AN ECONOMIC MODEL FOR THE EVALUATION OF DIFFERENT TECHNOLOGICAL SCENARIOS IN THE RAIL SECTOR

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1) The framework for innovation in the rail sector in the EU

2) The sector of train control

3) Train control innovation: the introduction of GNSS-based technologies

4) Economic evaluation: aims and tools

5) Application and conclusions
Framework for innovation in the EU rail sector

ERTMS

The European Rail Traffic Management System (ERTMS) is an initiative to enhance cross-border interoperability and the procurement of signalling equipment by creating a single Europe-wide standard for train control and command systems.

GALILEO

Galileo is the global navigation satellite system (GNSS) that is currently being created by the European Union (EU) and the European Space Agency (ESA).

INNOVATION IN TRAIN CONTROL SYSTEMS
The sector of train control

→ State of the art train control is based on Eurobalises (balises complying with ETCS standard)

→ The market of Trail Control systems is the fastest growing segment (after the Integrated Projects) of the global rail market, and it can be quantified in 5 billion Euro per year in Western Europe.

→ The global rail control market is expected to record a strong growth rate in 2015-2017 at 3.0-3.5% per year, with the roll-out of ERTMS and Positive Train Control being the main driver of this trend. The forecast growth in Europe is slower at 1.5-2.0% per year.

→ The main providers in the market of train control and signaling solutions are Ansaldo STS, Alstom, Bombardier, Hitachi, Siemens, and Thales (which accounts for 30% of the ECTS global market).

→ Increasing standardization of rail signalling solutions is one of the most important trends impacting the market today. Standardization allows suppliers to develop core, standards-based global architectures that both enable the interoperability necessary to meet local safety requirements and provide a common, reliable platform for building local solutions.
Innovation in train control systems: the introduction of GNSS-based technologies

The GNSS would be incorporated in the European train control system (ERMTS-ETCS)

- The space segment would provide the reference satellite system allowing the identification of the train position
- the on board units would be responding to the satellite using the GNSS signal
- the augmentation and integrity monitoring would be an alternative implemented in some areas not covered by EGNOS signal
Economic evaluations: aims and tools

AIMS
→ Business case for developers
→ Impact for other stakeholders
→ Public point of view

TOOLS
→ Business plan
→ LCC analysis, economic projections and indicators (NPV, ROI)
→ Cost-Benefit Analysis
Economic evaluations: aims and tools

AIMS

→ Business case for developers
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TOOLS

→ Business plans
→ LCC analysis, economic projections and indicators (NPV, ROI)
→ Cost-Benefit Analysis

IMs
RUs
Satellite service providers

GNSS antenna sales
Application

**Impact for Infrastructure Managers**

**Balise-based system**

**GSMR**
- Two options
  1. TelCo sells to IM
  2. TelCO sells to TCP which sells to IM

**ETCS+BTM+GSMR**
- TCP sells to RU

**BALISE**
- TCP sells to IM

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**GNSS-based system**

**GNSS terminal**
- SAT sells to RU

**ETCS+LDS**
- TCP sells to RU

**TLC package**
- TCP sells to IM

**GSM**
- RBC

TCP sells to a IM
Impact for infrastructure managers

**Tool: LCC analysis and financial indicators**

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Impact for infrastructure managers

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GNSS-based solution

Balise-based solution

Not present

Definition of an economic model for the use of balises
1) Estimation of the number of yearly failures of the BTM-balise communication in the concerned network

2) Estimation the average number of yearly breakdowns of balises

3) Estimation of the average cost of intervention for balise maintenance

4) Calculation of the total yearly cost for balise maintenance in the concerned network

5) Calculation of the average yearly maintenance cost per balise
1) **Estimation of the number of yearly failures of the BTM-balise communication in the concerned network**

2) Estimation the average number of yearly breakdowns of balises

3) Estimation of the average cost of intervention for balise maintenance

4) Calculation of the total yearly cost for balise maintenance in the concerned network

5) Calculation of the average yearly maintenance cost per balise

Source: the IM itself or adaptation from available figures for the Italian network
Eurobalises: economic model

1) Estimation of the number of yearly failures of the BTM-balise communication in the concerned network

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3) Estimation of the average cost of intervention for balise maintenance

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2) Estimation the average number of yearly breakdowns of balises

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4) Calculation of the **total yearly cost for balise maintenance in the concerned network**

5) $C_{\text{total}}$
1) Estimation of the number of yearly failures of the BTM-balise communication in the concerned network

2) Estimation the average number of yearly breakdowns of balises

3) Estimation of the average cost of intervention for balise maintenance

4) Calculation of the total yearly cost for balise maintenance in the concerned network

5) Calculation of the average yearly maintenance cost per balise

Estimation results still very variable in a wide range (90 – 400 Euro per balise per year)
Conclusions

→ Definition of the set of tools and methodological approach (scenario comparison) approved by authorities

→ Application of the Cost-Benefit Analysis proved solid and replicable (e.g. the Sardinia case)

→ Economic models to be defined for each relevant item heavily rely on operators’s data availability to allow for sound comparison throughout Europe

→ Relevant strength and opportunities for GNSS-based train control system

→ Research is ongoing

Costs and benefits (M€ in 35 years)

- Benefits from modal shift: 82.4
- Internal benefits (avoided costs): 1.0
- Operating costs: 20.6
- Investment costs: 19.8