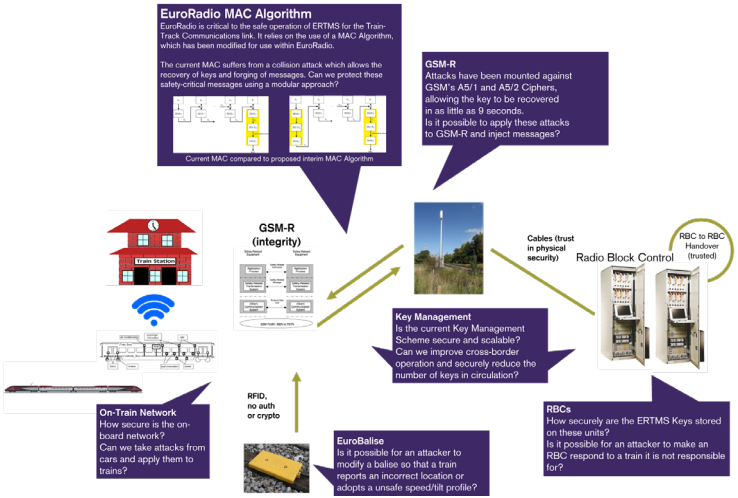
Cyber Security in the Rail Sector – An Integrated Approach

Richard J. THOMAS (R.J.Thomas@bham.ac.uk), Mihai ORDEAN, Tom CHOTHIA
University of Birmingham | railway.bham.ac.uk

The Challenge

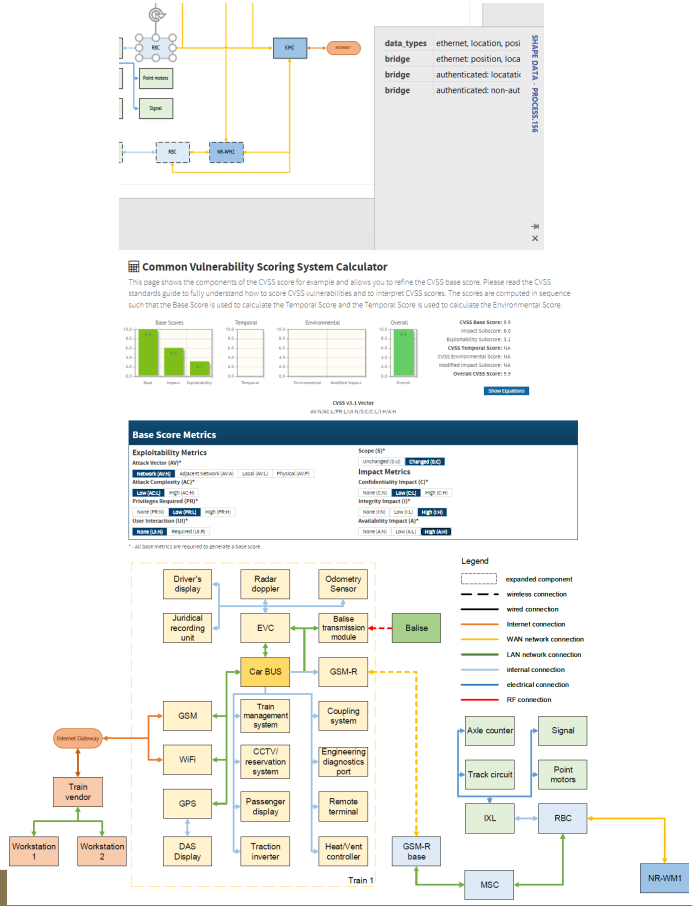
- Focus on safety and functionality over security
- Cyber security incidents (e.g., INCONTROLLER) leveraging the inter-connected nature of systems to attack systems
- Meeting the requirements of the NIS Directive, TS 50701 and ISO/IEC 62443 presents a **significant knowledge and skills gap in rail cyber security**

- *How do we evaluate the threats and risks to our systems to drive improvements in rail cyber security?*



The SCEPTICS Modelling Tool

- Visio-based tool allowing **rail engineering teams to diagram system architectures at any scale** (granular or generic)
- **Bridges** cyber security expertise with rail asset domain knowledge
- Applies the **CVSS Framework** to define the properties of the asset and what the impact is if compromised (e.g., loss of availability or impact on peer systems).
- Establishes **the risk of compromise and exploitation** across **complex systems-of-systems** in a probabilistic way and enables experimentation to get a ground-truth
- Types of Analysis
  - ‘All Roads Lead to’, ‘Patient Zero’ and testing of new strategies

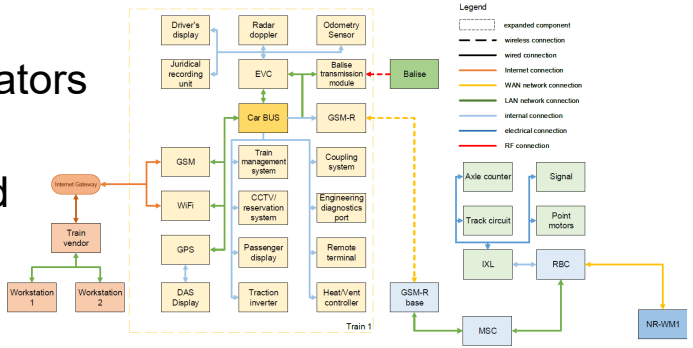


UNIVERSITY OF BIRMINGHAM

BCRRE

Applying the SCEPTICS Tool to ERTMS

- Complex, interdependent architecture with multiple organisations, asset managers and maintenance operators
- Modelled ERTMS and on-board train systems in the SCEPTICS tool, and validated the security profiles and outputs with asset owners and stakeholders
- Ran the tool to see:
  - If a compromised balise would affect the EVC and result in an errant Movement Authority
  - Whether a compromised 3rd party could affect on-board systems
  - What the effect of GPS spoofing is
  - How investments (e.g., secure balises) reduce the risk to the railway




```
Adversary a1:
[Balise]->[Balise transmission module]->[EVC]:0.32736
[Balise]->[Balise transmission module]->[EVC]->[GSM-R]->[GSM-R base]->[MSC]->[RBC]:0.00016
[Balise]->[Balise transmission module]->[EVC]->[GSM-R]->[GSM-R base]->[MSC]->[RBC]->[MSC]->
    ->[GSM-R base]->[GSM-R]->[EVC]:0.32747
[SecureBalise]->[Balise transmission module]->[EVC]:0.06591
[SecureBalise]->[Balise transmission module]->[EVC]->[GSM-R]->[GSM-R base]->[MSC]->[RBC]:0.00006
[SecureBalise]->[Balise transmission module]->[EVC]->[GSM-R]->[GSM-R base]->[MSC]->
    ->[RBC]->[MSC]->[GSM-R base]->[GSM-R]->[EVC]:0.06597

Adversary a2:
[Workstation1]->[Train vendor]->[Internet Gateway]->[WiFi]->[Car BUS]:0.13456
[Workstation1]->[Train vendor]->[Internet Gateway]->[GSM]->[Car BUS]:0.03275
[Workstation2]->[Train vendor]->[Internet Gateway]->[WiFi]->[Car BUS]:0.0313
[Workstation2]->[Train vendor]->[Internet Gateway]->[GSM]->[Car BUS]:0.00762

Adversary a3:
[GPS]->[DAS Display]:0.97222
[GPS]->[Car BUS]->[Passenger display]: 0.9452
[GPS]->[Car BUS]->[EVC]->[GSM-R]->[GSM-R base]->[MSC]->[RBC]:0.00085
```

Conclusion

- The pace of digitalisation in the rail sector means cyber security is a critical issue, where threat and risk assessments help to manage the risk
- Rail Cyber Security has a significant skills and competency gap, where the SCEPTICS Tool empowers railway engineers to understand cyber security risks to their infrastructures without being experts
- Knowing what's vulnerable and a risk is one aspect, where the SCEPTICS tool supports decision-making for investments to protect assets today, tomorrow and into the future

- Full paper and tool available from **research.rjthomas.io/wcrr2022-sceptics**