mFUND
Das Startkapital für die Mobilität 4.0

Rail2X

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DB

DLR

HPI Hasso Plattner Institut
Digital Engineering · Universität Potsdam

Dralle Systementwicklungen

Rail2X and ITS Security

Slawa Lang, Siemens Mobility GmbH;
“Rail2X” consortium

Safety meets Security 2019

How secure is an ITS communication system and can it be extended to rail traffic?

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Rail2X?

Contents

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C-ITS

Intelligent Transportation Systems

ITS shall make (road) traffic safer, more environmentally friendly, more efficient and more comfortable

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Intelligent Transportation Systems (ITS)

Essential for ITS is communication:

Traffic participant ↔ other participant

Traffic participant ↔ infrastructure

→ Cooperative-ITS (C-ITS)

In road traffic:

Car2X, Car2Car communication

Vehicle2X uses special Wi-Fi, but 5G mobile communications could be used too

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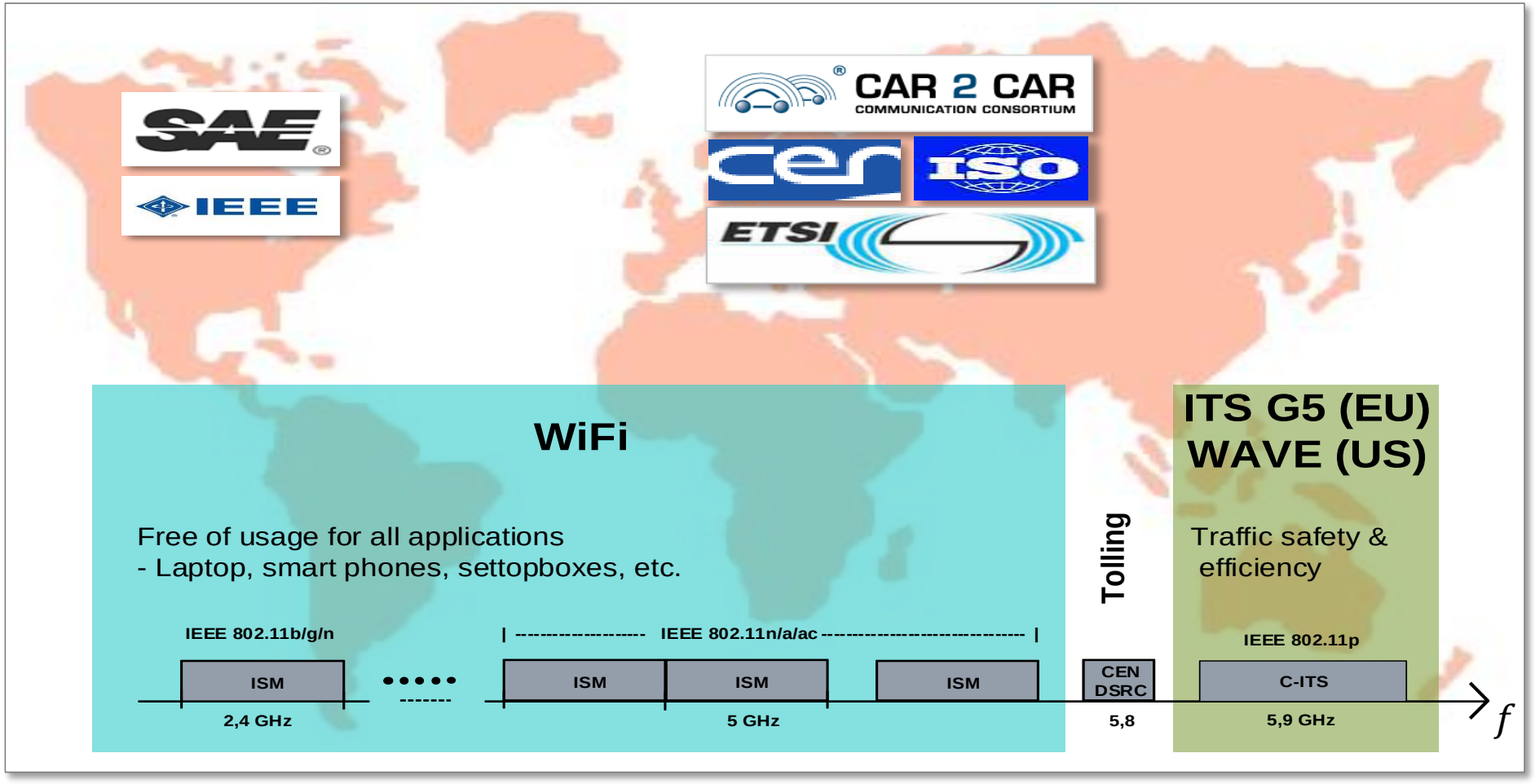
Vehicle2X – Standardization activities, frequency allocation



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Rail2X

Vehicle2X technology in rail traffic

www.siemens.com/mobility

Road ITS shall be adapted to rail traffic, to facilitate efficient services

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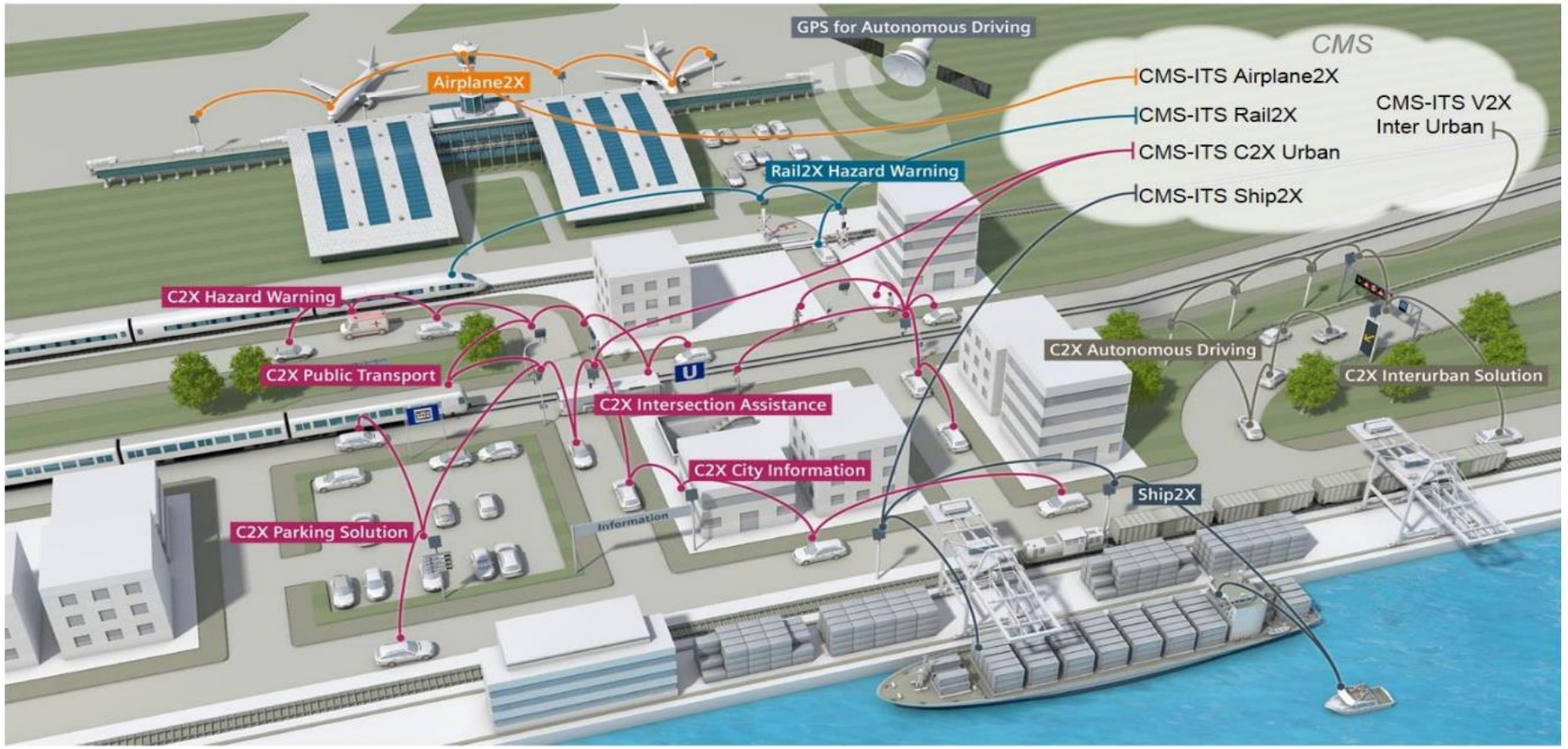
Rail2X – Smart Services

Adaptation of Wi-Fi Car2X communication to rail traffic / for rail ITS

→ increased safety
→ improved comfort
→ more efficient maintenance
→ cost reduction



Feasibility and reasonableness are demonstrated based on 3 use cases at Erzgebirgsbahn

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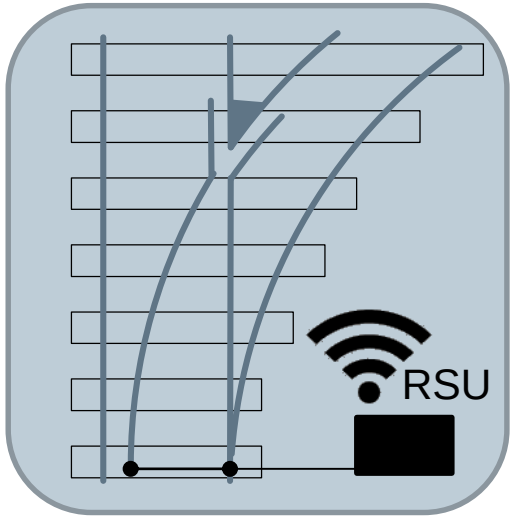
Rail2X – Use cases

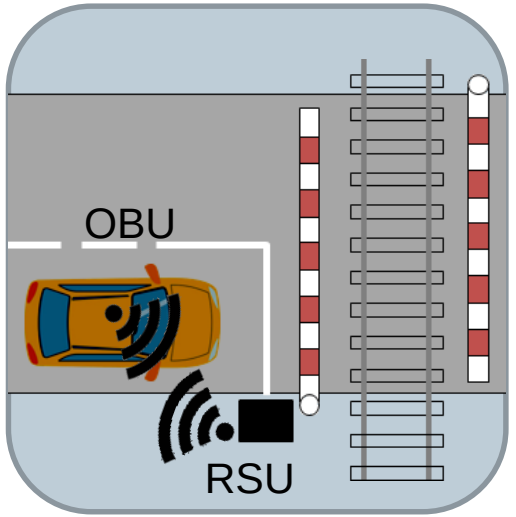
1: Service and diagnosis



Data exchange
Infrastructure ↔ train

→ inexpensive data capturing
→ more efficient maintenance

2: Barrier crossing on call



Information exchange
Vehicle ↔ level crossing

→ increased safety
→ improved comfort

3: Request stop

Information exchange
Train ↔ station

→ inexpensive communication
→ more efficient regional traffic

Data can be captured inexpensively and analyzed centrally

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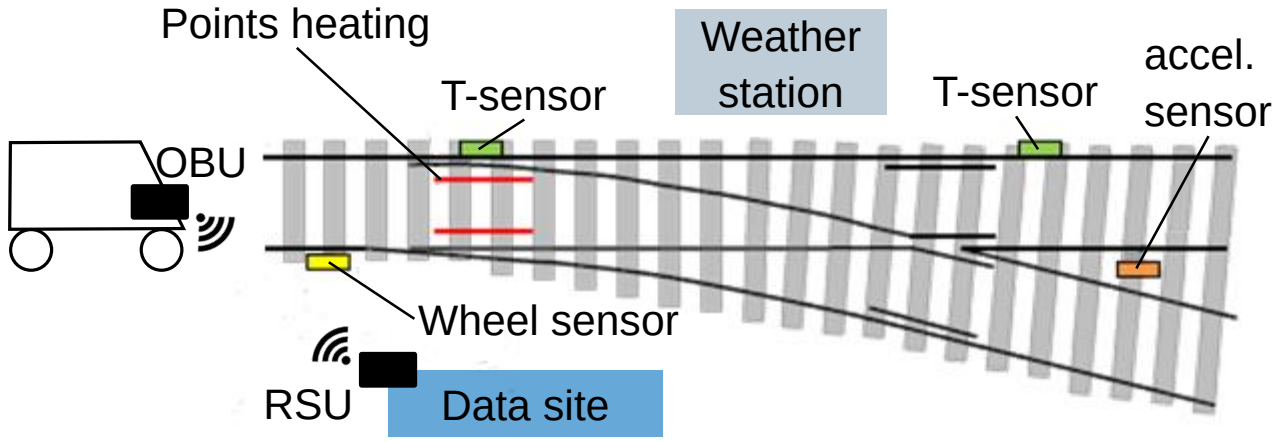
Use case 1: Service and diagnosis

- Collection of (sensor) data at important infrastructure locations (e.g. points)
- Collection of data by passing trains with Rail2X
- Transfer of data to central server e.g. in depot
- Saving and analysis of data at central place

→ inexpensive data capturing without permanent communication link

→ more efficient maintenance



Concept of barrier on call remains by more efficient log on and off

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Use case 2: Barrier crossing on call

- Barrier on call:
  normally closed, opens upon logging on (if safe)
- Traffic participants without Vehicle2X:
  manual log on and off as usual
- Traffic participants with Vehicle2X:
  automatic log on and off via communication with level crossing; display of acknowledgement

→ improved comfort
→ shorter waiting times
→ increased safety

Regional traffic becomes efficient by inexpensive and comfortable request stops

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Use case 3: Request stop

- Request stop:
  Train stops only upon request of passengers in train or at station
- Transmission of stop request at station to train via Rail2X
- Transmission ‘Train stops’ from train to station via Rail2X

→ improved comfort
→ inexpensive communication
→ more efficient regional traffic

A hopping station increases communication range

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Hopping station

- Hopping station:
  forwards Rail2X messages
- Placement e.g. in curves without line of sight

→ increased communication range

Data shall be collected, analyzed and used for better maintenance among others

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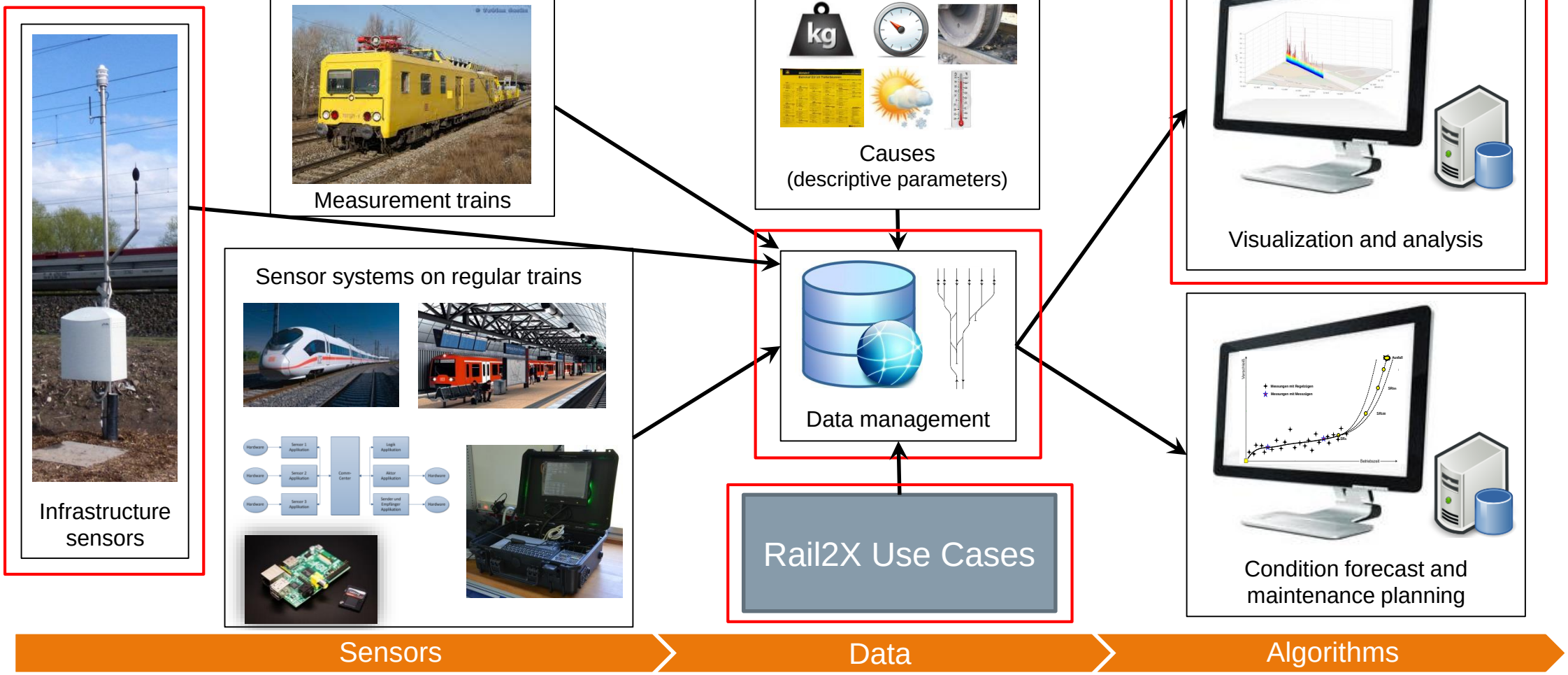
System environment with data server



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ITS-G5 PKI

Security architecture of Vehicle2X communication

There exist different kinds of ITS messages which shall fulfill different security goals

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Message models

Individual Public Messages (broadcast)

Authentication, authorization, integrity → All

Authentication, authorization, integrity, privacy → All

Individual Private Messages or Security Associations (unicast)

Authentication, authorization, integrity, confidentiality, (privacy) → Specific recipient

Security Association:
- Setting up of a secure communication channel
- Confidential communication

How to establish a secure communication between ITS-stations?

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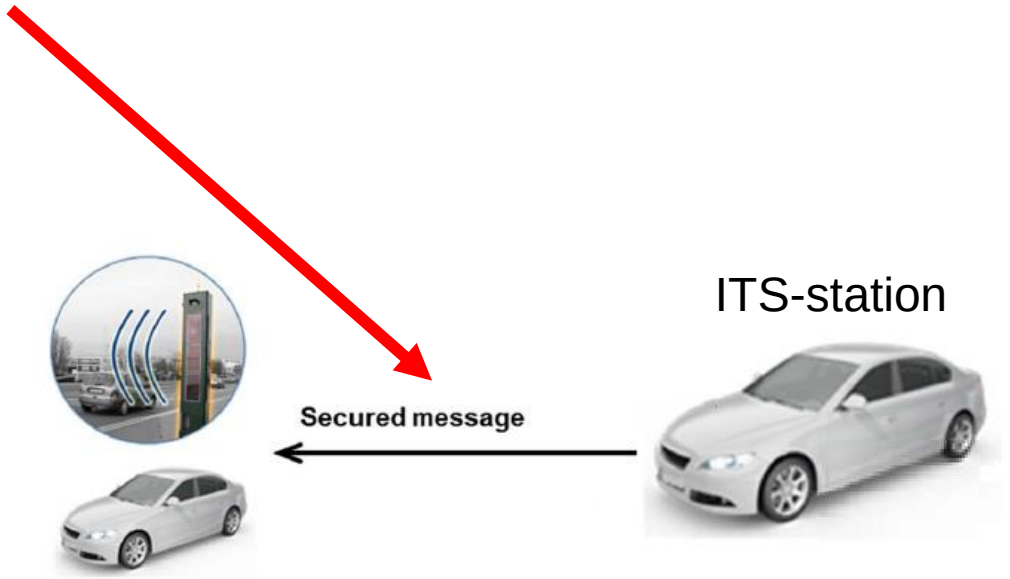
PKI architecture / C-ITS trust model

How to establish a secure communication between ITS-stations?



First the ITS-station registers with its predefined profile at the EA, to obtain eligibility

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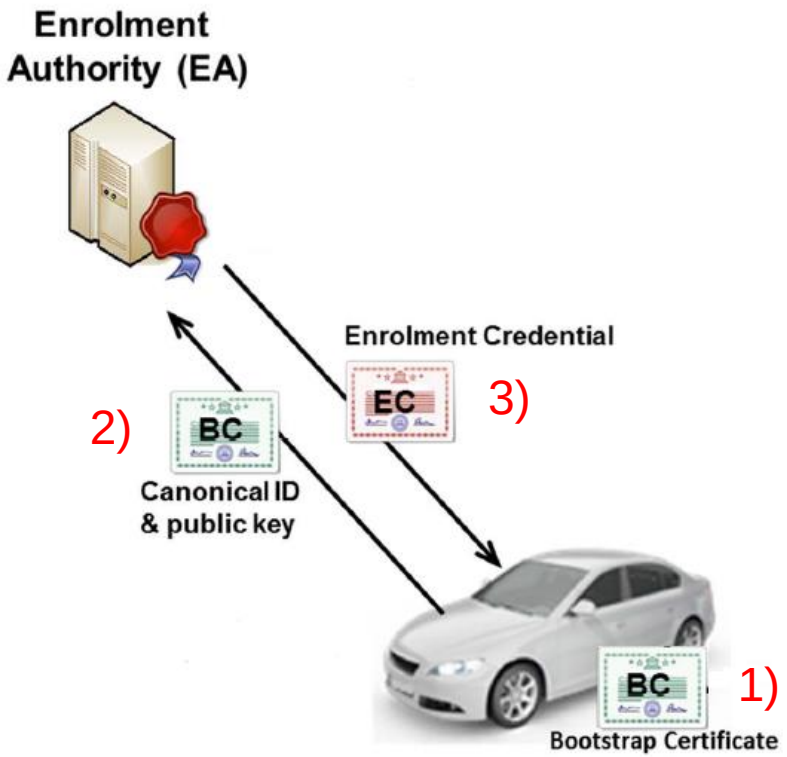
PKI architecture / C-ITS trust model

1) ITS-station obtains ID, keys and profile from manufacturer or operator, e.g. in form of a BC
2) ITS-station requests eligibility at EA with BC
3) After review EA issues general eligibility to participate at ITS in form of EC



Then the ITS-station requests from the AA specific, pseudonymized authorizations

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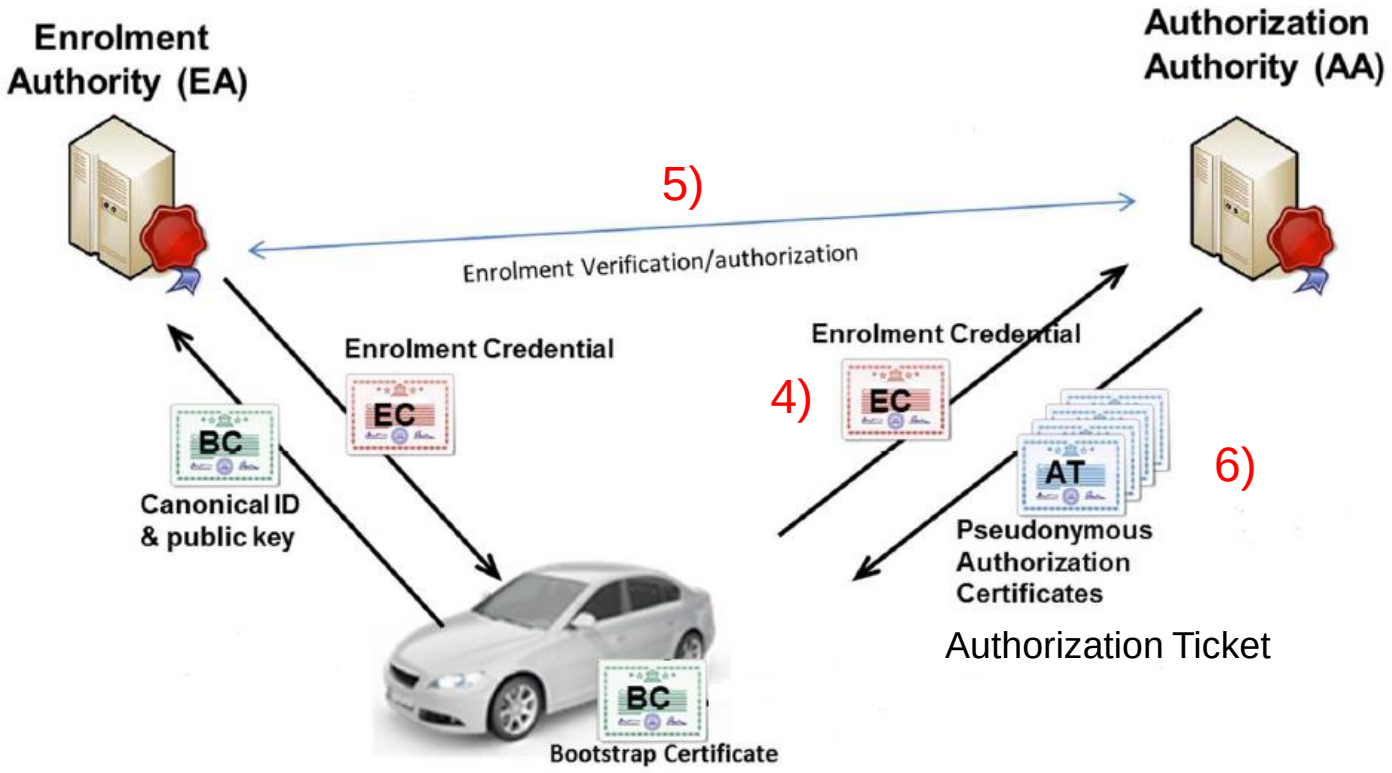
PKI architecture / C-ITS trust model

4) ITS-station requests specific authorizations at AA with EC
5) AA reviews EC via consultation with EA
(AA does not obtain true identity of ITS-station)
6) AA issues authorizations in form of ATs
(with data unknown to EA)



With authorizations communication is possible, in accordance with the principles authentication, authorization, privacy

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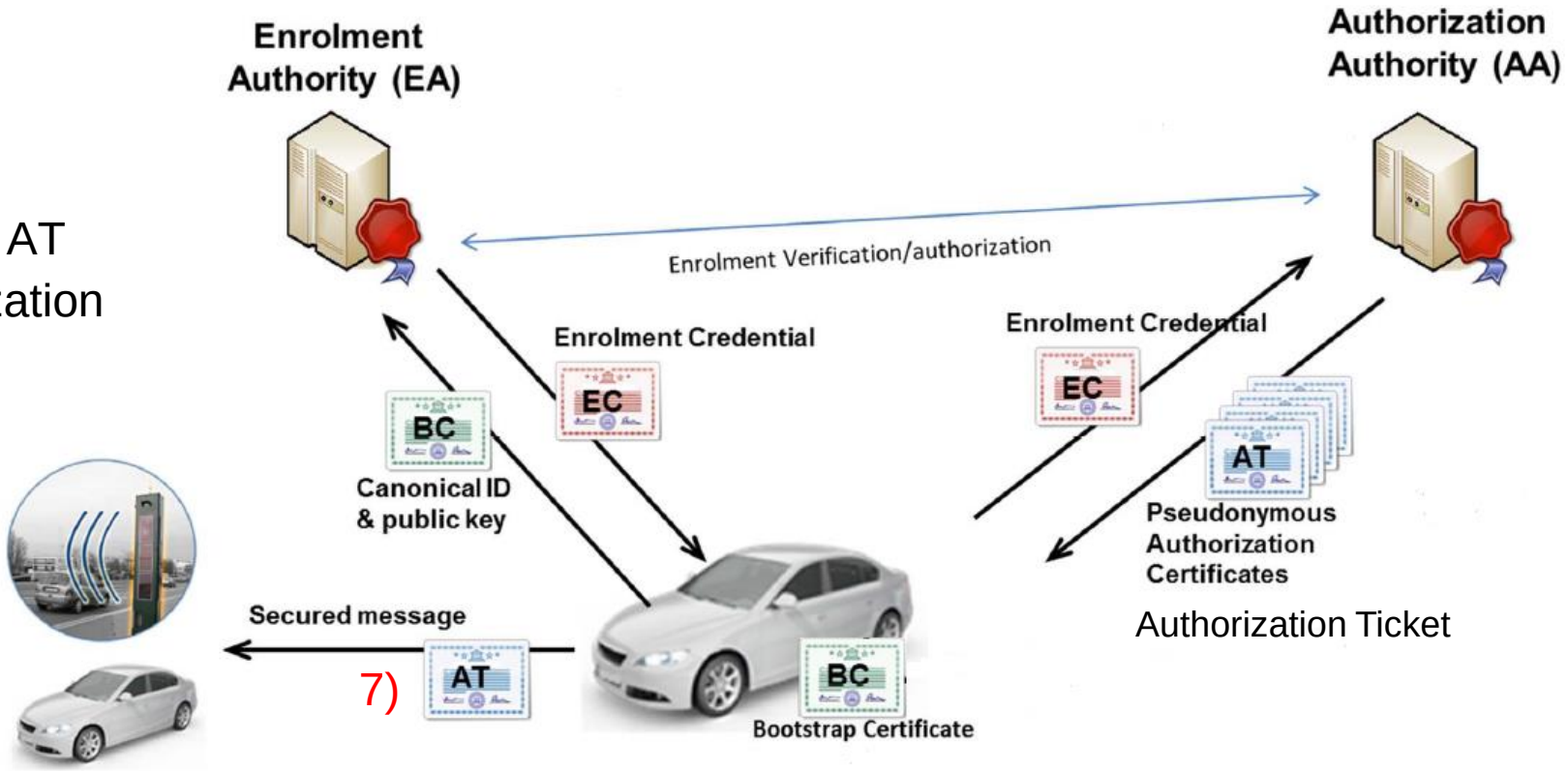
PKI architecture / C-ITS trust model

7) ITS-station sends signed messages with corresponding AT for authentication and authorization



EAs and AAs obtain permission to issue certificates from a Root Certification Authority

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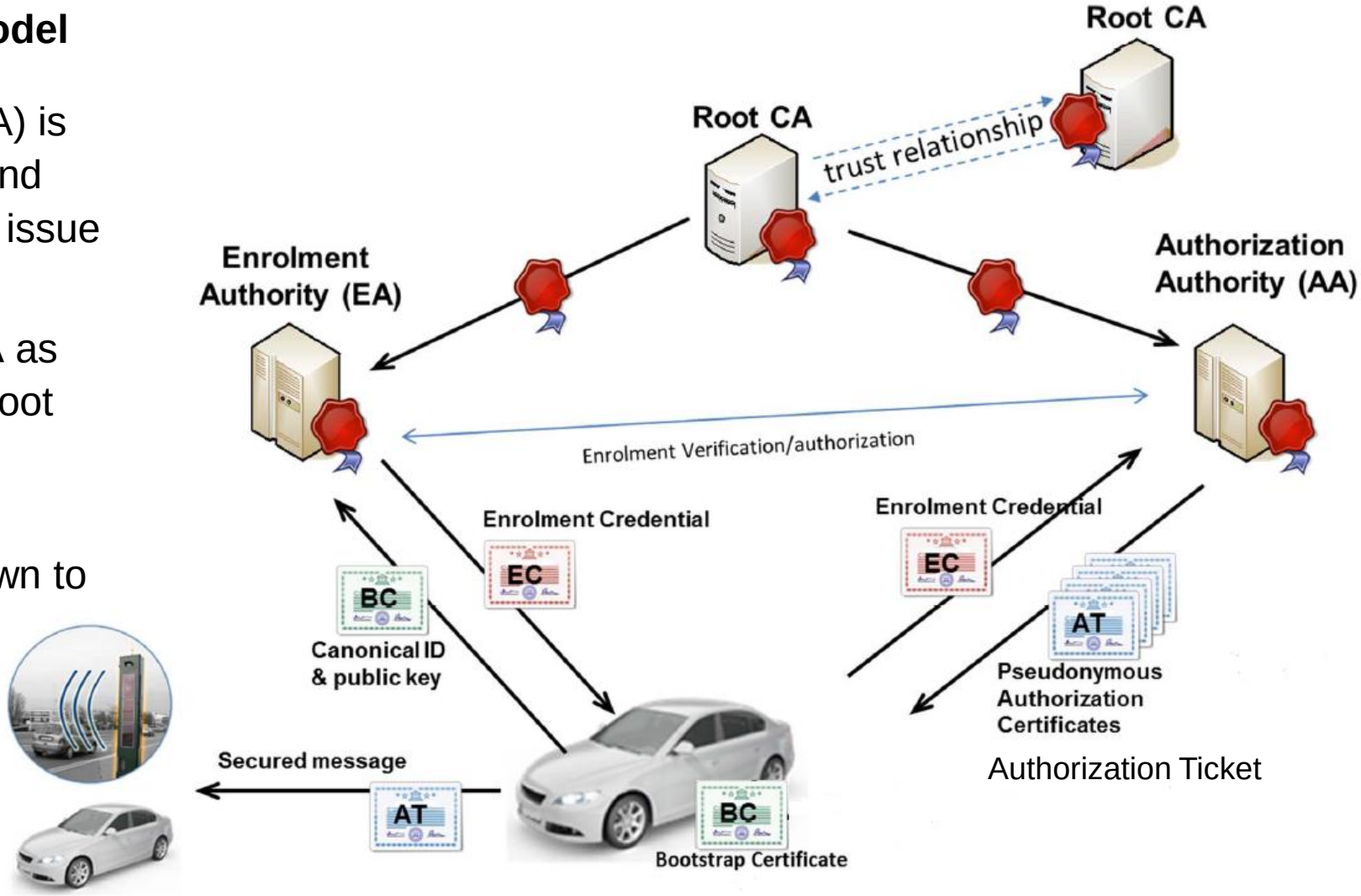
PKI architecture / C-ITS trust model

- Root Certification Authority (CA) is highest certification authority and certifies that EAs and AAs can issue ECs or ATs resp.
- There can be a single Root CA as an absolute entity or several Root CAs which verify each other
- Concrete: set of Root CA certificates is in place and known to all. One can apply for a certificate.

From standard:
ETSI TS 102 940



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ITS-G5 security

Security aspects of Vehicle2X communication

Security Services operate within the layers of the communication architecture, as well as across in the management

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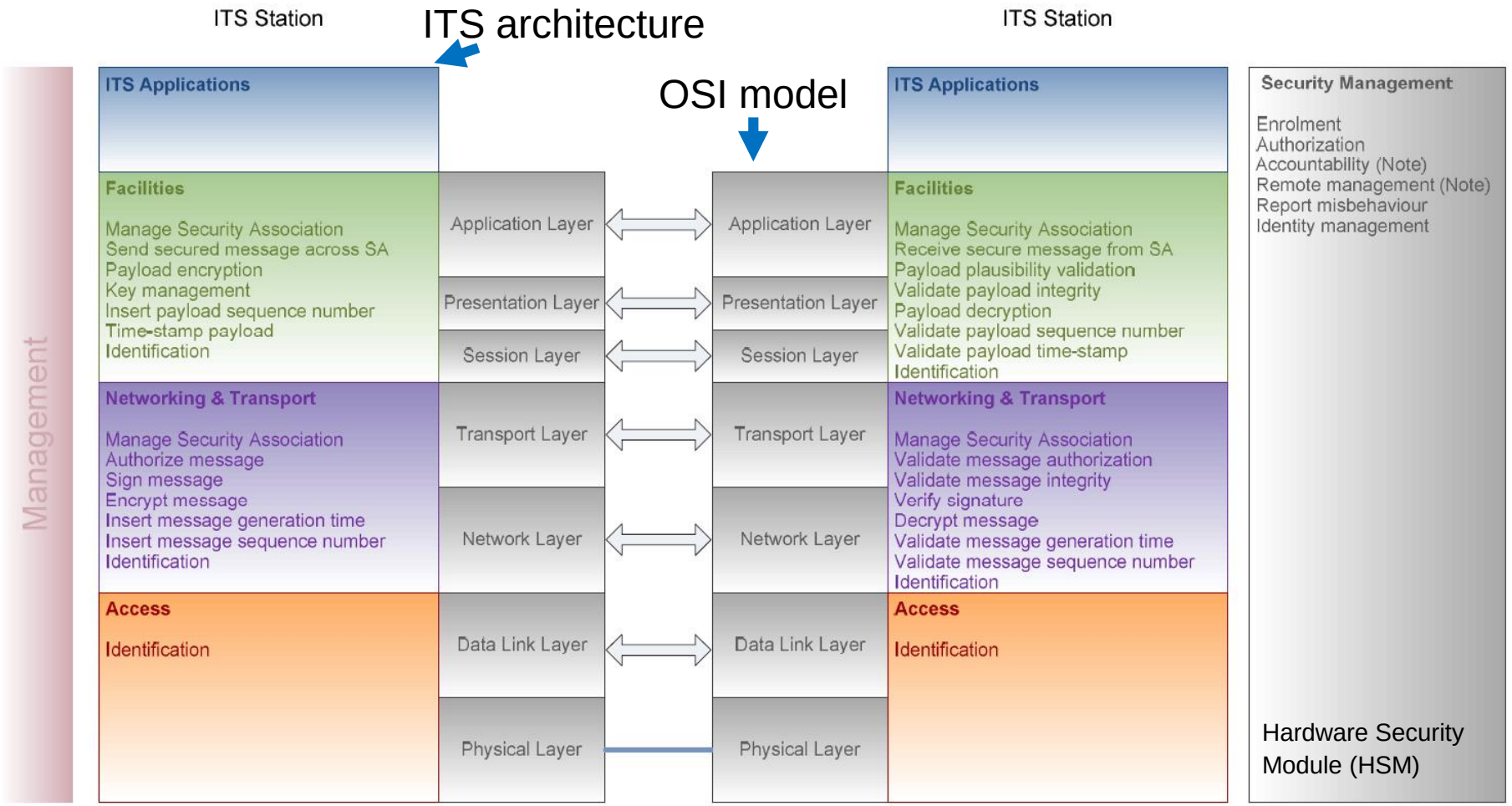
ITS security in communication architecture

Security Services offer

- Authentication
- Authorization
- Accountability
- Integrity
- Confidentiality
- Privacy
- Availability

From standard:
ETSI TS 102 940



An HSM is responsible for communication encryption and PKI handling

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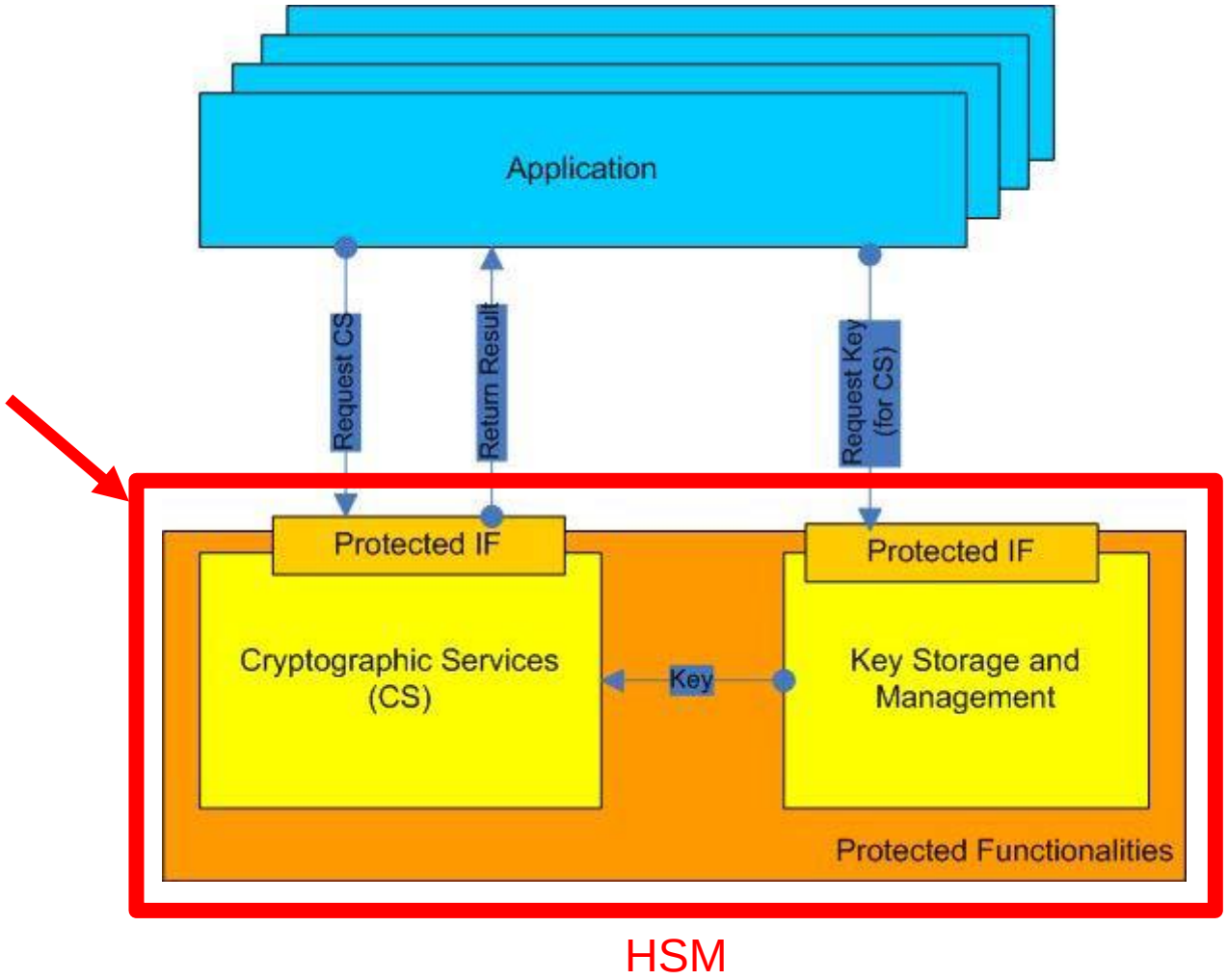
Hardware Security Modul (HSM)

HSM:

- Secure saving of private keys
- Secure execution of cryptographic functions
- Access to sensible data / keys only with explicit permission and via protected interfaces
- Siemens ESCoS RSU has an HSM



From standard: ETSI TS 102 940

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Rail ITS PKI

Structure of PKI for rail-specific ITS applications

A rail-specific sub-PKI as part of the whole ITS PKI is conceivable

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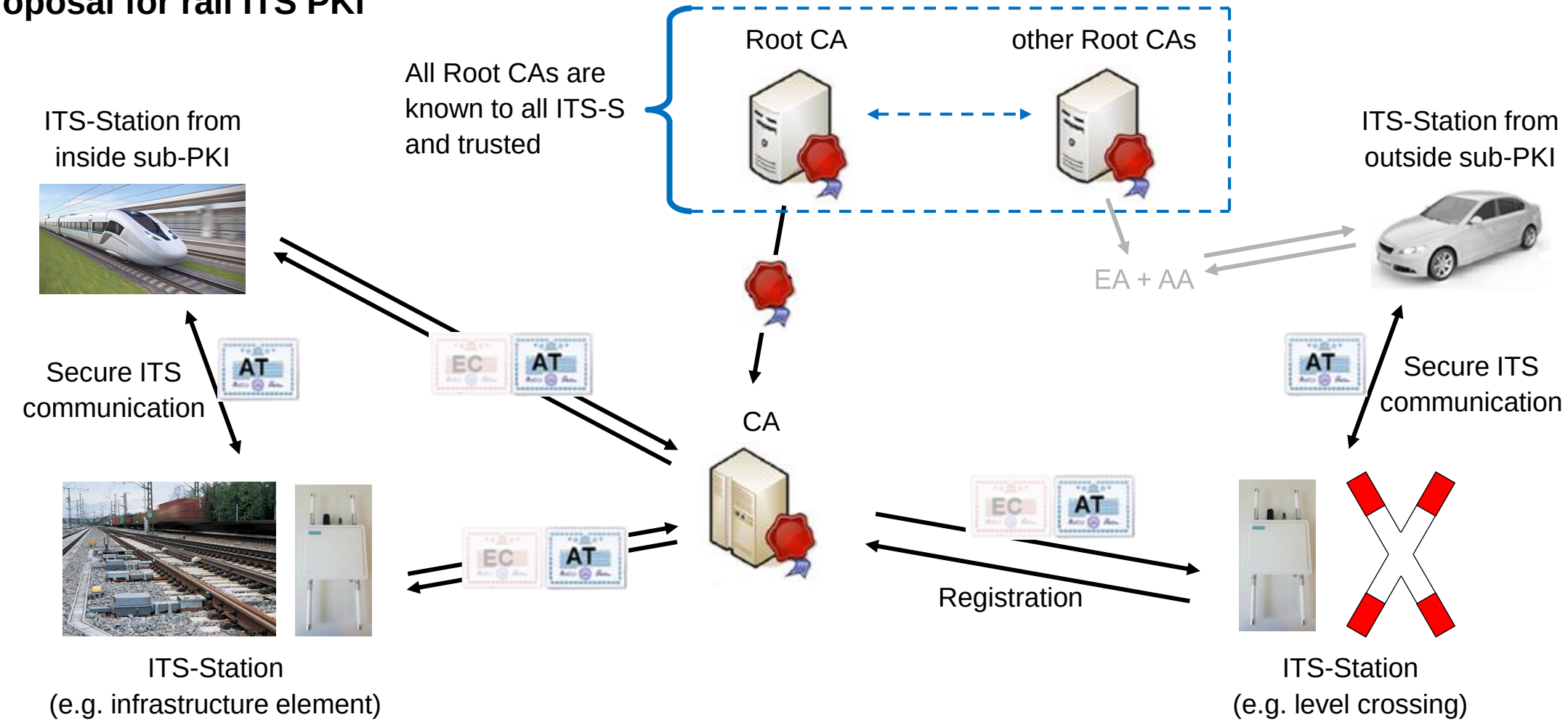
Proposal for rail ITS PKI



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