Connected Cars

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Overview of Connected Car

- Connected car business value lies in the range of services offered (B2C, P2P, etc.)
- Car as an integral part of system of systems (Eg. Smart cities)
- Rapidly emerging requirements: shared ownership, zero-casualty safety, reliable service development and deployment methodology, seamless interconnectivity, etc.

Safety   Mobility   Environment   Convenience
Challenges for future mobility systems

- Integration of automotive with heterogeneous subsystems and complex societal dynamics

- Highly networked, time coordinated interactions with highest degrees of assurance and safety

- Increasing complexity of V2X systems demand distributed computing with massive data

Source: US DOT

Source: 5GAA/NOKIA
Integrating Accessors with Automotive

Architectures that allow development, deployment and maintainability of evolving services are necessary.

- Open Interfaces
- Adaptive
- Real-time
- Dynamic

Platforms/Consortiums

Architectures

In-vehicle/Edge Computing

Fog Computing

Cloud-Centric

Networking/Languages
Collaboration with iCyPhy

1. Integrating Accessors with evolving in-vehicle platforms
   - Load balancing of vehicular compute tasks using a road side unit
   - Coordinated traffic control using RSU

2. Adaptive services leveraging Fog/Cloud
   - Load balancing of vehicular compute tasks using a road side unit
   - Coordinated traffic control using RSU

3. Semantic service discovery

4. Deterministic behavior of distributed connected car applications
Integrating with in-vehicle PFs

• Legacy automotive platforms are designed for in-vehicle applications running over network of dedicated ECUs such as seat temperature control, diagnostics, etc. Eg. Classic AUTOSAR

• Emerging platforms are on track to serve evolving Infotainment, ADAS, autonomous and connected (V2X, telemetry) functions Eg. AGL, Adaptive AUTOSAR

• Scalable service-Oriented Middleware over IP (SOME/IP) is the communication backbone for Adaptive AUTOSAR
  • also has implementations for interoperability with AGL
  • allows applications to communicate over Ethernet in pub/sub pattern
  • provides additional features such as serialization, service discovery

• SOME/IP is primarily meant for inter and intra-ECU application interaction.
SOME/IP Accessor in Capecode

- SOME/IP accessor allows interaction with Adaptive AUTOSAR Applications
  - The SOME/IP accessor provides interface to specify
    - Communication pattern (notify/subscribe/request/response)
    - Configuration (.json) to set local environment variables for SOME/IP
Integrating with in-vehicle PFs

- New accessors to be developed to interact with Adaptive Runtime and AGL’s Application framework
- ECU-level requirements factored in for connected application development relying on extra-vehicular environments for safety-critical applications
Adaptive services leveraging Fog/Cloud

- For complex connected and self-driving functions:
  - Endow **Computation Bandwidth** in-vehicle by offloading critical tasks to other compute nodes in the fog/cloud (eg. Trajectory planning)
  - Utilize latest, better **Service Implementations** at fog/cloud (eg. Maps)
  - Maximize the **Data Availability** for some services that rely on a wider set of sources not available from within the vehicle (eg. road conditions)
  - Perform **Configuration Management** of time-critical distributed applications (eg. Platooning)

[Diagram showing various connected car functionalities and connectivity models]

Load Balancing

- Driving behavior analysis offloaded to an RSU offering compute as service
- RSU maintains microservices composed of accessors that can be discovered
- Vehicle swarmlet downloads an accessor to this microservice
- Network latency and data bandwidth should be factored in to decide on “offloading”

1. Detect peak condition
2. Request Driving Behavior Analysis accessor service
3. Send accessor to utilize this micro service
4. OBD data now sent to RSU via reified mutable accessor
5. Execute computation
Semantic Repository for service discovery

- Maintain core vehicle ontology and dynamic temporal ontologies (from web services) in semantic repository

- Vehicle swarmlets query the semantic repository for location based service discovery

Details in Matt’s presentation
Semantic Repository for service discovery

- Parking lots that satisfy user criteria “nearest first”

1. parking lots register with cloud and provide serviceOnto
2. Specify location and query on user criteria
3. Based on car location and requested service if any, to return service accessor
4. Interact with selected business using service accessor
Conclusion & Future Work

• Accessors based connected car PF
  - Facilitates rapid prototyping and deployment of connected services
  - Has potential to interface and interoperate with in-vehicle and extra-vehicular things
  - Enables development of adaptive, dynamic and distributed services for connected automotive

• Evaluation of current work with test deployment of connected applications

• Continue development of connected car specific accessors and core libraries for Accessor PF
  - Interfaces to embedded ECUs and sensors to synergize with Self-driving applications
  - Networking (V2X interface accessors such as DSRC, C-V2X)

• Deterministic timing across network for connected swarmlets (Eg. Coordinated Traffic Flow)