Automotive and OTA Testbed

PLUS - Go Kart Testbed Demonstrator
Overview

Testbed Summary
The Testbed demonstrates how software can be managed on a fleet of vehicles remotely. Software can be deployed, updated, and replaced. A microservices architecture is used to provide the maximum functional improvement with a minimal of software change. This testbed covers standard topics such as vehicle control and data handling: collection, filtering, and analysis. The solution also addresses the specific automotive safety risks in a cybersecurity realm and introduces Li-Fi as a complementary wireless communication option for such updates as well as general V2X communication.
Why is the Testbed Important to IIC?

- Incorporates several technologies and initiatives that are at the core of IIC’s mission
- AIOTA is one of the task groups with IIC and this testbed is being presented under this task group
- The concept and technologies fall within IIC Distribution Delivery Network and IIC Intelligent Transport Systems (ITS)
- Relates to multiple IIC initiatives and technologies
- The solution incorporates Cyber Security elements related to OTA, ITS and connected vehicles
- Provides real world validation for crucial elements in the automotive industry
- Positions IIC as a thought leader in the OTA and connected vehicle aspects of the automotive industry
- Fosters collaboration amongst IIC members as well non-members in the automotive, cyber security and other industries that rely on OTA updates.
Overview - Market Segment

Market Segment

The basic challenges addressed are common among most IoT domains including whether it be medical devices, industrial machines, or vehicles.

- Automotive (OTA, connected vehicles, V2X)
- Healthcare (Medical Devices)
- Manufacturing (Industrial Machines)
Overview- Description of prior deployment

The concept for the testbed was originally in Austin Texas in 2018. The demonstration went through several upgrades and was subsequently demonstrated at the IIC quarterly meetings in 2018 and 2019 and at the IoT Solutions World Congress in Barcelona in February 2019 where it was one of the nominated concepts for testbed of the year.
Overview: Participants

Current Participants
- aicas
- AASA
- Linaro
- Bosch
- IIC Automotive and Industrial OTA Task Group

Potential Participants
- Car Manufacturers
- Automotive OEM’s
- Companies working on:
  - Cyber Security
  - Verification & Validation
  - Telecommunication
  - TSN
  - Edge Computing

Contacts:
Dr. James Hunt (Aicas): jjh@aicas.de
Dirar Hakeem (AASA): dhakeem@aasainc.com
Use Cases

Current Use Cases

• OTA Dependency Management: Standardized, technology-independent “manifest” for ECUs to provide release configuration information
• OTA for Heterogeneous Operations Management: Management of different bus systems and specialist deployment platforms (e.g. FPGAs)
• OTA Silicon to Cloud: Holistic Use Case for future OTA architectures
• OTA and Lifecycle Management: Security, Safety and validation

Future Use Cases

• Fleet management
• OTA for Autonomous Driving: Dealing with distribution of AI models
• OTA and Supply Chain: Creating tamper-proof trace of the vehicle’s change history
• OTA for distribution of personalized user profiles for car sharing.
• V2X Communication/Connected Vehicles
Solution Overview

- Li-Fi
- Wi-Fi and other Radios
- Commercial Wireless (4G, 5G, LORA, NB-IoT, SIGFox, and beyond)

Access

- Software Update
- Hot-Swap (SW/HW)
- Security Update

OTA & Security

- Optical Car Communications
- ITS – V2V, V2x, V2P Driving Assist
- Infotainment
- Device (Fleet) Management

Applications & Services
Solution Details: Validation Features

Testbed for validating:

- OTA Implementation
- OBD Software Update
- Security Updates
- Car Communications (Connected Cars)
- After-Market Add-ons
- New Services
  - Smart Garage/Smart Shops, Platooning with Light (OCC)
Kart System (Multiple Computers)

- Steering without bus signal encryption
- Breaking with bus signal encryption
- Power not yet connected
- HMI unit with (Wi-Fi) Ethernet connectivity
- Li-Fi-based (Li-Fi) near field (V2X) communication
- Li-Fi based augmented reality UI

Cloud Portal System

- Data connection
- Remote control
- Software/Device management (Aicas - Jamaica EDP) (no-code quick prototyping to a full code implementation)
- AWS based (but could be used on other systems)
Solution Details: System Components

Intra-vehicle communications network security testing on encrypted CAN Bus

Automotive Services for Early Design, Prototyping, and R&D Phases

Automotive Safety and Cybersecurity

Augmented Reality Visualization using Li-Fi

Vehicle communications through commercial and other communication accesses

- Cloud-enabled validation and certification capabilities for OTA
- Infotainment and Add-on Services

Testing System for Services, Safety and Security Assurance Case Validations

Dashboard for design, control, configuration, and measurement
Solution Details: Communication Layers

**Access**
- Radio (4.5G-6G/LoRA/Others)
- Visible Light Communication (Li-Fi)
- Optical (OCC, Camera/Li-Fi)

**OTA & Security**
- OTA Software Update (HOTSWAP)
- Validate automotive platforms against Safety and Cybersecurity issues
- Automotive Safety (Li-Fi V2x, V2P, V2V)

**Applications & Services**
- Prototyping & Testing (Apps & Products)
- AI-Assisted Application development
- AR for Shops - Li-Fi based Augmented Reality for fast and accurate identification of service points
### Solution Details: Features

#### Kart Systems (KS)
- Improved Container based Deployment
- Add 5G connectivity
- Add Li-Fi connectivity
- Flashing on-board devices

#### Cloud System (CS)
- Improved Asset and Software Management
- Further cloud data connections such as:
  - Azure
  - Salesforce
  - Private Cloud
  - R&D CAD

### All Java Data Dashboard (vDD)
- Based on OSGi and JavaFX standards Ref. Motorcycle Demo as is, Generic MQTT Server here.
Trustworthiness

- Security
- Safety
- Reliability
- Resilience
- Privacy
- Testbed Components Threat Analysis and Threat Ranking
  - App Codes
  - Hardware
  - Communication
  - Network & Cloud
Relationship to IIC Technologies:
IIC Distribution Content Delivery Network

- **Authoring**
  - Central Repository
  - Regional Repositories
  - Local Distribution

- **Distribution**
  - VPN
  - LAN
  - Wi-Fi
  - GSM
  - Li-Fi

- **On-Vehicle Deployment (OTA Functionality)**
## Relationship to IIC Technologies: IIC ITS

| Use Cases | Driver Assistance | Autonomous Vehicles | Platooning | Robo-Taxi | Sharing Economy | Passenger Services | Efficiency | ...
|-----------|-------------------|----------------------|------------|-----------|------------------|---------------------|------------|------------------------
|           |                   |                      |            |           |                  |                     |            |                        
| Software-defined-Vehicle | Edge Computing | Cloud | IoT | Big Data | AI | ...
| Networking |                   |                      |            |           |                  |                     |            |                        
|           |                   |                      |            |           |                  |                     |            |                        
| Lifecycle Management | TSN | V2V | V2X | 5G | Li-Fi | ...

<table>
<thead>
<tr>
<th>DevOps</th>
<th>Agile Product Development (HW+SW)</th>
<th>Over the Air Updates (OTA)</th>
<th>Verification &amp; Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security</td>
<td>Secure Development Lifecycle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Proposed Testbed Plan

<table>
<thead>
<tr>
<th>Test Bed Feature</th>
<th>Action Items</th>
<th>Phases</th>
<th>Deliverables</th>
<th>Target Dates</th>
<th>Actors/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS1</td>
<td>Improved Container based Deployment</td>
<td>I</td>
<td>Package Installed on the Go Kart</td>
<td>T+3 Months</td>
<td></td>
</tr>
<tr>
<td>KS2</td>
<td>Add 5G connectivity</td>
<td>II</td>
<td></td>
<td>T+9 Months</td>
<td>AASA</td>
</tr>
<tr>
<td>KS3</td>
<td>Add Li-Fi connectivity</td>
<td>I</td>
<td>Li-Fi modules installed on the Go-Kart</td>
<td>T+3 Months</td>
<td>AASA</td>
</tr>
<tr>
<td>KS4</td>
<td>Flashing on-board devices</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vDD1</td>
<td>Based on OSGi and JavaFX standards</td>
<td>I</td>
<td></td>
<td>T+4 Months</td>
<td>AICAS and Linaro</td>
</tr>
<tr>
<td>vDD2</td>
<td>Ref. Motorcycle Demo as is</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vDD3</td>
<td>Generic MQTT Server here</td>
<td>III</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vDD4</td>
<td>Competing JavaScript / Web Dashboards</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS1</td>
<td>Improved Asset and Software Management</td>
<td>II</td>
<td>Demo the final work on Go Kart</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS2</td>
<td>Further cloud data connections such as Azure, Salesforce, Private Cloud, R&amp;D CAD</td>
<td>II</td>
<td>Connectivity demonstrated and validated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Outcomes/Deliverables

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Deliverables</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Container based Deployment</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>5G connectivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li-Fi connectivity</td>
<td>Currently used for sending info from Kart. Next goal is to use for receiving updates</td>
<td></td>
</tr>
<tr>
<td>Flashing on-board devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on OSGi and JavaFX standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref. Motorcycle Demo as is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic MQTT Server here</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competing JavaScript / Web Dashboards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved Asset and Software Management</td>
<td>Demo the final work on Go Kart</td>
<td>• Testbed Progress Report</td>
</tr>
<tr>
<td>Further cloud data connections such as Azure, Salesforce, Private Cloud, R&amp;D CAD</td>
<td>Connectivity demonstrated and validated</td>
<td>• Use Cases Technical Report</td>
</tr>
<tr>
<td>Lessons Learned</td>
<td>Detailed lessons learned report</td>
<td>• Security Assessment Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Industry Guide and Recommendations Report</td>
</tr>
</tbody>
</table>
Testbed Benefits

<table>
<thead>
<tr>
<th>Benefits</th>
<th>To Clients</th>
<th>To Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast &amp; Portable</td>
<td>Validity of the offered solution</td>
<td>• Solutions or components’ testing and validation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Training and Education</td>
</tr>
<tr>
<td>Secure &amp; Reliable under use conditions</td>
<td>Proven &amp; Tested Components</td>
<td>• Solution or components’ fine-tuning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scenario's evaluation (what-if)</td>
</tr>
<tr>
<td>UI Automation</td>
<td>Flexible Interfaces</td>
<td>• Automation of Manual Tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Automation and verification of User functionalities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ability to Know Your Own Customer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Generate and evaluate test results</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• time and cost-effective</td>
</tr>
<tr>
<td>V2X Connect</td>
<td>Introduce another wireless communication method</td>
<td>More robust and reliable communication system</td>
</tr>
<tr>
<td>Data Patterns &amp; Analytics</td>
<td>Tailored &amp; customizable Services that meets the</td>
<td>Understanding and service-ready for clients</td>
</tr>
<tr>
<td></td>
<td>users’ expectations</td>
<td></td>
</tr>
</tbody>
</table>
Applicable Standards

- ISO 24089 (Road Vehicles Software Update Engineering)
- OSGi (Open Service Gateway Initiative)
- Eclipse hawbit
- Uptane
- UEFI (Unified Extensible Firmware Interface)
- IETF SUIT (Internet Engineering Task Force, Software Updates for Internet of Things)
- IEEE 802.11bb (Li-Fi)
• Primary Security Concerns

- Security and updatability are traditionally IT concerns; his solution addresses specific automotive safety risks in a cybersecurity realm.
- With OTA updates, only authorized entities should be able to monitor devices, and as such, encryption is an important aspect.
- The testbed will use message services, such as MQTT and XMPP, which have the advantage of not needing to have an open port on each device, making the devices harder to detect and attack.
- Implementation language plays a role from a security perspective; using a managed language will reduce security vulnerabilities of the system considerably.
Thank You!

Questions: info@iiconsortium.org