Open Source V2X Library

Steve Kwon @ Wayties, Inc.
V2X (Vehicle-to-Everything), What & Why Needs

Information Sharing Technology for Vehicles

- Road Safety, Traffic Efficiency, Smart Mobility, Environmental Sustainability, Driver Convenience
- Low Latency and Non-Line-of-Sight Awareness Sensor for High Levels of Driving Automation
- Globally Deployed & On-Going Pilot (DSRC/C-V2X/5G)
## V2X Communication Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Usage</th>
<th>OSI layer</th>
<th>Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11p 3GPP Rel15</td>
<td>WAVE PHY and MAC</td>
<td>1 and 2</td>
<td></td>
</tr>
<tr>
<td>IEEE 1609.2</td>
<td>Security Services for Applications and Management Messages</td>
<td>N/A</td>
<td>ASN.1 COER</td>
</tr>
<tr>
<td>IEEE 1609.3</td>
<td>Networking Services</td>
<td>2, 3, and 4</td>
<td></td>
</tr>
<tr>
<td>IEEE 1609.4</td>
<td>Multi-Channel Operation</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>IEEE 1609.12</td>
<td>Identifier Allocations</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SAE J2735</td>
<td>Message Set Dictionary</td>
<td>7</td>
<td>ASN.1 UPER</td>
</tr>
</tbody>
</table>

< V2X Communication Standard for U.S. >

### ASN.1 Handling

- Application Layer
  - Message Sublayer
- Network Layer - IPv6
  - Transport Layer - TCP/UDP
  - Network & Transport Layers - WSMP
- LLC Sublayer
- Mac Sublayer
- Mac Sublayer Extension
- PHY Layer

Proprietary device driver
Hardware not publicly available
ASN.1 & Message Set Dictionary

Basic Safety Message (BSM)
Common Safety Request (CSR)
Emergency Vehicle Alert (EVA)
Intersection Collision Avoidance (ICA)
Map Data (MAP)
NMEA_Corrections (NMEA)
Probe Data Management (PDM)
Probe Vehicle Data (PVD)
Road Side Alert (RSA)
RTCM_Corrections (RTCM)
...

< Messages of SAE J2735 >

< Protocol Stack Flow >
ASN.1 Compiler & Handling

$ asnc -fcompound-names -gen-PER -gen-DER ../asn1/1609Dot2all.asn ../asn1/J2735_201603DA.asn
WARNING: Parameterized type REG-EXT-ID-AND-TYPE expected for REG-EXT-ID-AND-TYPE at line 124 in ../asn1/J2735_201603DA.asn
WARNING: Parameterized type REG-EXT-ID-AND-TYPE expected for REG-EXT-ID-AND-TYPE at line 124 in ../asn1/J2735_201603DA.asn
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WARNING: Parameterized type REG-EXT-ID-AND-TYPE expected for REG-EXT-ID-AND-TYPE at line 124 in ../asn1/J2735_201603DA.asn
WARNING: Parameterized type PARTII-EXT-ID-AND-TYPE expected for PARTII-EXT-ID-AN
D-TYPE at line 151 in ../asn1/J2735_201603DA.asn
Compiled HashedId10.c
Compiled HashedId10.h
Compiled HashedId8.c
Compiled HashedId8.h
Compiled HashedId3.c
Compiled HashedId3.h
Compiled SequenceOfHashedId3.c
Compiled SequenceOfHashedId3.h
Compiled Time32.c
Compiled Time32.h
Compiled Time64.c
Compiled Time64.h
Compiled ValidityPeriod.c
Compiled ValidityPeriod.h
Compiled IEEE1609Dot2BaseTypes_Duration.c
Compiled IEEE1609Dot2BaseTypes_Duration.h
Compiled GeographicRegion.c
Compiled GeographicRegion.h
Compiled CircularRegion.c
Compiled CircularRegion.h
Compiled Region.c
Compiled Region.h
Compiled Region.c
Compiled Region.h

< IEEE 1609.2 Decoding - ASN.1 COER >

< SAE J2735 Decoding - ASN.1 UPER >

< ASN.1 Compiling using https://github.com/vlm/asn1c >
Design Concept

End-to-End Seamless Connectivity

- Service Access Point (SAP)
- DDS / RTPS over TCP/IP
- ROS2 IDL
- V2X Device

Low Latency & High Reliability

- FlatBuffers
- MQTT over WebSocket
- FlatBuffer IDL
- Cloud
### ROS2 IDL (Pub-Sub & Req-Resp)

#### Summary of primitives, from IEEE 1609.3-2016

<table>
<thead>
<tr>
<th>Type</th>
<th>Required in</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSM</td>
<td>WSM-WaveShortMessage.request</td>
</tr>
<tr>
<td></td>
<td>WSM-WaveShortMessage.confirm</td>
</tr>
<tr>
<td></td>
<td>WSM-WaveShortMessage.indication</td>
</tr>
<tr>
<td></td>
<td>WSM-WaveShortMessage.confirm</td>
</tr>
<tr>
<td>WME</td>
<td>WME-ProviderService.confirm</td>
</tr>
<tr>
<td></td>
<td>WME-UserService.request</td>
</tr>
<tr>
<td></td>
<td>WME-UserService.confirm</td>
</tr>
<tr>
<td></td>
<td>WME-WSMService.request</td>
</tr>
<tr>
<td></td>
<td>WME-WSMService.confirm</td>
</tr>
<tr>
<td></td>
<td>WME-ChannelService.request</td>
</tr>
<tr>
<td></td>
<td>WME-ChannelService.confirm</td>
</tr>
<tr>
<td></td>
<td>WME-TimingAdvertisementService.request</td>
</tr>
<tr>
<td></td>
<td>WME-TimingAdvertisementService.confirm</td>
</tr>
<tr>
<td></td>
<td>WME-Notification.indication</td>
</tr>
<tr>
<td></td>
<td>WME-Get request</td>
</tr>
<tr>
<td></td>
<td>WME-Get confirm</td>
</tr>
<tr>
<td></td>
<td>WME-Set request</td>
</tr>
<tr>
<td></td>
<td>WME-Setconfirm</td>
</tr>
<tr>
<td></td>
<td>WME-AddressChange request</td>
</tr>
<tr>
<td></td>
<td>WME-AddressChange confirm</td>
</tr>
<tr>
<td>LSAP</td>
<td>DL-UNITDATA</td>
</tr>
<tr>
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<tr>
<td></td>
<td>ISO/IEC 8802-2 (IEEE Std 802.2)</td>
</tr>
<tr>
<td>MLME</td>
<td>MLMEX DELETETXPROFILE</td>
</tr>
<tr>
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<tr>
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<td>MLMEX-ATA</td>
</tr>
<tr>
<td></td>
<td>MLMEX-CHSTART</td>
</tr>
<tr>
<td></td>
<td>MLMEX-CHEND</td>
</tr>
<tr>
<td></td>
<td>MLMEX-GET</td>
</tr>
<tr>
<td></td>
<td>MLMEX-SET</td>
</tr>
<tr>
<td>MAC</td>
<td>MA-UNITDATA</td>
</tr>
<tr>
<td></td>
<td>MA-UNITDATAAX</td>
</tr>
<tr>
<td>Sec</td>
<td>Sec-SignedData</td>
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<tr>
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<td>Sec-SignedDataVerification</td>
</tr>
<tr>
<td></td>
<td>Sec-SecureDataPreprocessing</td>
</tr>
</tbody>
</table>

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### Request - Response

#### WSM-WaveShortMessage.indication

- `uint8 wsm_p.version`
- `uint8 channel_number`
- `uint8 data_rate # 0x2-0x7F, increments of 500 kb/s, IEEE802.11-2016`
- `int8 transmit_power_level`
- `uint8[4] channel_load # undefined yet`
- `uint8 user_priority # 0-7`
- `uint32 length # 1 to WsmMaxLength = h, WsmMaxLength: def=100, max=2302`
- `uint8[2]302] data # length is included`
- `uint8[6] peer_mac_address # EU168`
- `uint64 provider_service_identifier`

### WSM-WaveShortMessage.request

- `uint8 channel_identifier`
- `uint8 time_slot`
- `uint8 data_rate # 0x2-0x7F, increments of 500 kb/s, IEEE802.11-2016`
- `int8 transmit_power_level`
- `uint8[4] channel_load`
- `uint8 info_elements_indicator`
- `uint8 user_priority # 0-7`
- `uint64 expiry_time # 0-(2^64-1)`
- `uint16 length`
- `uint8[6] peer_mac_address # EU168`
- `uint64 provider_service_identifier`

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Builtin Interfaces/Time stamp

- `int32 WSM-WaveShortMessage.timestamp`
- `uint32 result_code`
BasicSafetyMessage RX Demo

For Device Emulation  
IEEE 1609.3 Publisher

IEEE 1609.3 Subscriber  
IEEE 1609.2 Publisher

IEEE 1609.2 Subscriber  
SAE J2735 Publisher

SAE J2735 Subscriber

SAE J2735 Topic Echo
Low Cost V2X Device?

How to Begin V2X Development on Linux, Automotive Linux Summit 2015

Single Board Computers w/ mini PCI-E socket
Freescale™ i.MX6 800MHz Dual Lite with AR9592 mini PCI-E Card

< Low Cost V2X Device, On-Going Project >
Thank you

https://github.com/libv2x