OCTYS CBTC Project

Département ING/STF (Transport System Unit of the Engineering division) of RATP
Open Control of Train Interchangeable & Integrated System
Nicolas ESTIVALS

OCTYS CBTC project

Contents
1. Overview of the Paris network, CBTC projects
2. Modernization Program for Metro
3. Interchangeability - concepts and strategy
4. Schedules & migration
5. Key challenges & lessons learnt

STF, 2011/12/01
OCTYS CBTC project: context
RATP, a national public service company

State-owned national company created in 1949 as a public service company

One of the worldwide largest public transport network:

- **RER (Suburban)**
  - 2 lines (A & B)
  - 115 KMs (double tracks)
  - 67 Stations
  - 357 Trains
  - 446 million travels/year

- **Bus & Tramway**
  - 351 Bus routes
  - +3 Tramway lines
  - 3,868 KMs
  - 7,816 Stations
  - 4,300 Buses + 82 Trams
  - 1,031 million travels/year

- **Metro**
  - 14+2 lines (1 to 14)
  - 202 KMs (double tracks)
  - 300 Stations
  - 689 Trains
  - 1,388 million travels/year

OCTYS CBTC project: context
CBTC Projects on existing lines

**UTO**
- **SAET L14 (Siemens)**
  - Energy consumption optimized
  - (implemented since May 2011)
  - Increase of throughput adding 4 trains
  - (end 2012)
- **SAET L1 (Siemens)**
  - On revenue service since November 3rd
  - Gradual injection of UTO trains
  - Great Success!

**STO**
- **OURAGAN on line 13 (Thalès)**
- **OCTYS on lines 3, 5, 9 (this presentation)**
**OCTYS CBTC project: context**

Objectives for the Modernization/ OCTYS contribution

- **Obsolescence reduction**
  - Replacement of older systems, tricky to maintain (components & knowledge obsolescence)

- **Safety improvement**
  - Compliance with new safety standards (CENELEC)
  - Continuous speed control (incl. in manual driving mode)

- **Passengers capacity increase**
  - Headway, Regulation, Trains diagrams

- **Quality of service increase**
  - Availability & maintainability of new systems
  - Performance of degraded modes management
  - Passenger exchange control (Platforms screen doors)

- **Operation Costs reduction**
  - Reduction of staff in terminus (centralized OCC)
  - Less staff for line operation (when in driverless mode)
  - Less trains (thanks to commercial speed improvement)
  - Energy savings (with dedicated driving profiles in ATO mode)

---

**RATP current CBTC Projects**

- **UTO existing**
  - (SAET L14)

- **UTO on progress**
  - (SAET L1)

- **STO on progress**
  - (OUR L13)

- **STO on progress**
  - (OCTYS L3, 5 & 9)

- **STO contracted**
  - (OCTYS L10 & 12)

- **CBTC projected**
  - (all other M° lines)
• Ensure competitive procurement of interoperable CBTC/OCTYS systems for:
  - other lines
  - line extensions
  - rolling stock retrofit or renewal
  - upgrade of obsolescent pieces of equipment
  - equipment evolutions

• Establish design and operational standards for CBTC/OCTYS implemented by RATP
OCTYS CBTC project : Interchangeability
Concept of Interchangeability

OCTYS is a program for renewal of Train Control Systems (CBTC):
   based on the Interchangeability Concept applied to CBTC systems
   for metro lines to be renewed in STO mode

OCTYS = Open Control of Trains, Interchangeable & Integrated System
   i.e.: Interchangeable CBTC

OCTYS Contract signed in 2004 with 3 suppliers (ANSALDO, AREVA &
   SIEMENS), for 5 lines to be revamped, in parallel with:
   OCC modernization program
   Rolling stock retrofit or renewal program
   Signalling and Interlocking modernization program

OCTYS CBTC project
Technical features

A generic system :

- Features :
  - Reduced headway
  - Optional equipments
    - Cab-signal
    - Simplified wayside signalling
    - Wayside signalling cancellation
    - Train Detection reliability
    - Platform Screen Doors
    - Guideway Intrusion Detection
    - Full redundancy
  - Driving modes
    - ATO mode
    - Manual mode (full train protection)
    - Automated Turnback Mode

- LIGNE 3
  - no (110s)

- LIGNE 5 , 9
  - reduction by 15%
    - new RS
    - 
    - ability
    - 
    - ability
OCTYS CBTC project: Interchangeability
General standardized CBTC architecture

- Beacons
- Trainborne ATC
- Trainborne Radio
- Computerized Interlocking
- OCC
- Fixed ATC
- Block Relay Signalling
- Rolling Stock
- Trainborne Radio and Backbone
- Signalling
- Block Relay
- OCC
- Fixed ATC
- Standardized Interface
- Contract Share (Interchangeable component)

OCTYS CBTC project: Procurement
Contract sharing for CBTC system

- Trainborne ATC
- Trainborne Radio
- Trackside Radio and Backbone
- Fixed ATC

Lines 3, 12 & 10
- ANSALDO
- SIEMENS
- AREVA

Lines 5 & 9
- Trainborne ATC
- Trainborne Radio
- Trackside Radio and Backbone
- Fixed ATC
OCTYS CBTC project: Design documentation
Interchangeability Baseline documentation

External Interfaces
E1 Between OCTYS and OCC
E2 Between OCTYS and auxiliary (Interlocking, etc.)
E3 Between OCTYS and Rolling Stock
E4 Between OCTYS and Location System

Internal Interfaces
I1 Between DCS and I/O Interface module
I2 Between DCS and Zone controller
I3 Between DCS and On-Board equipment
I4 Between On-Board equipment and cab-signal
I5 Between DCS and Operation & Maintenance system

OCTYS CBTC project
BAQUS Validation Test bench “hardware-in-the-loop”
OCTYS CBTC project
L3 & L5 schedule

- OCTYS Contract: March 2004
- Interchangeability standard: April 2007
- Interchangeability tests focused on L3: Summer 2009
- Line 3 OCTYS: Revenue Service (VB2): January 2012
- Line 5: OCTYS intermediate phase (VB1): March 2010
- Line 5: OCTYS intermediate phase (VB1): 2nd half of 2013

Signaling contracts: March 2004 - Nov. 2005
Testing track: May 2005
End of L3 signaling: September 2009
TCC Line 3: Revenue Service: September 2009
L5: Light Version For MF01: June 2011
TCC Line 5: Revenue Service: mid-2012

Mixed fleet op.: 18 months

Line 9 schedule

- OCTYS L9: Optional Share: April 2011
- Line 9 OCTYS: Revenue Service (VB2): November 2018

Signaling contracts: phase 1: September 2011
End of Phase 1: Phase 2 signaling contracts: Mid 2014
L9: Light Version For MF01: September 2013
TCC Line 9: Revenue Service: mid-2012
End of L9 signaling: Phase 2: April 2016
TCC Line 9: Revenue Service: November 2018

OCTYS CBTC project
L9 schedule
Current situation

Trains operated in block mode with ATP/ATO (Speed Code ATC using magnetic loops)

Line operated from centralized OCC + Terminus

OCTYS CBTC project
Migration strategy

Step 1: renewal of signals (LED) and interlocking
new interlocking functions under a night/day switch
installation of beacons, optical barriers & radio AP
Step 2: CBTC Installation & tests at night, OCC renewal

Step 3: first train in revenue service in CBTC mode, mixed train operation: block mode performances
Drivers training using a "train simulator"
OCTYS CBTC project
Migration strategy

Step 4: Signals simplification and cancellation active
Removal of former ATC magnetic loops
All trains in revenue service in CBTC mode
Running in full performance mode

OCTYS CBTC project
Key challenges & lessons learnt

Key Challenge
To maintain good level of line availability
   No service disruption during migration
   Reliability of the new system since the start of the revenue service

Figures achieved
Line 3: CBTC OCTYS type 2 (w/o line capacity increase)
   650 nights for system testing & commissioning (late arrival of a "system test bench")
   No service interruption

   1 year to achieve an equivalent level of availability compared with legacy ATC

Lessons learnt
Test tracks, system test benches, and "shadow mode testing" are of utmost benefit
Possibility of long time tests without passengers on site to be valuable for availability (done on UTO line 1)
**OCTYS CBTC project**

**Key challenges & lessons learnt**

**Key Challenge**

Synchronize System migration with Signalling renewal and Rolling Stock replacement

**Figures achieved**

- **Line 3:** CBTC OCTYS type 2 (w/o line capacity increase)
  - Signalling renewal late in terminus, leading to a “CBTC service limited to main section of tracks: excluding of terminus” for 1 year.
- **Line 5:** CBTC OCTYS type 1 (with line capacity increase)
  - Signalling works complexity not enough anticipated led to postpone system deployment
  - => New trains arriving, operated manually but needing to install a "simplified trainborne equipment".

**Lessons learnt**

- Unlock signalling renewal program with CBTC installation (done for the coming next L9)
- Anticipate system “minimum requirements” for operation of new trains before complete CBTC deployment:
  - Allow for progressive migration strategies
  - Envisage “standalone” mode of operation for trainborne equipment

---

**OCTYS CBTC project**

**Key challenges & lessons learnt**

**Key Challenge**

Minimize costs for CBTC

**Figures achieved**

**CBTC OCTYS (L3, 5, 9, 10 & 12)**

- Open competition for 5 lines with a single specification, contracted with 3 suppliers (interchangeability basis)
- 5 lines contracted for 100 M€\(_{2004}\) (CBTC only, excl. of ATS and Signalling)

**Lessons learnt**

- Standardize specifications as far as possible
- Group (when possible) several lines in a single contract
- Keep competition opened with several suppliers: interchangeability
**OCTYS CBTC project**

Key challenges & lessons learnt

**Key Challenge**
Minimize impact on operating rules

**Figures achieved**
CBTC w/o line capacity increase (fixed block mode: OCTYS type 2 on L3)
- Strictly same op. rules but a great number of incidents linked to ergonomics factors.
- As for ex:
  - Zero speed detection needs a delay (~1") for the CBTC
  - But drivers didn’t use to wait that much before changing the master mode selector for turn-back operation => EB applied
  - With CBTC, the minimum safety distance for approaching a stabled train is about 8m. This may be reduced with a speed limit at 7 KPH: many drivers are tripped with this limit.

CBTC with Cab-Signal (OCTYS type 1 on L5)
- Special care to be brought on the Cab-Signal ergonomics. This ergonomic constraint might reduce some performances of the system (SACEM experience)

**Lessons learnt**
- Consider ergonomics factors; a digital system actually does not react same as analog ones.
- Extensive use of training simulators is of utmost benefit for smooth migration.

---

Thank you for your attention