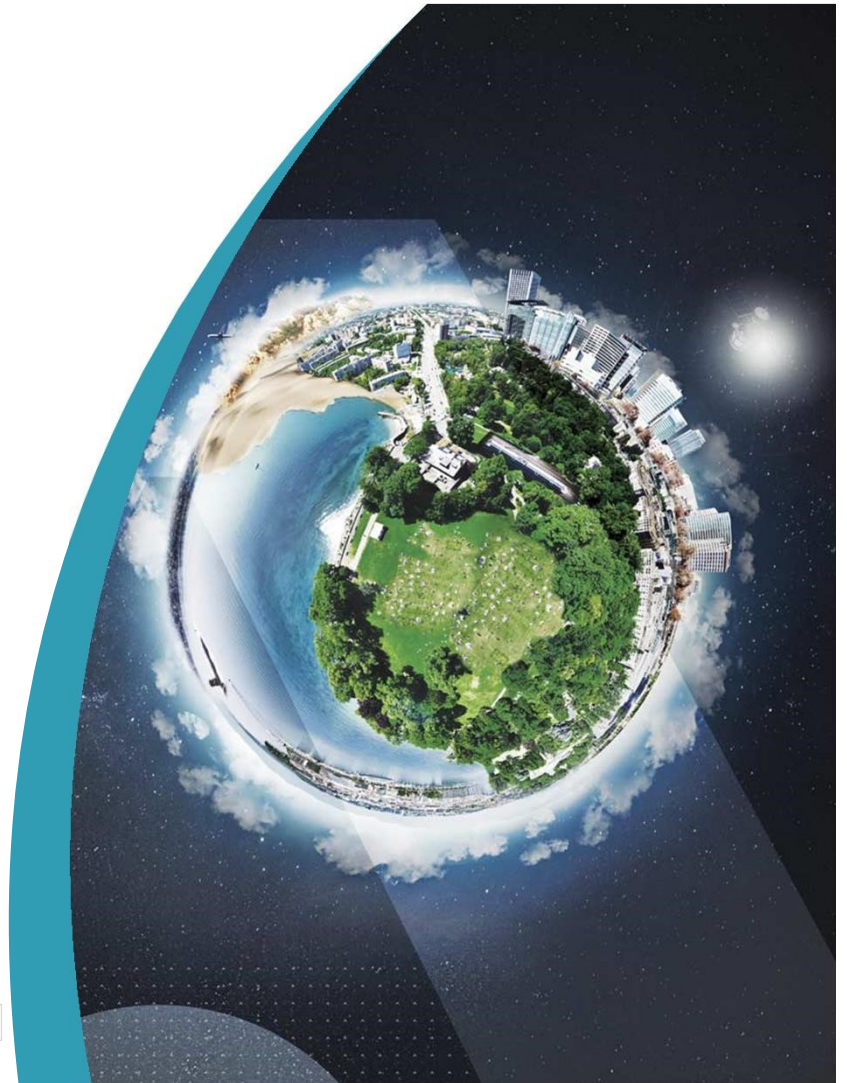




Re-signalling with CBTC

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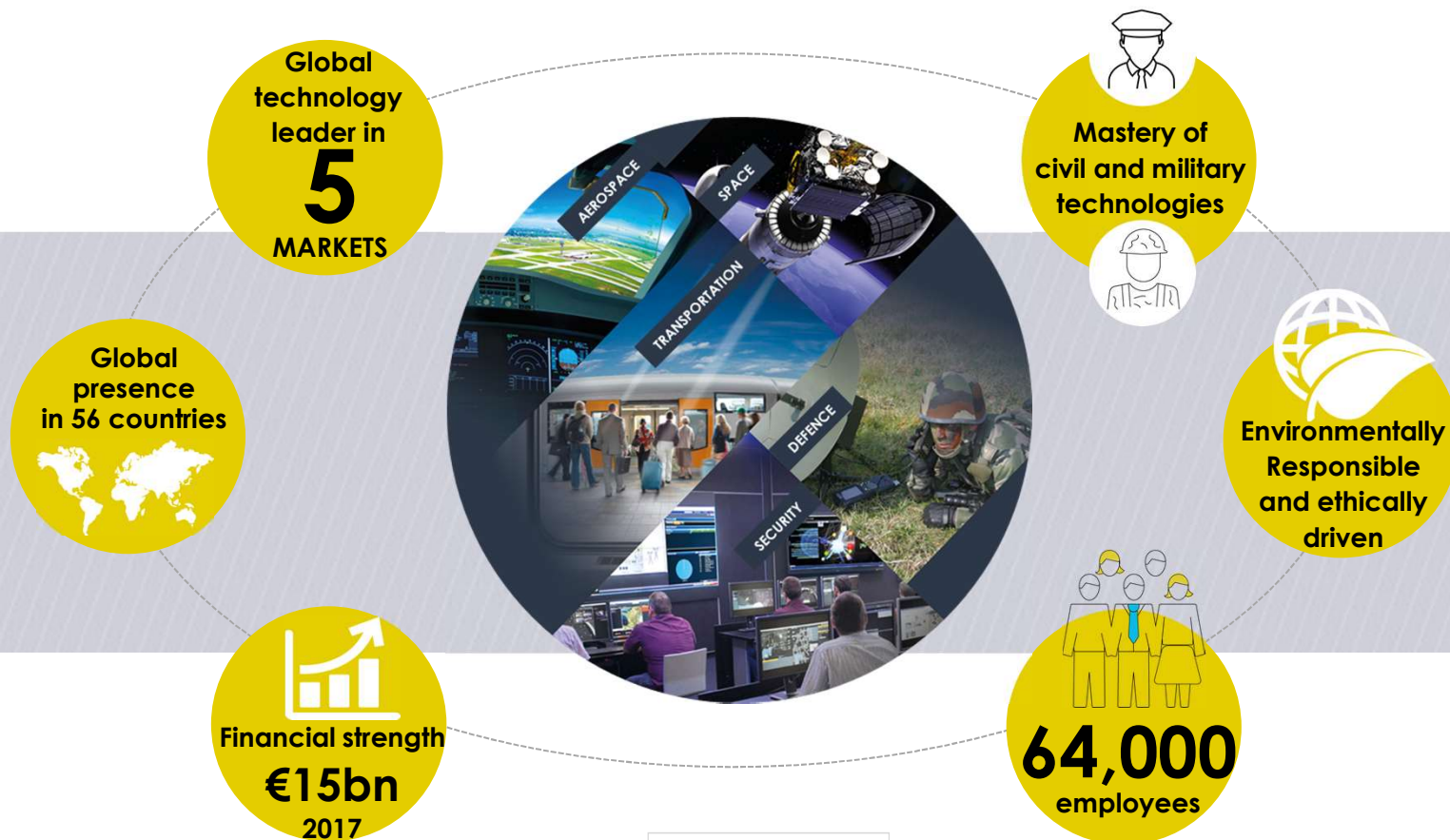


Our strength : part of the Thales Group

Thales 優勢 : Thales 集團交通運輸系統

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IT-based critical systems for ground transport

IT-based 為交通運輸系統之關鍵

Rail / metro infrastructure project

鐵路/捷運基礎設施項目



Civil
works

Track
works

Traction
power
& energy

**IT-based
critical
systems**

Rolling
stock

- Signalling
- Supervision
- Communications
- Security
- Passenger information & comfort
- Fare collection

Our Urban Rail Customer... / 都市繁忙之運輸系統...

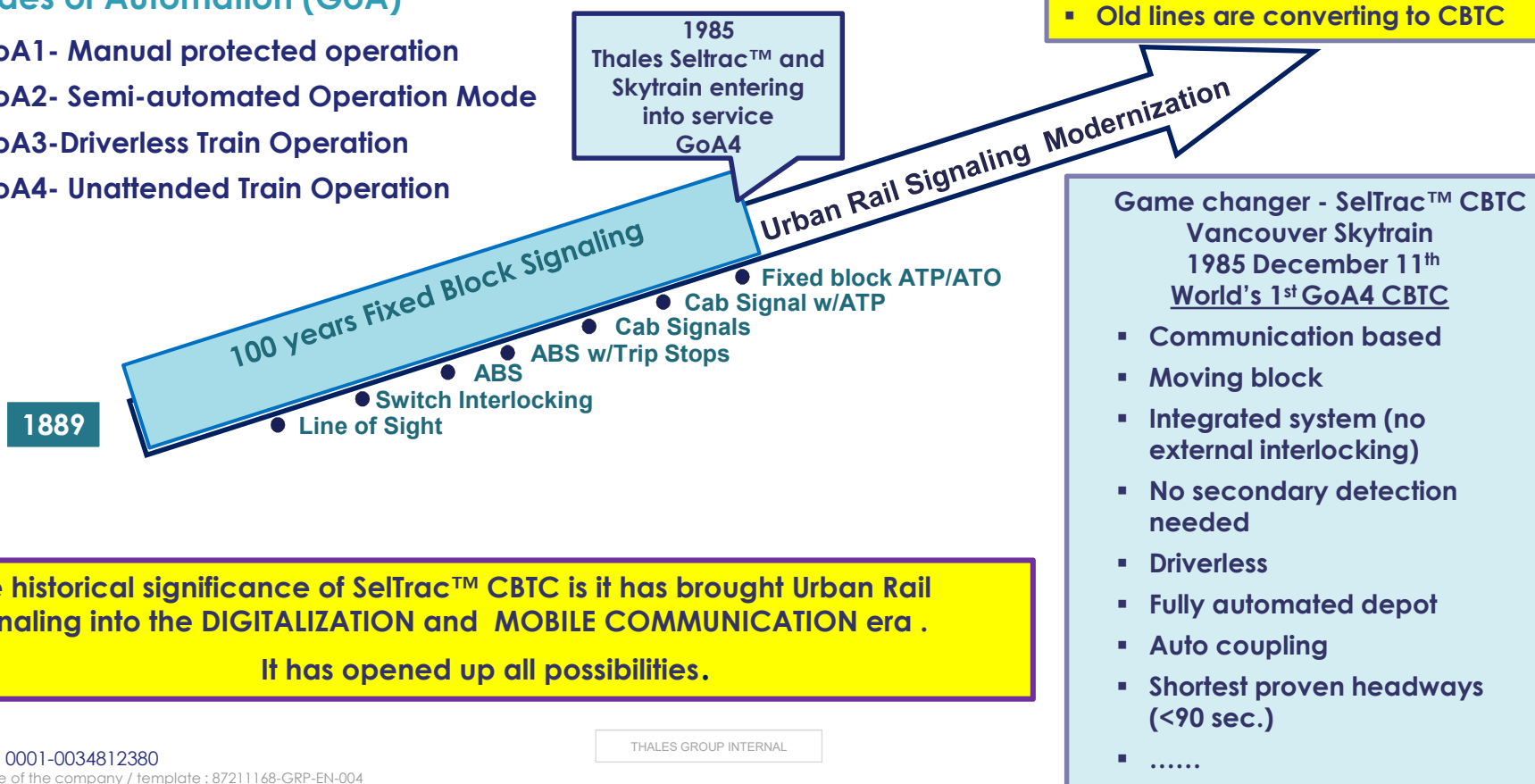


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A Game Changer in 1985 / 於1985年改變了系統發展的趨勢

Grades of Automation (GoA)

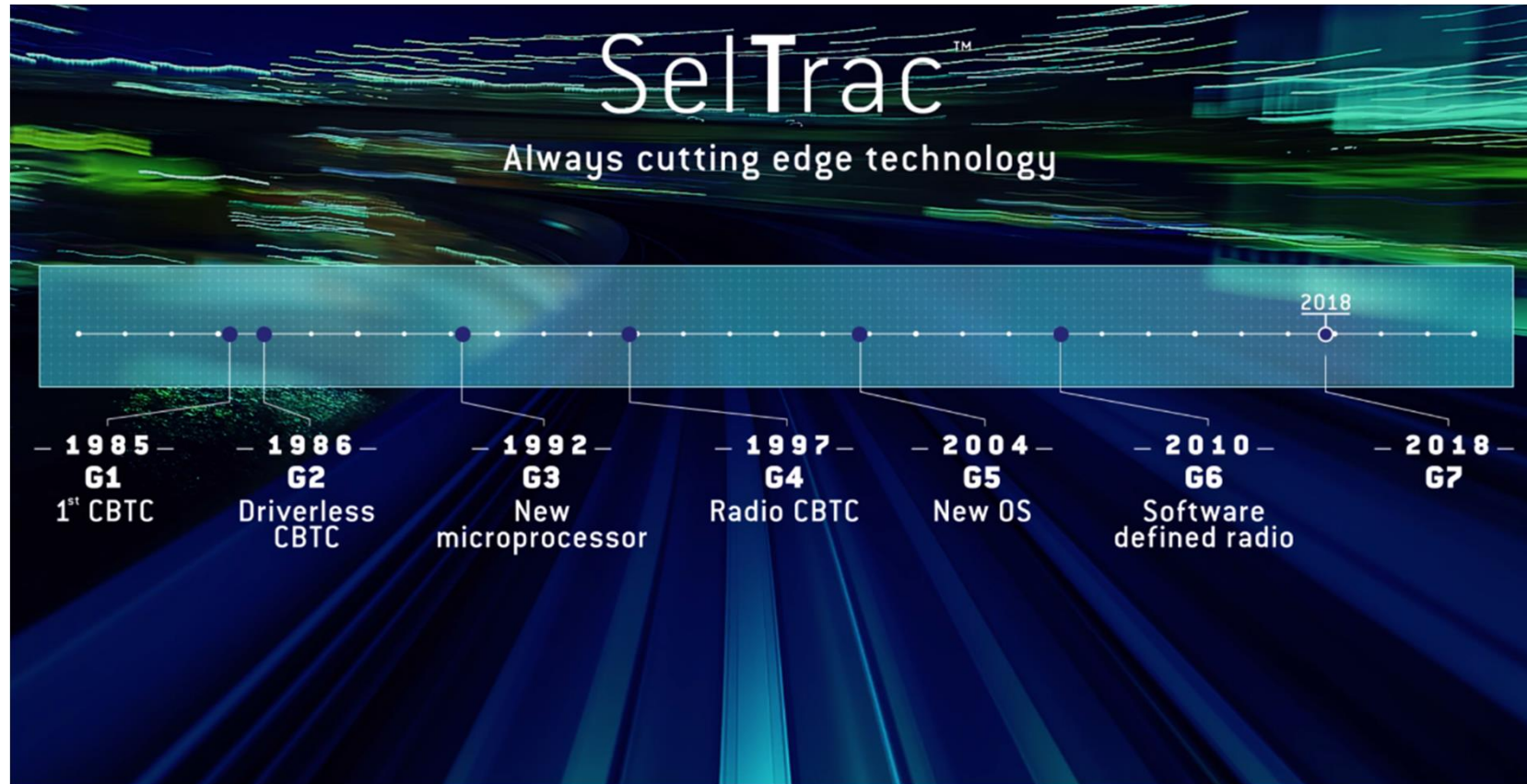
- GoA1- Manual protected operation
- GoA2- Semi-automated Operation Mode
- GoA3- Driverless Train Operation
- GoA4- Unattended Train Operation



SelTrac G7 - Next Generation Game Changer

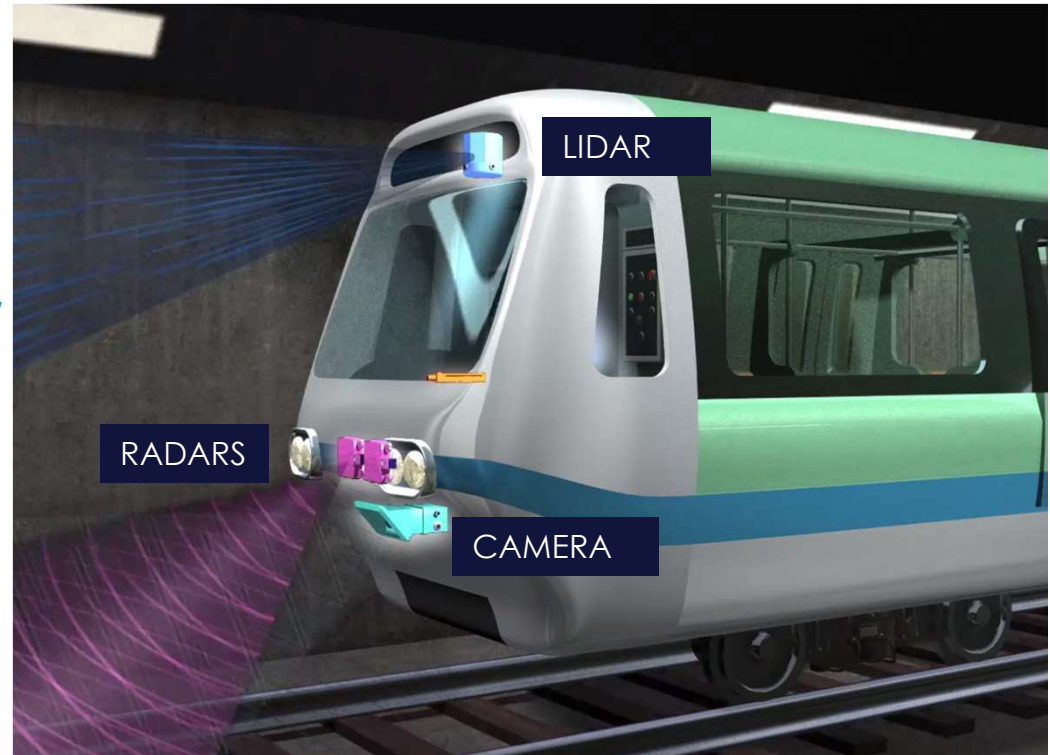
SelTrac G7 – 新世代系統

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G7 enables future Autonomous Trains / G7可結合未來之自主列車

- Sensors developed for the automotive industry can be applied to CBTC UTO systems
- Provide obstruction detection to allow trains to proceed beyond their movement authority
 - When communication or position is lost a train can move at slow speed to the next station
 - To allow a UTO train to perform a sweep
 - Close up of trains in yard
 - Many more operations possible....



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Distribution of Projects – Major Types of Systems

專案項目之分佈 – 主要系統類型



Light Rail/Dedicated Guideway



Automated People Movers



Light Rail



Heavy Rail/Subways



Commuter Rail

Worldwide SelTrac™ References

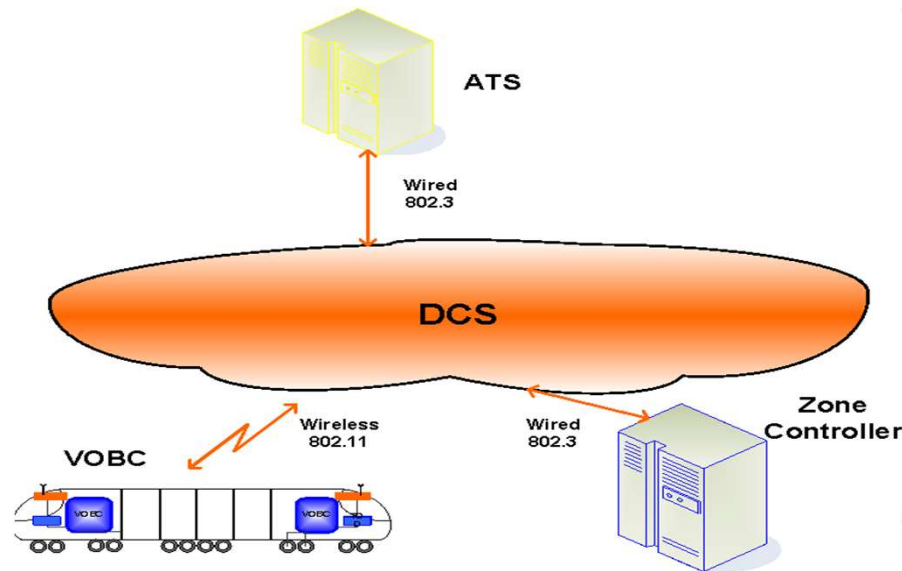
全球SelTrac™参考案例

85 lines, 2650 km

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Line	System	Year	Country	Length (km)	Speed (km/h)	Notes
Ningbo Line 3	GOA2	2015	China	38	120	
Wuhan Line 11	GOA2	2015	China	37	120	
London 4LM - District Line	GOA2	2015	UK	18.8	120	
London 4LM - Metropolitan Line	GOA2	2015	UK	67	120	
London 4LM - Hammersmith & City Line	GOA2	2015	UK	27	120	
London 4LM - Circle Line	GOA2	2015	UK	74	120	
Hong Kong - AT&D	GOA4	2015	Hong Kong	70	120	
Hong Kong - T&L	GOA4	2015	Hong Kong	14	120	
Hong Kong - KTL	GOA4	2015	Hong Kong	18	120	
Hong Kong - ISL	GOA4	2015	Hong Kong	16	120	
Hong Kong - TWL	GOA4	2015	Hong Kong	17	120	
DOHA - BLUE Lines	GOA4	2015	Qatar	10	120	
DOHA - GOLD Lines	GOA4	2015	Qatar	21	120	
DOHA - RED Line	GOA4	2015	Qatar	43	120	
DOHA - GREEN Line	GOA4	2015	Qatar	22	120	
Queens Bld - QBL West Phase 1	GOA2	2015	Canada	16	120	
Nanchang Line 2	GOA2	2015	China	16	120	
Qingdao Line 2	GOA2	2015	China	25	120	
Shilazhuang Line 1	GOA2	2015	China	37	120	
Wuhan Line 7	GOA2	2015	China	48	120	
Guangzhou Line 14 Phase 1	GOA2	2015	China	76	120	
Heifei Line 1	GOA2	2015	China	25	120	
West Virginia University	GOA2	2015	USA	9	120	
Shanghai Line 5 Resig + Extension	GOA2	2015	China	34	120	
Shenzhen Line 9	GOA2	2015	China	30	120	
Wuhan Line 3 Phase 1	GOA2	2015	China	30	120	
Shanghai Disney Line	GOA2	2015	China	13	120	
Ottawa LRT	GOA2	2015	Canada	13	120	
Guangzhou Line 9	GOA2	2015	China	20	120	
Nanchang Line 1 Phase 1	GOA2	2015	China	29	120	
Nanjing Line 4	GOA2	2015	China	34	120	
Hong Kong East West Line	GOA4	2015	Hong Kong	55	120	
Santiago L3	GOA4	2015	Chile	52	120	
Nanjing Airport Line	GOA4	2015	China	15	120	
Singapore EVL	GOA4	2015	Singapore	57	120	
Vancouver Evergreen Line	GOA4	2015	Canada	11	120	
Kuala Lumpur Ampang Line	GOA4	2015	Malaysia	45	120	
Orlando Disney World Monorail	GOA2	2015	USA	29	120	
Hyderabad Line 1	GOA2	2015	India	15	120	
Hyderabad Line 2	GOA2	2015	India	27	120	
Hyderabad Line 3	GOA2	2015	India	27	120	
Singapore NSL	GOA4	2015	Singapore	46	120	
New York Culver Line	GOA2	2015	USA	5	120	
Hong Kong APM	GOA4	2015	Hong Kong	4	120	
Edmonton North LRT	GOA2	2015	Canada	12	120	
New York Flushing Line	GOA2	2015	USA	15	120	
Korea Incheon Line 2	GOA4	2015	South Korea	29	120	
Mecca - Al Mashaaer Al Mugaddassah	GOA3	2015	Saudi Arabia	20	120	
Istanbul Kadikoy-Kartal	GOA3	2015	Turkey	26	120	
Shanghai Line 11	GOA2	2015	China	68	120	
Korea Sin Bundang Line	GOA4	2015	South Korea	31	120	
Shanghai Line 7 + Northern ext	GOA2	2015	China	44	120	
Korea Busan-Kimhae Line	GOA4	2015	South Korea	24	120	
Beijing Line 4	GOA2	2015	China	29	120	
Beijing Daxing Line	GOA2	2015	China	22	120	
Shanghai Line 6	GOA2	2015	China	33	120	
Shanghai Line 9	GOA2	2015	China	63	120	
Paris RATP Line 13	GOA2	2015	France	23	120	
Vancouver Canada Line	GOA4	2015	Canada	18	120	
Shanghai Line 8	GOA2	2015	China	33	120	
Dubai Metro Red Line	GOA4	2015	UAE	67	120	
Dulles APM	GOA4	2015	USA	4	120	
Bundang Commuter	GOA2	2015	South Korea	6	120	
Guangzhou - Line 3	GOA2	2015	China	64	120	
London Tube Lines - Northern	GOA2	2015	UK	58	120	
London Tube Lines - Jubilee	GOA2	2015	UK	37	120	
Hong Kong Disney Resort Line	GOA4	2015	Hong Kong	3	120	
Wuhan Line 1	GOA2	2015	China	38	120	
Hong Kong Ma On Shan	GOA2	2015	Hong Kong	11	120	
Las Vegas Monorail	GOA4	2015	USA	6	120	
JFK APM	GOA4	2015	USA	13	120	
Hong Kong West Rail	GOA4	2015	Hong Kong	46	120	
Kuala Lumpur Kelana Jaya Line	GOA4	2015	Malaysia	14	120	
Jacksonville ASE	GOA4	2015	USA	6	120	
Ankara	GOA4	2015	Turkey	14	120	
San Francisco MUNI	GOA2	2015	USA	14	120	
London DLR	GOA3	2015	UK	38	120	
Tampa APM	GOA4	2015	USA	2	120	
Detroit DPM	GOA4	2015	USA	5	120	
Vancouver SkyTrain	GOA4	2015	Canada	50	120	
Toronto Scarborough RT	GOA2	2015	Canada	6	120	

G7 - SelTrac Radio CBTC System / G7 - SelTrac 無線電 CBTC 系統



Three main CBTC subsystems:

- Automatic Train Supervision (ATS)
- Zone Controller (ZC)
- Vehicle On-Board Controller (VOBC)

Data Communication System (DCS)

- Provide the SelTrac subsystems the communication support to communicate with each other:
 - **Multiple path redundancy**
 - **Bidirectional**
 - **Secure**
 - **Reliable**

Consistent architecture maintained for each deployment

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Customer Needs & Challenges

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Customers Priority and Expectation from Re-signalling 號誌系統係以乘客優先及期望之考量下重建

- Keep system in good repair - no degradation of public services due to aging equipment
- Enhanced Safety - Provides Safety Assurance to meet Current Standards
- Increase capacity - to address growing ridership into the future (another 20-25 years)
- Provide improved availability and reliability
- Takes advantage of new technology to :
 - Bring in more and richer functionality
 - Provides better efficiency and operational flexibility for operators
 - Provides easier maintenance
 - Facilitate operation management
 - Improved Performance and Capacity with existing tracks
- Efficient use of site access

Challenges / 面臨的挑戰

Brown Field Challenge

- Migrate from existing technical and operational systems
- Limited time to install and test on operational railway
- Restoration to normal operations each Working day
- No impact to revenue services
- Consideration for reuse of existing components
- Possible mixed mode operation
- Early demonstration of technical solution
- Upgraded User Interface
- Variety of Rolling Stock



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Case Studies Re-Signalling With CBTC

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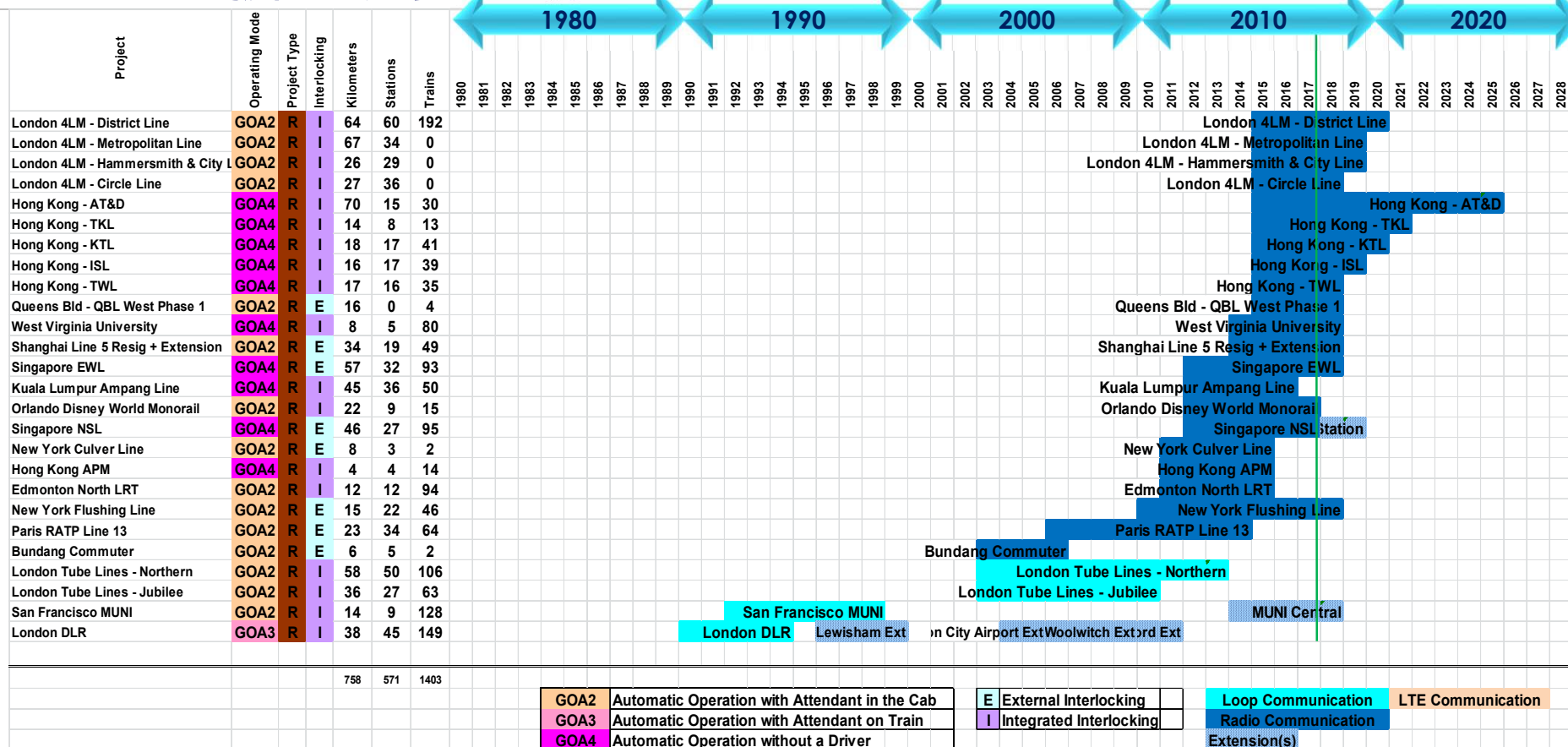
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SelTrac™ Re-signalling Projects SelTrac™ 號誌重建參考案例

SelTrac™ global position

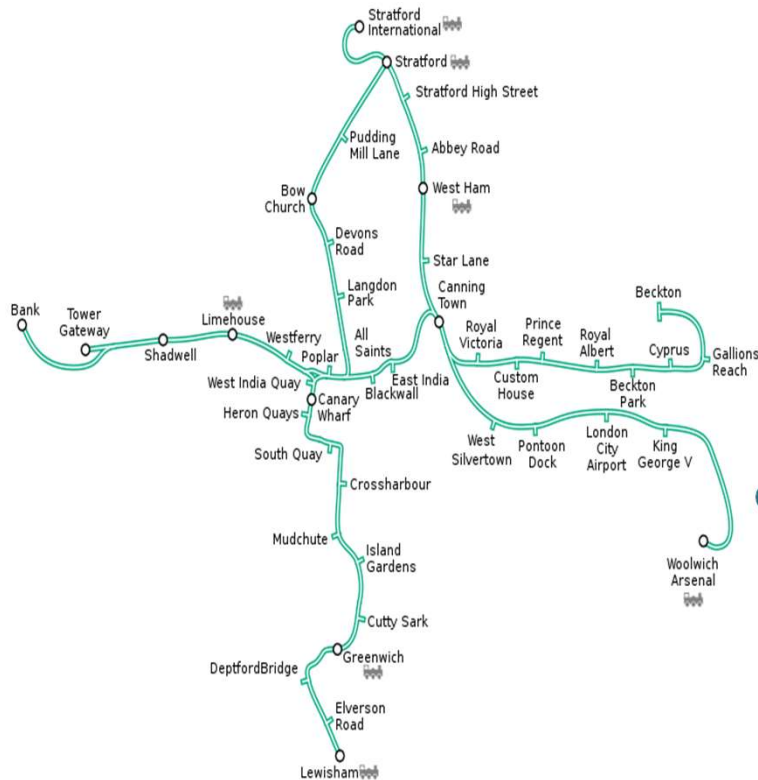
26 lines, 758 km



First CBTC Re-signalling project - London Dockland Light Rail

第一個CBTC號誌更新項目 – 倫敦碼頭區輕軌

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- Initial scope: Re-signalling 13 km, 15 stations
- First SelTrac Revenue: 1994
- Follow on Extensions
 - Beckton: 1995
 - Lewisham: 1999
 - London City Airport: 2005
 - Woolwich Arsenal: 2009
 - Canning Town – Stratford: 2011

Current DLR system

- 34 km; 45 Stations
- 149 Trains
- Main transit for the London Olympics

Case Study on LUL Jubilee and Northern Lines (1/2)

案例研究 - LUL Jubilee 及 Northern Lines (1/2)

- A mature, complex operating railway
- Complex Operations and Timetable

JUBILEE LINE

- 35 Km
- 27 stations,
- 63 trains,
- 2 Depots
- New Control Centre
- ATO Operation
- 3 Migration Areas



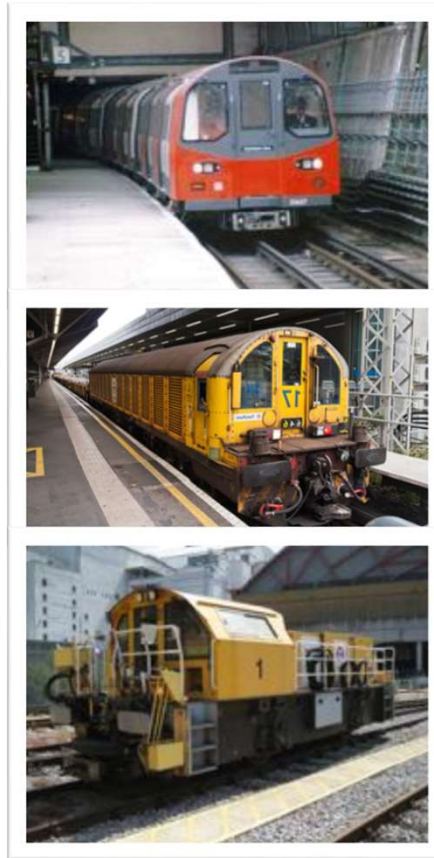
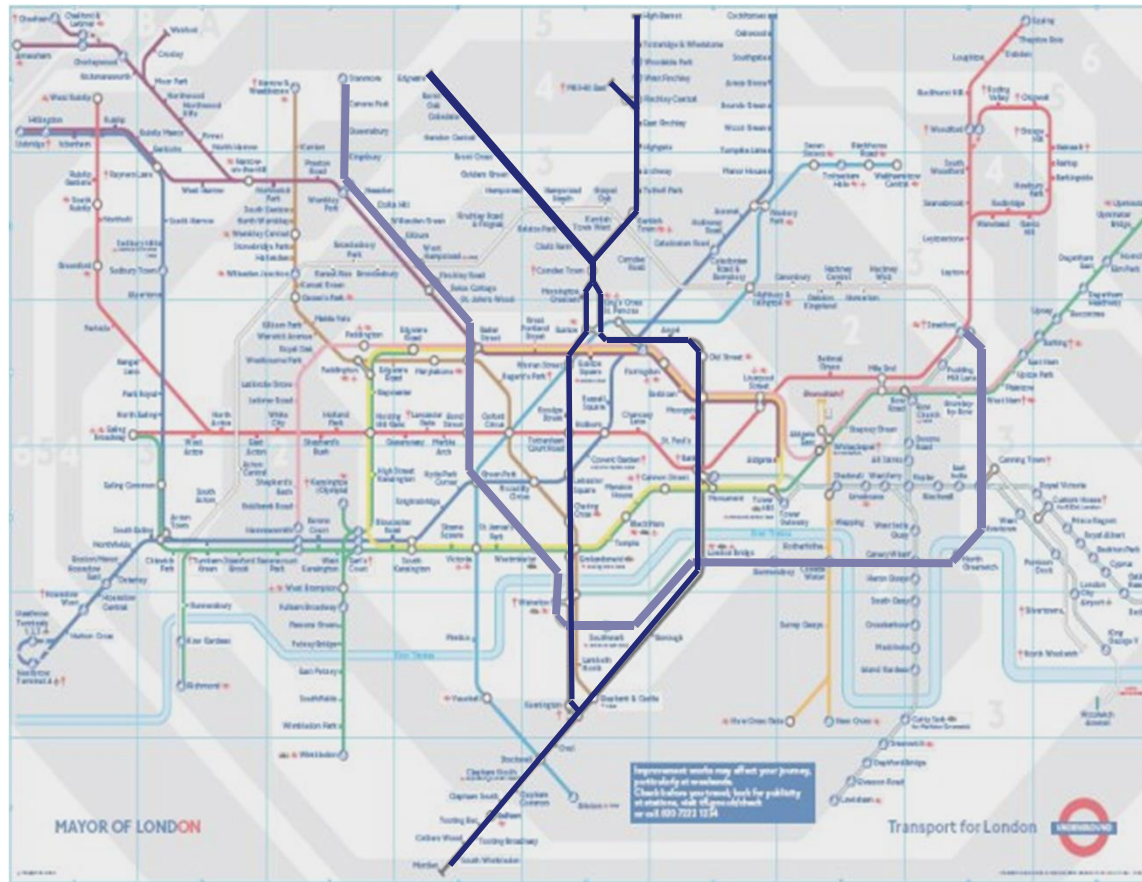
- Complex Junctions
- Access restrictions
- Minimum Impact to Passenger Service

NORTHERN LINE

- 58 Km
- 50 stations,
- 106 trains,
- 5 Depots
- 660,400 passengers per day
- New Control Centre
- ATO Operation
- 6 Migration Areas

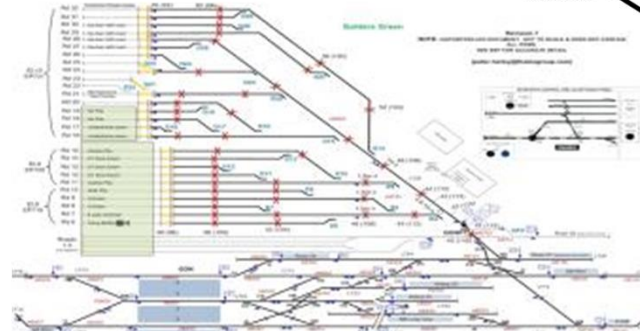
Case Study on LUL Jubilee and Northern Lines (2/2) 案例研究 - LUL Jubilee 及 Northern Lines (2/2)

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Northern Line Complexity / Northern Line 之複雜性

- 252 Million passengers a year in 2011, approaching a million on weekday.



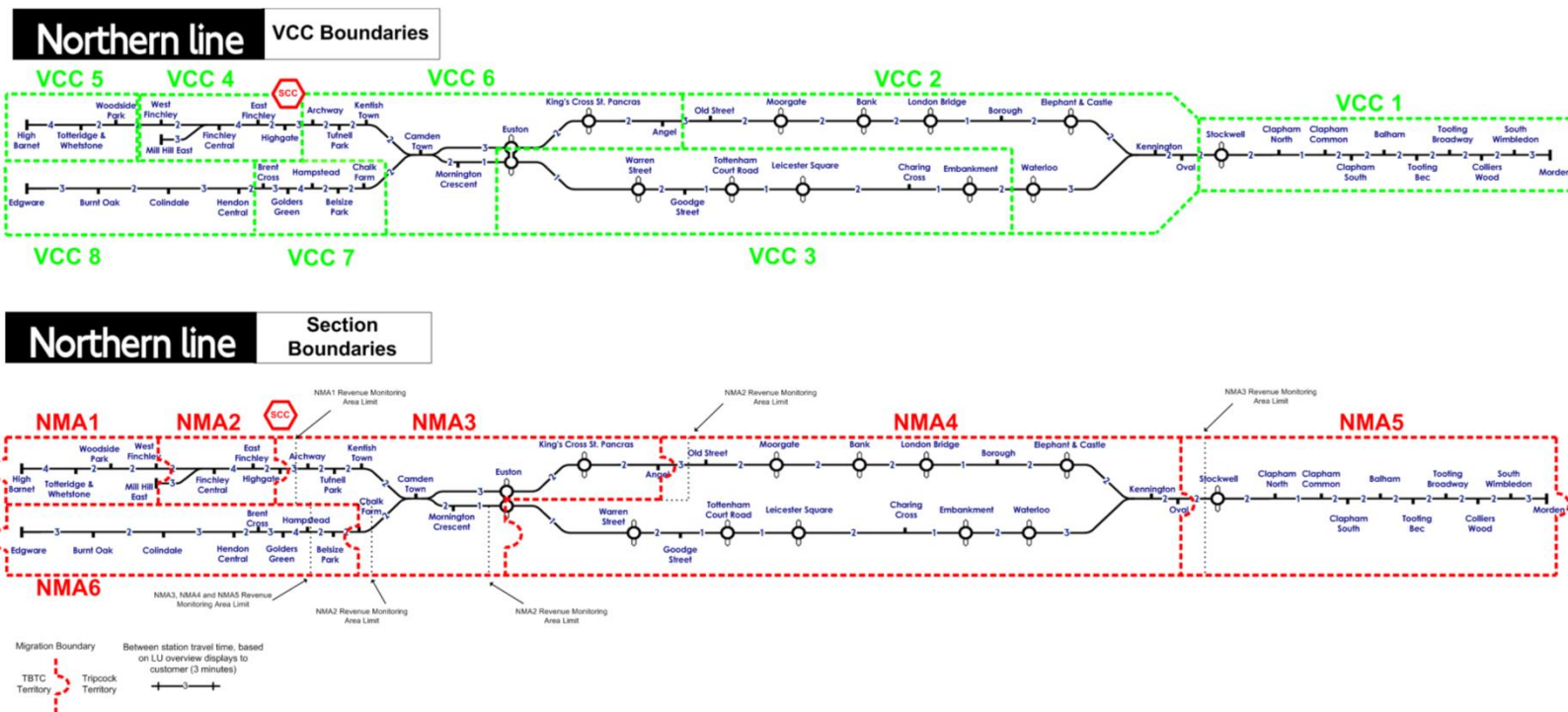
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Large Number of Legacy Systems / 大量舊有的系統存在

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- Bakerloo Control
- SMD Westrace
- SMD Backup Panel
- PAC Loops
- Mainline Westrace Points
- NL Control System
- MCS
- DCS
- TMS
- ATO Controller
- Existing WESTRACE PLC
- PTI System
- Driver Controls
- Existing Route Locking
- NL CSDE
- Signal Selection Circuit
- Kings Cross Slot
- Local Site Computer
- PED Control
- Keyswitches
- NL Depot Slots & Plungers
- Point Heater Control
- Trainstop
- Train Braking & Propulsion
- Train Wires
- Lever Control
- Signal Circuit Indications
- MLCC
- Neasden Depot CC
- Tripcock Testers
- Surface Stock Detector
- Current on Line Detection
- Floodgates
- Overview Diagram
- PID System
- CIMS & SIMS
- Tripcock

Northern Line – Migration Sequence / Northern Line 系統更新順序





Return on Investment

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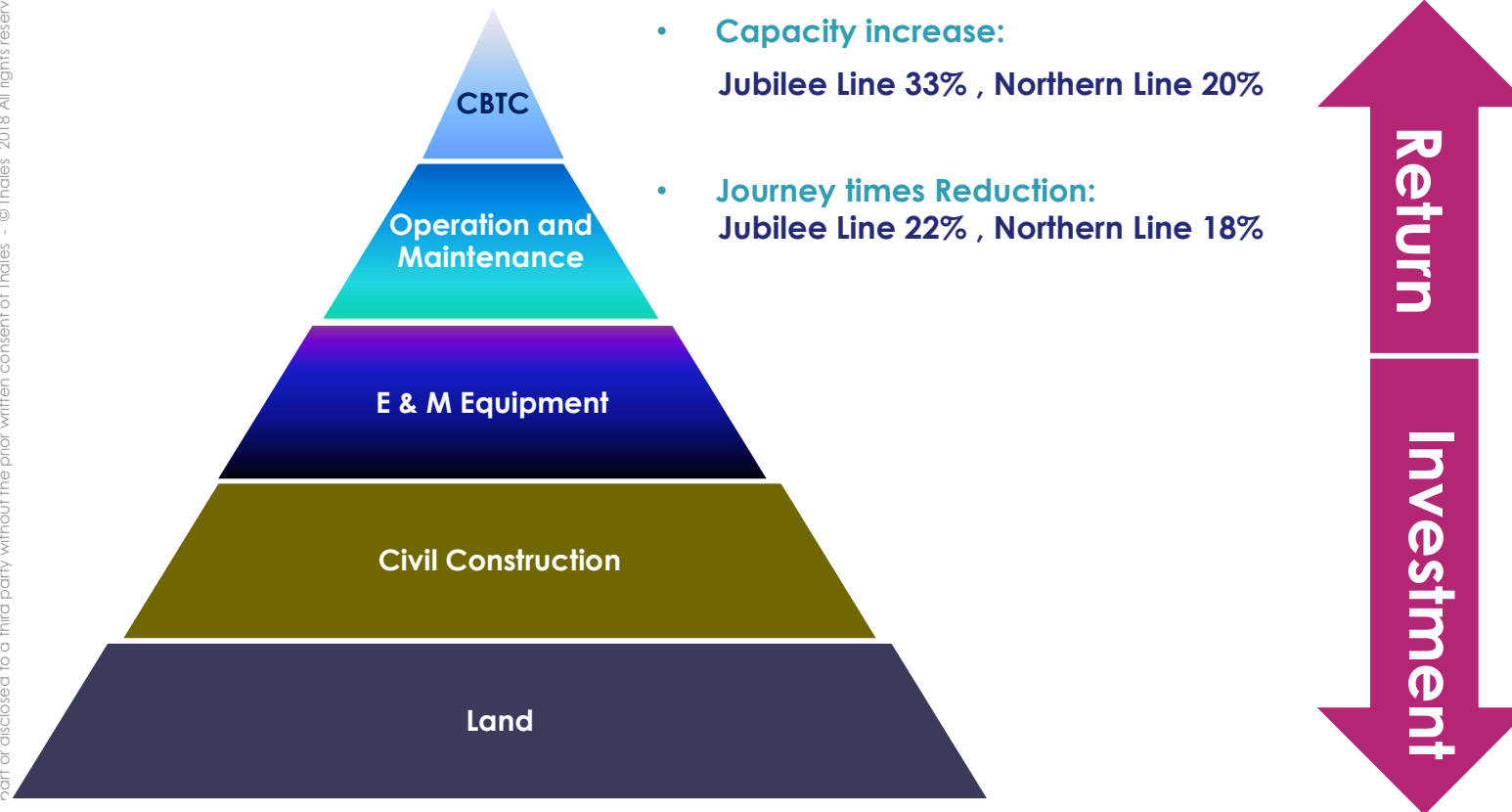
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Jubilee Line and Northern Line Re-signalling Return of Investment

Jubilee Line和Northern Line號誌更新之投資回報

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New Challenges / 面臨新的挑戰

Ever strengthening relationships

In July 2015 Thales were awarded the re-signalling of 4 additional lines (Metropolitan, District, Circle and Hammersmith and City) by London Underground, known as the 4LM project.

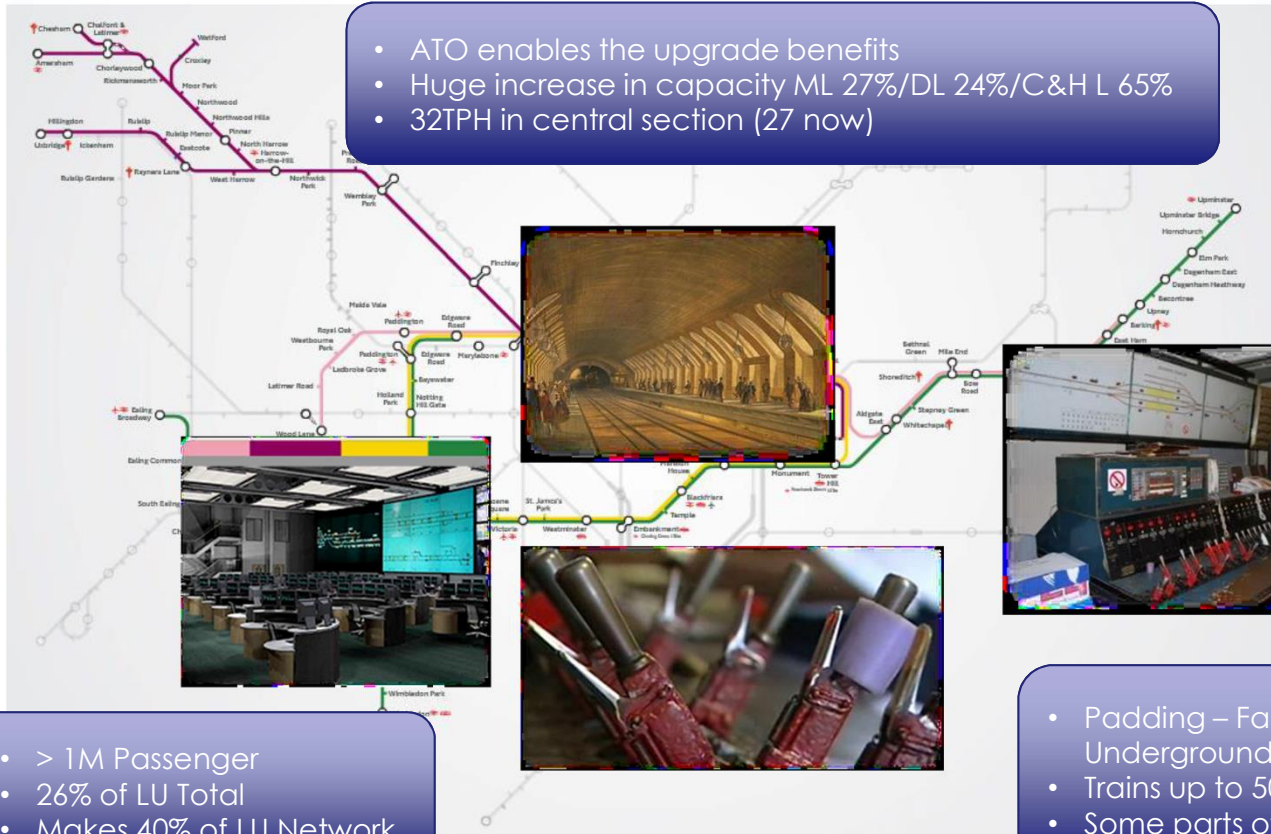
- Solution based upon proven Jubilee and Northern Line Solution
- Enhanced to meet latest requirements e.g. radio
- Continued collaborative working approach
- Minimise disruption to passengers
- Foster long term partnerships



Automating the most Complex Metro in the World

世界上最複雜的地鐵自動化系統

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4LM Migration Strategy / 4LM系統更新策略

Project Complexity and Size

330Km Route Tracks

Trains

191 New S-Stock Trains (ML, DL, CL + H&C Line)

2 S Stock Type S7 (133) and S8 (58)

5 Types of Engineering Trains

Depots

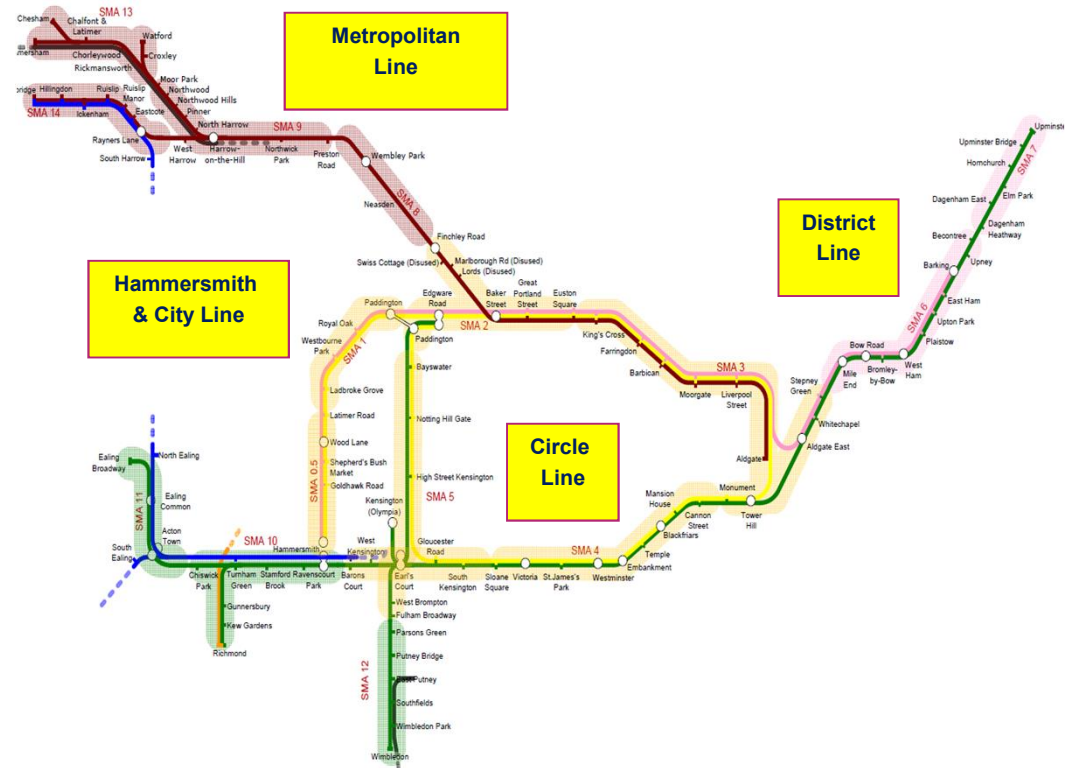
4 Major Depots

2 Major Sidings

4 Other Sidings

- Position based Transponders
- Radio Communication
- Mixed Train Operations (CBTC and Non-CBTC)
- Both Moving Block and Fix Block Signalling
- Inter-Lines Stock Move Interfaces
- 16 existing control locations rationalized to one new OCC

4LM Migration Areas



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Test and Commissioning / 系統測試與啟用

4LM Challenges

➤ Site Installation & testing challenges

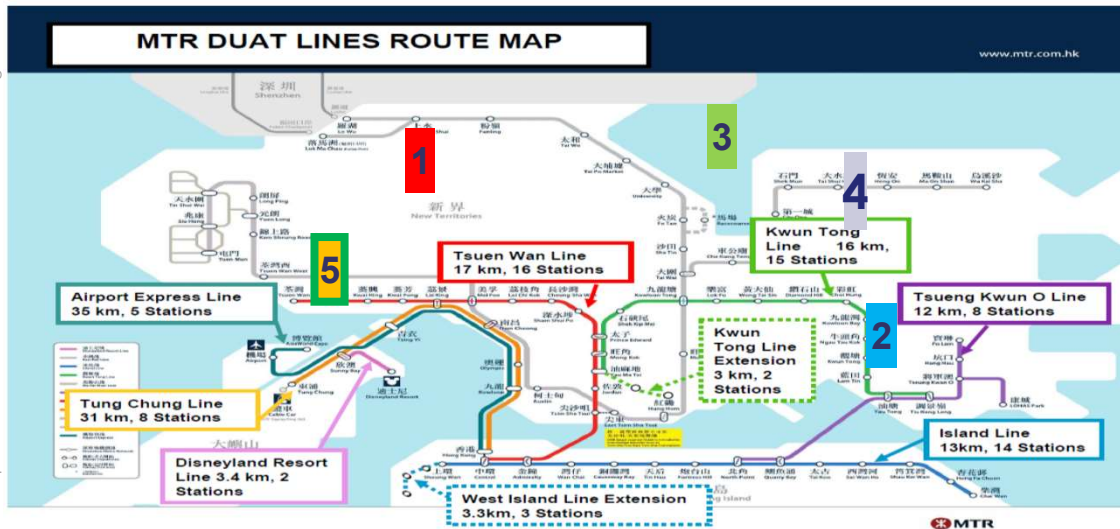
- Parallel installation teams across 3 sections.
- Early and accurate Guideway Survey and As- built data feedback to the design team
- Shadow mode running to increase stability and reliability of system

➤ Interfacing to legacy existing systems

- Availability of existing system documents
- Interface specifications created early in collaboration with the Customer & interfacing parties.
- Site Operating Rules produced by the Customer & available to the design team to understand the operations.
- Maximize In house testing capabilities by building simulators to replicate external interfaces

Hong Kong DUAT Overview / 香港DUAT概述

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Base Contract scope covers :

- 7 lines, 134 km double track and 73 stations
- 7 types of veh, (158) and 3 types loco/engineering trains (48)
- 5 depots with test track
- De-commissioning

Maintenance Contract scope covers:

- 5 + 5 years maintenance service
- 5 + 5 years workshop service

Hong Kong 7 lines Re-signalling Project Overview

香港7條地鐵之號誌系統更新概況

To be replaced











To be replaced

To be replaced

QTY to be optimized

Lines	Train Supervision	Supplier	Interlocking	Supplier	ATC	Supplier	Train Detection	Supplier	Point Machine	Supplier
KTL	SICP / ATS / ATR	CSEE	Relay / SSI / SICAS	Westinghouse/Siemens	SACEM DTG	GEC-Alsthom	CVCM	GEC-Alsthom	BR Clamp Lock / MJ 80 / MJ 81 / MCEM	Westinghouse/GEC-Alsthom/Vossloh
TWL		CSEE	Relay	Westinghouse						
ISL		CSEE	Relay NS	GEC-Alsthom						
AEL/TCL	ATS	GEC-Alsthom	SSI	GEC-Alsthom		Siemens	FTGS	Siemens	MJ 81	GEC-Alsthom
TKL	ATS	Siemens	SICAS	Siemens					S700KM	Siemens
DRL	ATS	Thales	WCU	Thales	CBTC	Thales	CBTC/AXCO	Thales	MCEM	Vossloh
WIL	ATS	GEC-Alsthom	Smartlock	GEC-Alsthom	SACEM DTG	GEC-Alsthom	CVCM	GEC-Alsthom	MJ 81	GEC-Alsthom
KTE	ATS	Siemens	Smartlock	GEC-Alsthom	SACEM DTG	GEC-Alsthom	CVCM	GEC-Alsthom	MJ 81	GEC-Alsthom

MTR DUAT Lines Fleet

 <p>URL M-Train 93 x 8-car EMU</p>	 <p>KTL K-Train 13 x 8-car EMU</p>	 <p>TCL CAF Train 12 x 8-car EMU</p>	 <p>AEL Train 11 x 8-car EMU</p>	 <p>TCL K-Train 4 x 8-car EMU</p>
 <p>DRL Train 3 x 4-car EMU</p>	 <p>BE Locomotive 38 nos.</p>	 <p>Rail Grinding Unit 2 nos.</p>	 <p>Diesel Locomotive 8 nos.</p>	 <p>URL/KTL C-Train 22 x 8 car EMU</p>

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Hong Kong Challenges / 香港地鐵面臨的挑戰

MTR messages

- Zero tolerance to train service delay
- No programme (key dates) delay

Project delivery

- Interfacing with existing trains, trackside equipment, infrastructures and other interfacing systems (over 60 external interfaces)
- Track possessions for train test limited to 3 NTH per week. Track access for installation and PAT limited to 5 NTHs per week with 3-4 hrs per NTH
- Signalling Equipment Room (SER) spatial use
- Mixed Fleet Operation: CBTC trains with existing SACEM trains

Project planning:

- Delivery of Test Track at NTP+16 months



Migration Options

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Migration Plan - Key Success Criteria

系統更新計劃 – 成功關鍵之標準

Early common understanding of customer needs and priorities

- Minimize service interruptions, and guideway installation time

Early verification of guideway data

- LIDAR survey

Availability of a test track

- Substantial benefits to test the CBTC system early

Keep the system simple

Ensure efficient and consistent customer review process

Ensure final customer acceptance

Anticipate and ensure safety approval by authority

Understand equipment deployment constraints

Ensure installation efficiency

Migration Plan - Key Principles

系統更新計劃 – 關鍵原則

- The installation of CBTC equipment and its connection to existing equipment will be transparent and will not degrade existing revenue service.
- CBTC equipment will be isolated from the existing system by cutover devices that provide safe and efficient switching between the existing system and the CBTC system.
- An agreed over-back process will allow smooth hand-over and hand-back during the Test and Commissioning phase.
- Full flexibility for track possession and test execution will be possible using a stage-by-stage and zone-by-zone approach.
- The new Automatic Train Supervision (ATS) will co-exist with the existing ATS which will remain available until the decommissioning stage.
- There will be no impact on the level of safety or operations provided by the existing signalling system.
- All potential risks are identified at an early stage of the programme and comprehensive mitigations are in place to minimise impact.

Migration Plan – Options

系統更新計劃之可行性方案

Option 1 – No revenue service until all trains are equipped

- Allows for a system without secondary train detection
- Option 1a Trial Operations
- Option 1b Phased Deployment

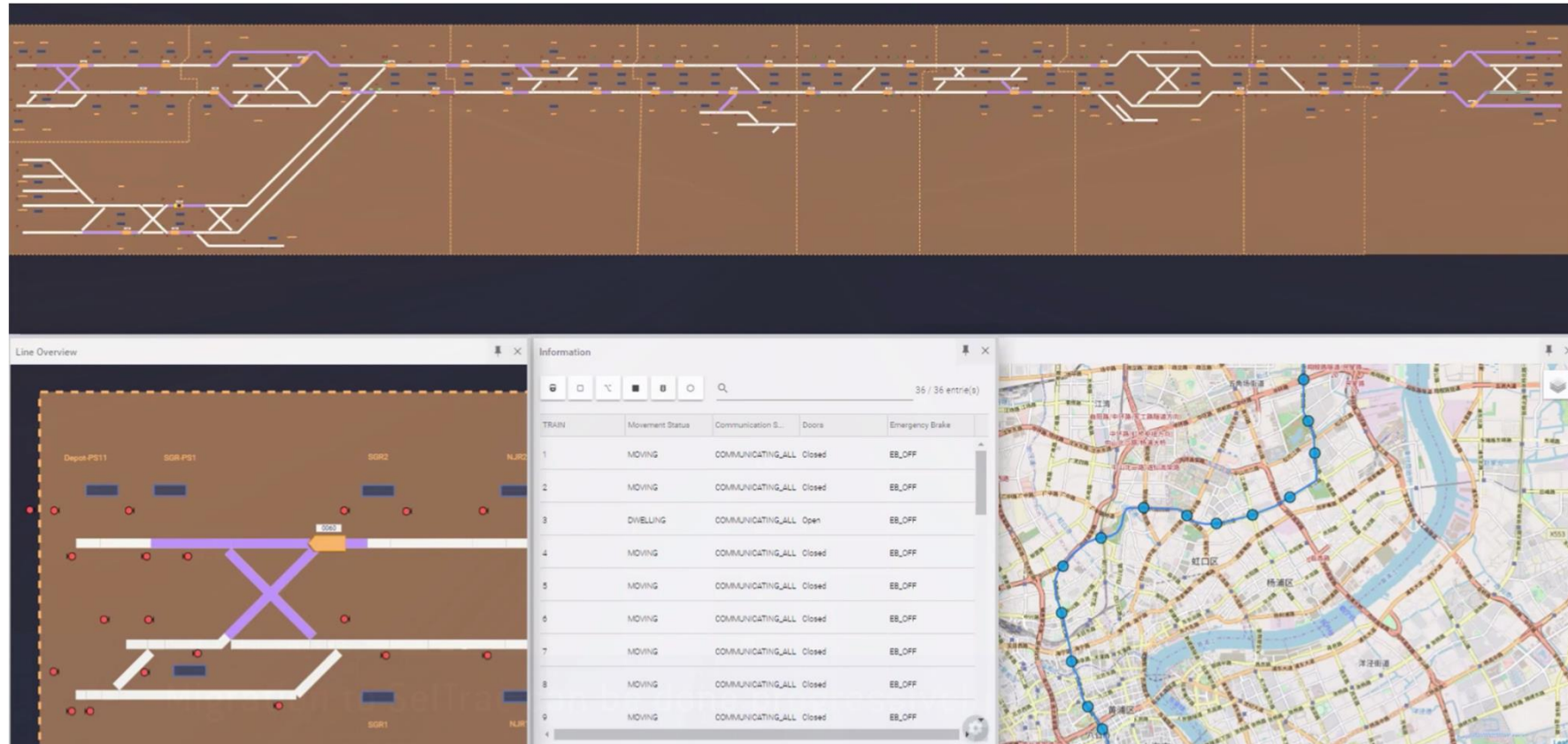
Option 2 – CBTC system works with Equipped and Unequipped Trains.

- Secondary train detection required

Migration Plan – Option 1b: Phased Revenue Deployment

系統更新計劃 – 可行性方案1b: 分階段部署之收益

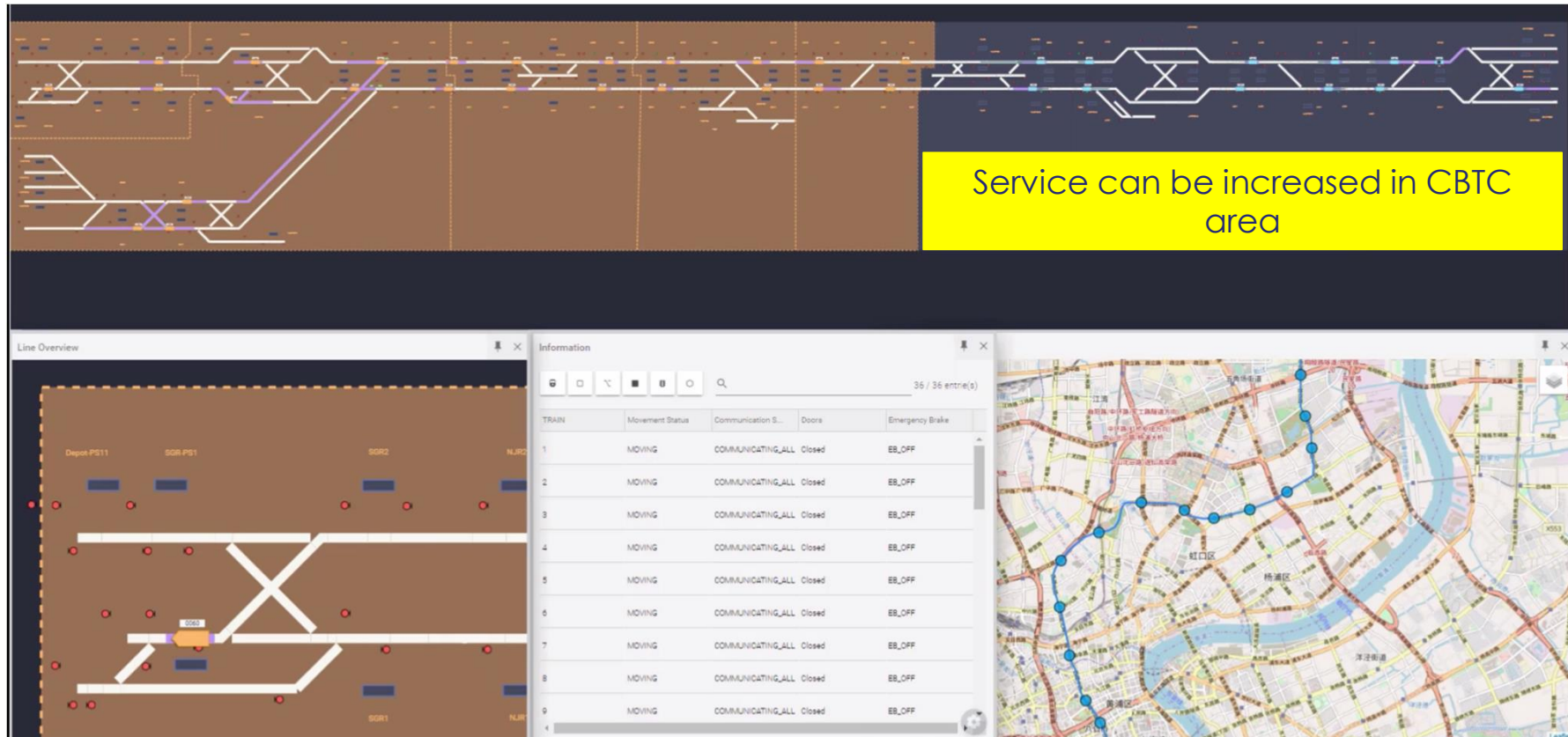
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Migration Plan – Option 1b: Phased Revenue Deployment

系統更新計劃 – 可行性方案1b: 分階段部署之收益

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Conclusion

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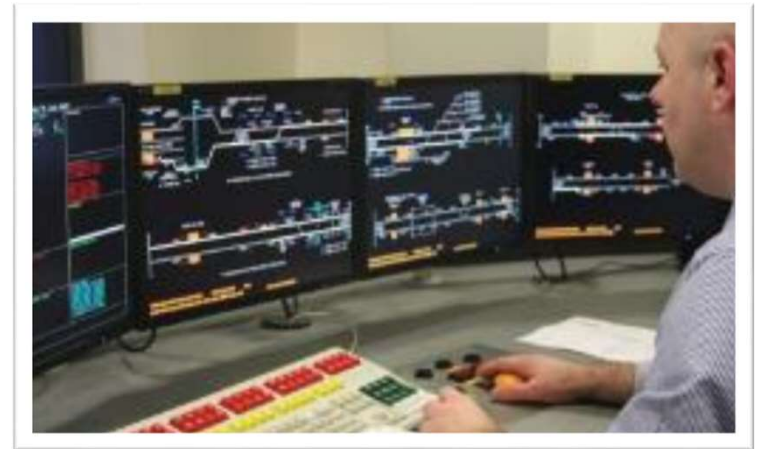
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Conclusions / 總結

Focus On Risk

- Understand Baseline Features and “Delta Functions”
- Prove as much as possible ‘off site’
- Migration Sequence and Interfaces to Existing Signalling
- Manage Parallel Design/Development Streams
- Watch out for Overload – Both on Customer and Suppliers
- Make Difficult Decisions Upfront
 - **Hold Open Discussions**



Conclusions / 總結

Collaboration breeds success

Key to successful brown field re-signalling includes:

- Excellent communication in a collaborative manner
- Robust technical problem solving
- Mature system architecture
- Celebrate success
- Learn lessons and continually improve.
- A good contract will enable collaboration
- **The most important is ONE TEAM**



**UK National Rail Awards,
Outstanding Teamwork Award**

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Thank You

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