ALSTOM Signalling presentation

CBTC, the right Solution for the right Needs

Istanbul – 7th September 2016
1. Urban Signalling solutions

2. CBTC: the right solution for high performances

3. CBTC: the right solution for easy operation

4. CBTC: the right solution with light maintenance

5. CBTC: the right solution with high level of safety

6. CBTC: the right solution with friendly support to traffic controller

7. URBALIS™ CBTC U400: the right solution with platform approach
1 Urban Signalling solutions

2 CBTC: the right solution for high performances

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6 CBTC: the right solution with friendly support to traffic controller

7 URBALIS™ CBTC U400: the right solution with platform approach
What is CBTC?
Communication-Based Train Control System

- CBTC means Communication Based Train Control
- CBTC is the modern version of ATC and ATC means Automatic Train Control
- As defined in the IEEE 1474 standard, a CBTC system is a continuous, automatic train control system using:
  - high-resolution train position reports, independent of track circuits the trains send their position to wayside computers,
  - continuous, high-capacity, bidirectional train-to-wayside data communications,
  - trainborne and wayside processors capable of implementing Automatic Train Protection (ATP) functions, as well as optional Automatic Train Operation (ATO) and Automatic Train Supervision (ATS) functions.

CBTC is the standard Signalling solution for Metro Operation
What is ATC?
Automatic Train Control system

- ATC or Automatic Train Control is an electronic system that protects trains against **over speeding, collisions** and **derailment** when trains pass crossovers (or curved lines)

ATC includes two (2) main functions: **ATP** and **ATO**…

- ATP or Automatic Train Protection is the fail-safe part that stops a train when any **dangerous situation** arrives;

- ATO or Automatic Train Operation is the “robot” that **drives the train** under the close supervision of the ATP.

**ATC = ATP (Safety) + ATO (Performance)**
How does CBTC work?

- **Train Location** computed on-board each train
- Train location sent by radio from each train to wayside Zone Controller
- Wayside Zone Controller computes “End of Authority” of each train and sends it by radio to each train
- **ATP safe braking speed curve** computed on-board each train

...thanks to Moving Block, CBTC increases line capacity (more trains)
Why the need for CBTC?

**Conventional signaling**

- Based on **fixed blocks** for protection
- Provides **rough position** of trains
- Protecting long space to ensure protection

**more distance needed between trains**

...with less wayside equipment, CBTC increases line capacity (more trains)

**CBTC solution with moving block**

- Continuous communication link between trains and wayside
- Much more precise position of the train at all times
- Less space needed to ensure protection

**Distance between trains is reduced**
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CBTC Performances
Capacity increase: up to 60 trains per hour

- High performance moving block shortens train interval
- Short headways achieved without compromising commercial speed
Automatic Train Operation strategy
Energy saving & Optimized driving

- Maximised energy savings and optimised maintenance through accurate train simulation

- ATO Combines different strategies to enhance energy savings
  - Coasting optimization
  - Power limitation
  - Limited acceleration
  - Speed limitation
  - Optimization of Electrical brake

- Decreases number of activations of braking and traction relays to reduce maintenance & energy consumption

⇒ up to 30% Energy Savings (with intelligent ATO and ATR)
Automatic Train Operation strategy
Train Stopping accuracy

Shenzhen L5

Shanghai L10

Measuring stopping accuracy

95% : +/- 9.5cm
99% : +/- 11.5cm
99.5% : +/- 13cm
100% : +/- 15cm

Robust stopping accuracy whilst preserving commercial speed and passenger comfort

ALSTOM - 09/09/2016 – P 11
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URBALIS™ Grades of Automation
IEC Standard 62290-1

Designed for driverless – Can operate at any Grade of Automation

Grade of Automation: from GoA1 to GoA4, from Manual Operation (driver) to Full Automated Operation (FAO) through an overall System Approach

- ATP: Automatic Train Protection
- ATO: Automatic Train Operation
- DTO: Driverless Train Operation
- UTO: Unattended Train Operation
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CBTC typical architecture with its sub-systems

A modular and scalable architecture, either distributed or centralised
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Highest Level of Safety… and Availability!

Safe Design

- IXL and ATC sub-systems at the highest Safety Level (SIL4) by international & official authorities

Service proven: circa 40 lines in revenue service and as many on-going projects… and more to come

Available Architecture

- Highly Available architecture (with redundancy principles and stand-by mechanisms)

Track records: 99.998% of signaling system availability
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Automatic Train Supervision: through a modular software architecture

Functional layering and modules

Layer 1: Basic functions, supervision & control
- IXL monitoring and manual control
- Train control
- Train tracking and identification
- Route setting

Layer 2: Planning and automation
- Online timetable management
- Traffic regulation (from timetables to headway)
- Terminal management
- Junction management

Layer 3: Operation Decision Support
- Management of operations and Incidents
- Regulation modes management
- Automatic garage management

Support Functions
- Alarms & Events
- Login & Territory assignment
- Quality of Service
- Archiving
- Playback

HMI
- Signaling layout
- Train graphs
- Timetables
- Forms

A scalable application with different layers, to better support Metro Operation
Integrated Control Centres: the eyes of the operator

ICC: Solution for Integrated Control Centres

- Passenger information
- Security (CCTV, …)
- Energy, Ventilation, Ancillaries
- Signalling
- Mass transit
- Suburban
- Train interface

Efficient Operation for new lines, extensions or revamping
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Platform strategy – … to system and deployment

URBALIS™ Platform deployment is based on data preparation

- URBALIS™ Solution is a **Generic Platform** used for previous projects
- This generic platform is already integrated and validated with generic data, in factory, with a typical configuration
- Then, it is **instantiated** (or configured) for deployment on each project by parameters that describe the line*

  * The principle is similar to the data preparation used for Computer Based Interlocking (CBI)

**Benefits**
- No need to redevelop a new solution for each project
- Solution builds on experience: it benefits from feedback of previous projects
- Shorter projects
- Important and dedicated R&D means
- High quality level of the engineering process

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* The principle is similar to the data preparation used for Computer Based Interlocking (CBI).
URBALIS™: a robust engineering process

- Formal specification of vital software
- Formal proof (B method) for vital software
- **Factory Integration and Validation Platform (FIVP)**
- Duplicate of the delivered system in a factory environment
- 75% of I&V process is performed with the FIVP: trouble shooting is done before delivery to the field
- **Stable and mature** software & data/parameters delivered to site. Shortens and masters the site test period for:
  - a full and integrated Testing Strategy covering all the needs of the Project / Customer: functional, operational and safety;
  - a fully Safety compliant process with Customer / ISA attendance.
- Supports Customer **training** (O&M staff) and maintenance activities
A platform deployed from various sites around the world with a given tooling suit to be as close as possible to end users.