Norway ERTMS National Implementation

Vincent Garin

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The Norway ERTMS Onboard Project

1. Key figures

2. Challenges

3. Technical evolutions

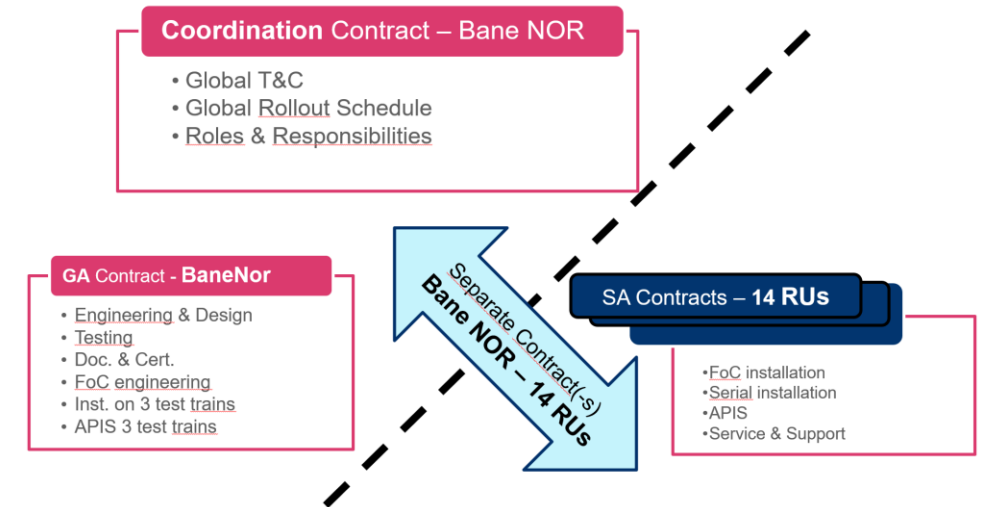4. Managing large fleet retrofit

5. Conclusion

Key figures

- The Norwegian rail network:
  - 4 209 route-km
  - 256 km (ca. 6 %) double track
  - 736 tunnels
  - 2 577 bridges
  - 337 stations and stops with passenger traffic

- **The Norwegian rail fleet:**
  - **~20 Railways Vehicle Owners**
  - **> 650 vehicles**
  - **> 60 types of trains**
  - **Operation in Norway and Sweden**

- **The Project**
  - **Deploy ETCS B3R2 and legacy ATC-2 on up to 498 vehicles of 47 different types (as of today 440 vehicles of 36 types already contracted)**

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The Challenges

- **The Retrofit Challenge**
  - 47 different types of trains
  - Poor availability of "as-is" drawings
  - Complex contractual structure with many stakeholders
  - Strong depot and logistic management for minimal immobilization of fleet

- **Certification and Authorization**
  - New Roles and Processes
  - Adoption of the 4th Railways Package

- **Harsh Environment**
  - High availability requirements, including for odometry

- **Project timescale**
  - Coordination with wayside deployment (all trains shall be equipped before line opens)
  - Training drivers on ATC-2 STM then on ETCS just before use – avoid them to forget (use of driving simulator)
  - … and unexpected Sanitary crisis…
  - All trains to be equipped by 2026

Coordination Contract – Bane NOR
- Global T&C
- Global Rollout Schedule
- Roles & Responsibilities

GA Contract - BaneNor
- Engineering & Design
- Testing
- Doc. & Cert.
- FoC engineering
- Inst. on 3 test trains
- APIS 3 test trains

Separate Contract(-s) Bane NOR – 14 RUs

SA Contracts – 14 RUs
- FoC installation
- Serial installation
- APIS
- Service & Support
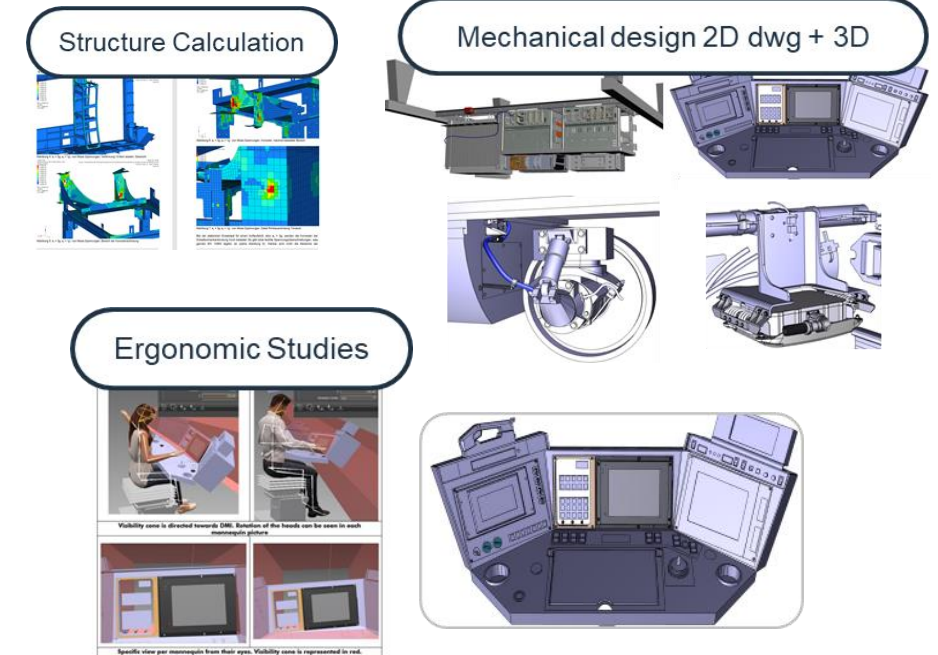
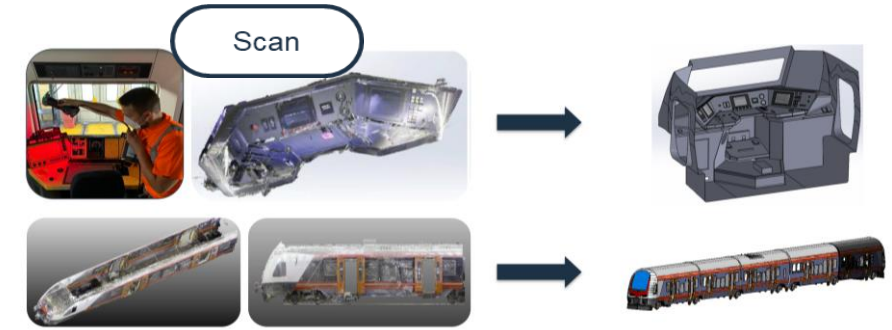**ALSTOM**

Technical features

- **Integration of ATC-2**
  - Fully integrated in EVC
  - No additional hardware, less space, less energy, higher availability, less maintenance, no need for future decommissioning

- **Highly innovative odometry solution based on GNSS/IMU sensors and data fusion**
  - Replacing external radars which are sensitive to snow/ice accumulation, resulting into speed errors and/or sensor unavailability
  - Very high performance Sensors,
    - easy to install,
    - using pure GNSS speed based on GPS, GLONASS, GALILEO, BEIDU,
    - enhanced with Inertial Movement Unit with 3D and 3-axis measurements,
    - with additional internal hybridization (GNSS+IMU)

- **Fully certified and authorised**
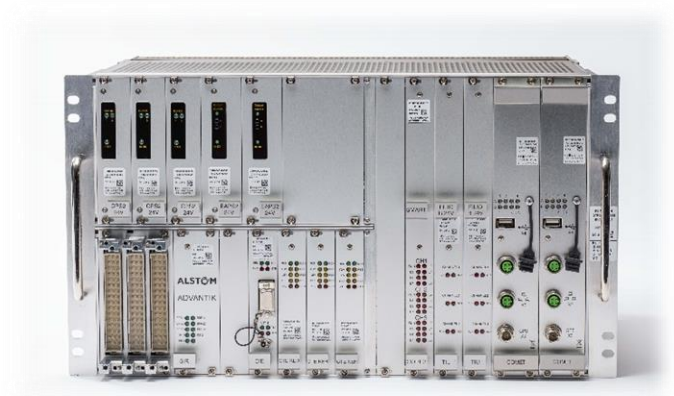
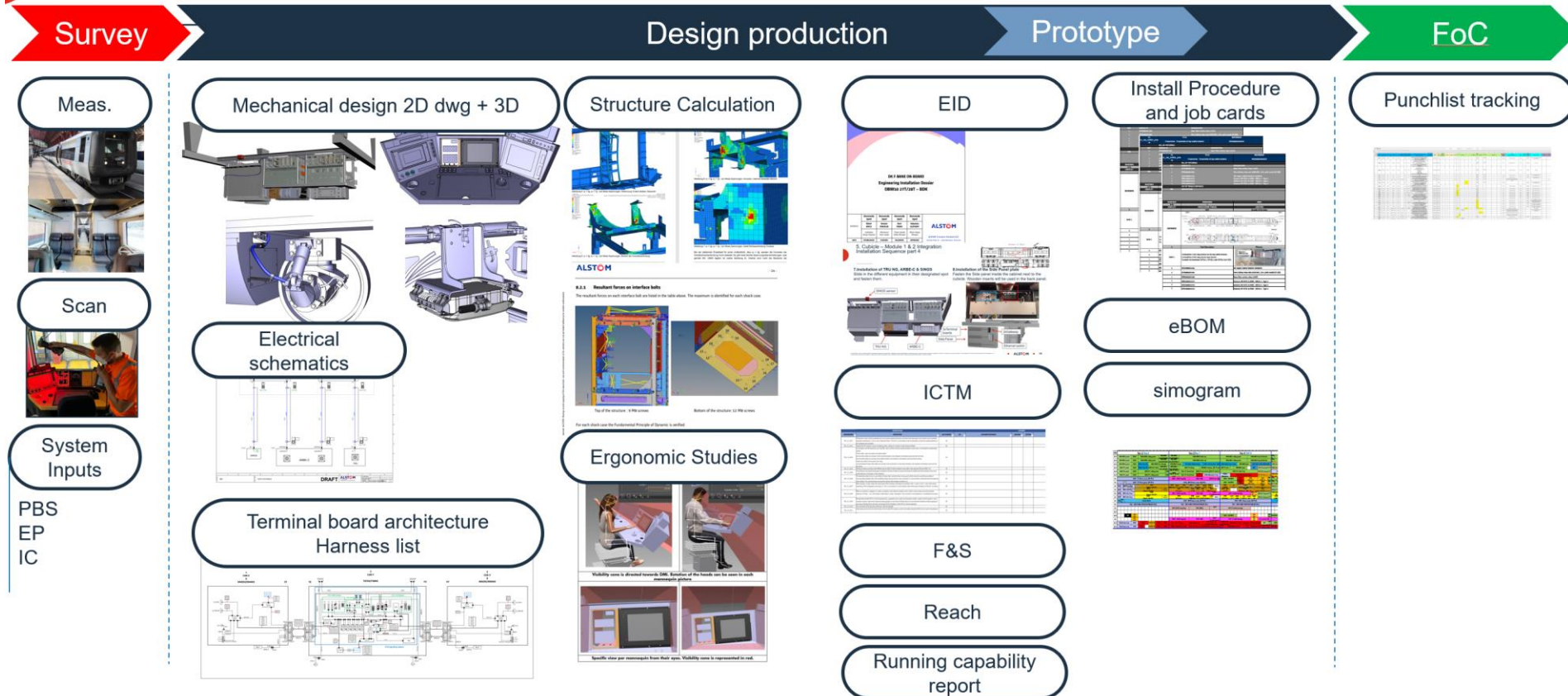**Innovative solution for increased performances and reduced LCC**

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Digitalizing the Engineering

Scan

- **Vehicle Engineering**
  - Digital « virtual » generic train created
    - ◗ Includes all project features
    - ◗ Addresses vehicles diversity (train interfaces, mechanical, and space constraints, hazard log, …)
    - ◗ Flexible & modular train interfaces, supporting bus and/or direct wiring

  - Per train class, specific:
    - ◗ Extraction from virtual train the specific needs of a given vehicle type
    - ◗ Tailoring of interfaces
    - ◗ TCMS adaptation limited when interfaces signals are missing or cannot be reconstructed
    - ◗ Validation of implementation and associated hazards

  - High level of digitalisation
    - ◗ Existing « as-is » documentation incomplete or not reliable
    - ◗ Use of 3D Scan, augmented reality

Structure Calculation

Mechanical design 2D dwg + 3D

Ergonomic Studies

Fully digitilized process from Vehicle Survey to Commissioning

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Digitalizing the Engineering

Survey → Design production → Prototype → FoC

- Survey
  - Meas.
  - Scan
  - System Inputs
    - PBS
    - EP
    - IC

- Design production
  - Mechanical design 2D dwg + 3D
  - Electrical schematics
  - Terminal board architecture Harness list
  - Structure Calculation
  - Ergonomic Studies
  - EID
  - ICTM
  - F&S
  - Reach
  - Running capability report
  - Install Procedure and job cards
  - eBOM
  - simogram

- FoC
  - Punchlist tracking

Fully digitilized process from Vehicle Survey to Commissioning

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The Logistic Center

- **Train fitment**
  - Logistics center for installation
    - Procurement
    - Kitting
    - Cable harnesses production facility for first of class (flexibility to adapt in short time)
    - Quality control
  - Main depot with full logistics and secondary depots to support production rate
  - Strong coordination with RVOs to get access to vehicles

- **Digitalisation of all installation tasks**
  - Methods statements, check lists, digital cable scans, verification reports
  - Faster installation, reduced reworks

- **Partnership with local maintainer**
  - Good knowledge of vehicles
  - Established relationship with RVOs
  - Training « in the field » for future maintenance of ETCS system

Install Procedure and job cards

Strong focus on minimising vehicle immobilisation

Vehicle Authorisation

- Project scope is based on a « turnkey » concept
  - Full scope covered by Alstom
    - Safety case, ISA, AsBo, NoBo, DeBo
    - Coordination with NSA

- National and European Authorisation
  - Several vehicles are cross-borders with Sweden
  - 4RP has been adopted by Norway
    - Pre-engagement with ERA already made

- Strong efforts are being made to reduce installation time, but flexibility to receive autorisation to return train in Operation as soon as they are fitted is key to secure timely deployment on large fleet
  - Mixed Traffic Authorization for Commercial Operation (MTA-CO) is used ahead of APIS to return vehicle in service with no delay
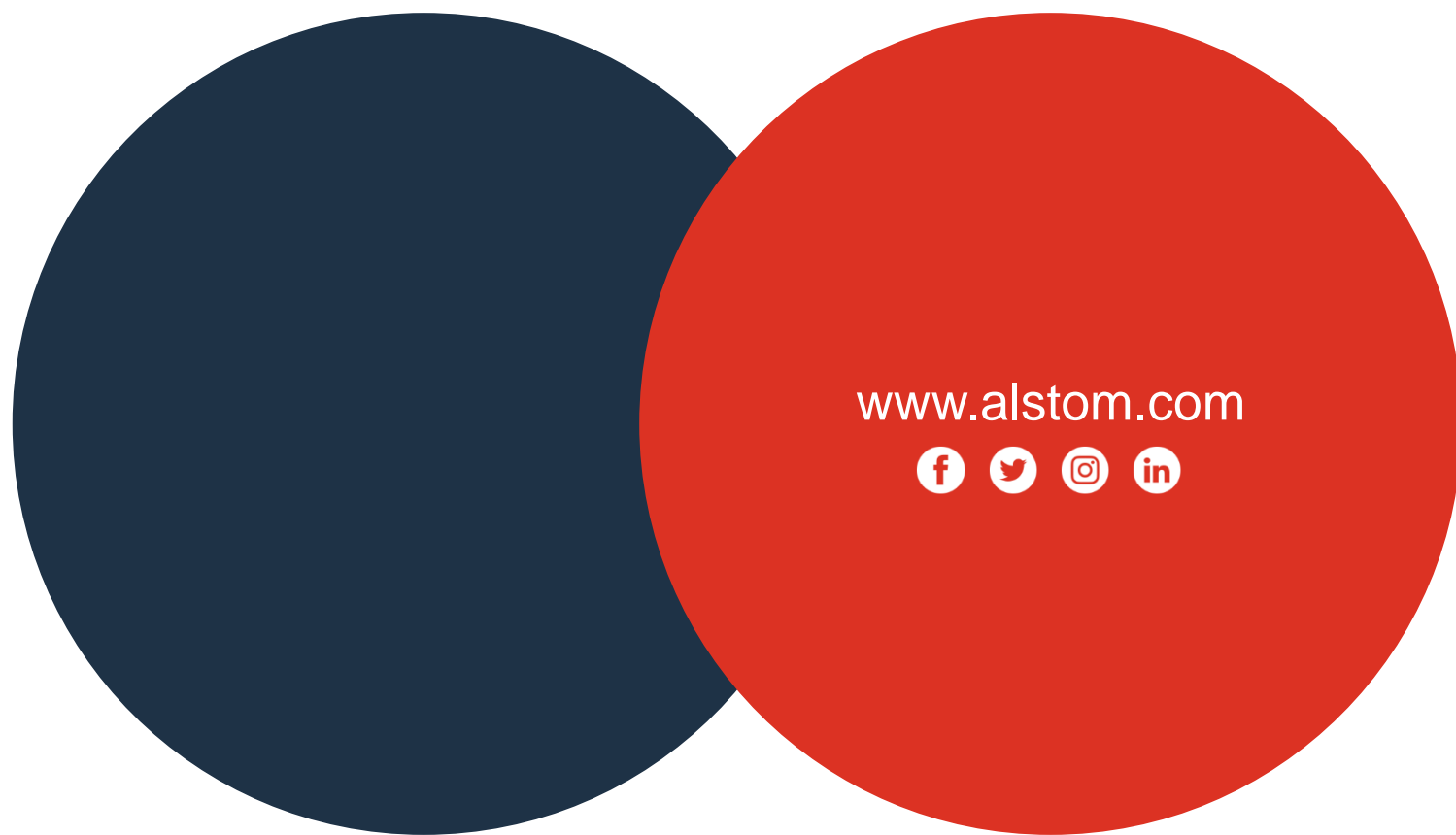
Flexibility on Autorisation is key for retrofit project.

Conclusion

- Norway Onboard Solution integrates innovative features, and performances have been demonstrated during field tests in all weather conditions in both ATC-2 and ETCS operation

- Alstom leading expertise in retrofit project has been further extended, anticipating the needs for a smooth large scale deployment
  - with standardisation of vehicle design and interfaces,
  - setting logistics means,
  - digitalisation of installation processes, and
  - flexible authorisation

- First APIS in place on full project scope

- ETCS go live end of October 2022 !

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