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CBTC Interoperability:
From Real Needs to Real Deployments

New York's Culver CBTC Test Track Project

Gabriel Colceag and Gerard Yelloz

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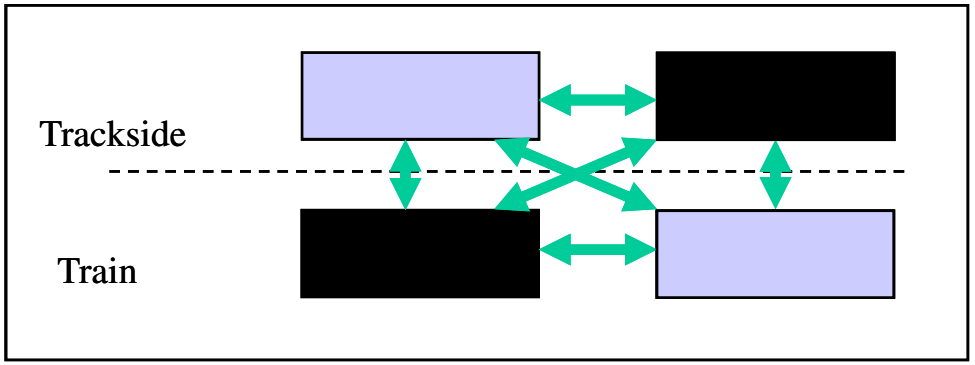
CBTC Signalling Interoperability Context

"Interoperability is the ability of systems to provide services to, and accept services from other systems, and to use the services exchanged to enable them to operate effectively together"

- Signalling and Communications Based Train Control (CBTC) Interoperability: a metro line running with a signalling system provided by at least two different (sub)systems suppliers
  - Exclusion of « dual » signalling systems
  - On board provided by supplier X running on a trackside provided by a supplier Y and vice versa



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Signalling Interoperability History Brief (1/2)

Signalling B.C. era: « Before CBTC » technology

- USA: 1970-80's operation, development by industry of fixed block speed code technoloy to improve metros with ATP/ATO
  - Multi sourcing: compatible different US suppliers
  - Today many metros still run under this US standard technology

- France: 1990's operation, RATP improving suburban network performance, quality and maintainability with ATP/ATO distance-to-go SACEM, developed by 3 suppliers, with interoperable and multi-sourcing objectives
  - Paris RER, Hong Kong MTR TKO line and other metros are still using it

- **ATCS in USA / Canada**
  - Precursor of CBTC and PTC for Main Lines, radio technology retained for further applications

- **ERTMS / ETCS in Europe**
  - Success for Main Lines interoperability, driven by strong EU policy for borderless, seamless train travel. Now spreading to others: Asia, Latin America, Australia, Africa
  - Limited application on Urban and Suburban Railways (performance limitations vs. CBTC)
  - Possible evolution for urban performance, but not a European policy, nor a priority of metro operators

Signalling Interoperability History Brief (2/2)

CBTC technology

- **UGTMS and ModUrban in Europe**
- **CBTC in Paris RATP OCTSYS**
  - 5 lines and 200 trains to be re-signalled: multi-sourcing and long term procurement needs
    - 3 suppliers, on a same agreed specification, developed the overlay CBTC OCTYS system
    - 4th supplier defined external interfaces for ATS (PCC) and CBI (PMI)
    - Line 3 in operation 2010, Line 5 for 2012.
- **New York City Transit Authority (NYCTA) network upgrade**
  - Subject of the following presentation

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New York Needs

- Massive signalling modernization for higher performance and lower Life Cycle Cost (LCC)
  - From state of good repair to major performance, safety and service upgrade
  - *CBTC*
  - ATS, Electronic Interlocking
- *Interoperability* across the network, over very long time and track length
  - Successive, phased projects
  - Separate procurement: trackside vs. trains
  - Multiple suppliers for stability, capacity

CBTC Interoperability

- Not a desire, a necessity!

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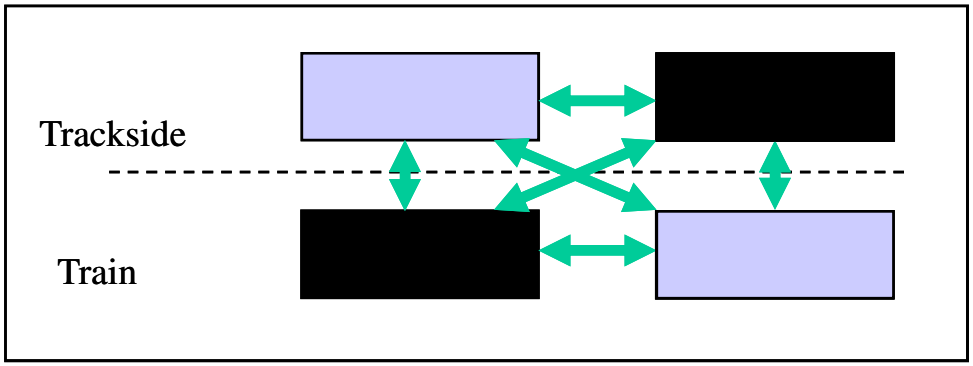
New York Projects

- Interoperable CBTC modernization program
  - Technologies assessment with expert independent consultants
  - 6 suppliers competitive proposals, out of which 3 selected for initial phases
- Canarsie Line CBTC
  - Siemens has provided the first whole line CBTC system in operation
  - Thales has demonstrated sub-systems interoperability on test track
- Flushing Line CBTC
  - Thales is deploying the whole line CBTC system, with additional functions
- Culver Line CBTC Test Track
  - Interoperability test track contract award to validate multi-supplier CBTC procurement for the B-division of New York network over the next 30 years.
  - Interoperable CBTC Subsystems « shares » provided separately by Thales / Siemens
  - Siemens & Thales consortium for System Integration « share »
- Industry consultations and experience sharing started by NYCTA in 2011 with a view towards accelerating and expanding the CBTC modernization program

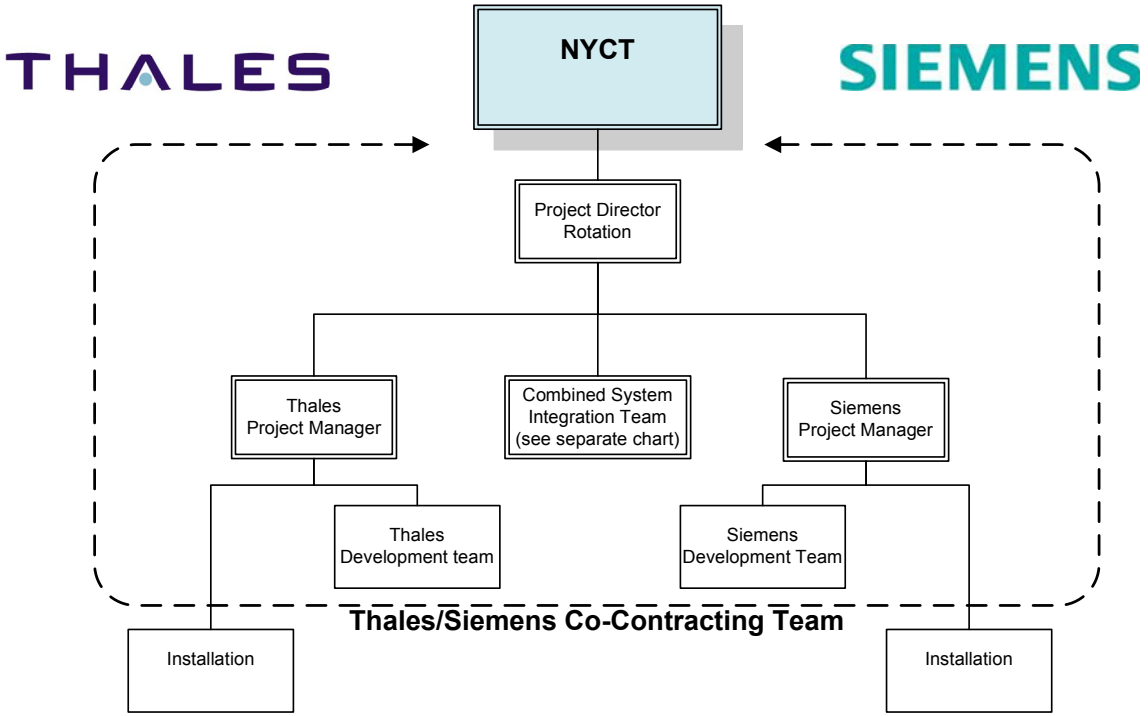
Culver Line Project Goals

- Update and finalize the NYCT Standard CBTC System Design and associated Interoperability Interface Specifications (I^2S), that will be used as reference (standard) for future CBTC deployment in the NYCT environment
- Provide an operational CBTC simulation testing environment (Integrated Test Facility) to demonstrate compliance of supplier's subsystems to the I^2S
- Provide NYCT a permanent operational CBTC Test Track on the Culver Line
- Provide safety certification of "mixed" interoperable CBTC system by the Systems Integrator consortium



Culver Line Project Contractor Organization

- Thales and Siemens have proposed a co-contracting consortium
- Contractor operates as a “one team” to deliver the Share 1, with Siemens responsible for Share 2 (Church Ave.) and Thales responsible for Share 3 (4th Ave)



Culver Line Project Schedule

- Target milestones:

Notice of Award (Sept 30, 2011)	month 0
System Design Review	month 9
Final Design Review	month 12
Delivery in New York of the ITF	month 18
SW FAT complete for ITF	month 26
Interoperability Demonstration on the ITF	months 31-34
Field Installation Complete	month 29
Integration testing and formal demo	months 39-45
Substantial Completion	month 46

Share 1: System Integration Scope Allocation

- For all integration engineering activities, Thales and Siemens have combined resources to perform the activities
- In order to be practical, the SI supply subsystems (ATS, ITF, etc.) have defined allocations to Siemens or Thales

Work Item	**Work Description** SYS = System Engineering DES = Design Engineering DEL = SW/HW Deliv. & Install.	**Share 1** (see Note 2 for Share 2 & 3)	
		Thales	**Siemens**
System Integration[1]	SYS	*Thales support*	***X***
System Performance[1]	SYS	*Thales support*	***X***
System RTM[1]	SYS	***X***	*Siemens support*
Configuration Management[1]	SYS	***X***	*Siemens support*
Project Manager	-	See 'GPM' tab for Project Director rotation	
Project Management / Offices	-	Syst. Safety Manager, T&C Manager, Quality Manager	System Integrator, Scheduler, Project Admin
System Testing[1] ***- ITF***	SYS	*Thales support*	**X**
System Testing - Test Track	SYS	**X**	*Siemens technical support*
System I2S Update	SYS	*See 'I2S' tab for I2S document allocation*	
Database Management and Tool	SYS / DES / DEL		**X**
System Safety[1]	SYS	***X***	*Siemens reviews & also approves*
CBTC ATS	SYS / DES / DEL		**X**
ITF Simulator: Including Simulator engine, Satellite simulators[3] **and Interoperability test scripts**	SYS / DES / DEL		**X**

Share 2: Siemens

Siemens to design, develop, procure, configure, factory test, ship, supervise installation & engineering field test :

- Wayside CBTC equipment for Church Avenue
- Carborne CBTC equipment on one train including radio and transponders

➢Zone Controllers:

- ZC for Church Ave Relay Room
  - ZC for Church Avenue will control CBTC train movements on the test track and interface with Church Avenue Interlocking
- Siemens ZC is based on the Canarsie design with hardware upgrades

➢Carborne Controllers:

- Modify carborne CBTC equipment set on one 4-car R160 Canarsie train
  - The equipment set includes OBCU, CIU, CRD, MIU and Digimove
- Siemens CC is based on the Canarsie design with hardware upgrades

Share 3: Thales

Thales to design, develop, procure, configure, factory test, ship, supervise installation & engineering field test :

➢Zone Controller Equipment

- Based on Thales ZC for Flushing
- Interface to Interlocking based on NY standard
- Two ZCs supplied; 1 at 7th Ave and 1 at 570 CIR

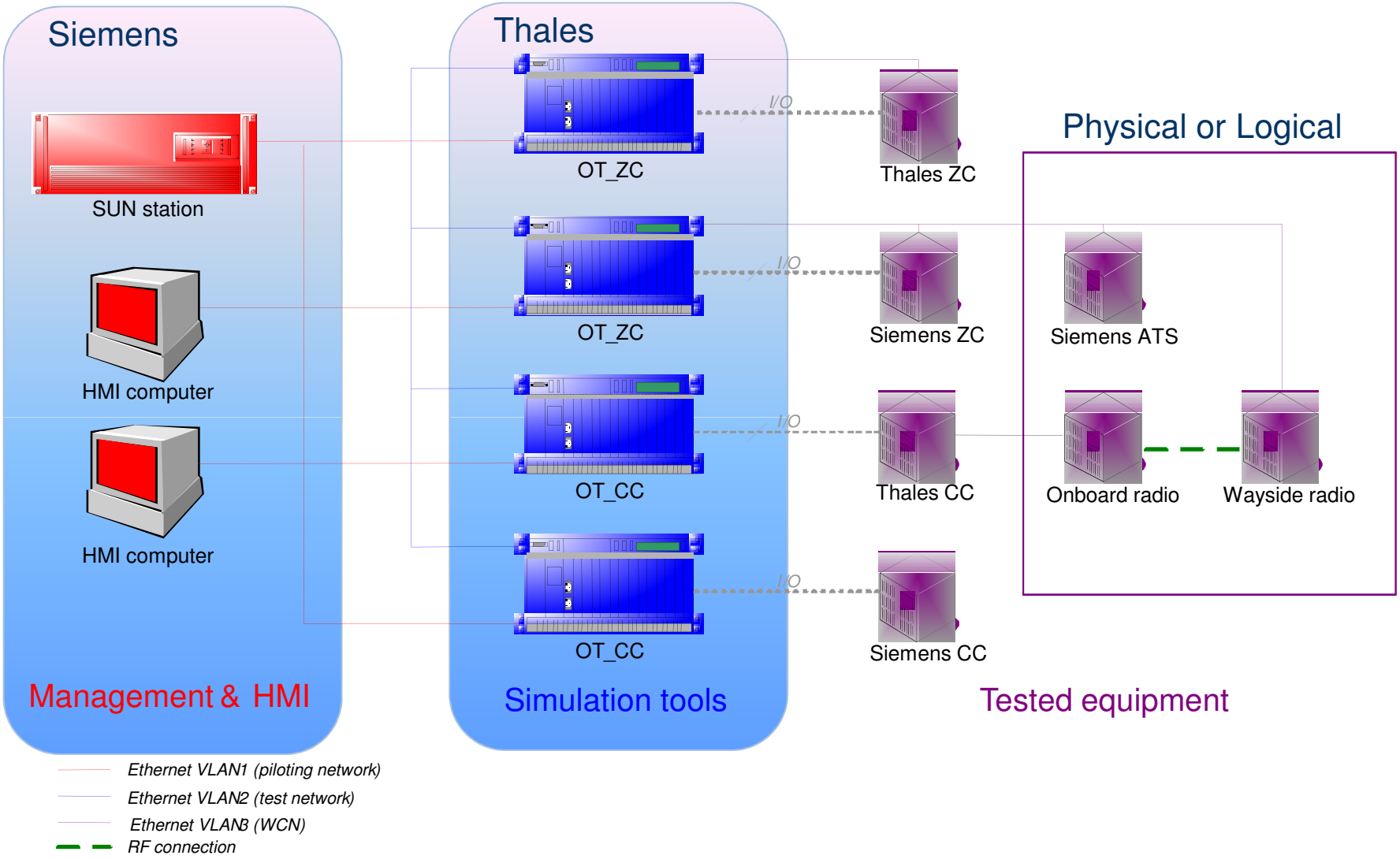
➢On-Board Equipment

- Based on Thales OBCU for Flushing
- Siemens Radio and Transponder Interrogator
- One carborne controller supplied for a 4-car train

Integrated Test Facilities (ITF)

- **Joint definition of the interoperability test list**
  - Siemens is responsible for the Lab ITF test scripts
  - Thales is responsible for the Field Test procedures
- **Each supplier tests its own subsystems, in factory, on the ITF and then on the Culver Test Track, prior to interoperability testing**
  - Where practical, all test cases performed on site on the Culver Test Track will be part of the ITF test plan
- **The ITF is capable of simulating any NYCT line, including Flushing and Canarsie**
  - Culver Test Track simulation is included
  - Additional simulation scenarios can be developed for future lines

ITF Platform



System Engineering Activities

- Siemens leads the system engineering activities for Culver at the system level
  - Full-time **SI System Manager** primary technical interface to the customer
  - Thales has a dedicated full-time system engineer
  - SI System Manager leads the effort for the System Design Review with both parties to review and approve any content prior to customer review & approval
  - SI System Manager manages the technical relationship with the customer and ensures there is formal acceptance by both parties
- Thales leads the RTM activity and documentation of SFS/SDD/I2S requirements into DOORS

I2S Documents: Shared Responsibilities

I2S document	Siemens	Thales
SFS		X
SDD	X	
Carborne <-> Wayside CBTC	X	
Wayside <-> Wayside CBTC		X
Carborne <-> Carborne CBTC		X
AWS <-> ZC		X
System Database	X	
Software Database		X
Safety Principles	X	
ATS <-> CBTC	X	
CC<-> Carborne DCS	X	
CC <-> TIA (tag reader)	X	

Next Steps

- Potential CBTC opportunities in New York's modernization plans
  - Queens Blvd Line
    - Union Turnpike to 5thAvenue
  - 8th Ave Line (in next Capital Program)
    - Connect with QBL
  - 6th Ave Line (in next Capital Program)
    - Connecting with QBL

NYCT Note: "While NYCT generally concurs that the factual information included in this presentation is accurate, it does not necessarily depict NYCT's future plans or how procurements for future CBTC program plans will be handled. Funding of its future Capital projects is subject to policy determinations of its Board and the Governor and is subject to legislative and regulatory actions."

Future

- Additional CBTC suppliers may join the NYCT program
  - Compliance with NYCT I2S standard
  - Interoperability qualification testing on Culver Test Track
  - Participation to future competitive procurement process

- Benefits of NYCT I2S
  - Real-life re-signalling deployment and in-service experience
  - I2S specifications stability and control by NYCT owner and operator
  - Critical procurement mass and long term life cycle synergies

Leading edge, high performance technology proven interoperable, by an experienced major historical metropolitan operator, accompanied by the two CBTC industry pioneers, fulfilling its vision for the 21st century

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CBTC Interoperability

QUESTIONS