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5G Cross Border Control

Innovation Action H2020-ICT-18-2018
Contract 825050

Cooperative, Connected and Autonomous Mobility (CCAM)

a 5G PPP Phase III Project

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825050-5GCroCo

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5G Backend Cross-border Challenges

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With Inputs from 5GCroCo project partners (CTTC, Orange, RSA, Stellantis, Ericsson)

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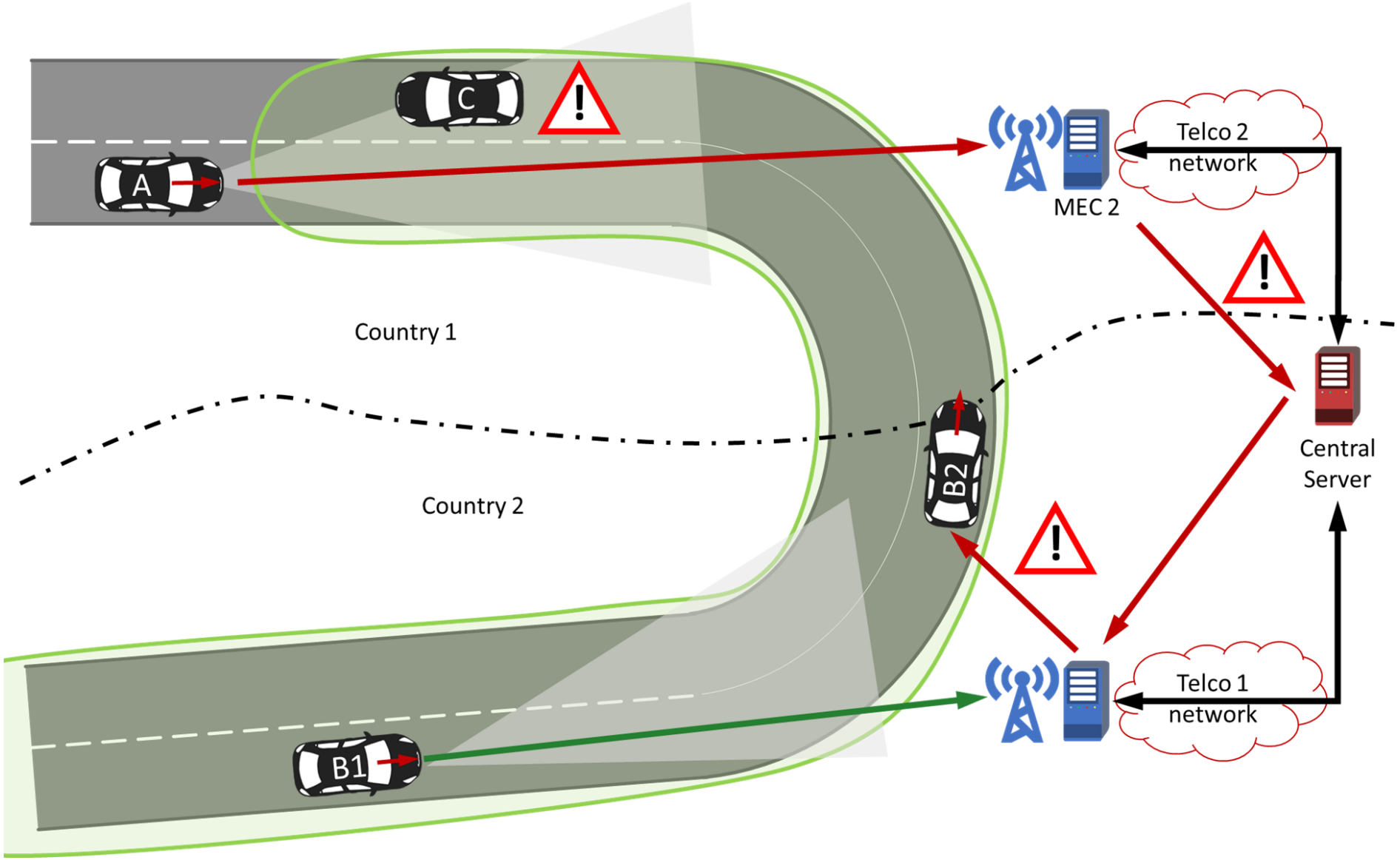
Agenda

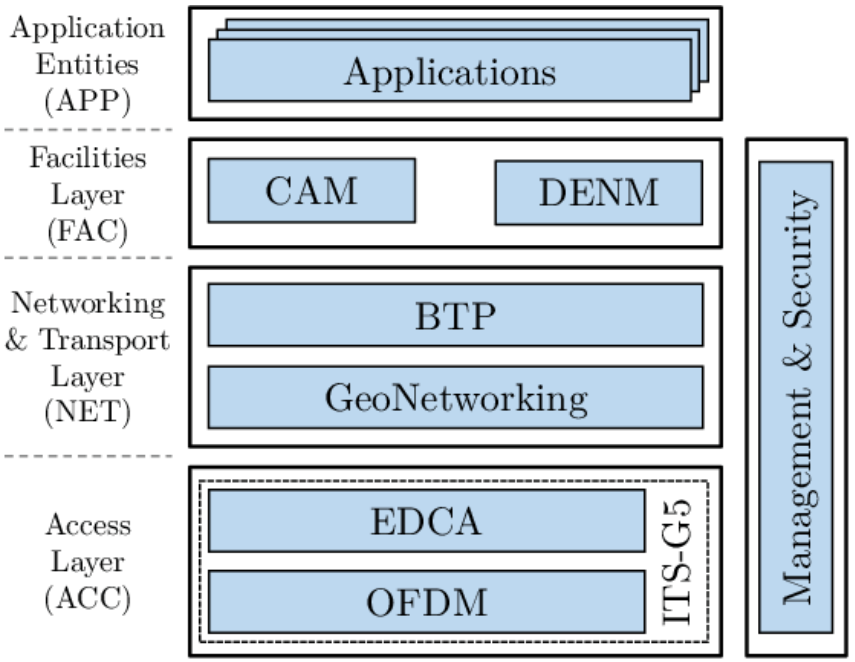
- ACCA use case
- Challenges and mitigation
  - Heterogeneous message format
  - DENM duplicate detection
  - Hazard subscription and notification
- Geoserver architecture
- Operational steps
- Conclusion and lessons learned

ACCA use case



Decentralized Environmental Notification Message (DENM)

- Used by ITS applications in order to alert road users of a detected event.
- Describes a variety of events (e.g., broken down vehicle)
- Different types – New, Update, Cancellation, Negation
  - Variable repetition numbers



Source – https://www.etsi.org/deliver/etsi_en/302600_302699/30263703/01.02.01_30/en_30263703v010201v.pdf

DENM Format

- ETSI geonet ASN1 format
  - Sent over UDP
- But 5GCroCo project needed to support DENM exchange using MQTT as well
  - Sent over TCP
- **Geoserver must support both flavours**

```
<DENM>
 <header>
  <protocolVersion>2</protocolVersion>
  <messageID>1</messageID>
  <stationID>3385689695</stationID>
 </header>
 <denm>
  <management>
   <actionID>
    <originatingStationID>3385689695</originatingStationID>
    <sequenceNumber>1</sequenceNumber>
   </actionID>
   <detectionTime>498748486773</detectionTime>
   <referenceTime>498748486773</referenceTime>
   <eventPosition>
    <latitude>436269174</latitude>
    <longitude>70495402</longitude>
    <positionConfidenceEllipse>
     <semiMajorConfidence>4095</semiMajorConfidence>
     <semiMinorConfidence>4095</semiMinorConfidence>
     <semiMajorOrientation>127</semiMajorOrientation>
    </positionConfidenceEllipse>
    <altitude>
     <altitudeValue>800001</altitudeValue>
     <altitudeConfidence>
      <unavailable/>
     </altitudeConfidence>
    </altitude>
   </eventPosition>
   <validityDuration>60</validityDuration>
   <stationType>5</stationType>
  </management>
  <situation>
   <informationQuality>1</informationQuality>
   <eventType>
    <causeCode>47</causeCode>
    <subCauseCode>0</subCauseCode>
   </eventType>
  </situation>
 </denm>
</DENM>
```

DENM JSON Format

JSON based format

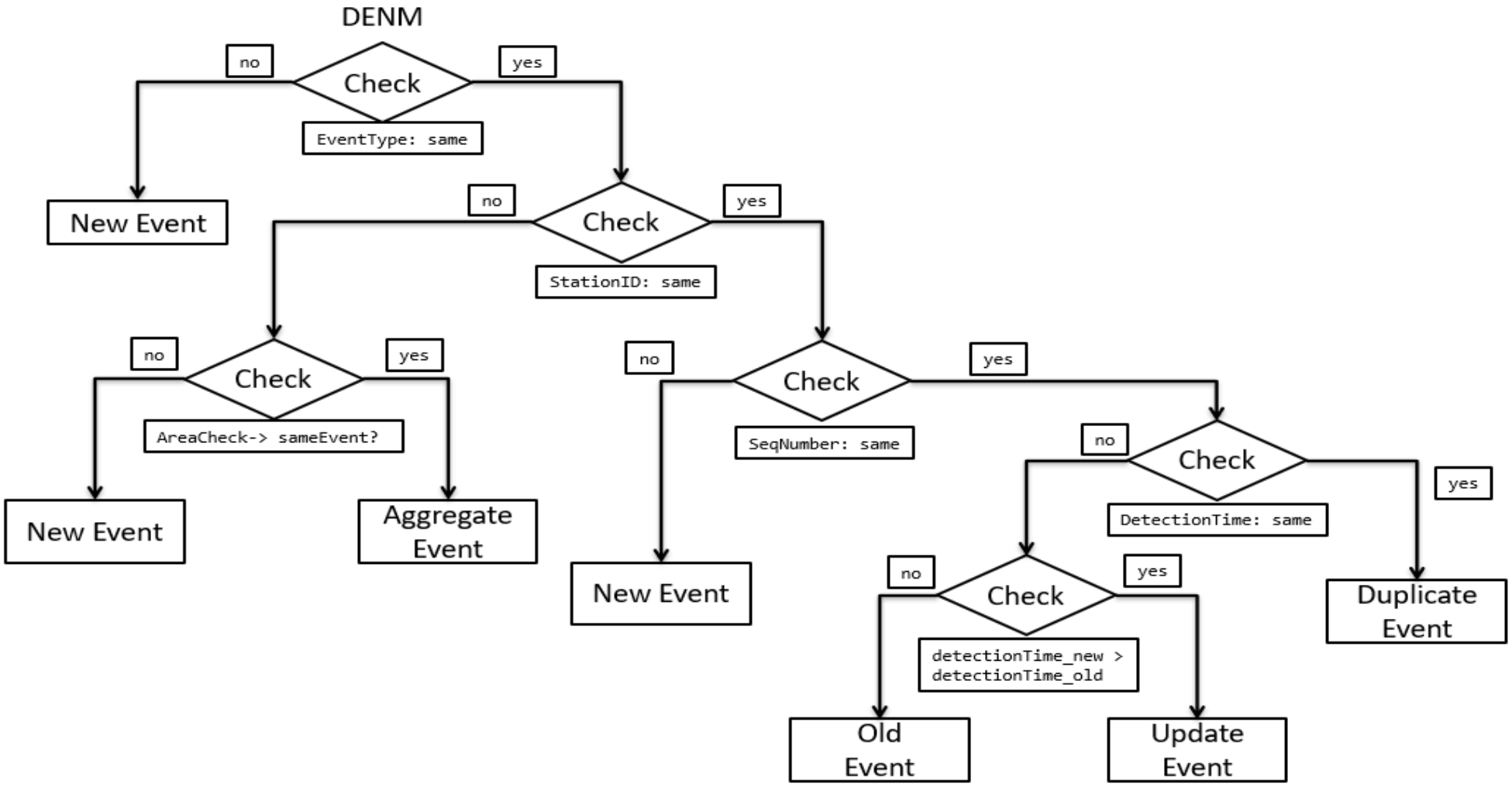
{"type":<string>, // mandatory field
"context":<string>, // optional field
"origin":<string>,
"version":<string>,
"source_uuid":<string>,
"destination_uuid":<string>,
"timestamp":<uint64>,
"message":{<message content>},
"message_id":<string>,
"signature":<string>}

CAM and DENM JSON versions:

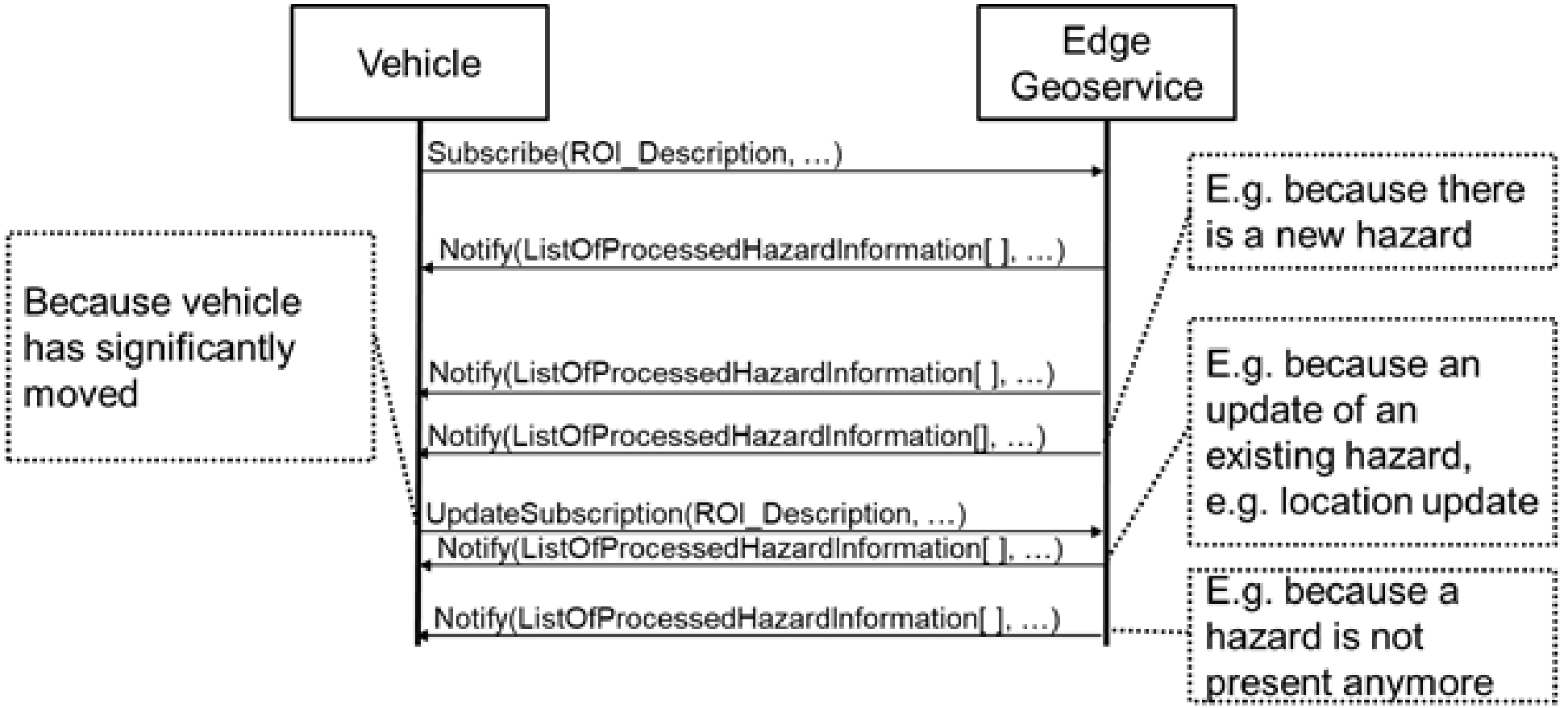
https://wayglem.github.io/v2x-json-validator/


```
{
 "type": "cam",
 "origin": "self",
 "version": "0.1.0",
 "source_uuid": "uuid14",
 "timestamp": 1574778515424,
 "message": {
  "protocol_version": 42,
  "station_id": 42,
  "generation_delta": 42,
  "basic_container": {
   "station_type": 5,
   "position": {
    "latitude": 486263556,
    "longitude": 22492123
   }
  },
  "high_frequency_container": {
   "heading": 1639,
   "speed": 365,
   "longitudinal_acceleration": 0,
   "yaw_rate": -6
  },
  "low_frequency_container": {
   "vehicle_role": 2
  }
 }
}
```

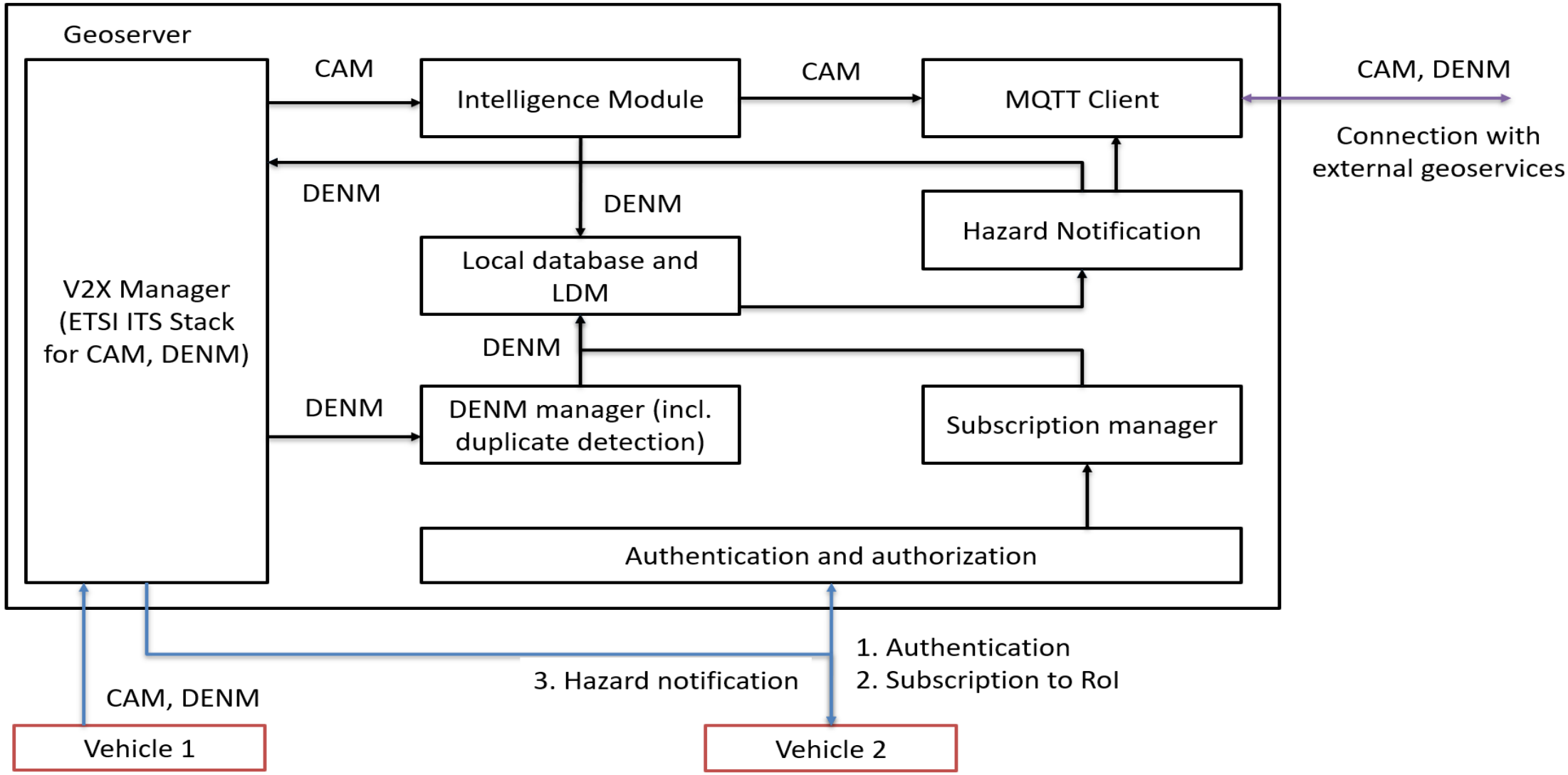
DENM – Duplicate Detection



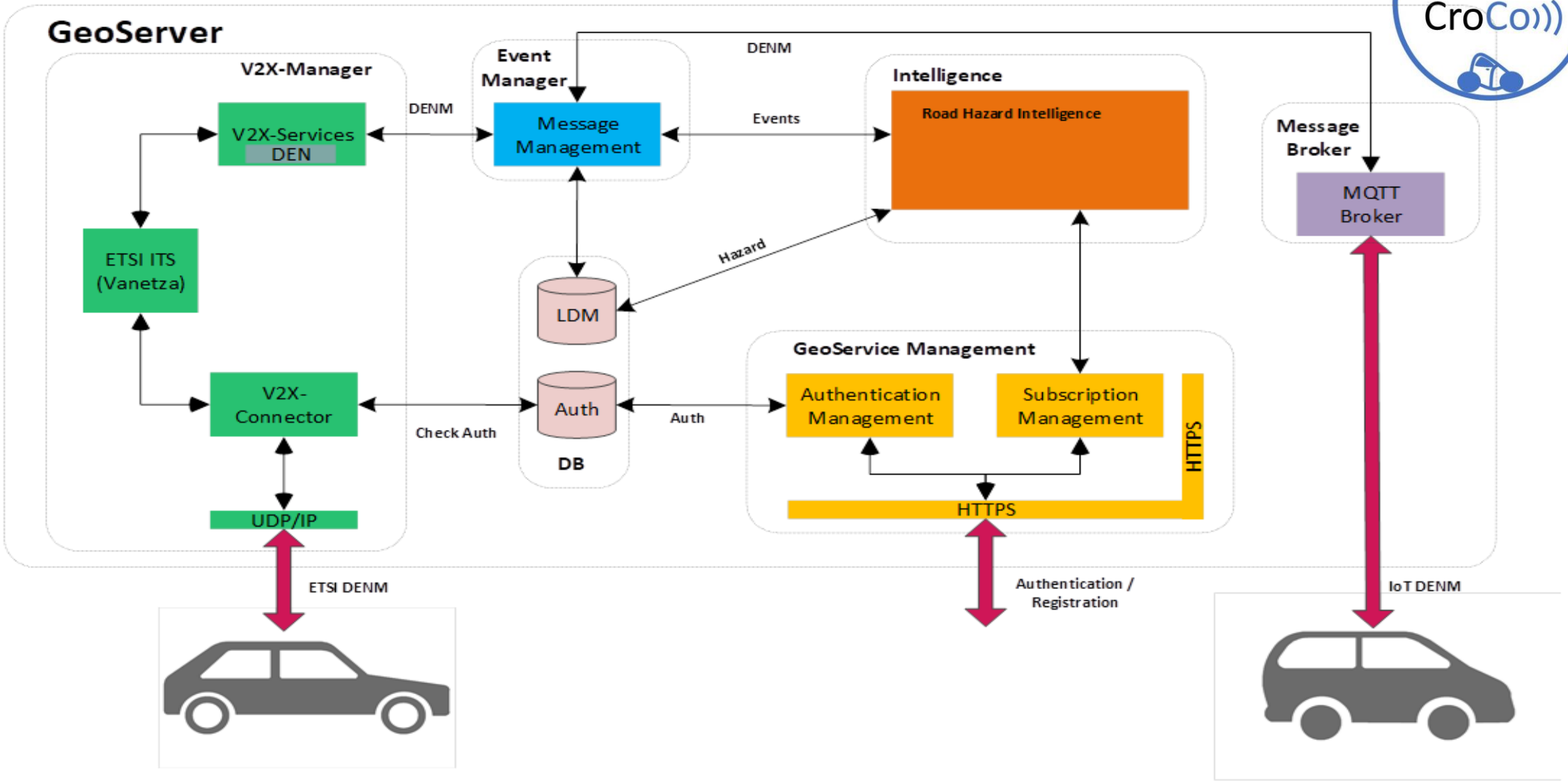
Subscription to receive continuous hazard notification



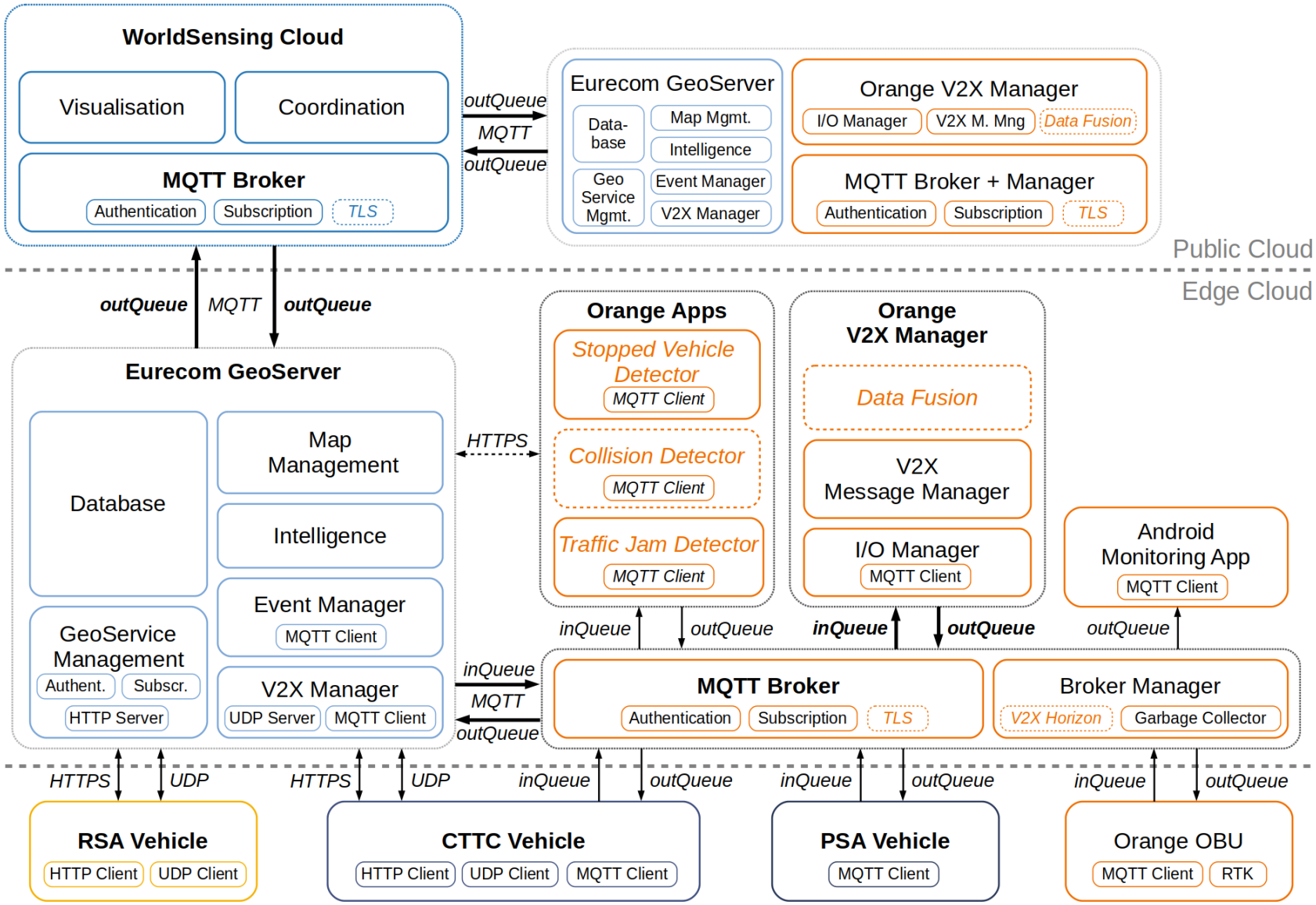
Simplified Geoserver Architecture



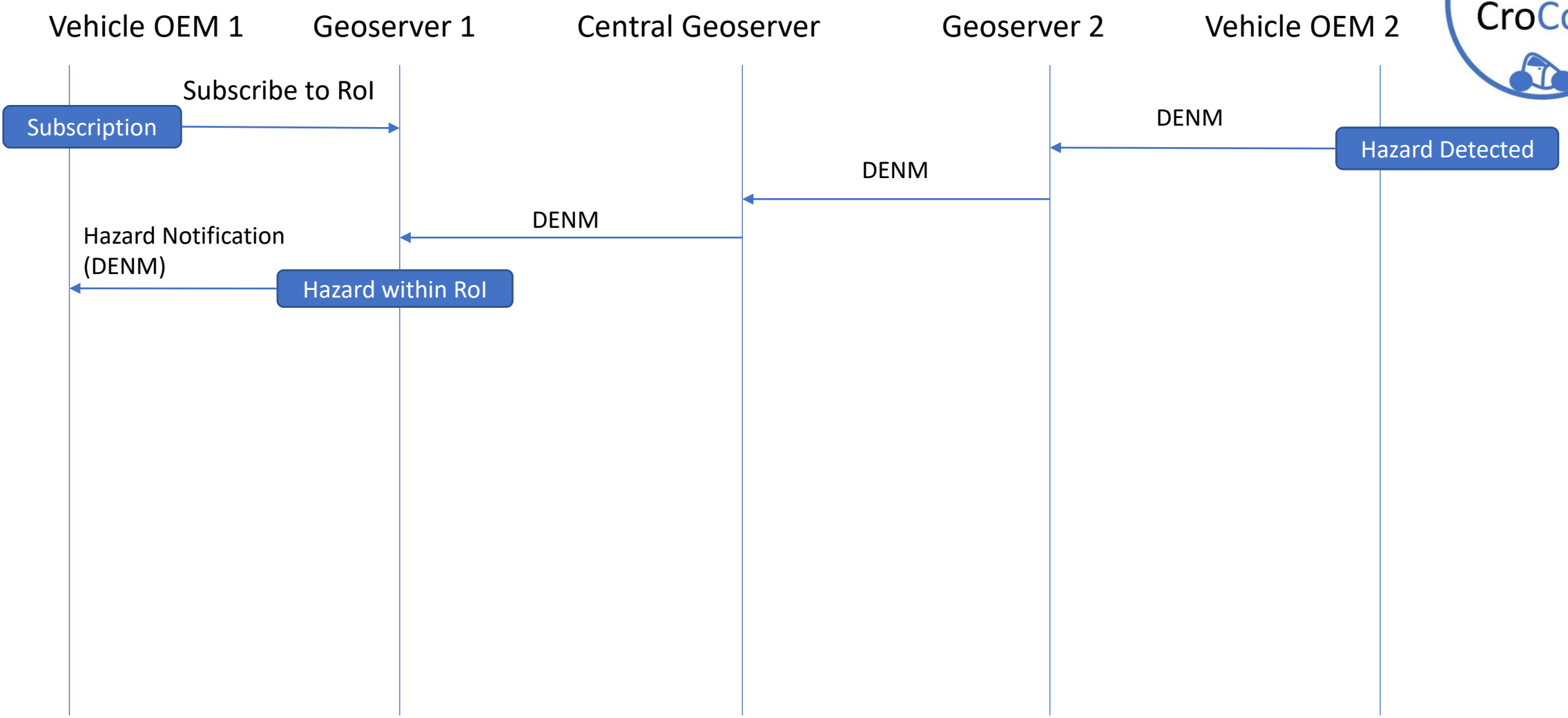
Geoserver supporting multiple stacks



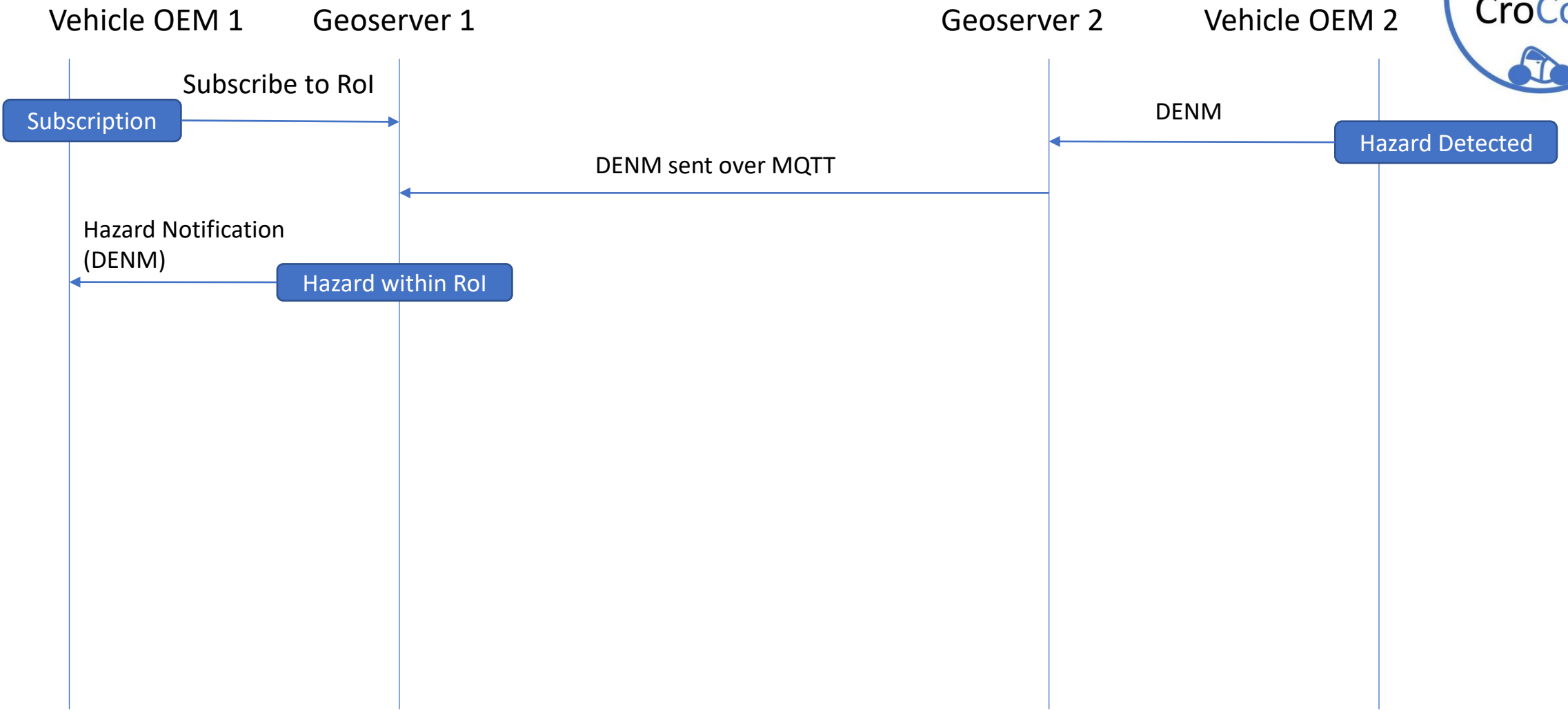
Global Geoserver Architecture



Operational steps (Indirect MEC-to-MEC)

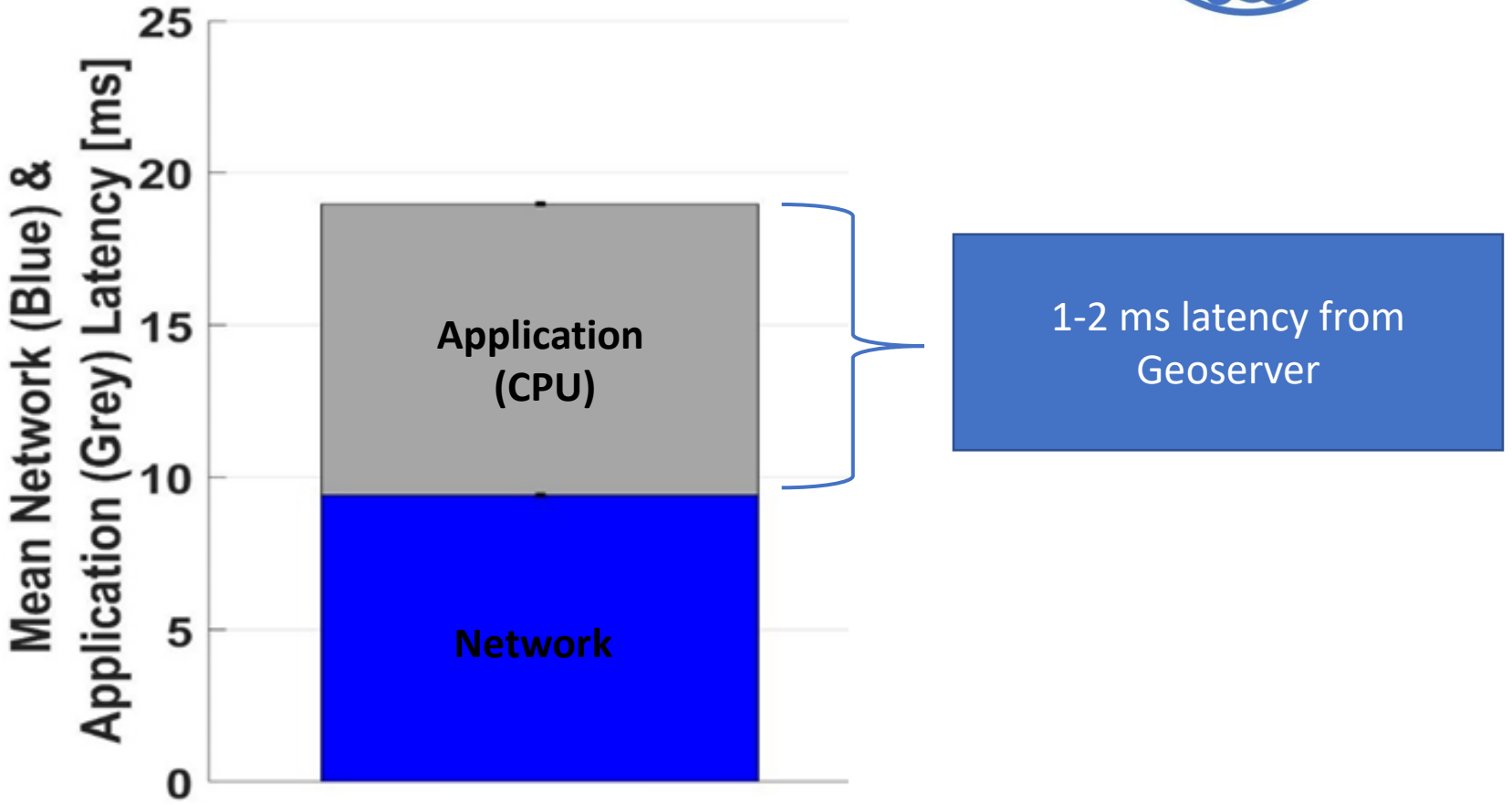


Operational steps (Direct MEC-to-MEC)



Results: ACCA – Application Level Latency

- From sending a hazard notification until receiving the hazard warning
- <20 ms end-to-end application delay
- Application processing in the backend (CPU) has similar latency impact as the network



Conclusions and Lessons Learned

- Geroservers will be an important component in CCAM and ITS applications.
- Geoserver must support multiple vehicle OEMs, protocol stacks (ETSI V2X, MQTT), software stacks (MERN, MEAN…), standards.
- Software development life cycle should be followed with continuous development and integration.

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Thanks!

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