced RedCap for power saving and bandwidth reduction (down to 5 MHz) for:
    - Surveillance camera and advanced mobile sensors/alarms (fire, temperature, motion, etc.)
  - Support enhancements in RedCap considering low latency capabilities:
    - For Wireless Intercom and wireless microphones, latency should be < 5ms*
  - Sidelink for smart home/buildings:
    - Support sidelink for RedCap devices (e.g., device to smart-home gateway)**
    - Support sidelink operation in unlicensed bands
    - Support sidelink with smart relaying (i.e., U2U or U2N)

* Common with IIoT requirements
** Common with e-Bike/ reduced cost mobility requirements

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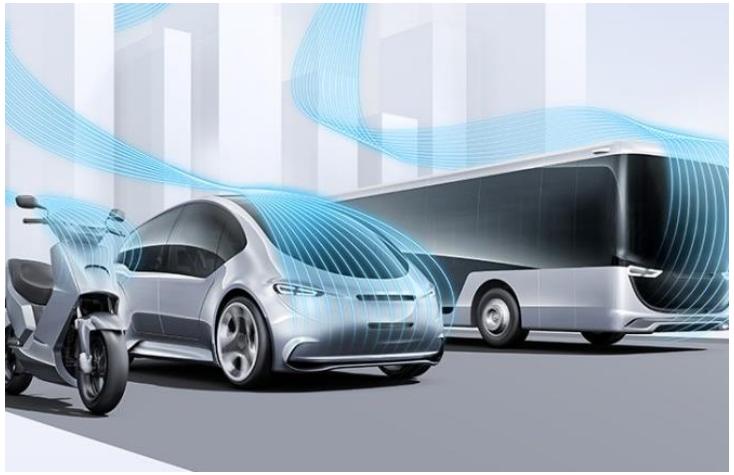
Bosch focus areas for 5G-Advanced



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A cross-vertical requirement: functional safety communication

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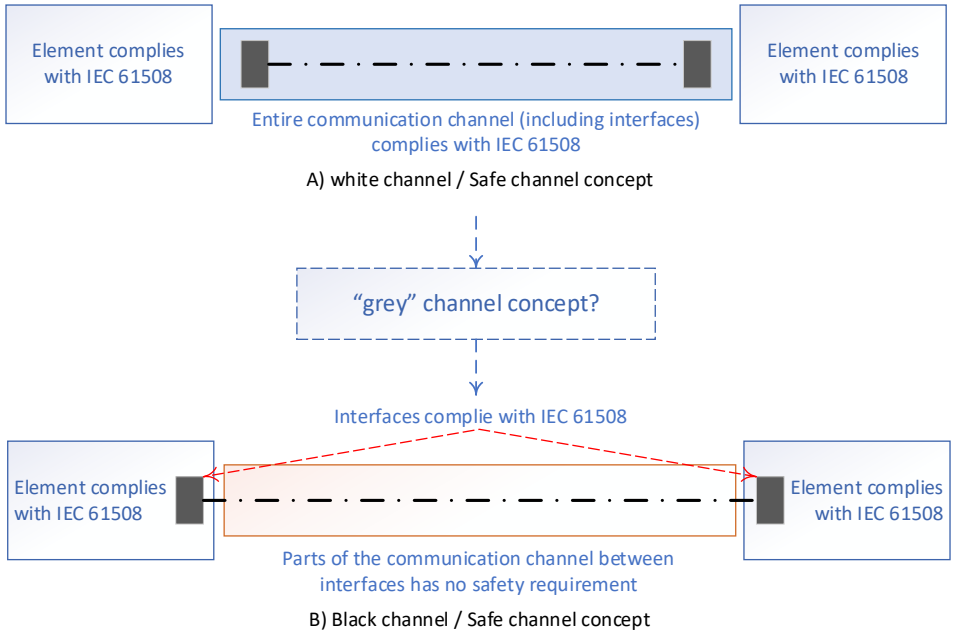
5G-Advanced RAN Enhancements for Verticals

RAN-assisted functional safety (FuSa)

- Functional safety (FuSa) communication:
  - Existing solution: “Black Channel” Concept (service agnostic channel)
    - communication failures, channel errors, corruption should be estimated, but safety compromised
    - does not utilize 5G capabilities to fulfil safety requirements, e.g.,: packet duplication, HARQ/ARQ, communication service availability** with confidence (e.g., survival time**/burst distribution), cyclic communication (e.g., CG/SPS),…
  - Proposed study: “grey” or “FuSa-aware channel” concept:
    - Reporting and proactively monitoring QoS deterioration, e.g., varying latency and transfer interval**, loss of communication, insufficient throughput, etc. (mostly can be conducted in RAN with minor modifications)
  - Proposal: Study the feasibility of the following RAN-assisted mechanisms for:
    - FuSa integrity levels identification at lower layers (for monitoring, reporting, and resilience)
    - detecting channel/service loss/deterioration/irregularity (e.g., using keep-alive-msgs /heartbeat)
    - monitoring channel availability (e.g., enhanced survival time/burst distribution, etc.)
    - monitoring timing errors and prediction of timing failure
    - Predictive QoS impacting FuSa integrity level
    - Schedule-aware FuSa integrity levels (e.g., enhancements to configured grant and SPS)
    - RAN resilience mechanisms, e.g., packet duplication/multi-connectivity, HARQ enhancements, scheduling enhancements, etc.



A “grey” channel and RAN-assisted FuSa aware communication need to be studied in 5G-Advanced

*Note: network performance measurements at different CSIF is introduced in TS 22.104
** Note: communication service availability, end-to-end latency, survival time, burst, and transfer interval definition and their relation are in TS 22.104

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