Banedanmark TMS
ETCS as the foundation for attractive and efficient railway service
Outline

1. Introduction: ETCS – ERTMS
2. Banedanmark TMS
3. How does Banedanmark TMS work?
4. Service Intentions and Production Plans
5. TMS for attractive and efficient railways
6. Questions
1. Introduction
ERTMS = GSM-R + ETCS + ETML

European Rail Traffic Management System

= 

Global System for Mobile Communications–Railway

+ 

European Train Control System

+ 

European Traffic Management Layer (TBD)
Levels

- **ETCS Level 1** = Movement authority sent to trains via balise. Trackside signals generally remain. Train position detected by occupancy detection.

- **ETCS Level 2** = Movement authority sent to trains via radio. Trackside signals often removed. Train position detected by occupancy detection.

- **ETCS Level 3** = Movement authority and train position data sent by radio (“moving block”).
ERTMS in Europe

- ERTMS in service/construction in 20 EU countries;
- Approximately 19,830 km track as of Sept. 2013;
- National governments/infrastructure owners responsible for implementing ERTMS;
- European Commission (EC) focused on policy, research and supporting implementation of international corridors;
- EC is currently addressing the political, technical, and financial challenges delaying international corridor implementation.
ETCS implementation strategies:

- **Migrate**: install ETCS on new lines and when existing equipment reaches end of service life.
  - (Germany), France, Spain, Switzerland, Austria ...

- **Replace**: completely replace signalling system with state-of-the-art ETCS.
  - Denmark, Norway, Netherlands, UK (sector-based).
Denmark

Situation in 2000

- Increasing demand and desire to shift traffic from road to rail.
- Decreasing punctuality: 50% delays caused by signal failures.
- Increasing maintenance costs.
- 60% of signaling will exceed final service-life by 2024.
- Losing know-how for legacy system maintenance.
Total signalling system replacement is better than piecemeal replacement because it:

- Reduces costs by eliminating the need for creating provisional interfaces;
- Provides economies of scale, although some existing equipment would be written off early;
- Reduces maintenance costs (important: loss of know-how in maintaining legacy systems);
- Improves the quality of railway operations.
**Banedanmark Signalling Programme**

**Project elements:**

- **S-bane** – Copenhagen regional rail (170 km closed network); CBTC system, completion: 2020 (Siemens).

- **Fjernbane West** – Long distance network; ERTMS Level 2, completion: 2021 (Thales).

- **Fjernbane East** – Long distance network; ERTMS Level 2, completion: 2021 (Alstom).

- **Onboard ETCS Equipment** – (Alstom).
Banedanmark ERTMS System

ERTMS Level 2 – Baseline 3
### Signalling Programme Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Fjernbane</th>
<th>S-bane</th>
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<tbody>
<tr>
<td>2009</td>
<td>Procurement: 3 Years</td>
<td>Procure: 2 Years</td>
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<tr>
<td>2010</td>
<td>Design: 3 Years</td>
<td>Design: 2 Years</td>
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<tr>
<td>2011</td>
<td>Test: 3 Years</td>
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<td>2012</td>
<td>Roll-Out: 4 Years</td>
<td>Roll-Out: 6 Years</td>
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<td>2020</td>
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<tr>
<td>2021</td>
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</table>

- **Parliament approves program 2009**
- **Contracts with main suppliers signed 2011-12**
- **S-bane roll out Jan 2016**
- **Full implementation S-bane: 2020**
  - **Fjernbane: 2021**
ETCS designers recognised:

The data required for ETCS provides an excellent foundation for creating an advanced traffic management system ...

... Banedanmark TMS
2. Banedanmark TMS
What is the Banedanmark TMS?

An advanced traffic management system to precisely plan and provide railway service for our customers.
TMS is based on 3 key ideas:

1. Customer focus: *services not trains*

2. Control: *precisely defined tasks*

3. Integrated management: *planning & execution*
Customer Focus
Why? Travellers don’t care about trains … … they care about travelling.
Service Intentions

... are a way of describing customer needs in terms of services.
Precise Control
Precise control:

Why? Timetables do not provide sufficient information to control trains effectively in complex and busy rail networks.
Production Plans

... precisely describe how to operate the railway system.
Integrated management:

Differing Methods & Data ➔ Integrated Planning & Execution

Why? Using congruent methods and data supports more accurate planning and faster recovery from disruptions.
Integrated Management

... means using the same methods and data to plan and execute railway service.
3. How does TMS work?
Planning Tools

Idea

Planning

Evaluation

Select TT

Operations

Dispatcher Reacts

Monitor Operations

Time Table

Delay

On Time

Dispatching Instructions
Limited systematic methods and tools for addressing disruptions.
TMS integrates railway management ...

... by using the same data and functions to plan and operate railway service.
TMS: integrates planning and operations

Planning

- Idea
  - Revise Service Intentions
- Feasible?
  - NO
  - YES

TMS

- Database
- Scheduler
- Production Plan (Tasks)
- New PP

Production Plan

Operations

- Monitor Tolerance
  - Out of Tolerance
  - OK

Production Plan (Tasks)

NEW PP

Feasible?

Idea

NO

YES

Use PP
**TMS Applications:**

- **TMS** = Traffic Management System = interface for managing service (dispatching);
- **TPS** = Traffic Planning System = interface for planning schedules and investments;
- **History** = Database for learning and improving service.

*All applications share the same functions and data.*
TMS and TPS are interfaces to a single database.
The **TMS** uses real time data to manage railway service.

**TPS** uses TMS data and TMS functions to plan railway service.

**History** can be analysed to improve the quality of TMS and future planning.
Benefit:

TMS increases the efficiency and accuracy of planning.
Idea expressed in Service Intentions.

Idea

Scheduler provides a feasible production plan.

Feasible?

Out of Tolerance

Monitor Tolerance

OK

New PP

Database

Scheduler

Production Plan (Tasks)

Use PP

NO

Revise Service Intentions

YES

Idea expressed in Service Intentions.
Precise Production Plan improves evaluation quality.

Production Plan is ready for implementation.

Planning

TMS

Idea

Database

Scheduler

Production Plan (Tasks)

Feasible?

NO

YES

Use PP

Revise Service Intentions

Precise Production Plan improves evaluation quality.

Production Plan is ready for implementation.
Benefit:

TMS increases the effectiveness of dispatching.
TMS uses data from multiple sources to monitor production plan task tolerance.
Task tolerance is more precise than timetable delay.

TMS develops new *Production Plan* to address disruption.

TMS

- Database
- Scheduler
- Production Plan (Tasks)
- New PP

Production Plan

Out of Tolerance

Operations

- Monitor Tolerance
- OK

Planning

Feasible?

- NO
- YES

Use PP

Idea

Revise

Service Intentions

Use PP

Production Plan (Tasks)
4. Service Intentions & Production Plans
Service Intentions

... precisely describe railway objectives in terms of their elementary customer service components.
Railway Customers & Services:

- Passengers & Freight
  → transport services;

- Maintenance
  → track access: possessions;

- Train Operators
  → resource management (rolling stock, staff).

Different customers use different types of service intentions ...
Types of service intentions (SI):

1. **Transport** (SI-T) – represent a transport service (passenger or freight);

2. **Link** (SI-L) – connect two service intentions (e.g., passenger transfer, rolling stock used for two services);

3. **Perpendicular** (SI-P) – provide train access/egress (e.g., passengers board a train);

4. **Track Access** (SI-TA) – used to apply operating restrictions to track sections (e.g., maintenance possession);

5. **Handover** (SI-H)
Production Plans

... use tasks to precisely describe railway operations.
Production Plans:

- Tasks are the building blocks for Production Plans.
- Production Plans ...
  - Describe all tasks needed to fulfill Service Intentions.
  - Assign all tasks to “task owners”.
  - Describe tolerance bands for task performance.
  - Assign resources to tasks.
  - Describe the planned state of infrastructure and trains including how traffic circulates, route setting, train speed, etc.
Task Management Window

Task owners can be people or systems!

Task ID & Description
Task Start & End Times
Task Owner
Task Status
Task owners perform their assigned tasks “at ease” ... (i.e., within tolerance band).
5. TMS for attractive and efficient railways
TMS can revolutionise the railway business:

- **Increase railway capacity**
  - precise production = more efficient use of resources;

- **Improve service quality**
  - TMS + real time data = effective management of disruptions and accurate customer information;

- **Facilitate innovation**
  - Service Intentions provides a structure for re-imagining railway planning and operations to serve new markets and customers.
But TMS is also ...

... a departure from business as usual and therefore will be difficult to operationalise.
**TMS and Change Management:**

1. **Stakeholder communications** – design team is working closely with all stakeholders to understand needs and develop effective training programs;

2. **Phased implementation** – TMS will be gradually introduced and features will be added over time;

3. **Attractive and efficient HMIs** (human machine interfaces) and support applications.
Banedanmark
Building the railway of the future.

TMS
Building the future for railways.
Questions?