V2X EVOLUTION WITH THE TELUS REFERENCE ARCHITECTURE FOR CONNECTED CAR (TRAC)

Oct, 2018

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Key Solution and Business Requirements/Assumptions

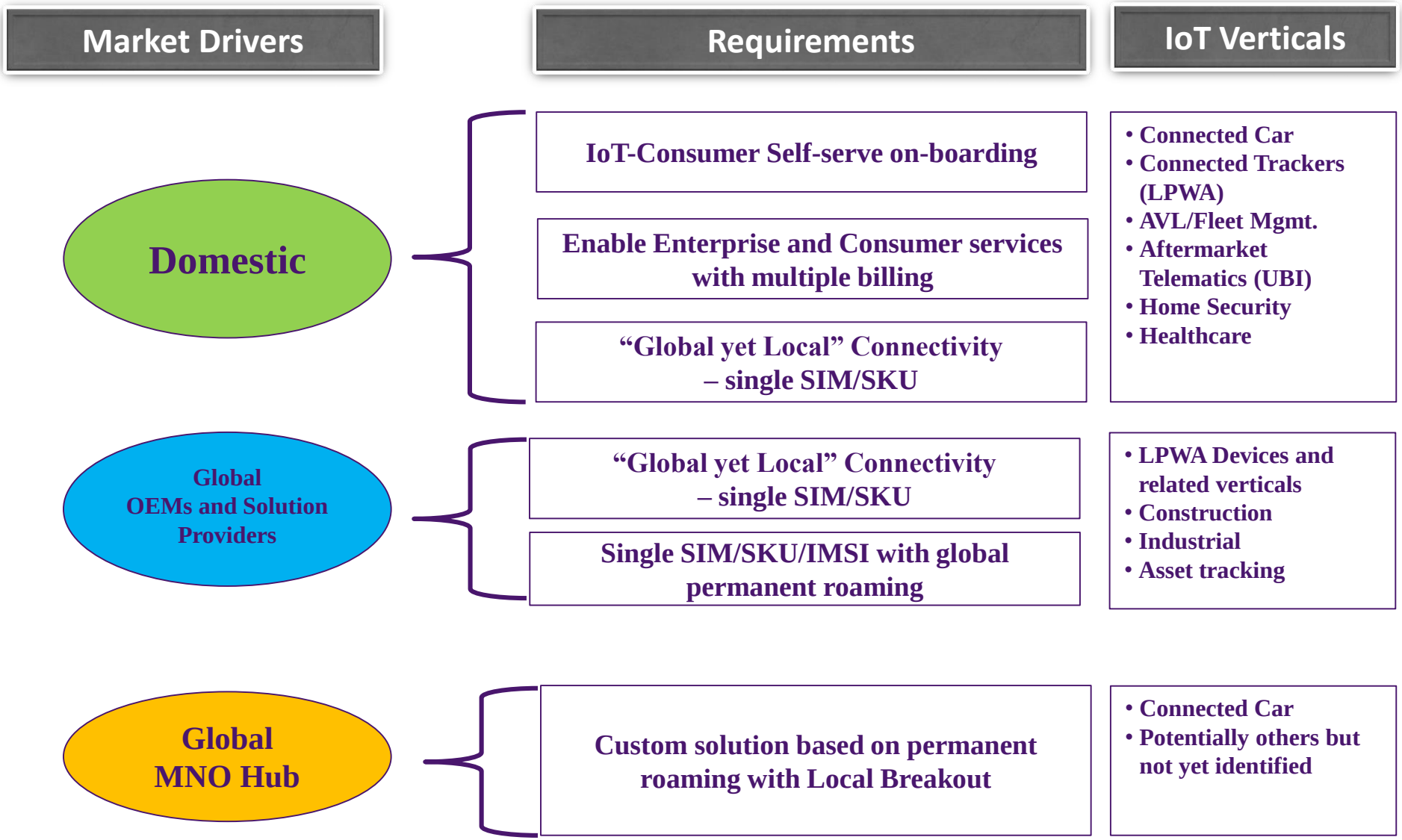
Connected Car

- **MNO Requirements**
  - Support OEM global markets reach – SIM/IMSI/Resource Mgmt.
  - Local Network based service delivery, limited “custom” solution
  - Sales, Marketing, Acquisition and Branding
- **Connected Car Solution Requirements**
  - Connected Car OEM device to support two sets of services:
    - Telematics Services (safe, security, and diagnostics)
    - Consumer Services (in-car Wi-Fi, Infotainment & Apps)
  - Telematics Services offered directly by the OEMs
  - Consumer Services offered by local Operators and require to support Prepaid, Post-paid, and Standalone Service Plans
  - Flexibility of rate plans with long device lifecycle.
- **OEM Solution Requirements**
  - Single SIM/Single SKU and Resource management
  - Both services delivered locally in the country by a local operator.
  - Choice of in-country operators, with national coverage

V2X

- **C-V2X Solution Network Requirements**
  - Better coverage by exploring existing cellular network
  - Improve service reliability, by using existing mobile infrastructure
  - Increase application by supporting wide-area coverage.
- **C-V2X Solution Service Requirements**
  - Broader business ecosystem with smart-city and others which use cellular technology.
  - Autonomous self-driving cars & passengers experience with eMBB, and automated telematics experience.
  - Network based analytics can gather intelligence on services.
- **C-V2X Solution OEM Requirements**
  - Provide backward capability between modules in order to support a 5-10 year device lifecycle.
  - Drive a single module to lower the cost down by providing a common chipset supporting both PC5/Uu (and later 5G).

TELUS IoT Reference Architecture – Deployment Drivers



Evolving C-V2X towards 5G for Autonomous Driving

C-V2X

- **C-V2X link budget leading to 2x longer better performing range,** FDM provides longer transmission time for the same number of bits; Resulting in 2db better transmission compared to 802.11p TDM.
- **Safety, Emergency,** Electronic Brake Light (EEBL), Control Loss Warning, Blind Spot and Lane Change Warning Automated Driving and Advanced Driver Assistance Systems (ADAS): Improved reliability at higher speeds and longer ranges
- **Value Added Services**: Route planning, map dissemination, and fleet management.

eV2X Scenarios

- **eV2X advantages based on,** Higher throughput, ultra-low latency. Wideband transmission for more accurate positioning (Rel-16 1ms).
- **Advanced Driving** supports automated driving where each vehicle and/or RSU shares their trajectories for safer traveling and improved traffic efficiency.
- **Remote Driving** enables a remote driver or a V2X application to operate a remote vehicle based on cloud computing

Key Components	DSRC/ IEEE 802.11	Rel 14 C-V2X	5G C-V2X (Rel 15,16)
Dependent on Network	No	Yes	Yes
High Speed Support	No	Yes	Yes
High Speed Density	No	Yes	Yes
Multimedia services	No	Yes	Yes
High Throughput	No	High Throughput	Ultra-High Throughput
Economical scale	No	Yes	Yes
Regulatory efforts	Yes	Limited	No
Positioning	No	Share positioning information	Wideband ranging and positioning
Latency	Low Latency for Short range D2D	Low latency for wide range safety applications	Ultra-low latency
High reliability	Local reliability	Enhanced safety applications	Ultra-high reliability

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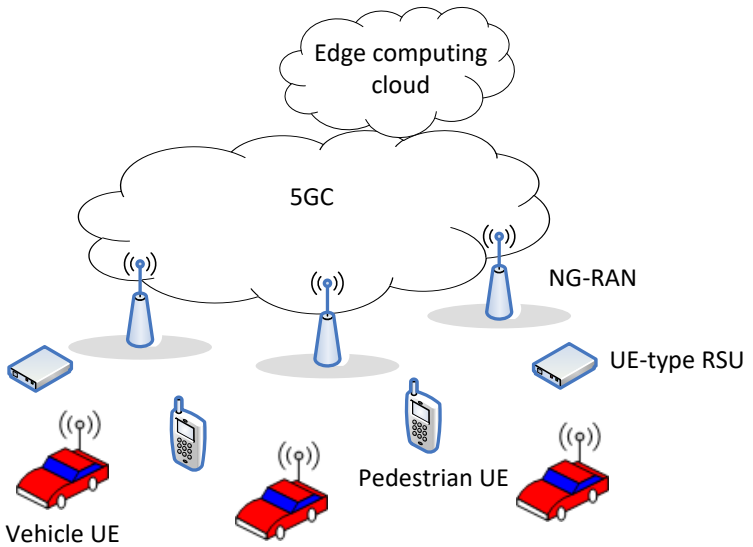
5G Performance & Mobility Requirements

- **5G Traffic Routing & Steering reduces latency**
  - UL Classifier of UPF is used to divert to the local data plane in order to steer the local application.
  - Vehicle mobility can be controlled by the AF via the PCF/NEF to influence the traffic routing and steering.
- **5G Session & Service Continuity improves resiliency**
  - Changes to the user plane results in no loss of connectivity since the connection is sent to a new PDU session anchor point before the previous connection is terminated.
  - Mobile network supports collecting and processing time critical information



System Level Performance

Scenario	End-to-end latency	Speeds (Absolute/Relative)	Message Size
Vehicle speeds	100 ms	250/500 km/h	300 /1200 bytes

Network Performance Requirements

Scenario	End-to-end latency	Data rate (Mbps)	Service availability & reliability
Remote driving	5ms	25	99,999%
Video sharing	10ms	700	99,99%
Advanced Driving	3ms	50	99,999%
Vehicle platooning	10ms	65	99,99%
Sensor information sharing	10ms	1000	99,999%

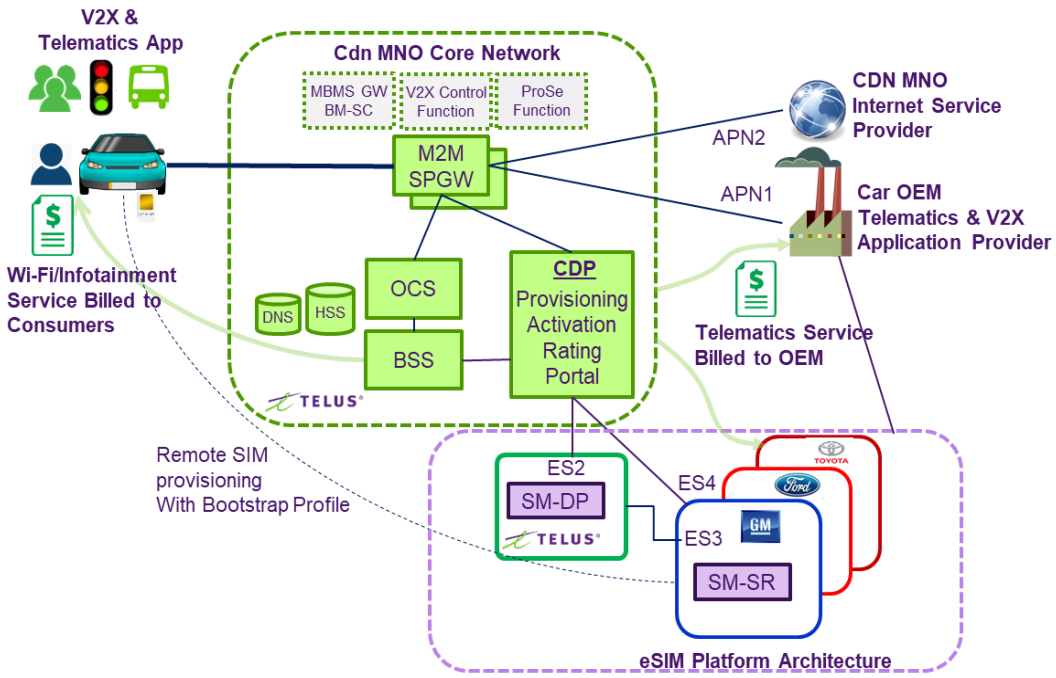
TELUS Reference Architecture for Connected Cars

Components of IoT Reference Architecture:

1. eSIM Architecture Integration
a) with TELUS IoT Reference Architecture, enabling TELUS IMSI Profile Mgmt with any global IoT Solution Provider or MNO.

2. Multi-Service, Multi-Billing
a) To enable two or more sets of services (High BW/Usage and Low BW/Usage) simultaneously on a single IMSI.
b) To enable simultaneous billing to multiple business entities on a single IMSI – consumer and enterprise.
c) To enable Post-paid Shareplans on a Connected Device.

3. Self-serve Consumer On-boarding System
a) To enable consumers to activate any service plan via a self-serve IoT System. No calls to activate a new device.
b) Integration to support consumer on-boarding via multiple retail channels.



- **Role of local MNO**
  - Provide SM-DP function in the multi-Operator eSIM eco-system
  - Deliver both Telematics and Consumer services via local MNO SIM Profile
  - Deliver Multi-billing and support both Prepaid and Post-paid Share Plans

- **Role of OEM**
  - Provide single SIM/SKU to car OEMs
  - Provide bootstrap connectivity and SIM provisioning with initial resource mgmt.
  - Act as SM-SR to MNOs

- **Role of eSIM Vendor**
  - Each entity, including the MNO, OEM manages their own subscription management platform independently.
  - Support multi-vendor solution using GSMA V3.1 SGP.02v3.1 Standards

Thank You