In-Car Gateway Software for Internet-of-Vehicles (IoV)

Dr. Billy Chan
Senior Manager,
Communications Technologies, ASTRI
Outline

- Background of Internet-of-Vehicles (IoV)
  - ASTRI’s Technologies for Internet-of-Vehicles (IoV)
    - In-Car Gateway (ICGW)
    - IoV Management with IMAP
    - ASTRI’s IoT Successful Cases
  - Concluding Remarks
Networks and Applications - Internet-of-Vehicles (IoV) System & Apps

- **Internet-of-Vehicles (IoV)** - dynamic mobile communication systems between vehicles & public networks/Internet using **V2X** (802.11p WAVE/DSRC for V2V, V2I & V2H) & **Wireless Backhaul (3G/LTE)** communications, and enables

  - **Information gathering & sharing** between vehicles, roads, & Internet services
  - **Mobile IoV applications** - navigation, road & car status monitoring, diagnostics, road emergency & assistance, telematics, infotainment, route planning, insurance, fleet management etc

---

**Explanation:**

- **V2X:** V2V (Vehicle-to-Vehicle), V2I (Vehicle-to-Infrastructure), V2H (Vehicle-to-Human)
- **CAN:** Controller Area Network
- **OBD:** On-Board Diagnostics
- **ECUs:** Electronic Control Units
- **WAVE:** Wireless Access in Vehicle Environment
- **DSRC:** Dedicated Short Range Communications
- **IoT:** Internet-of-Things
- **IoV:** Internet-of-Vehicles

---

*Sources: Google Images*
Background - IoV Huge Market Potential

- **IoV** is emerging trend for **IoT** with huge global market potential, in **China & APAC**
- **Automotive** contributes **29%** of China’s GDP for 2013-25 for new **Internet apps** *(by McKinsey, Jan 2015. #1)*

- **By 2020, new cars are expected to have some 1,000 chips per vehicle,** ..... That same year, **Chinese car buyers are expected to make up about 35 percent of all new car sales.....**, by Broadcom, Apr 2015. #2

- **“The future IoV market will see rapid growth in the Asian-Pacific region. ....., leading to potential economic impact of $2.3 trillion for the global manufacturing industry...”,** by APEC, Oct 2014. #3

- **“...the dramatic increase in vehicle connectivity will increase the value of the global market for connectivity components and services to €170 billion by 2020 from just €30 billion today.”**, by McKinsey, Sept 2014. #4

---


#4 [http://www.mckinsey.com/insights/manufacturing/whats_driving_the_connected_car](http://www.mckinsey.com/insights/manufacturing/whats_driving_the_connected_car)
New vehicle in-average contains > 50-100 ECUs (Electronic Control Units)

- ECU Domains: PowerTrain, Chassis, Body & Comfort, Driver Assistance, HMI, Multimedia

ECUs (AutoSAR & OPEN standards) over Automotive Ethernet is emerging trend

OBDii (On-board Diagnostics) Interface provides ECUs information & Data*

In-Car GW plays important role – gather & share ECUs information & data

Data users: Drivers, Car Owners, Mechanics, Insurance & Traffic Dept etc

*ECU Info & Data: Dashboard (Engine RPM & Load, Speed, Fuel status & economy (MPG), Coolant temp, Intake air temp etc), Diagnostics Trouble codes, Oxygen Sensor, Vehicle Identification Number (VIN) etc

* pics sourced from google images & digikey.com
Background – IoV Ecosystem

Cloud, Application & Service Layer
- Navigation
- Infotainment
- Road Emergency & Assistance
- Diagnostics & Maintenance
- Real-time Car Status

Business Cloud Platform, Data Center, Services, Management, Control

Network Infrastructure & GNSS Layer
- GPRS, 3G, LTE, Wifi, 802.11p (V2X)
- GNSS (GPS, BeiDou, Galileo)

IoV & V2X Terminal Layer
- IoV/V2X Terminal HW & Middleware
- IoV/V2X Terminal SW, OS & Middleware
- Wifi
- Bluetooth
- RS232
- USB
- Linux
- Android
- CarPlay (QNX)

Telecom/ Internet Services/ GNSS Providers
- China Mobile
- China unicom
- China Telecom
- GARMIN
- Google
- Baidu
- Alibaba
- Tencent
- IBM
- Intel

IoV/V2X Terminal /Chipset Vendors
- CohdaWireless
- NXP
- freescale
- Tencent
- Broadcom
- Novo
- Arada

Car Device & Interface Layer
- Smartphone/Tablet
- OBDii
- ECU (w/ AutoSAR & OPEN based)
- HMI
- PowerTrain
- Chassis
- Body & Comfort
- Driver Assistance
- Multimedia
- CANBUS
- AutoEthernet
- LIN
- FlexRay
- MOST

Car Manufacturers/OEM/ECU Vendors/Alliance
- Mercedes-Benz
- BMW
- AUDI
- VOLKSWAGEN
- FORD
- TOYOTA
- HONDA
- NISSAN
- BYD
- CHRYSLER

ASTRI Proprietary
Background – IoV Network Architecture

- IoV Management & Applications
- Communications
  - V2X
  - LTE Backhaul
- In-Car Gateway (ICGW)
- Car Devices, ECUs & Backbone

![IoV Network Architecture Diagram]
In-Car Gateway (ICGW) - Key Tech Enabler for IoV

1. Bridges the “gap”, connect & interface with ECUs & data in diff domains & backbone
   • retrieve & share In-Car info & data (via OBDii interface)

2. Provides IP connectivity & communications between vehicles, infrastructure & Internet applications
   • Integrates with V2X (802.11p) & Wireless Backhaul (IP/LTE)
Outline

- Background of Internet-of-Vehicles (IoV)
- ASTRI’s Technologies for Internet-of-Vehicles (IoV)
  - In-Car Gateway (ICGW)
  - IoV Management with IMAP
  - ASTRI’s IoT Successful Cases
- Concluding Remarks
ASTRI’s In-Car Gateway (ICGW) - Technical Focus

- **In-Car GW (ICGW) supports**
  - Standard OBDii PIDs of ECUs via
    - CAN (CANBUS)
    - TCP/IP (Automotive Ethernet)
  - GPS for location info
  - IP/Wifi/LTE/802.11p for Internet & network connectivity
  - Standard web interfaces (REST, HTTPS) for device & data interfacing
  - Interfacing with IoV Management & App Server

- Demonstrate car status monitoring, ECU info & data sharing, connectivity
- Enable IoV Applications

---

**IoV:** Internet-of-Vehicles  
**V2X:** V2V + V2I  
**V2V:** Vehicle-to-Vehicle  
**V2I:** Vehicle-to-Infrastructure

**CAN:** Controller Area Network  
**OBD:** On-Board Diagnostics  
**ECUs:** Electronic Control Units  
**PID:** Parameter ID  
**REST:** Representational Transfer  
**HTTPS:** Hypertext Transfer Protocol Secure  
**GPS:** Global Positioning System
In-Car Gateway (ICGW) – Software Framework

- In-Car GW supports multi-vendor standards, protocols, interfaces & models (device & comm)

- Adaptation Layer (AL)
  - Standard OBDii PIDs of ECUs* via CAN (CANBUS) or TCP/IP (AutoEthernet)
  - Extensible SW adaptors for vendor-specific OBDii PIDs
  - GPS adaptor for location info

- Management Layer (ML)
  - ECUs status, data, monitoring
  - Data security & device authentication

- Presentation Layer (PL)
  - Northbound Standard Web Interfaces (REST/HTTPS) for data access & sharing
  - CLI for GW management
  - Network Interfaces & Adaptors
    - IP/Wifi/LTE/802.11p (V2X)

* Standard OBDii PIDs (SAE- J1979), AutoSAR & OPEN standard-based ECUs

V2X: V2V + V2I
CAN: Controller Area Network
PID: Parameter ID
CLI: Command Line Interface
OBD: On-Board Diagnostics
ECUs: Electronic Control Units
In-Car Gateway (ICGW) – Design Approaches

1. Ensure extensible In-Car GW for multi-vendor standards, protocols, interfaces, & data models
   - IP, 802.11p, LTE, Wifi, RS232, Bluetooth, Ethernet, GPS, CAN, TCP/IP, OBDii PIDs & Vendors’ proprietary

2. Able to identify & access various types of ECUs & data
   - Various types of ECUs (Engine, Door, Transmission, Speed, ABS, ....) connected to CANBUS or Automotive Ethernet

   Approaches:
   - Flexible device & interface adaptation (SW adaptors) & standard data modeling (XML, JSON)
   - Leverage efficient “Naming” scheme (using REST URI, IP address) for ECU identification & lookup
   - Leverage standard REST interface & In-Car GW resource model for efficient ECU & data access
In-Car Gateway (ICGW) – Design Approaches

3. Enable data security & device authentication for In-Car GW
   • Protect data security & privacy, only authorized users & In-Car GWs can access & share data/info to web platform

   ❌ Approaches:
   • Design **data security & access control** (e.g. encryption with HTTPS, authenticate users & connections etc)

   • Design **gateway authentication** to register into IoV management platform (e.g. using shared API keys, secrets, hash digest etc)
In-Car GW (ICGW) – Other Considerations

- Many car manufacturers do not open its full set of OBDii PIDs (only available to specific service subscriptions)
  - Focus on Standard OBDii PIDs & AutoSAR ECUs only
  - Use OBD simulators,
    - 3rd-party commercial (e.g. ECUSim-2000), Open Source (e.g. OBDsim)
    - ASTRI’s simulator software as tools

- Facilitate local vendors & application developers for development & testing without the need of real cars

- Automobile & V2X standards (OPEN, AutoSAR, Ethernet, 802.11p & LTE-V) are still evolving,
  - Follow closely with vendors’ product, Automobile & V2X standard development & evolution.
  - Scalable & flexible gateway software design, Not hardware-platform dependent

- Facilitate local vendors to deploy ICGW software onto their specific hardware platform
Outline

- Background of Internet-of-Vehicles (IoV)
- ASTRI’s Technologies for Internet-of-Vehicles (IoV)
  - In-Car Gateway (ICGW)
  - IoV Management with IMAP
  - ASTRI’s IoT Successful Cases
- Concluding Remarks
IoV Management with ASTRI’s IMAP

Follow ETSI M2M standard, based on REST architecture & interfaces, using standard Web technologies & protocols

Enable Platform Scalability, Flexibility, Reliability & Security!
**IoV Management – IoV Device & Data Management**

- **IoV Device Management**
  - Multi-vendor multi-standard device management (ECUs, GWs)
  - Device registration, ICGW authentication & access control
  - Provide inventory, status, alarm, map & topology, configuration, performance, device & user groups etc

- **IoV Data Management**
  - Application Data Access Control
  - Data Integrity Protection & Encryption
  - Database schema & interfacing for Big Data handling

- **Web-based & Customized GUI**
  - User access control
  - GUI features
Smart City Apps – (1) Solar Street Light Management

• Leverage ASTRI’s IMAP to enable large-scale city-wide management of solar street lights, providing real-time status monitoring & remote control, to reduce maintenance costs & manual operations
• Successful deployment in campus & roads in Wuhan
• Target & Plan for large-scale city-wide deployment in Wuhan, in next years

Successful deployment in campus & road in Wuhan, China
Smart City Apps – (2) Environment Monitoring & City Management

- Based on Solar Street Light Management Platform
  - Integrate other sensors (like sound, CO₂, PM2.5, temperature & humidity) for city & street environment monitoring

- Provide efficient support for smart city management

*Photo source from Google/Internet*
Smart City Apps – (3) Renewable Energy (RE) Device Management

- **RE Device Example**
  - **Solar Power Stations**
  - Standalone with NO remote management & monitoring

- **Provide green energy for many smart city facilities & applications**
  - River/Canal/Bridge Monitoring & Toll Management
  - City facilities

- **ASTRI’s RE Device Management for RE devices**
Smarthome - Alljoyn-based Management System

- Smart Home Controller, Home App, Device Emulators, Remote Access Server
- Provides centralized management, status monitoring & remote control, notifications of Alljoyn-enabled home appliances & devices

AllSeen Alliance announces ASTRI as one of the eight new members at MWC 2016
ASTRI’s IMAP – Commercial-Grade Quality

**Asia Research News** Jan Issue, 2015

[Link](https://issuu.com/asiaresearchnews/docs/asia_research_news_2015/51)

**Hong Kong Entrepreneurs (企業雄才)**

Jan Issue, 2014

**InnoCarnival 2014 & 2015**

HK

**CES 2014, LV, USA**

**IoT Symposium 2014 & 2015, HK**

**APAC Innovation Summit 2014**

**京交會 2014, BJ**

**MWC 2016, Barcelona**

ASTRI’s Showcases in CES 2014, Appledaily (蘋果日報), 24 Jan, 2014


TKP 大公報, 24 Jan, 2014

ASTR’s IoT Demo System

- Sensors, Actuators & Smart Devices
- IoT Gateway
- ASTRI’s Implementation of ETSI Interfaces (mld, mla)
- IoT Management & Application Platform (IMAP)
- Web GUI
- Demo Applications
  - Solar Street Light Management
  - Solar Power Station Management
  - Alljoyn Smarthome Management
Concluding Remarks

- **ASTRI’s In-Car Gateway is Key Enabler for IoV**
  - Connect & interface with ECUs & data in diff domains & backbone
  - Provides IP connectivity & communications between vehicles, infrastructure & Internet applications

- **ASTRI’s IoT & Comm Technologies for IoV**
  - IoV Management with IMAP
  - Platform Scalability, Flexibility, Reliability, & Security to support different IoT applications (smart city, smart home, IoV etc)
  - Emerging Communications Technologies (LTE/4G/NGN – 5G, D2D, V2X, LTE-V)

- **Benefits Device Vendors, System Integrators (SIs), App Developers & Users**
  - Cost-effective & customizable IoT management system
  - Efficient & scalable data management, standard REST/Web interfaces & data models, APIs/SDKs/Modules for IOT app development
  - Complete end-to-end solution to customers
End of Presentation
Thank you.

Suggestions are welcome!
Our corporate website: www.astri.org