Driving to the Edge

How Open APIs and Open RAN will Transform Ordinary Parking Lots into Dynamic Data Centers

Natasha Tamaskar
VP, Global Marketing and Ecosystem Development, Radisys
The Next 30 Minutes

- Auto Industry Evolution
- Connected & Autonomous Vehicles
- Increasing Role of Mobile Networks in Realizing the Vision
- Challenges: What it takes
Auto Industry On the Brink of a Revolution?

Connected Car: Most visible example of IoT in the industry

Innovation: Sensors to artificial intelligence to big-data analytics

Smart Everything Everywhere
Road signs to wrist watches

$273 Billion
Potential application revenue of connected vehicles by 2026
Source: GSMA, Machine Research
Innovation Is a Constant, but Pace is Changing, Moves are Bolder

250 million Vehicles Will be Connected Globally by 2020

Source: Deloitte University Press

Source: Gartner
Auto
Autonomous Vehicles

+ Mobile
Connected and Controlled with Highly Efficient Mobile Networks

new AutoMobile
Driving New Efficiencies and Economies

Self-Driving

$273 Billion
Potential application revenue of connected vehicles by 2026
Source: GSMA, Machine Research

Self-Parking
62% reduction in space needed if the garage was reserved exclusively for self-parking cars.
62% reduction in space needed if the garage was reserved exclusively for self-parking cars. 26% when co-exists with human-based parking

Trillions forecasted in overall economic value driven by self-driving cars – fuel savings, accident avoidance, traffic efficiencies, personal productivity, etc.

Source: PCMag
Comes With the Tsunami of Mobile Data

4 TB per day

Estimated amount of data that an autonomous car will generate in about an hour and a half of driving

Source: Intel

- CAMERAS: ~20–40 MB PER SECOND
- RADAR: ~10–100 KB PER SECOND
- SONAR: ~10–100 KB PER SECOND
- GPS: ~50 KB PER SECOND
- LIDAR: ~10–70 MB PER SECOND

Source: Intel
Demanding Unforeseen Requirements of Low Network Latencies

- **Vehicle Steering**
  - Collision Warning
  - Platooning
  - Self-Parking
  - Autonomous Navigation

- **Traffic Efficiency**
  - Real time traffic re-routing
  - Bird’s eye view of roads and parking lots
  - E-Tolling
  - Fleet Management

- **Personal Services**
  - Infotainment
  - Parking subscription
  - LBS
  - Traffic updates
  - Augmented Maps

**Latency**
- Ultra-Low: 1 ms
- Very-Low: 5 ms
- Low: 10 ms

**Experience Centric Intelligence**

**Time Sensitive Responsiveness**

**Mission Critical Reliability**
Evolving Role of Mobile Networks
New Mobile Standards to Accelerate Innovation & Adoption

- Part of 3GPP Release 14
- Builds upon existing LTE connectivity developments for automotive applications
- Leverages existing LTE networks for V2N communications
- 5G compliant
- Strong ecosystem support

Win-Win for Automakers, Infrastructure Operators, Mobile Operators, Consumers
Autonomous Driving Needs Autonomous Networks

- **Proprietary**
  - Vendor lock-ins, slow time to market and high innovation cost

- **Embedded**
  - Integrated control and data, proprietary interfaces

- **Fixed**
  - Pre-programmed control logic and fixed network resources

- **Integrated**
  - Integrated RRU & BBU with high cost last mile transport

- **Software-Defined**
  - Open white box hardware and software (NFV, SDN) efficiencies

- **Unbundled**
  - Disaggregated control / data, Open APIs

- **Programmable**
  - Programmable based on real world network conditions

- **Flexible**
  - Deployment architecture and front haul agnostics

**Roadside Comm. Wired/Wireless**
- 2G/3G/4G

**Telematics**
- V2X (802.11P 4.5G)

**Safety Driving**
- 5G

**Comfort Driving**
MEC Paving the Path based on Open Principles

- High Bandwidth Data Analytics & Overlay at the Edge – AR/VR, HD Maps
- Local Breakout of Data to Local Service Providers - Telematics
- Ultra-Low Latency V2I and V2N IoT Communication – Autonomous Navigation
- Real-time RAN Aware Data Treatment – FOTA, SOTA, Emergency Response
- Location Aware Service Insertion Based on Crowdsourced Data

Mobile Edge Cloud

- Reduces latency & improves QoE
- Enable new services based on location
- Dynamic service creation
- Reduce load on back haul & core network
Use Case: Transforming Ordinary Parking Lots into Dynamic Data Centers

Policy driven
- Time
- Location
- Service

Data Feeds

Parking Edge Application

Radisys MEC Host Platform

Parking Server

Core Network

- Parking spots subscribe and notify their status to the cloud parking MEC application
- Parking event requested by car via connected mobile network
- MEC host receives the parking request and location information from eNodeB
- Parking MEC application authenticates the car, triangulates available parking spots in the area and automatically assigns a parking to the car based on its location
- The car can be configured to accept the assigned parking automatically or manually
- Location and HD map of the parking spot is sent to the car
- The car’s GPS system navigates the car to the assigned parking spot
- Once the car is parked, it tracks parked duration and automatically charges subscribers credit card
Use Case: RAN Aware Over The Air (OTA) Upgrade of Vehicle Firmware

- **Augments scalability** by adding new features and infrastructure to products after they are released.
- **Continuous Improvement**: Bugs and product behavior can be continuously improved even after the device is in the hands of consumers.
- **Agility**: Companies can test new features by sending updates to one or multiple devices.
- **Time to Market**: Developers can deploy frequently and reliably, knowing that products will stay functional as updates are released.

CSPs can save on firmware transport costs

Higher reliability and policy enforcement to prevent upgrade failures

![Diagram of RAN Aware OTA Upgrade Process](image)
Pulling Together the Solutions
What Does it Take to Pull Together a Mobile Edge Solution?

- ETSI MEC Architecture is used as an example, but it’s use is not mandatory.
- Each domain represents a specific aspect of the solution with a number of potential choices.
- Each choice introduces tradeoffs that affect the overall solution architecture.
- We’ve not explored all domains (OSS, UE apps etc. are left out).

#1: Identifying choices that map to each domain & location
#2: Software and Hardware Integration of those choices
#3: Functional & performance testing, including scaling

3 major problems to be solved
Radisys Edge Computing Platform Software

**Multi-Access**
- **Wireless** (RAN solution)
- **Wireline** (software defined broadband access)
- **P4 based** Data Plane Software

**Cloud Edge & 3rd Party Mobile Edge Applications**

- CDN Node
- Smart Parking
- AI Inference & Analytics
- Radio NW Services
- Location Services
- Networking Services (x86 Data Plane, Packet Routing & Filtering)

**Edge Computing Platform Services**

- ETSI MEC APIs – mp1 & mp2
- RNIS APIs
- USER INFO APIs
- NW APIs

**VNF/Container Onboarding Layer**
Software services around onboarding 3rd party MEC applications as containers/VNFs

**Management Layer**
- SDN control
- VNF management
- Orchestration management
- Orchestration tool

**Platform Agnostic Solution**
Cloud Native Platforms

**Radisys Software**

**Cloud Native Platforms – Data Center**

- Compute (x86)
- Networking
- Storage

**Network Functions Virtualization Infrastructure (NFVI)**
- VIM
- OPENSTACK

**ETSI MEC APIs**

**Cloud Applications**

**Internet**

**Traditional CDN**

**Management Layer**
- VIFV as containers/VNFs
- Orchestration tool
- SDN control
- VNF management
- Orchestration management

**Cloud Native Platforms**

**Radisys Edge Computing Platform Software**
Smart Parking - Implementation Architecture

P4 Programmable Data Plane

IP/Transport Network

Internet

Edge Cloud

MEC Host SW Platform

Service Orchestration Lifecycle Management

vApps Smart Parking

Live Video/Content

Application Server

Virtual Media Server

Radio Network Services

vMME

vSGW

vPGW

RSYS L2/L3 +

Intel® FlexRAN

3rd Party

Open Source + Radisys

Centralized Cloud

ONAP Orchestration & Automation

Parking Requests Made by Vehicles

vRAN

eNodeB

M-CORD

(XOS, ONOS, OpenStack)

Smart Parking

Requests Made
by Vehicles

Smart Parking

- Implementation Architecture

Parking

Requests

Made

by Vehicles

#A

#B

#C

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Summary

- The automobile industry is on the verge of disruption, creating new ecosystems with auto manufactures, software and content providers as well as network operators.
- Market movement is dependent on innovations in the mobile space.
- “Open networks” will not be good to have but a requirement.
- Open RAN will bring in new advancements in innovation, but will require strong understanding of “how” to put these solutions together – hardware, software, open, proprietary, edge, centralized.
Thank You