Poster Presentations:

- Overview of SFERA and relation with ATO
- Core Use Cases
- Advanced Use Cases:
  - Power Management
  - Degraded Adhesion
- Message structure
- Communications
- Proof of Concept
Overview
And Relation with ATO
Who we are.

• **Henk Tijssen**  
  ICT Architect, CIO Office  
  ProRail

• **Thomas Sutter**  
  Corporate Development Operations  
  SBB Infrastructure
What is the SFERA Objective?

Standardize DAS data exchange between on-board and traffic management.

This means, the SFERA standard must be applicable:

- In a multi RU environment.
- Cross IM border.
- On ERTMS Lines.
- On Legacy Class B ATP lines.
We realised that data requirements for ATO and DAS are very similar.
Why is this relevant for SFERA?

- ATO over ETCS
- SFERA / DAS

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<th>Route Data</th>
<th>Timetable Data</th>
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<td>C-DAS</td>
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- Automatic Driving
- Driving Advice
Introduction to the Poster.

In addition to the DAS-Concept, our poster covers:

- Similarities between ATO o. ETCS and C-DAS.
- Differences between ATO o. ETCS and C-DAS.
- Data requirements for C-DAS.
- Advantages our IRS 90940 approach brings.
Introduction to the Poster

IRS 90940 GENERAL OVERVIEW AND RELATION TO ATO OVER ETCS

**IRS 90940 Objective:**
Standardize DAS data exchange between on-board and traffic management

- In a multi-RU environment
- Cross IM boarder
- On ERTMS lines
- On Legacy Class B ATP lines

Data requirements for ATO and C-DAS are very similar

Standards for ATO over ETCS and C-DAS cannot be identical

For C-DAS, IM should deliver extra train, infra, timing and communication data

IRS 90940 ensures one single set of data to support ATO and DAS for all RUs
Key Takeaways: What You Really Need to Know.

- The data requirements for ATO and DAS are very similar and the respective standards should therefore be compatible.

- Because DAS does not have a connection to ETCS, Infrastructure Managers must provide additional data from traffic management systems.

- The IRS 90940 ensures one single set of data to support ATO on Class B ATP lines and C-DAS for all Railway Undertakings.
SFERA: Core Use Cases

Sébastien Dislaire – TMS Functional Specification, SNCF Réseau
Daniele Arena – Consultant, UIC
IRS 90940 (Project SFERA) Stakeholder Workshop, Paris 05/11/2018
Who we are

• Sébastien Dislaire
  • TMS Functional Specification, SNCF Réseau

• Daniele Arena
  • Consultant, UIC
- S-DAS + C-DAS Initialization

- Initial Setup
  - Driver Check: Train Type
  - Driver Check: Degraded Train Functions
  - DAS Operation

- C-DAS operational use cases
  - DAS
    - On-Board Triggers
    - DAS Initial Reaction
  - TMS
    - TMS calculation and DAS update
  - Track-Side Triggers

- Other IM systems

Stakeholder Workshop
IRS 90940 (SFERA Project)
05/11/2018
### S-DAS + C-DAS Initialization

**DAS**
- DAS turns on
- Handshake between DAS and TMS
- DAS requests Segment Profiles not in DAS memory

**TMS**
- TMS sends Journey Profile to DAS
- TMS sends requested Segment Profiles
- TMS sends requested Train Characteristics

**Driver Check: Train Type**
- Is the train type correct?
  - Yes: Driver corrects Train Type.
  - No: DAS requests Train Characteristics if not in DAS memory

**Driver Check: Degraded Train Functions**
- Are functions of the train degraded?
  - Yes: TMS sends requested Train Characteristics
  - No: DAS or driver requests RU to correct TAF/TAP Composition Message

**DAS Operation**
- DAS calculates and presents advice to driver
- TMS takes into account degraded train characteristics

This use case is repeated:
- for all IM’s on the train Journey when initializing in S-DAS mode;
- When necessary in C-DAS mode (for example: at the last stopping point before a border).

### C-DAS operational use cases

**DAS**
- DAS determines train position/speed
- Driver declares Degraded train function
- Driver declares change in Adhesion conditions (see advanced use case poster)
- TMS calculates new Journey Profile
- DAS calculates optimal speed profile based on known Journey Profile
- Can the train respect the journey profile?
  - Yes: DAS sends to TMS “Train cannot respect time window”
  - No: DAS presents advice to driver

**TMS**
- TMS sends requested Segment Profiles
- TMS sends Journey Profile to DAS
- TMS calculates Journey Profile
- TMS sends Journey Profile to DAS
- DAS sends to TMS “Train cannot respect Time Window”
- DAS presents advice to driver
- TMS sends requested Segment Profiles

**Other IM Systems**
- Track-Side Triggers
  - Train Position/speed merging with other sources
- Power supply and/or TMS decide changes in traction current supply conditions (see advanced use case poster)

**Key**
- Mandatory Functions and links (main flow)
- Mandatory TMS Functions and links (annex flows)
- Optional Functions and links

**IRS 90940 (SFERA Project)**

Stakeholder Workshop
05/11/2018
SFERA Core Use Cases – Detail

- Detailed use cases have been developed for each part of the process
Key Takeaways: What You Really Need to Know

• Initial setup
  • It is the same for S-DAS and C-DAS
    • DAS initiates handshake with TMS upon startup, which results in TMS sending the Journey Profile
    • DAS requests Train Characteristics and Segment Profiles not in memory
  • It is possible for the driver to change some parameters
    • Train type / composition
    • Declare that some train functions are degraded

• C-DAS operation
  • SFERA considers on-board and trackside triggers
    • On-board triggers can cause a direct reaction by the DAS
    • Trackside triggers can be from TMS or other systems
  • All triggers can generate
    • A recalculation of the Journey Profile
    • Communication between ground and board to transmit the journey profile
  • DAS can notify ground that it cannot respect the timing points
Use Case Power Management

Markus Halder – SBB Energy
Bart Van der Spiegel – Infrabel
Niklas Biedermann - Trafikverket

IRS 90940 (Project SFERA) Stakeholder Workshop, Paris 05/11/2018
Who we are

• Markus Halder
  • Swiss Federal Railways, SBB Energy
  • Head power demand management program

• Bart Van der Spiegel
  • Infrabel
  • Expert Energy Management

• Niklas Biedermann
  • Trafikverket
  • Expert Power System Design
Why is this relevant for SFERA?

1 day in Zurich city (50 Hz)

1 day at SBB (16.7 Hz)
Why is this relevant for SFERA?

• Dynamic power profile of railways is challenging and expensive.

• Connection from ground to train offers opportunities to centrally influence power offtake.

• Benefits:
  • Reduction of investment costs for new power supply
  • Additional options in critical grid situations (Business Continuity Management)
  • Less backup power to be provided
Why is this relevant for SFERA?

- Commuter train converter station: Factor 6 between median and peak value
- Info to the drivers – degraded power supply
- Comparison between two Tuesdays
- Train: Coradia Nordic, Pmax=5,6 MW
- Measurement right – line current for a single train
- Simulations show reduction of more than 50 % without affection to the timetable
Introduction to the Poster

WHY?
- Reducing costs for electricity production or purchase by reducing power peaks
- In case of failure of a critical component or thermal alarms, power offtake is limited
- Increase capacity of tracks by optimising the usage of available power
- Optimise exchange of regenerative energy
- Use thermal and kinetic inertia of railways to support stability in European electricity transmission grid

WHAT?
- Adjust power consumption of trains to available power on location and time

REMARKS
- Reasons/benefits depend on railway power supply system
- It might be that part of regenerative energy is still lost in rheostats.
Calculation of consumption and regeneration expected for next 5 to 15 minutes (also taking into account flexibility in HVAC consumptions)

Collection of expectations of all trains and calculation of amount of regenerative braking that can be reused by other trains. TMS can also simulate these values.

Define trains that should receive the request for traction power limitation (including maximal current from point A to point B in the Temporary Constraints)

Sufficient power available?

- yes
  - Request to other trains nearby to increase power offtake in specific time period
  - Reuse of regenerative energy possible?
    - yes
      - TMS CALCULATION AND DAS UPDATE
    - no
      - Define trains that should receive the request for traction power limitation (also available percentage % / power)

- no
  - Sufficient power available?
    - yes
      - Activates traction power limitation to maximal current from point A to point B: reduction of HVAC and traction consumption
    - no
      - DAS calculates optimal speed profile based on known Journey Profile

DAS presents advice to driver

Linked to core use cases graph

Calculation of consumption and regeneration expected for next 5 to 15 minutes (also taking into account flexibility in HVAC consumptions)

Increase HVAC and traction consumption in specific time period if possible

Reusing of regenerative energy possible?

- yes
  - Request to other trains nearby to increase power offtake in specific time period

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DAS presents advice to driver
Key Takeaways: What You Really Need to Know

• Continues availability of electric power is not for free. It influences railway production costs.

• The connection from ground to train offers opportunities for system optimisation
  ➢ Cost savings on infrastructure side by influencing power offtake on trains.
  ➢ Enhancement of the robustness / reliability of the railway power supply system and in consequence the railway system.

• SFERA defines the needed interfaces between ground and train enabling in the future profit from this opportunities.

• Challenges and opportunities vary dependent on railway power supply system (AC, DC, own production or purchase,...).
Use Case

Degraded Adhesion

Didier Boulanger – SNCF Mobilités
Bart Van der Spiegel - INFRABEL
IRS 90940 (Project SFERA) Stakeholder Workshop, Paris 05/11/2018
Who we are

• Didier Boulanger
  • SNCF Mobilités
  • Head of DAS project & train driving expert

• Bart Van der Spiegel
  • Infrabel
  • Expert Energy Management
Why is this relevant for SFERA?

The degraded adhesion has a strong impact on the reliability of the train routing and scheduling.

The drivers have a direct perception of the state of the rail.

A live information allows to recalculate for the train but also to anticipate the vehicle routing and scheduling.
Introduction to the Poster

The driver can indicate at any time during the driving a zone where the adhesion is particularly degraded
Introduction to the Poster

DEGRADED ADHESION USE CASE

WHY?
- In case of low adhesion, trains will need more time to accelerate and to brake.
- The theoretical schedule can not be respected.
- DAS needs this information to calculate the optimal trajectory.

WHAT?
- Driver can indicate better or worse adhesion conditions.
- Information is transmitted to Traffic Management (TMS).
- Traffic Management informs all trains on expected lower adhesion conditions on parts of the infrastructure.

BENEFITS
- Anticipate the organization of the scheduling.
- Protect the rolling stock.

REMARKS
- With built-in DAS the feedback can be given automatically from train towards DAS.

TRAIN
- Driver declares change in adhesion conditions.
- DAS calculates optimal speed profile based on the known journey profile.
- DAS presents advice to the driver.

TMS
- Driver activates on DAS "adhesion conditions better/worse than expected".
- Declare "better/worse adhesion" zone to other trains.

TMS CALCULATION AND DAS UPDATE

OTHER TRAINS
- Activate on DAS "better/worse adhesion conditions".
- Part of Status report from Board to Ground.

Part of Journey Profile
Key Takeaways: What You Really Need to Know

• Climate-related events often have an impact on the reliability of the vehicle routing and scheduling

• A consideration of the degraded adhesion allows to anticipate and to adapt the vehicle routing and scheduling

• An adapted vehicle routing and scheduling limits the degradation of the rolling stock and infrastructure

• The early information of the customers is always better perceived
IRS 90940
Message Structure
Who we are

• Harm Jonker
  Nederlandse Spoorwegen
  IT department for supporting operations staff
  Solutions architect mobile

• Tibor Weidner
  DB Netz AG
  Algorithms specialist for traffic management and connected DAS

• Alain Wenmaekers
  Infrabel ICT
  Traffic Management
  Business analyst for the domains Train planning, Simulation and Analytics
The poster

Look for this poster to find us
Purpose of the message structure

• The SFERA messages are
  • Flexible
  • Extensible
  • Interoperable
  Use of XML (instead of binary formats)

• Structure that is compatible with ATO Over ETCS Subset 126
  • Subset 126 messages can be expressed in SFERA

• Avoid using mandatory parts
  • Not all IMs and RUs are able to deliver full datasets
  • Target on the minimum what is needed to operate a (connected) DAS

• Train point of view
  • Concentrate on the events a train run will encounter
Message flows

• Two types of messages
  • Ground-to-Board: used to communicate data from the TMS to the onboard DAS
  • Board-to-Ground: used to communicate status and conditions information from the onboard DAS to the TMS

• Two communication patterns
  • Request/Response based: for data on demand use cases
  • Event based: actively publish changes to interested systems
Ground-to-board structure

Ground-to-board messages are based on Subset 126 information structure.

**Train Characteristics**
- mainly fixed by RU-planning
- changes sometimes
- train composition changes
- temporary rolling stock limitations

**Journey Profile**
- highly variable
- many updates to adjust train movements to current traffic situation

**Segment Profile**
- pretty static structure
- same for many train journeys
Ground-to-board example

A complete journey for a trip from one country to the neighbouring country could look like this:
Board-to-ground messages

Board-to-ground messages serve to give status or feedback to TMS according to use cases defined in the working group.

Currently foreseen:

- Position and speed
- DAS status change
- Change of adhesion conditions
- Expected energy consumption
- Train cannot respect time window
Progress of Message Structure definitions

• Ground-to-board messages: stable, nearly final

• Board-to-ground messages: need additional input and finalisation
Communications
Challenges and Solutions

Bart van der Spiegel – Infrabel
Christophe Tassin – SNCB / NMBS
Jan Hoogenraad – NS / Spoorgloren

IRS 90940 (Project SFERA) Stakeholder Workshop, Paris 05/11/2018
Who we are

• Jan Hoogenraad
  Consultant
  NS /Spoorgloren

• Christophe Tassin
  Engineer Energy Efficiency and Innovation
  SNCB / NMBS

• Bart Van der Spiegel
  Expert Energy Management
  Infrabel
What is difficult on SFERA communication protocols?

• We start with a working S-DAS SFERA protocol
  • Communication to train is easy: fire and forget
  • Communication IM-RU needs to be compatible as well

• For C-DAS, we need a compatible protocol which is:
  • Secure,
  • Reliable,
  • and Interoperable,

• Bidirectional communication.
• Compatible with DAS and ATO.
How did we implement SFERA communication protocols?

- Data layer independent of content and S-DAS or C-DAS or ATO
- Three different supported communication architectures.
  - BACK OFFICE TO BACK OFFICE
  - USING ATO OVER ETCS
  - DIRECT COMMUNICATION
- Two architectures well defined, one under construction.
Introduction to the Poster.

• Our poster covers
  • The 3 architectures
  • The benefits of each architecture

• Come and discuss the different architectures with us
Key Takeaways: What You Really Need to Know.

• By separating the data layer from the communications layer, IM and RU systems can be kept simple
• By supporting 3 architectures, SFERA has solutions for most IM-s and RU-s in Europe.
• 2 architectures are already in use
PROOF OF CONCEPT

On Thalys runs

Theo Vis - NS

Chloé Lima-Vanzeler – SNCF Mobilités

IRS 90940 (Project SFERA) Stakeholder Workshop, Paris 05/11/2018
Who we are

• Theo Vis
  Requirements engineer
  NS

• Chloé Lima-Vanzeler
  Program manager in traction energy efficiency
  SNCF Mobilités
The goals of the POC

- Check the consistency of SFERA standard message
- Check that DAS can operate with SFERA data
PROOF OF CONCEPT

DATA PREPARATION

TEST LIVE IN PASSENGER COACH

25/10/18

TEST LIVE IN DRIVER COACH

Coming soon
## PROOF OF CONCEPT

### DATA PREPARATION

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</tbody>
</table>

### TEST LIVE IN PASSENGER COACH

- 25/10/18

### TEST LIVE IN DRIVER COACH

- Coming soon
PROOF OF CONCEPT

DATA PREPARATION

TEST LIVE IN PASSENGER COACH

TEST LIVE IN DRIVER COACH

25/10/18

Coming soon

10 experts

2 DAS

10 devices

Paris ↔ Amsterdam
THE POSTER

THALYS TEST

Why / Waarom / Pourquoi

- Make sure the data of the 3 countries/fr into the standard EUREA language
- Check the operation on 3 DAS systems
- Make sure it works on the 3 networks (interoperable)
- Convince the relevant ISM systems

How / Hoe / Comment

1. Check data availability for every country
   - FR - BE - NL - yes
2. Simplify FT / NFT / NL data to EUREA
   - FR - BE - yes
3. Bring the 3 countries’ data together
   - FR - BE - yes
4. Integrate the data into Optis-consult DAS (EFCS)
5. Integrate the data into Tissima DAS (EFCS)

What / Wat / Quoi

- 2 Days Test
  - 1 in passenger coach
  - 1 with the driver

Learnings

- Method is effective in the trials conducted
- Difficult to collect all the (inf) data from info managers (sources)
- Current DAS are working with different data
Key Takeaways: What You Really Need to Know

• A POC is being handled on an international Thalys trip with french and dutch existing DAS, integrating data from France + Belgium + Netherlands

• What has been done so far :
  • Data collection > translation into SFERA standard > integration in DAS
  • Run Paris → Amsterdam and back in passenger coach
    ➔ First results are ok: DAS operated well over the complete journey

• To be done :
  • Logs analysis
  • Run in driver cabin
Thank you for your kind attention