Model-based Cybersecurity Engineering for Connected and Automated Vehicles

The FLOURISH Project

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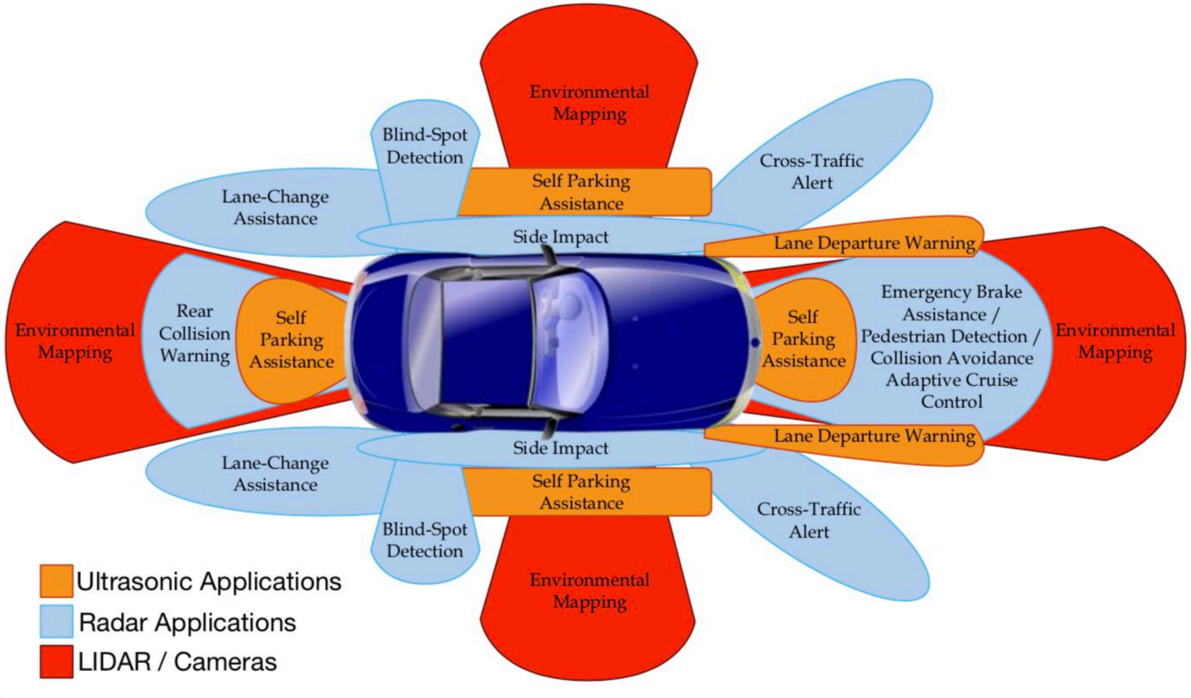
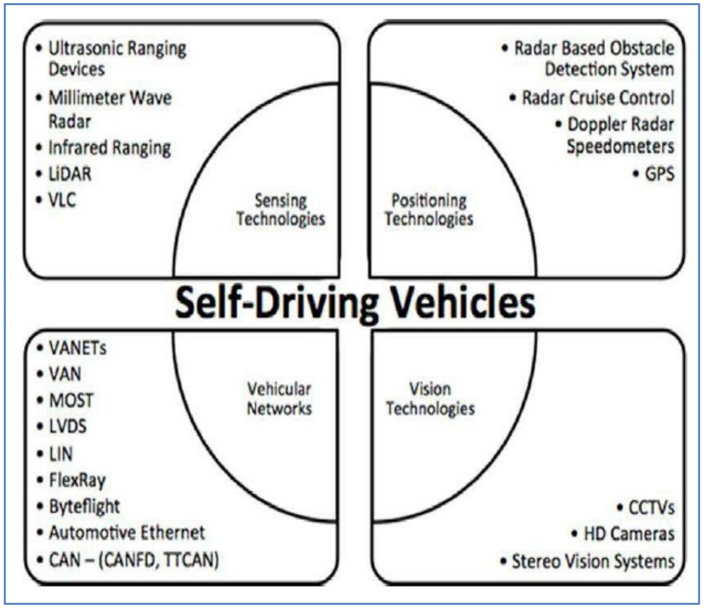
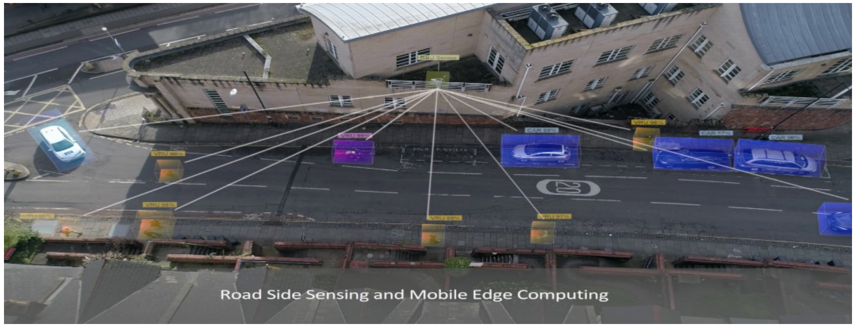
Irish Sea
Dublin
Liverpool
England
United Kingdom
Birmingham
Bristol
London
M20 Motorway
Bristol Channel
English Channel
Map
Photos
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Connected and Automated Vehicles?





- FLOURISH is a multi-sector collaboration aiming to contribute to the delivery of advanced technologies for Connected Autonomous Vehicles (CAVs) in the UK. The Flourish project addresses two different but critical issues for CAVs:
  - Ensuring that wireless connectivity and cybersecurity of CAVs are considered by design; and
  - Optimising individuals' experience when using the technology, with a particular focus on the needs of an ageing population.



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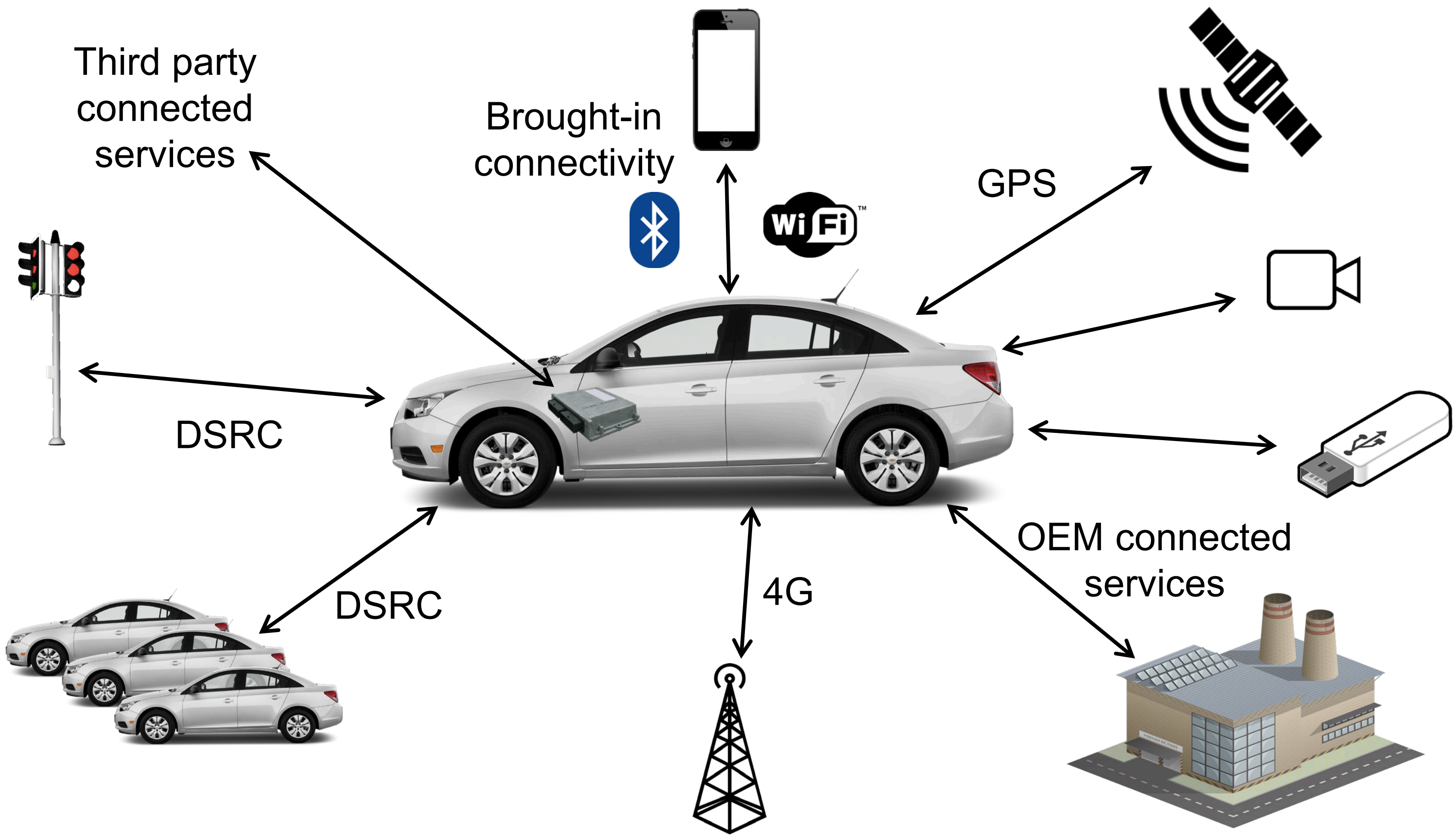
EMPOWERMENT THROUGH **TRUSTED** SECURE MOBILITY

Open Challenges

- Geographical addressing
- Risk analysis and management
- Data-centric Trust and Verification
- Anonymity, Privacy and Liability
- Secure localization
- Forwarding algorithms
- Delay and Reliability constraints
- Prioritization of data packets and congestion control

Attack Surfaces



Solutions for Security, Privacy and Trust (SPT)

- **Proactive security**: digitally signed messages with certificates (PKI), proprietary system design (protocols and HW), tamper resistant HW
- **Reactive security**: signature-based and anomaly-based intrusion detection
- **Anonymity and privacy**: linkability between *pseudonyms*
- **Secure localization**: tamper-proof GPS, etc

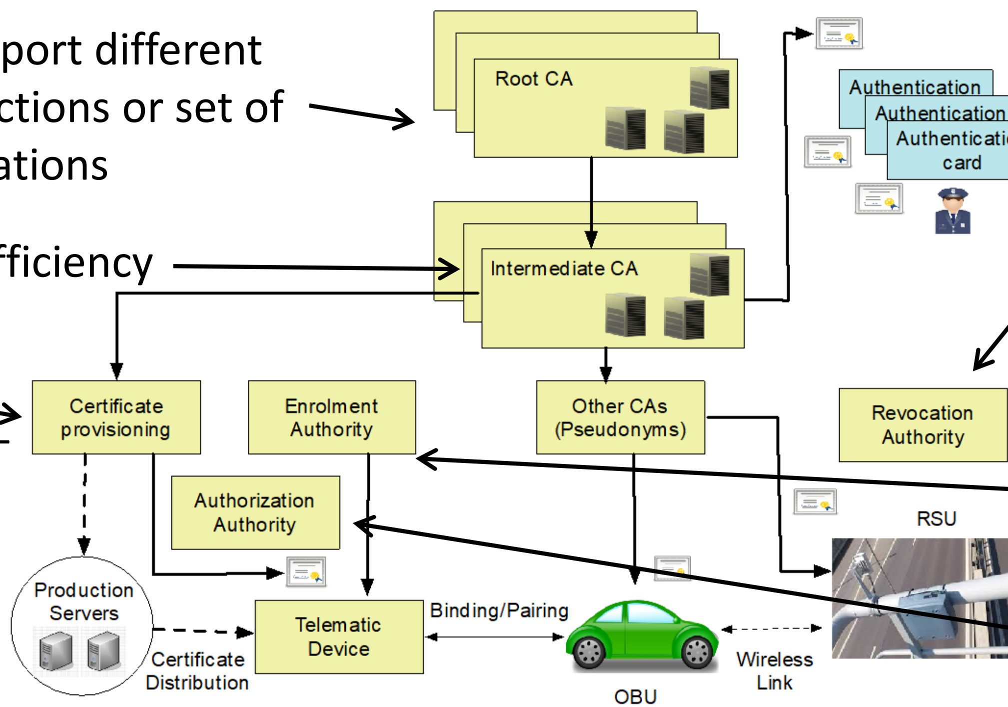
Public Key Infrastructure for C-ITS: an example

Generic C-ITS deployment model for generation and distribution of cryptographic material (EU C-ITS WG5-Annex 1)

To support different jurisdictions or set of applications

To increase efficiency

To distribute certificates to C-ITS device



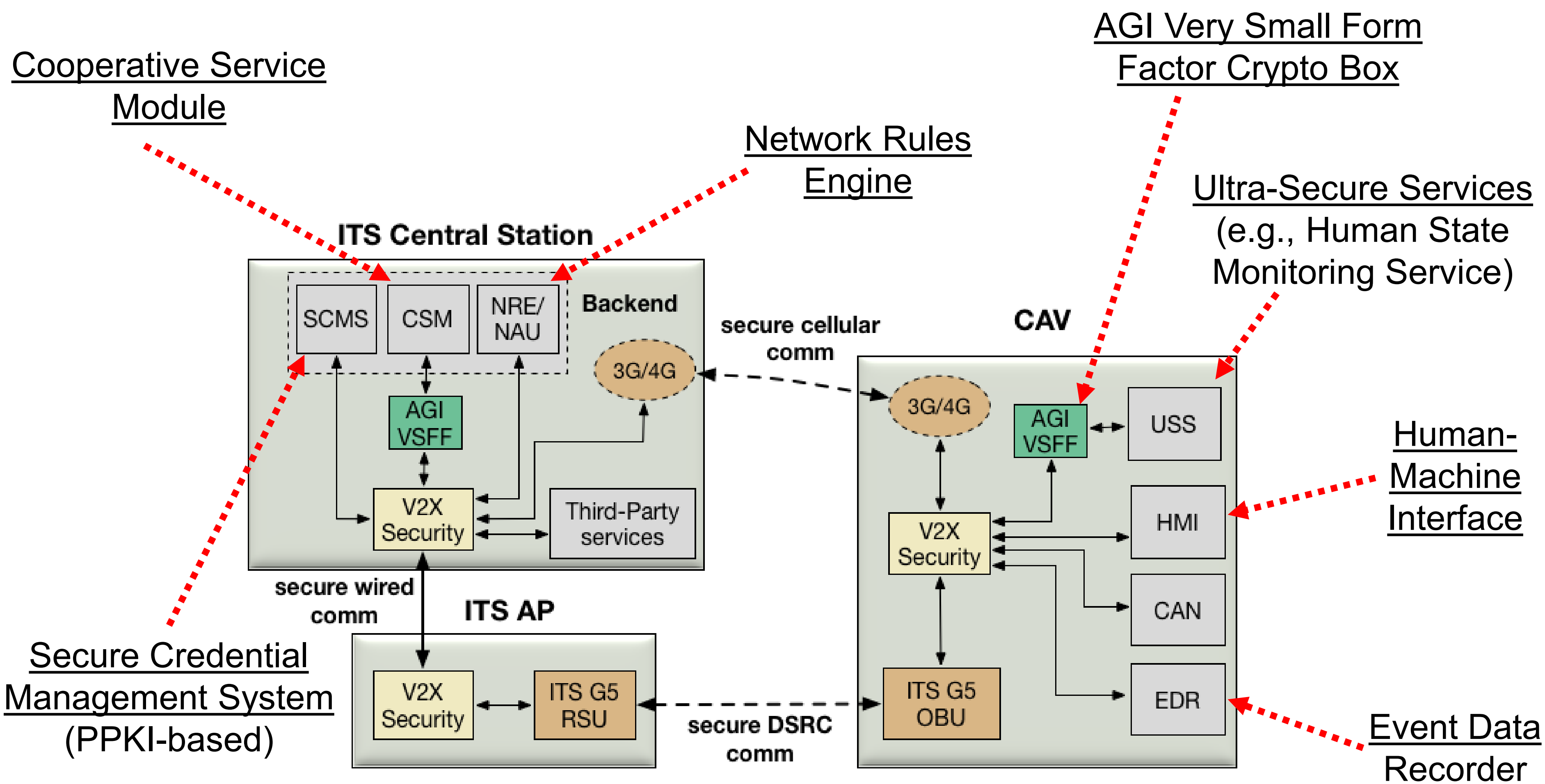
To revocate certificates associated with specific telematics devices

To ensure the registration of the telematics device

To grant the permission to operate

Building blocks

23 March 2020



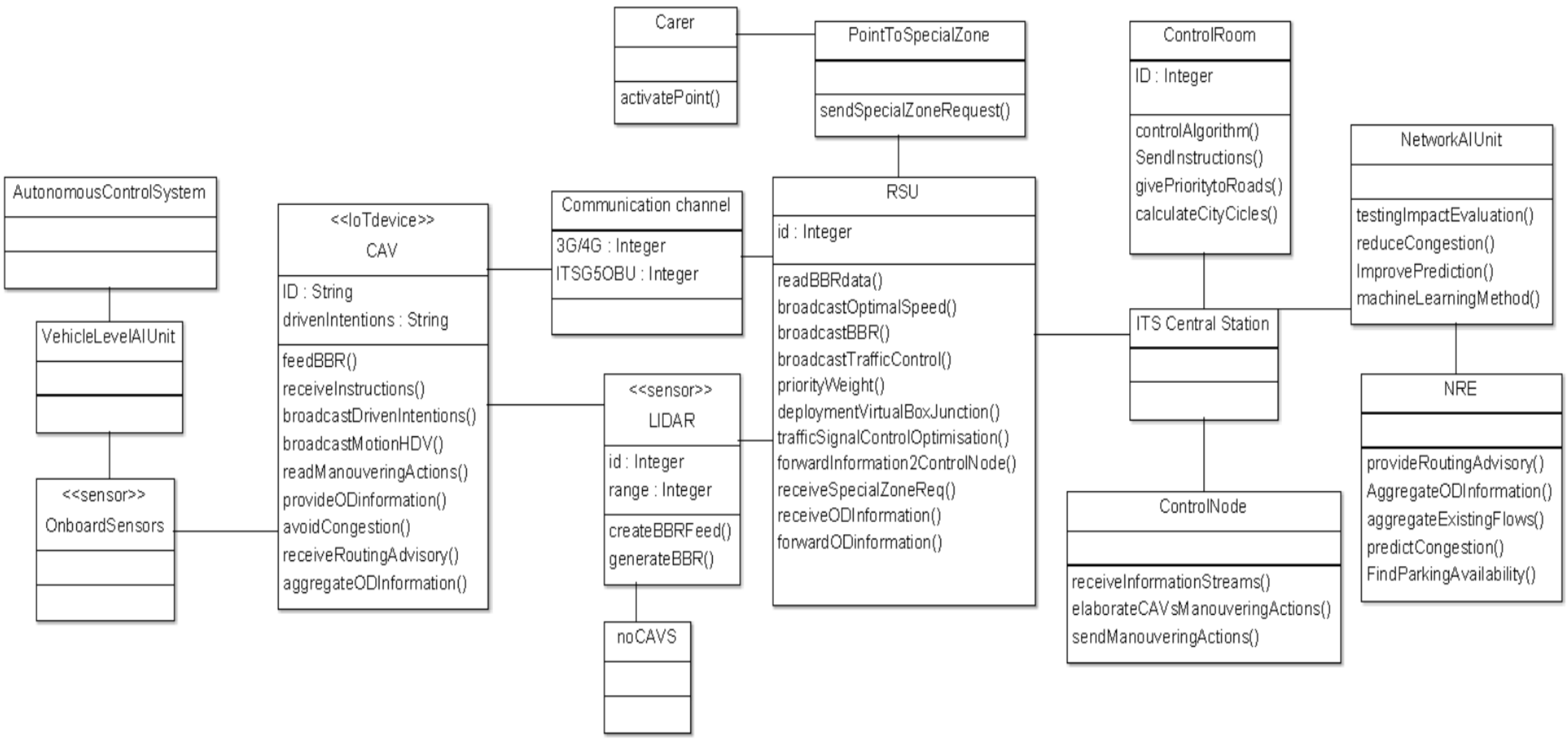
Model-Based Systems Engineering

- Define CAV development lifecycle and IV&V strategy
  - Considering alignment with ISO/IEC 15288 “Systems Engineering Life Cycle Processes” and/or IEEE 1220 “Application and Management of the Systems Engineering Process”
- Develop generic CAV system architecture
  - Using MODAF/SysML embedded systems modelling
  - In line with MoD Standard 23-09 (GVA)

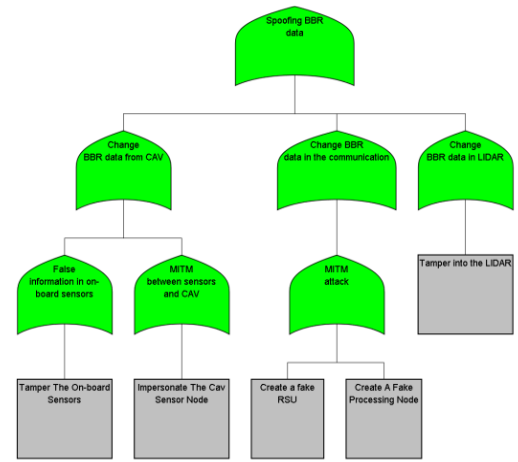
Model-Based Systems Engineering (cont'd)

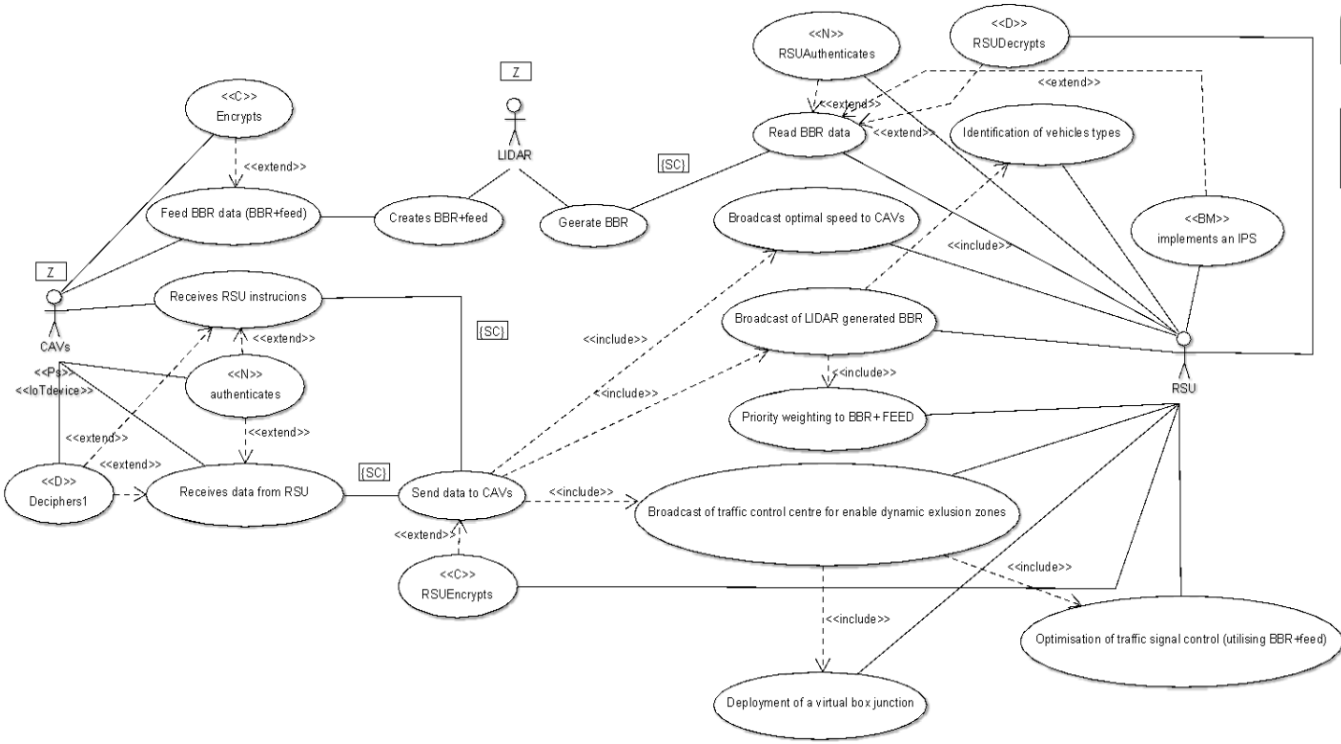
- Assess CAV GVA against C-ITS platform 2016 report key requirements
  - Consider tailoring IV&V processes towards generic certification
- Develop an SoS view of CAV operation
  - System-of-systems (or network-of-networks) model
  - Suitable simulation (e.g. system dynamics, cybernetics/viable system, game theory etc. - tbc) to identify emergent behaviours, unintended consequences and potential risks

Original Architecture



LIDAR scenario diagram

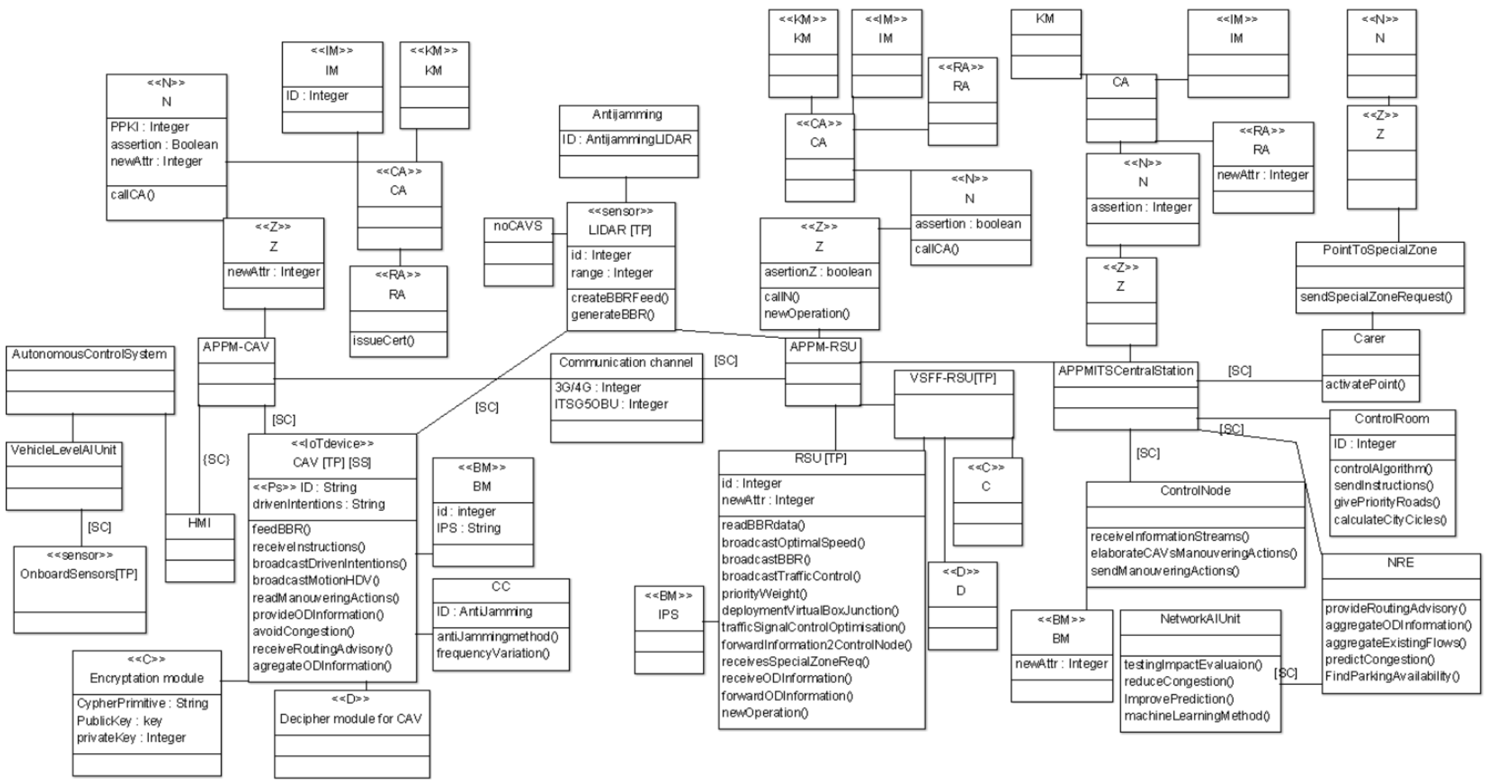




Use case name: <<N>> authenticates
Participating actor: CAV
Entry condition: An entry package is sent from RSU
Events flow: The package is received. The CAVs actor runs the authentication element. The <<N>> element obtains the RSU credentials from the package. The <<N>> stereotype instance creates complementary information from de credentials. The <<N>> stereotype instance runs the authentication function. The <<N>> creates the assertion {True, False}. This use case extends the Receives RSU instructions use case and Receives data from RSU use case
Exit condition: The CAVs authenticate the package received

Use case name: <<N>> RSU Authenticates
Participating actor: RSU
Entry condition: Receive data from the LIDAR
Events flow: The package is received. The RSU actor runs the authentication element. The <<N>> element obtains the LIDAR credentials from the package. The <<N>> stereotype instance create complementary information from de credentials The <<N>> stereotype instance runs the authentication function. The <<N>> creates the assertion {True, False}. This use case extends the Read BBR data instructions use case.
Exit condition: The RSU authenticates the package received.

Re-engineered architecture using IoTSecM



Model-based security

- Systematic documentation of security requirements
- Controls not just baselined, but selected based on need
  - which became clear to all
- Ability to simulate the logic of external security analysis techniques
  - here fault trees, could be others (or combination)
- Compatible with use cases implemented at other WPs
- Potentially standardizing the UK GVA for CAVs

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- Thank you