System Architecture Aspects
in Vehicular Communication Environments

1 July 2009
Marc Bechler
BMW Group Forschung und Technik

preparation for driving implementation and evaluation of C2X communication technology
Typical Scenario for Cooperative Systems

Source: ETSI
PRE-DRIVE C2X

- **Mission**: Prepare for driving implementation/evaluation of C2X technology
  - Connecting vehicle to vehicle, roadside & backend infrastructure
  - A priori estimations of impact on traffic safety & mobility
  - Paving the road for field operational tests on cooperative systems
  - Identify key enablers (and disenablers) for market introduction

- **BUT**: Requires system architecture!
  - Common (and interoperable) understanding of the overall system
    - Establish European architecture for cooperative systems
  - Described by different aspects („views“) of the system. Focus of this talk:
    - Backend Services Integration View
    - Testing View
Architectural Domains in PRE-DRIVE C2X

- ITS Ad Hoc Domain
- ITS Roadside Infrastructure Domain
- Generic Access Domain
- Internet Domain
- Legacy Internet Service Domain
- ITS Application Service Domain
- ITS Operational Support Domain
Networking Protocol View

ITS Management

- ITS Applications
  - BSA
  - ESA

- ITS Facilities

- ITS Transport

- ITS Network
  - IPv6 (Optional: Mobile IPv6 NEMO*)

- ITS-G5A
- ITS-G5B
- UMTS

ITS Security

BSA: Basic Set of Applications
ESA: Extended Set of Applications

UTC: 01.07.2009
Backend Services Integration View

• Bring together backend services/applications/processes and vehicles
• Typical example: fleet management
• Architectural patterns in PRE-DRIVE C2X
  • SOA (Services-Oriented Architecture)
    • Vehicle is considered as a (mobile) service
      • Integrated into enterprise application
    • Based on Web Services
  • EDA (Event-Driven Architecture)
    • Event-based, asynchronous
    • Based on Web Services Notification (Publish/Subscribe principle)
• Security support according Web Services Security
Backend Integration

Enterprise Applications

Vehicle Integration Platform
- C2X application support
- Service and infrastructure management

In-Vehicle Integrator
- Connecting the vehicle application unit to backend service infrastructure
Backend Aspects

- Event generated in vehicle is propagated to enterprise application
- Business Connector (in Vehicle Integration Platform)
  - Enhance events with enterprise application specific parameters (e.g., login credentials)
  - Add additional data provided by 3rd party information providers (e.g., weather information for more accurate data)
- Invocation Service (in Vehicle Integration Platform)
  - Enterprise Application may trigger services in vehicle
Testing View

- 3 test environments:
  - Simulations
  - Test bench
  - Field operational tests
Conclusions & Outlook

- Architecture framework specified
  - Based on initial work from EU project COMeSafety
  - Input for „Common Architecture Document“
    - Harmonized among all ongoing EU projects
- Goal: Standardization as European architecture framework for cooperative systems.
  - Interoperability of different applications for safety and mobility