HOLISTIC CAPACITY OF RAIL NETWORKS - EXPOSING ASSET DEFICIENCIES IN A COMPLEX SYSTEM

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Holistic – can be defined as:

‘Emphasising the importance of the whole and the interdependence of its parts’.

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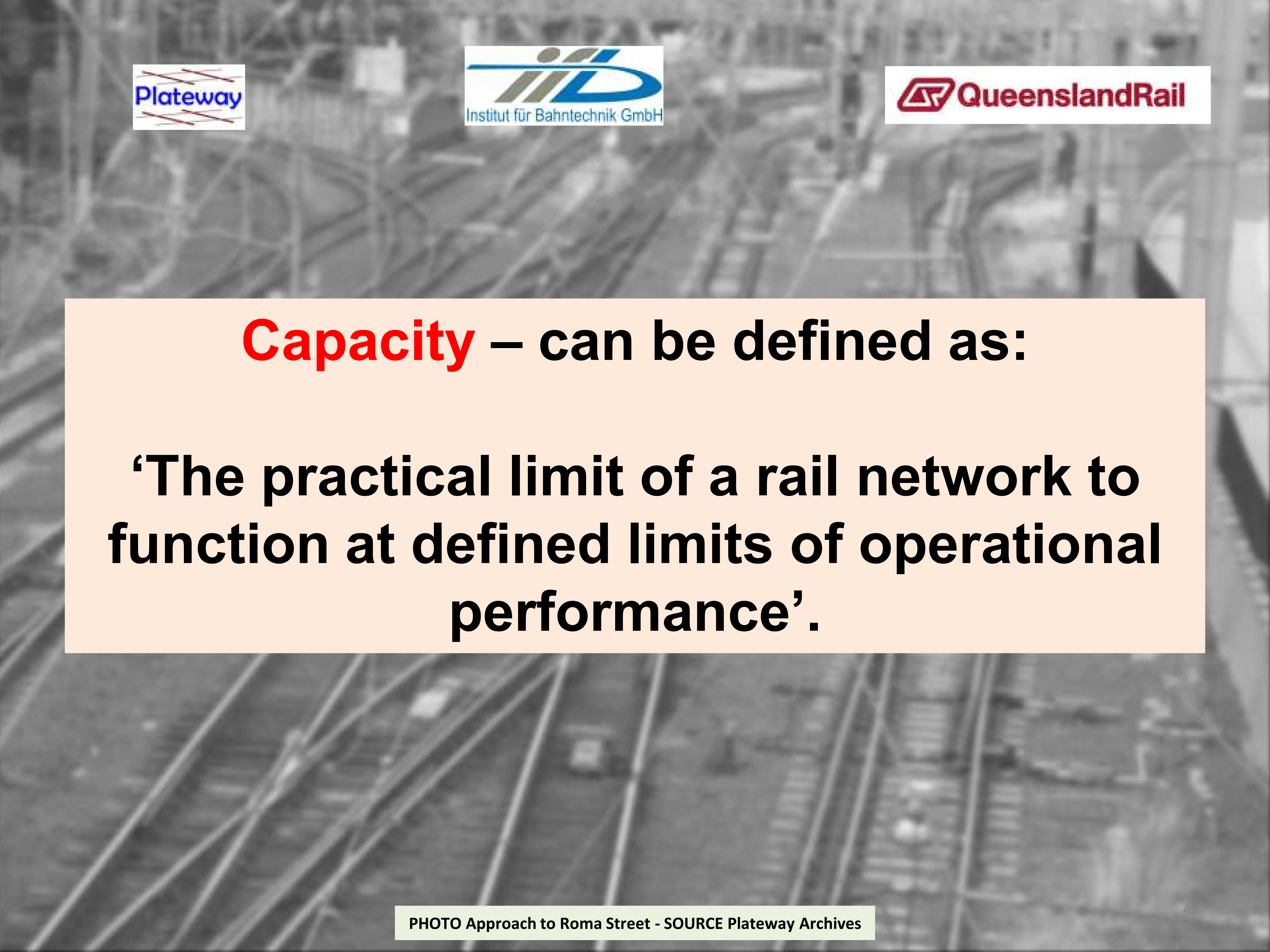

PHOTO Approach to Roma Street - SOURCE Plateway Archives

All Australasian Railways are under stakeholder pressure to improve services

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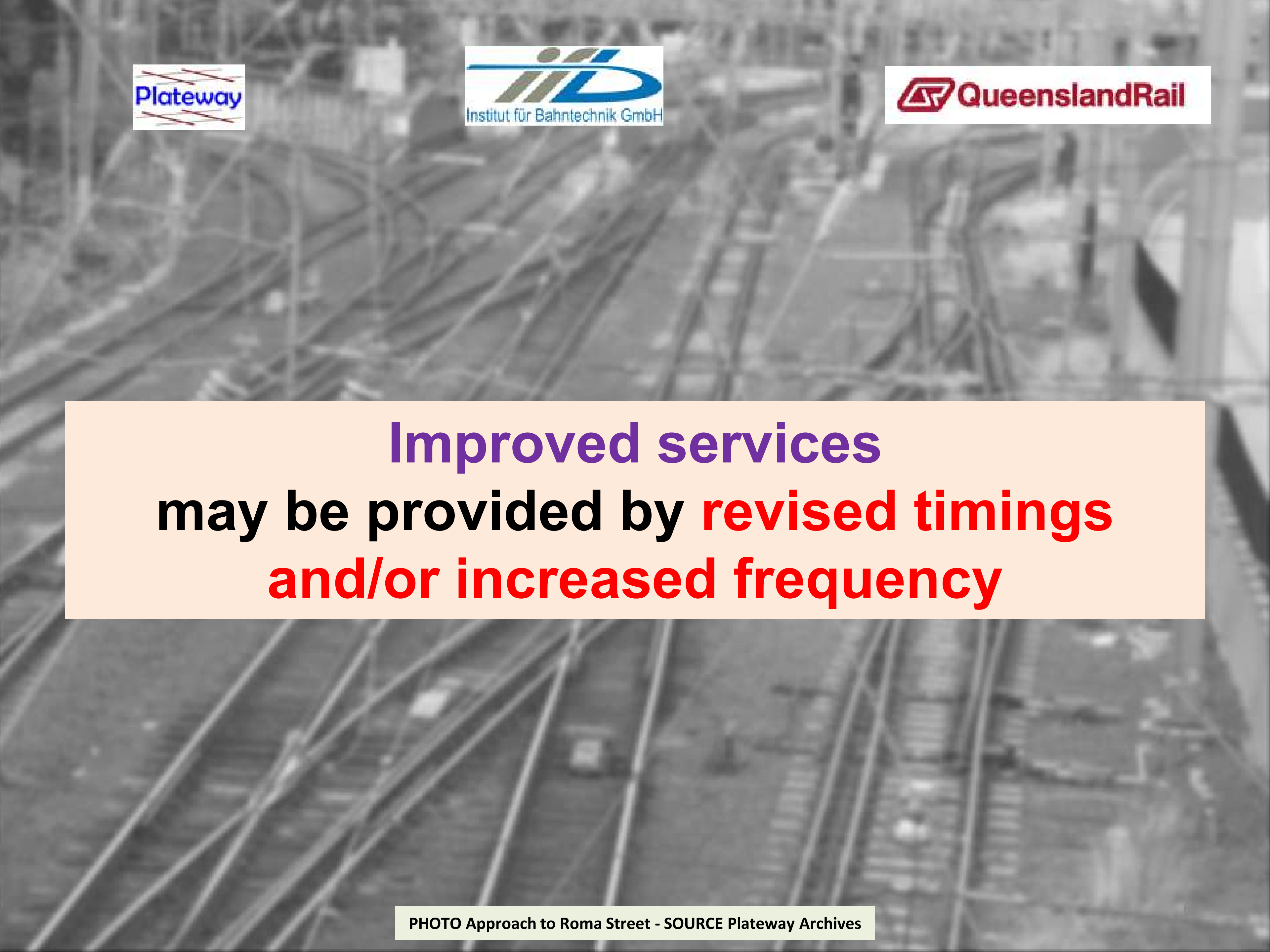

Improved services

may be provided by revised timings and/or increased frequency

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Improved services

can be provided by new lines to growth areas

PHOTO Approach to Roma Street - SOURCE Plateway Archives

Improved services

can be provided by new trains with enhanced performance & customer features

PHOTO Approach to Roma Street - SOURCE Plateway Archives

PHOTO Approach to Roma Street - SOURCE Plateway Archives

Can the existing infrastructure support an increased service frequency?

PHOTO: Murarrie Curve – SOURCE: Queensland Rail Trevor Bagnall

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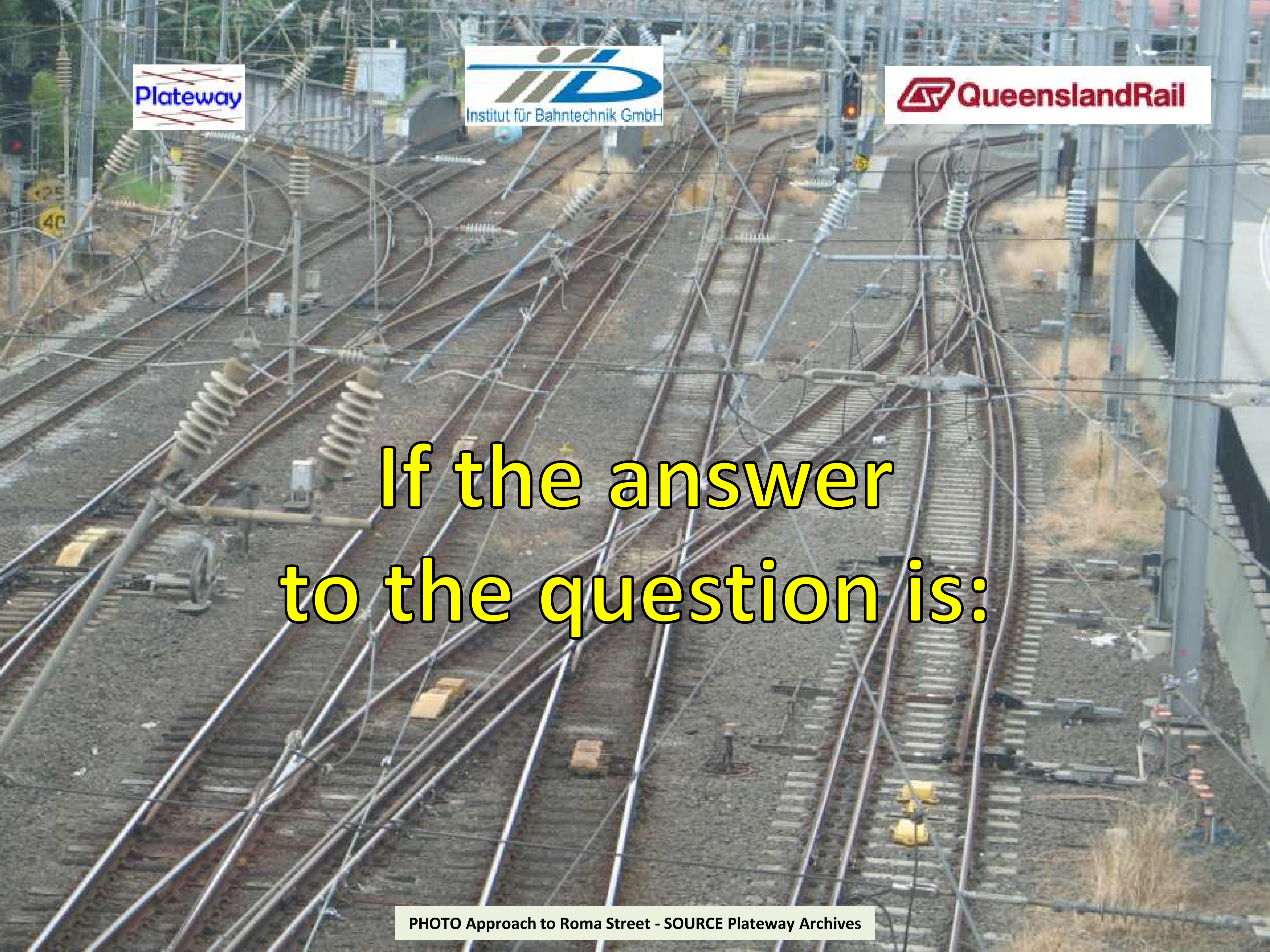
Can the existing infrastructure support additional traffic from new lines?

PHOTO: Murarrie Curve – SOURCE: Queensland Rail Trevor Bagnall

Can the existing infrastructure support the enhanced performance of new trains?

PHOTO: Murarrie Curve – SOURCE: Queensland Rail Trevor Bagnall



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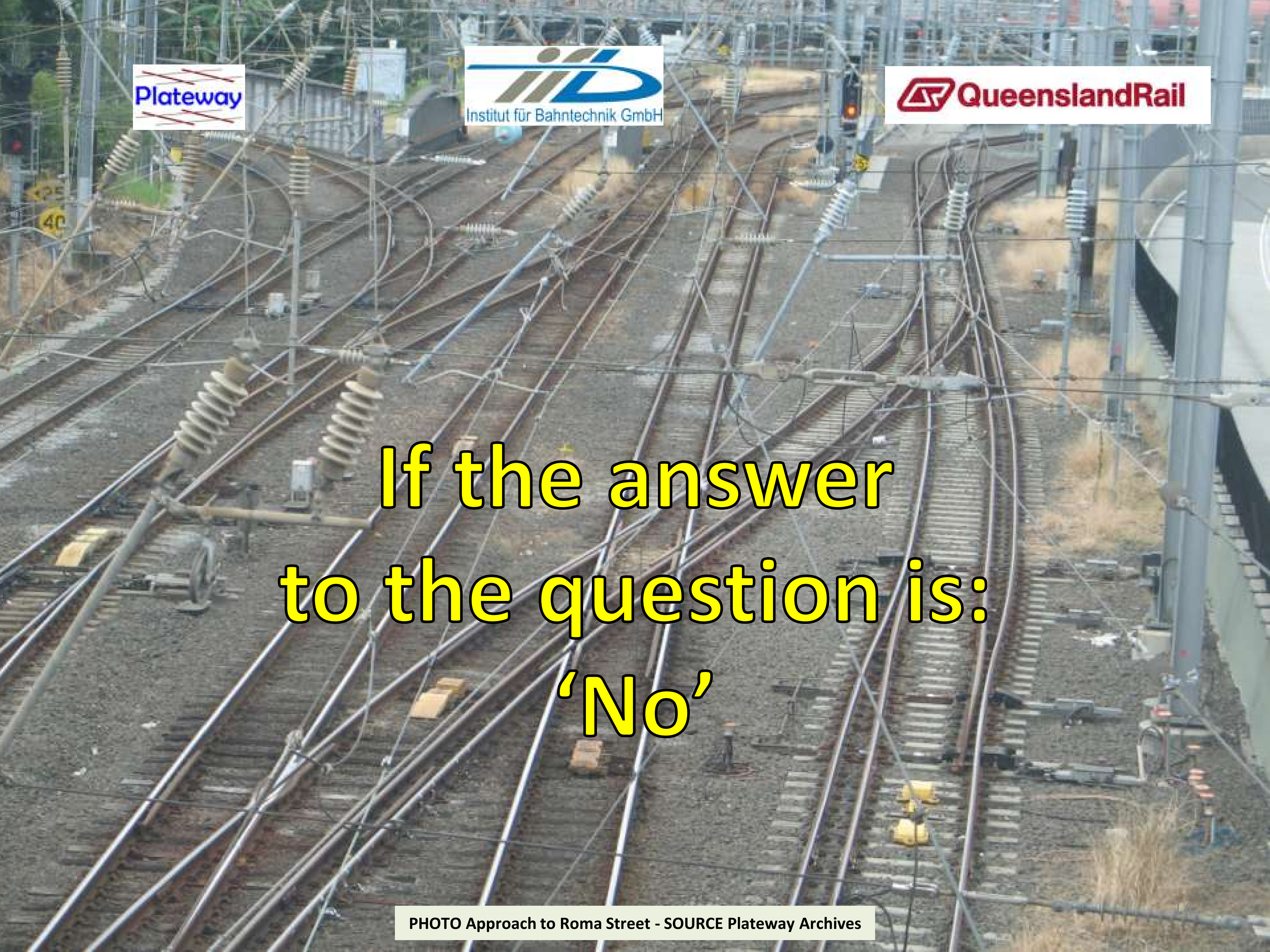

If the answer to the question is: ‘No’

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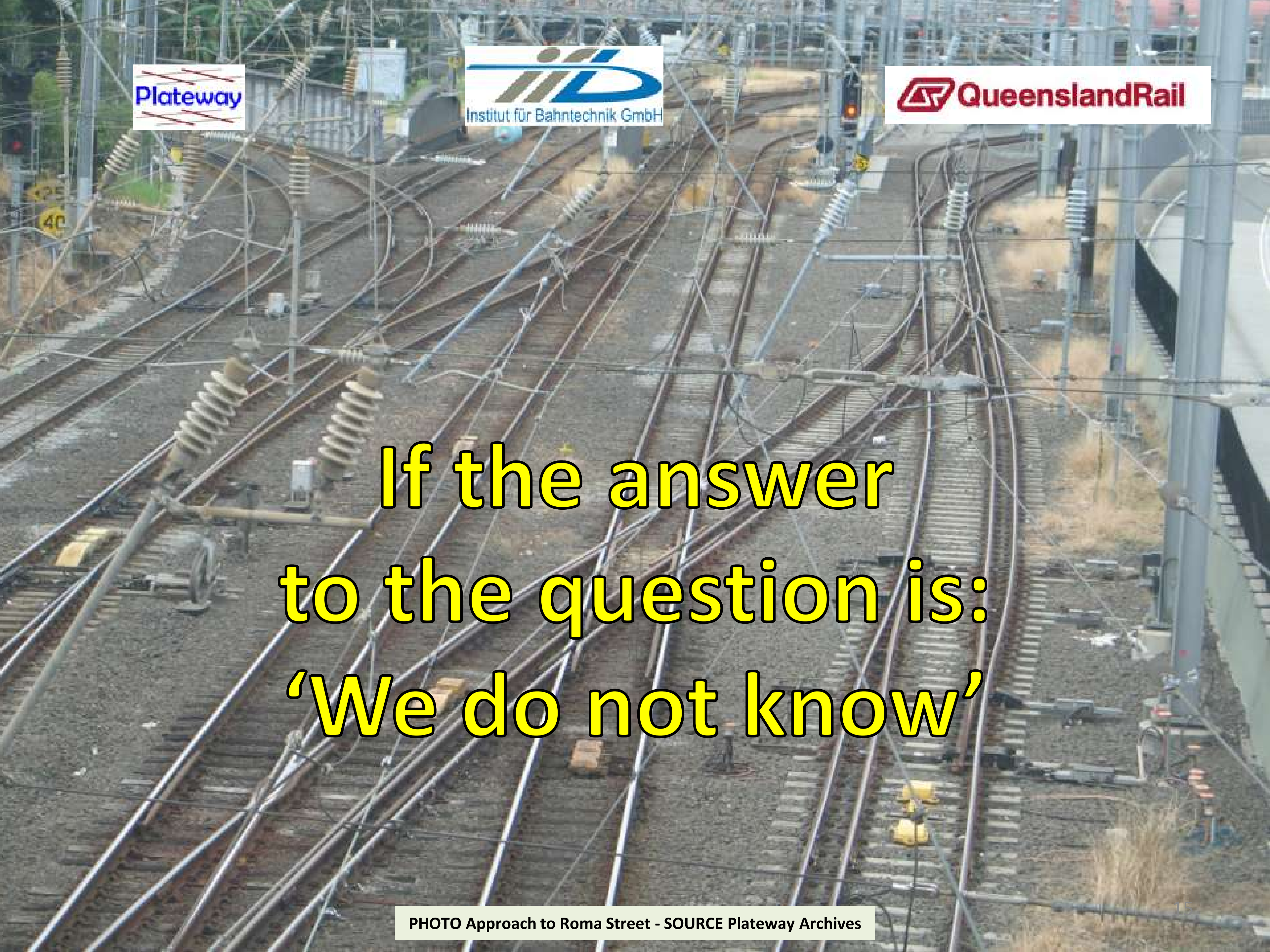

If the answer to the question is: ‘We do not know’

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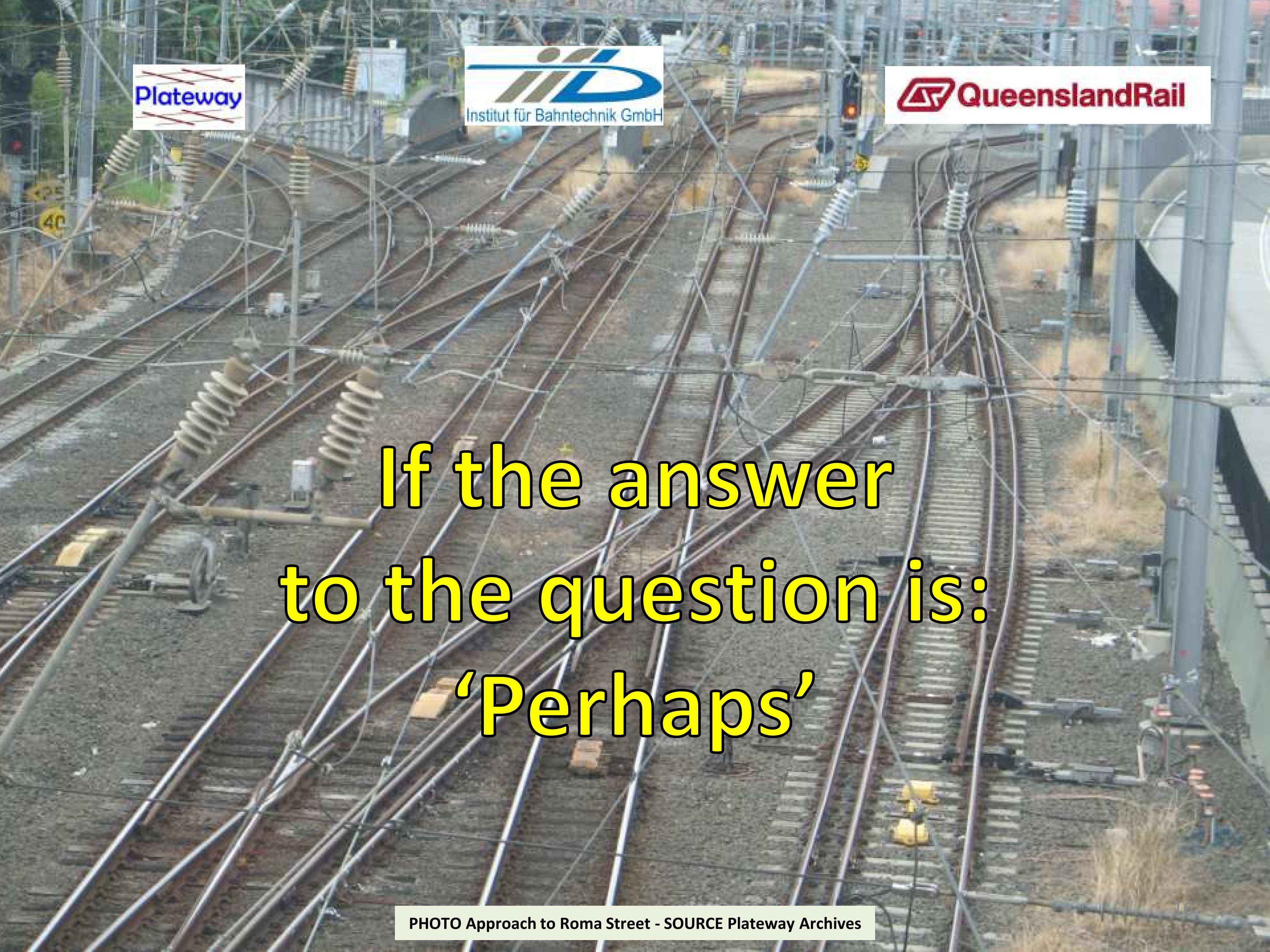

If the answer to the question is: ‘Perhaps’

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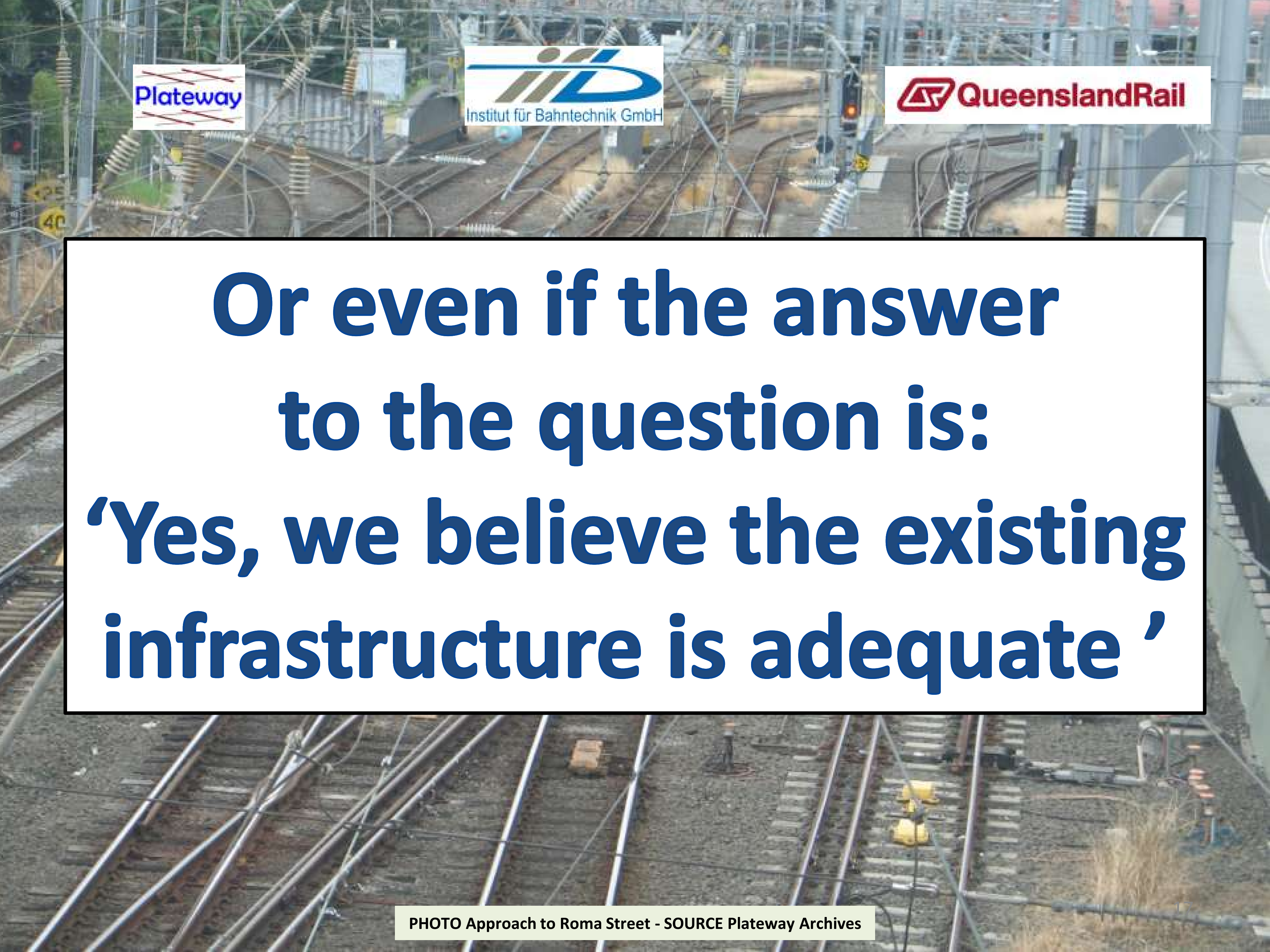

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Or even if the answer to the question is: ‘Yes, we believe the existing infrastructure is adequate ’

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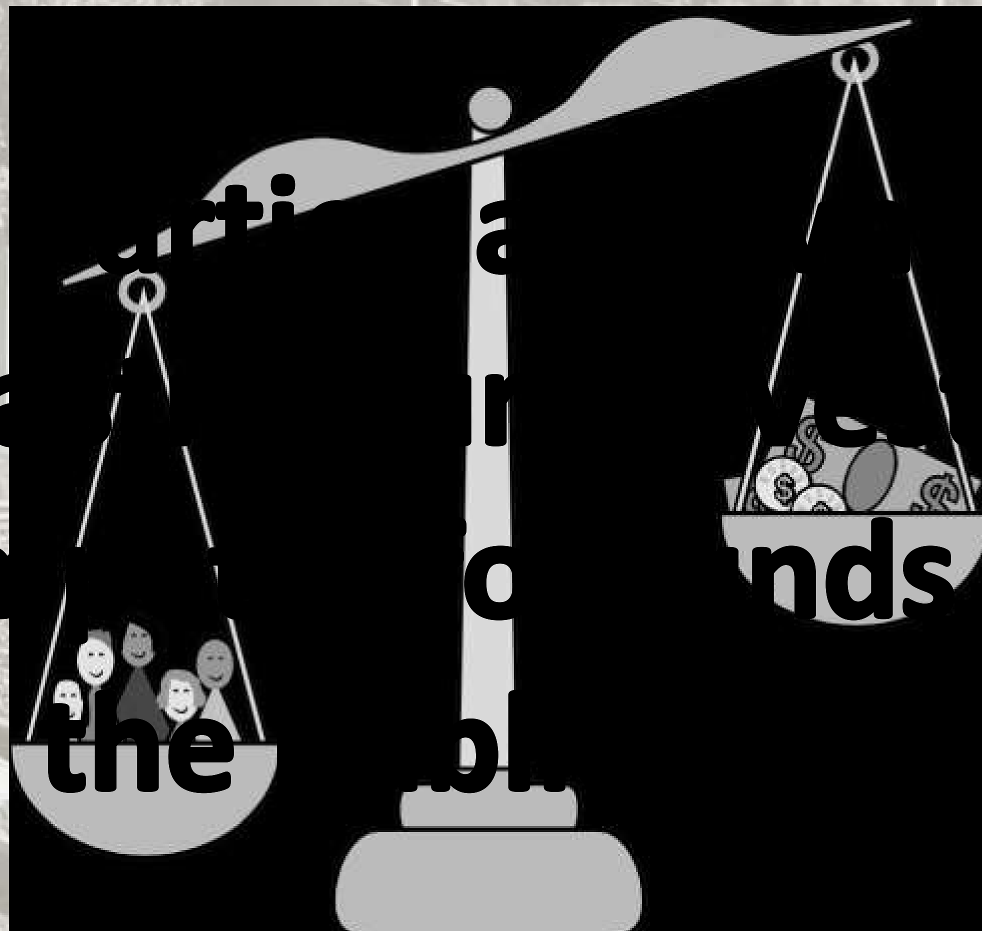
PHOTO Approach to Roma Street - SOURCE Plateway Archives

If additional infrastructure is required : How do we justify it?

PHOTO Approach to Roma Street - SOURCE Plateway Archives



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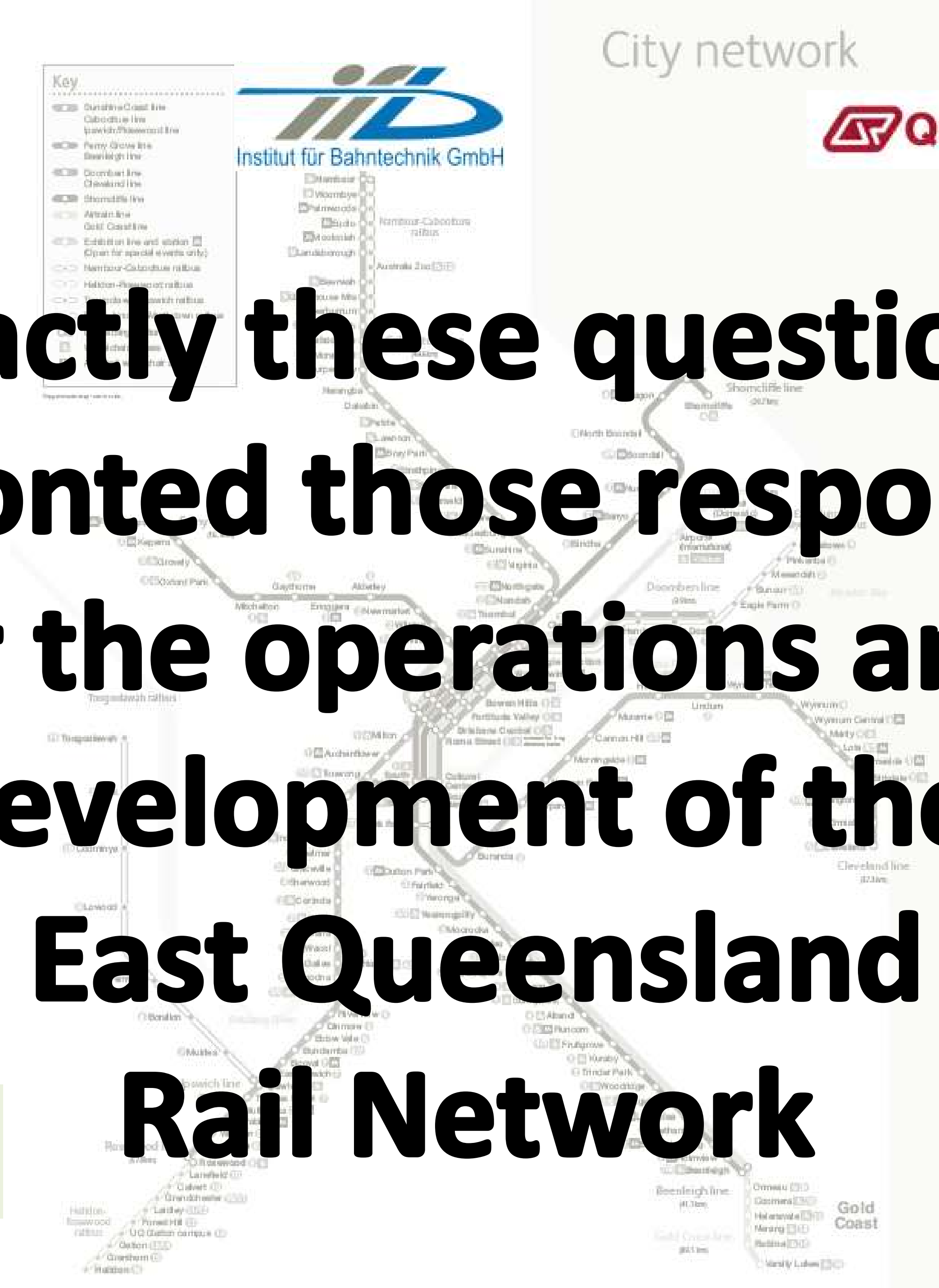
the ...bl... ...e!

PHOTO: Murarrie Curve – SOURCE: Queensland Rail Trevor Bagnall



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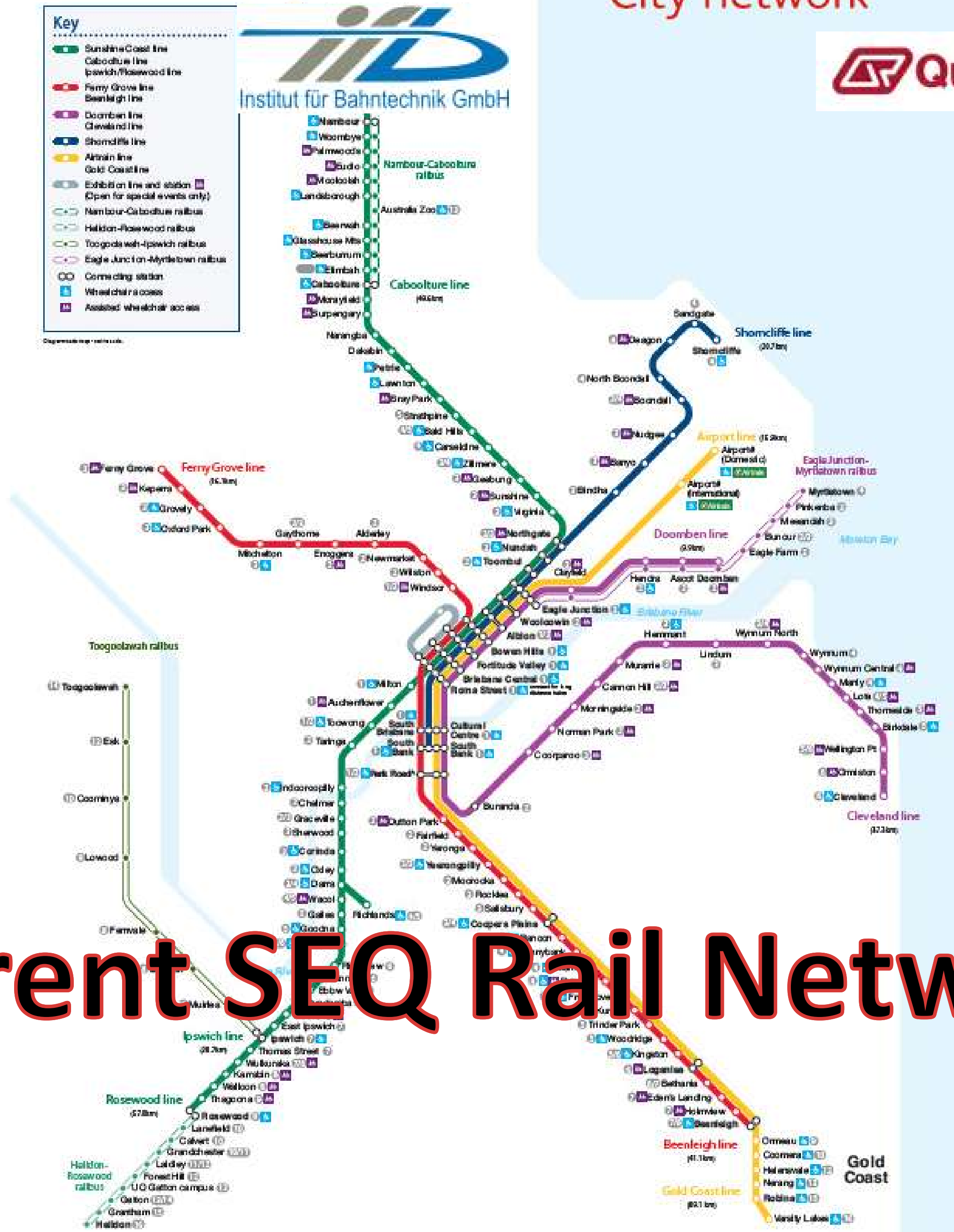
Exactly these questions confronted those responsible for the operations and development of the South East Queensland (SEQ) Rail Network

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK

City network

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK SOURCE: TRANSLINK 2010/2011 ANNUAL REPORT



Current SEQ Rail Network

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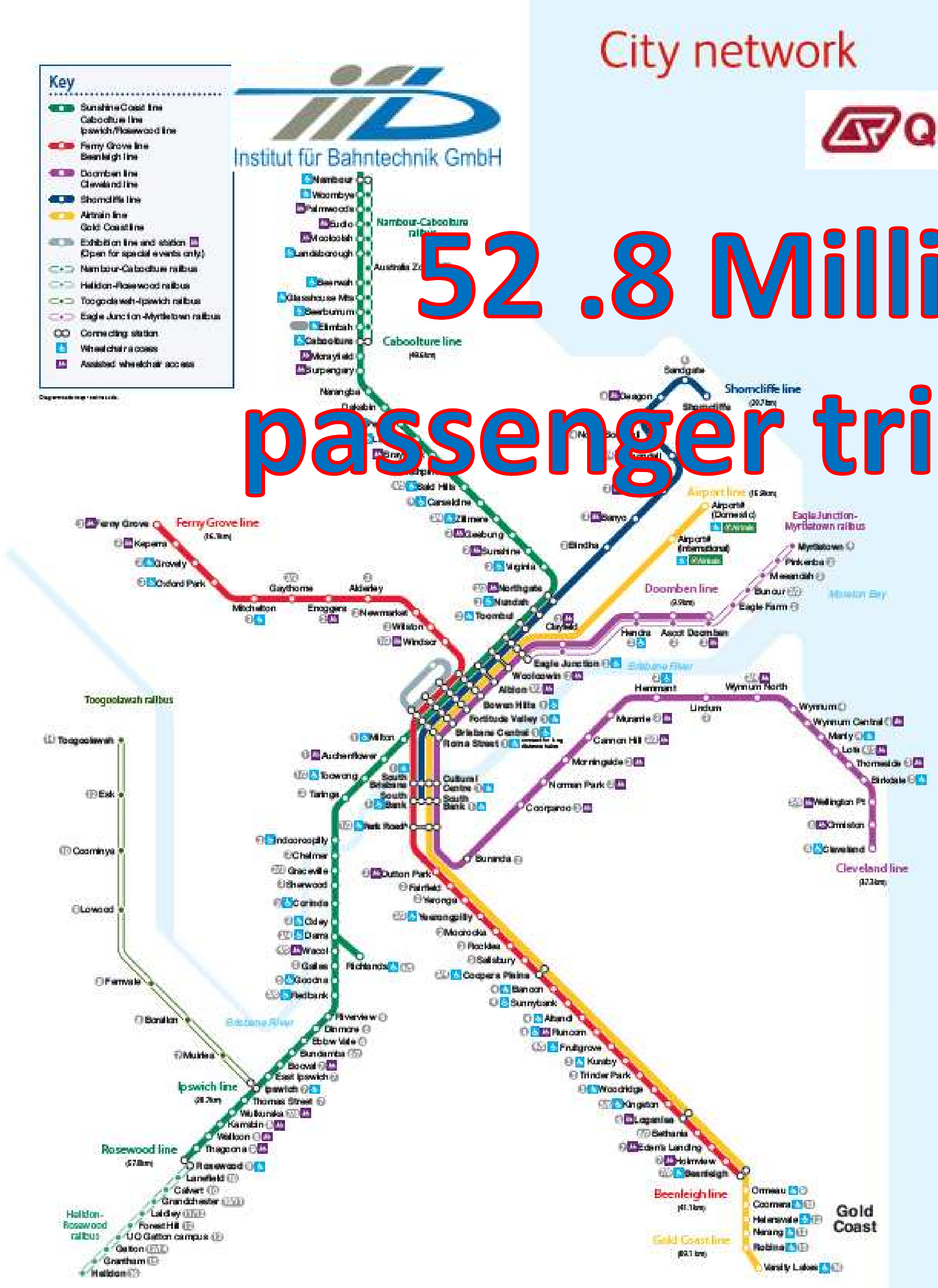


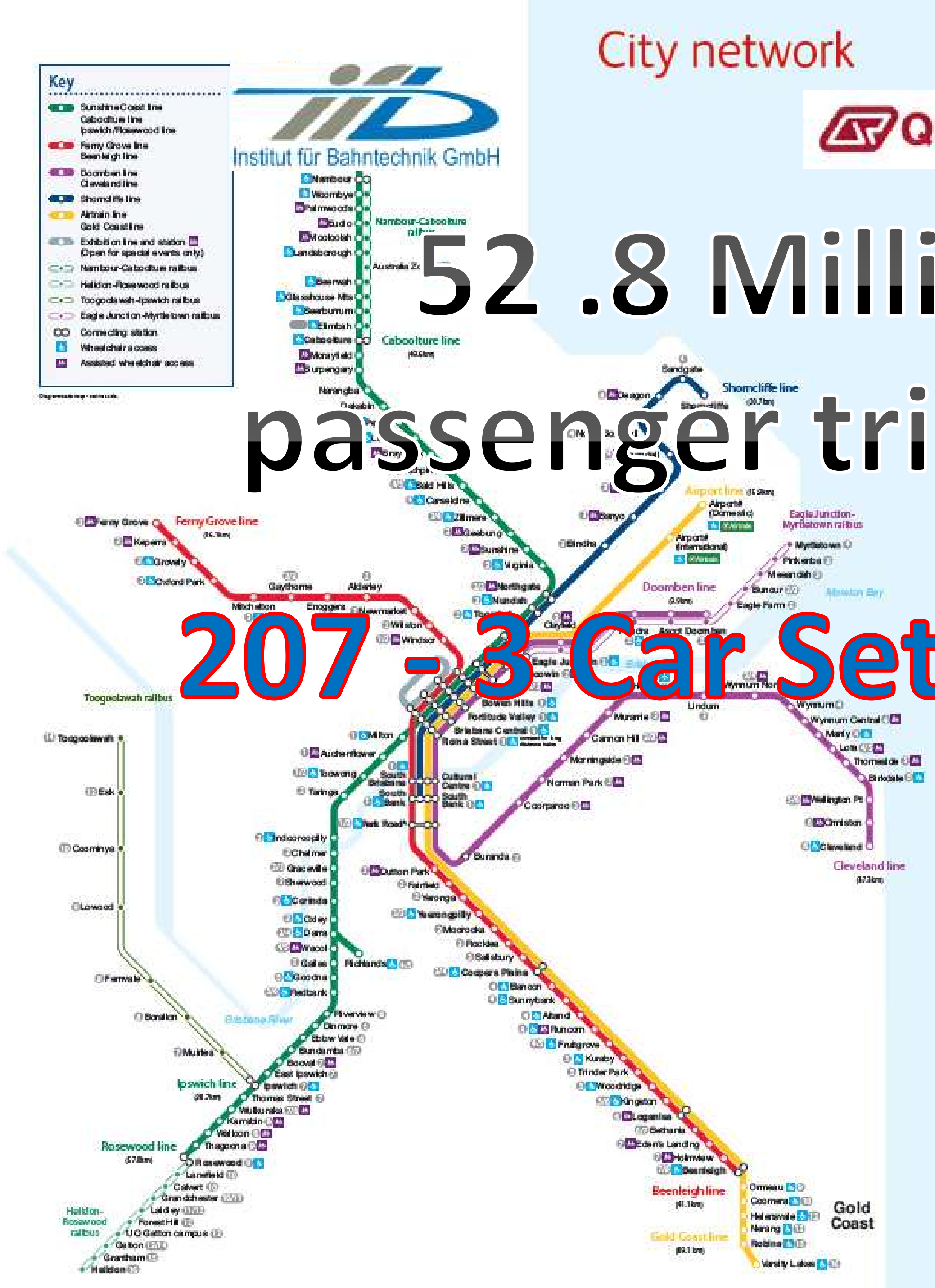
52 .8 Million passenger trips p.a.

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK SOURCE: TRANSLINK 2011/2012 ANNUAL REPORT

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK SOURCE: TRANSLINK 2011/2012 ANNUAL REPORT

52 .8 Million passenger trips p.a.

207 - 3 Car Sets



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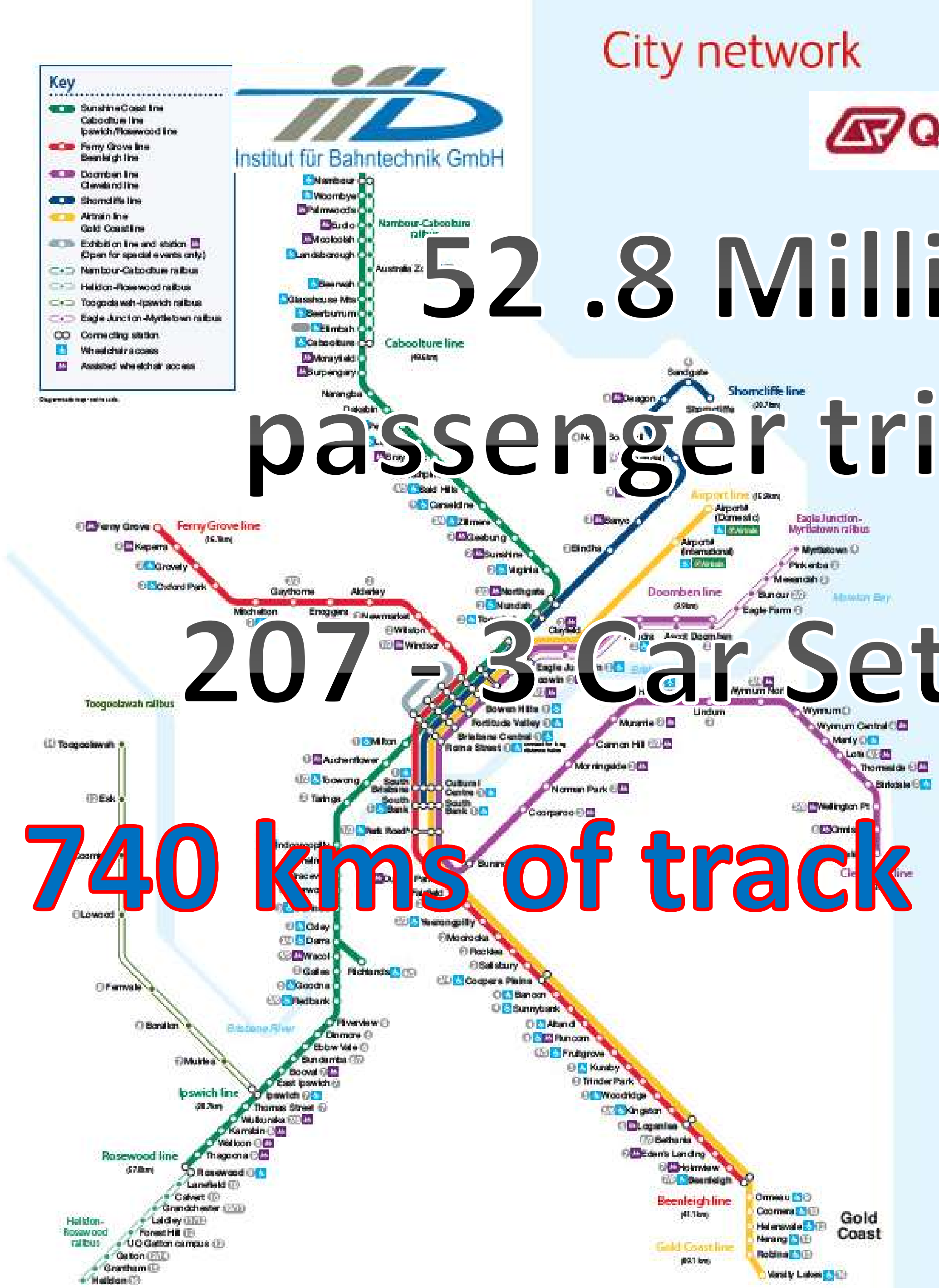

52 .8 Million passenger trips p.a.

207 - 3 Car Sets

740 kms of track

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK 2011/2012 ANNUAL REPORT

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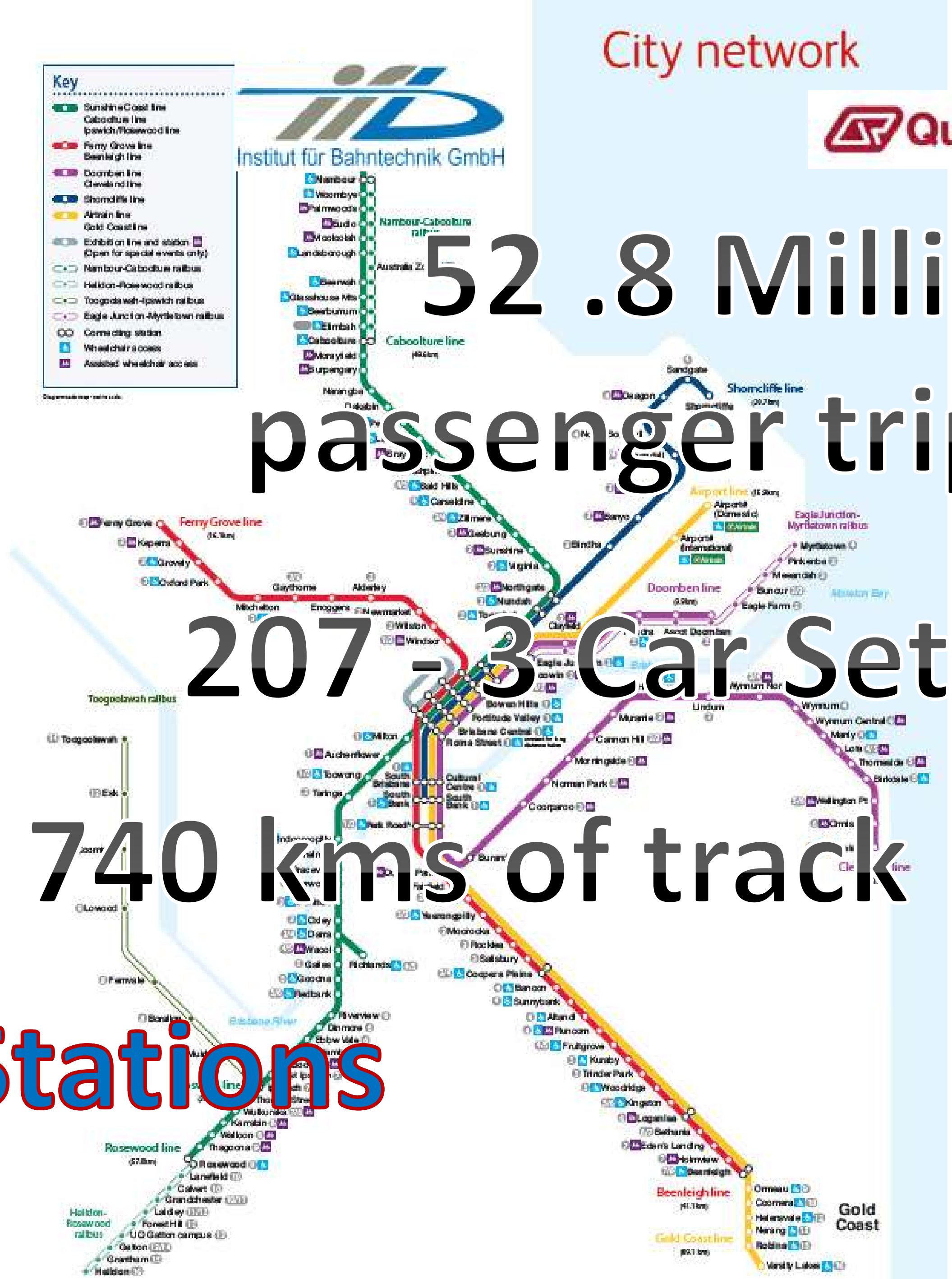


52 .8 Million passenger trips p.a.

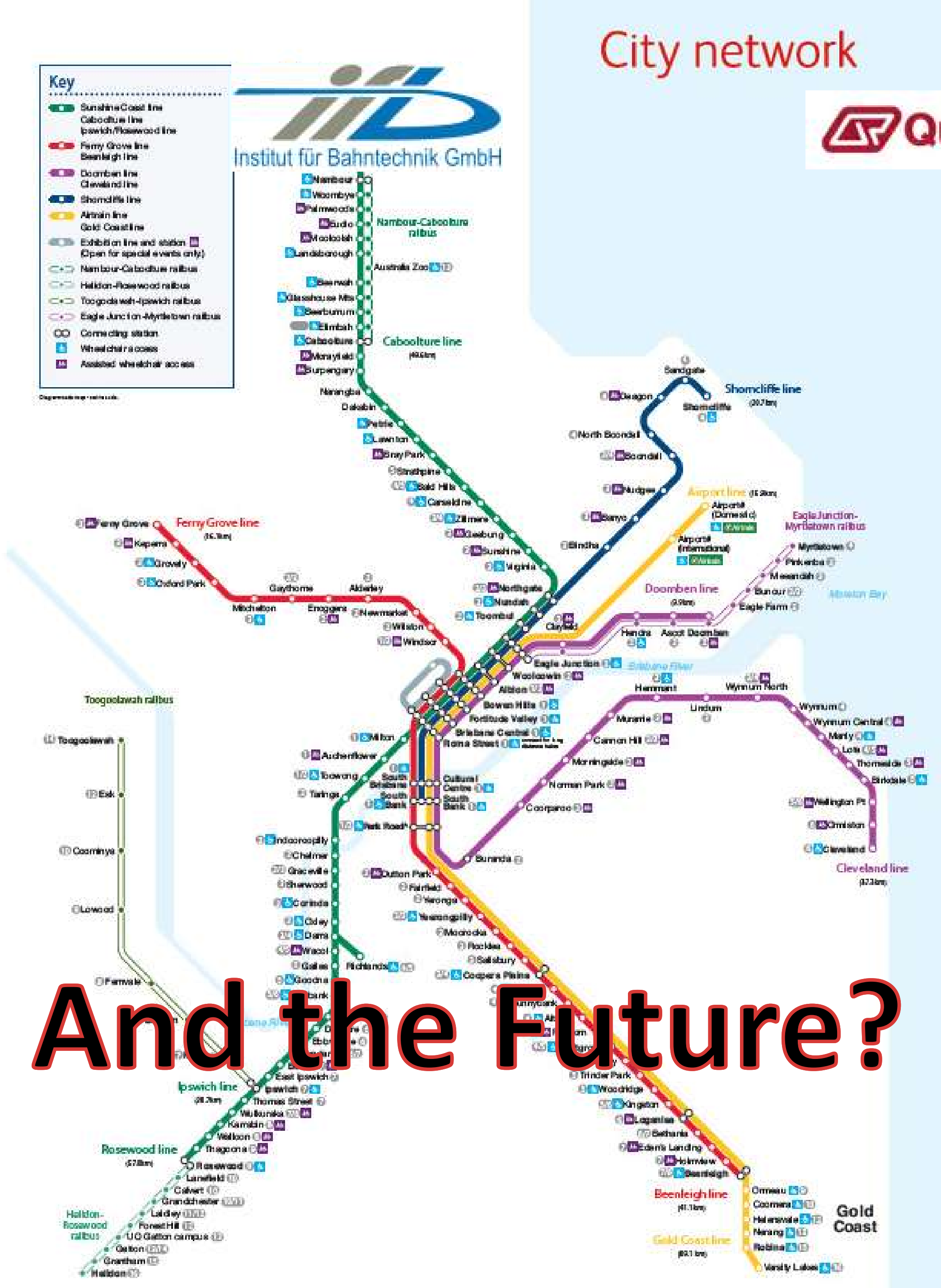
207 – 3 Car Sets

740 kms of track

147 Stations

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK 2011/2012 ANNUAL REPORT

DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK 2010/2011 ANNUAL REPORT



And the Future?

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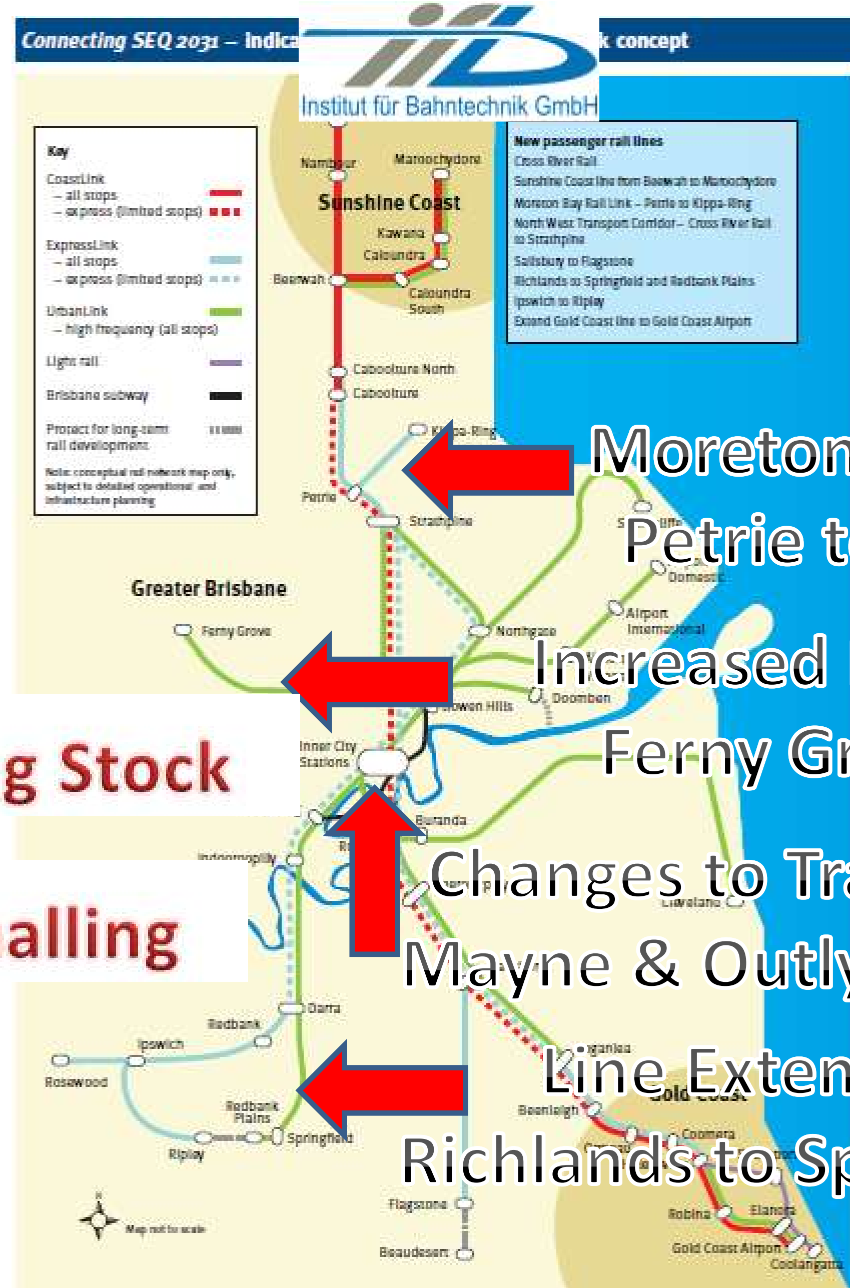
Short Term Projects

DIAGRAM: SEQ 2031 INDICATIVE RAIL NETWORK
SOURCE: CONNECTING SEQ 2031



Moreton Bay Rail Link
Petrie to Kippa Ring

Increased Frequency
Ferny Grove Line

New Rolling Stock

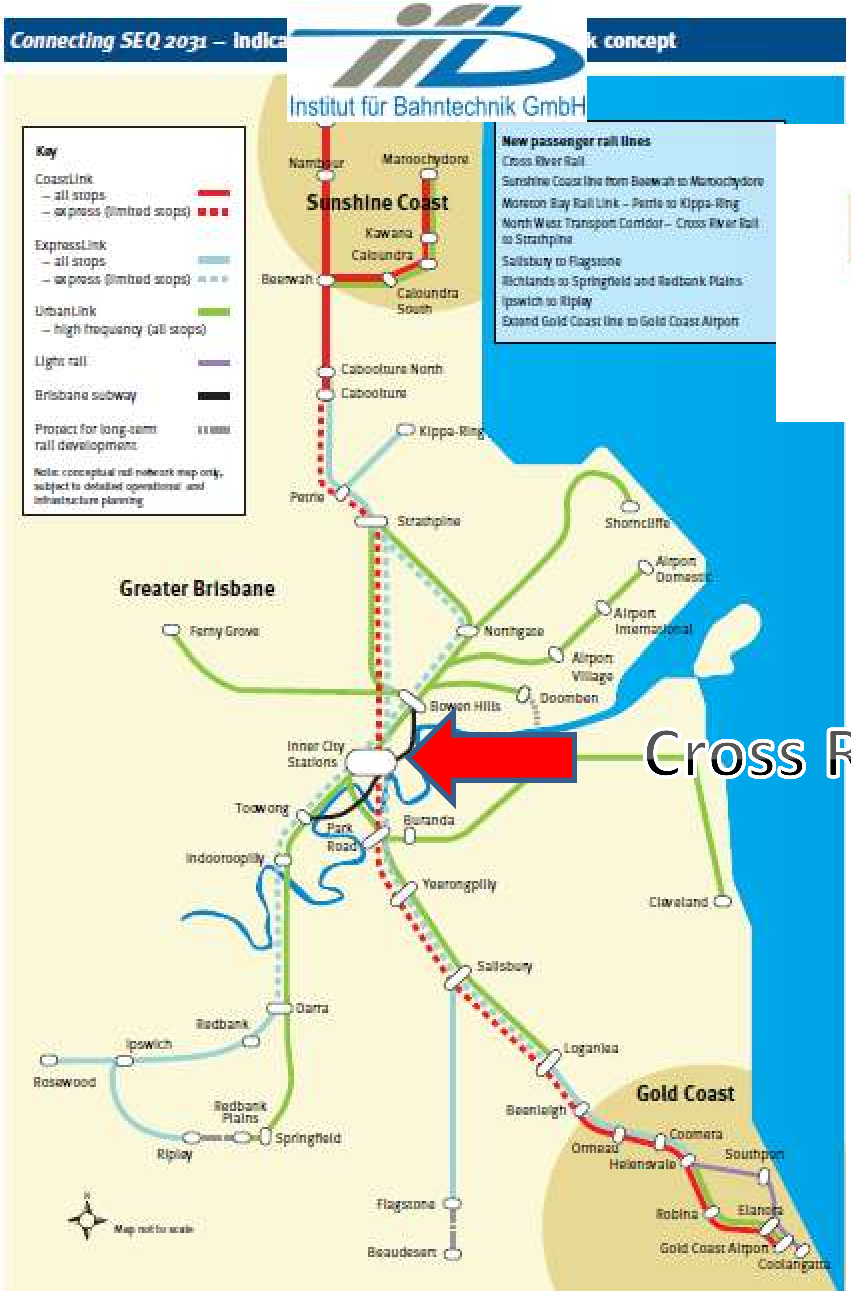
Changes to Train Stabling
Mayne & Outlying Stations

New Signalling

Line Extension
Richlands to Springfield

Medium Term Projects

DIAGRAM: SEQ 2031 INDICATIVE RAIL NETWORK
SOURCE: CONNECTING SEQ 2031



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Longer Term Projects

DIAGRAM: SEQ 2031 INDICATIVE RAIL NETWORK SOURCE: CONNECTING SEQ 2031

Sunshine Coast Line

North West Corridor

Ipswich to Riplay

Salsbury to Flagstone

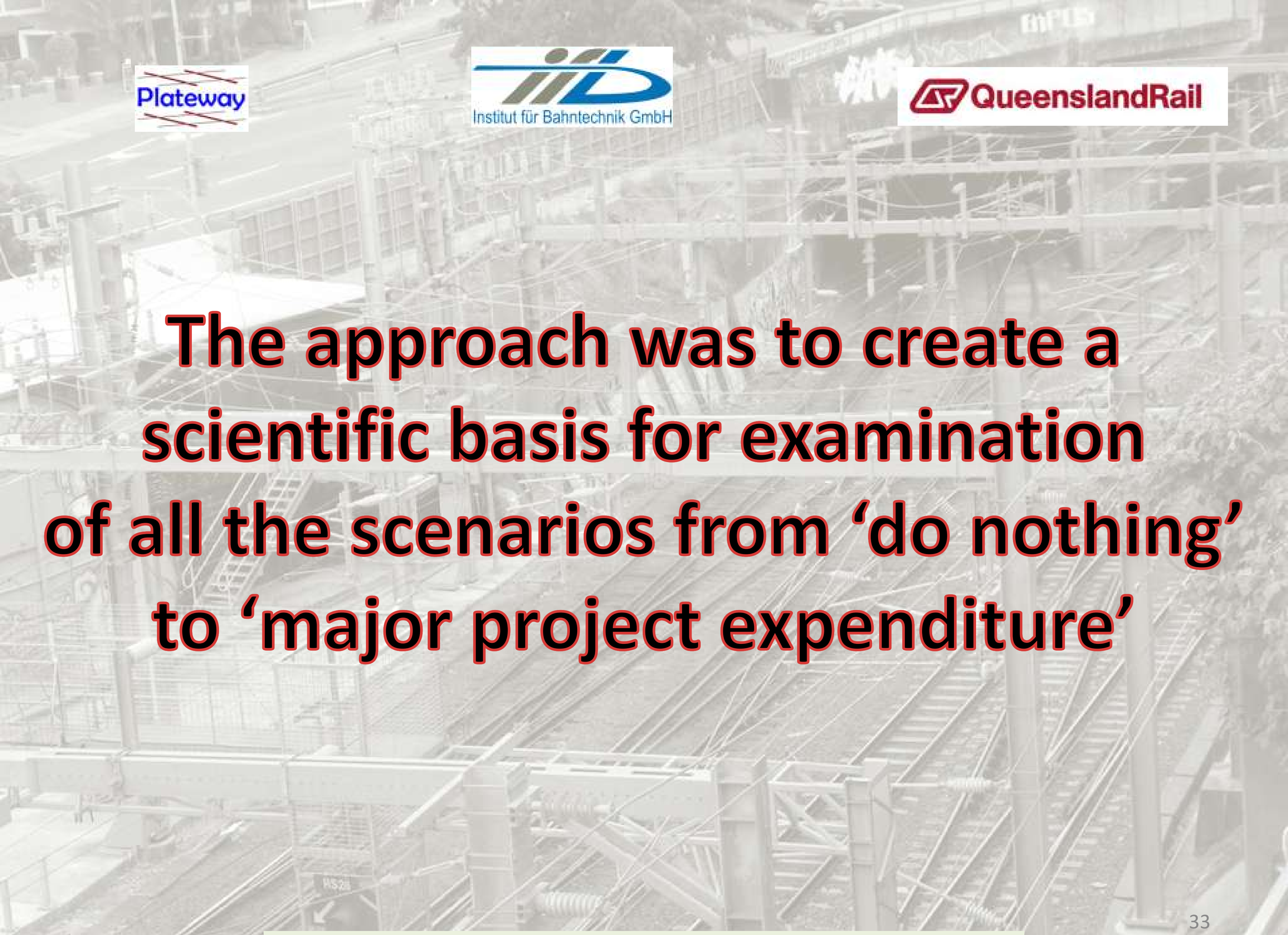
Varsity Lakes
To Gold Coast Airport

All of these projects revisit the question 'Can the existing infrastructure cope?'

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

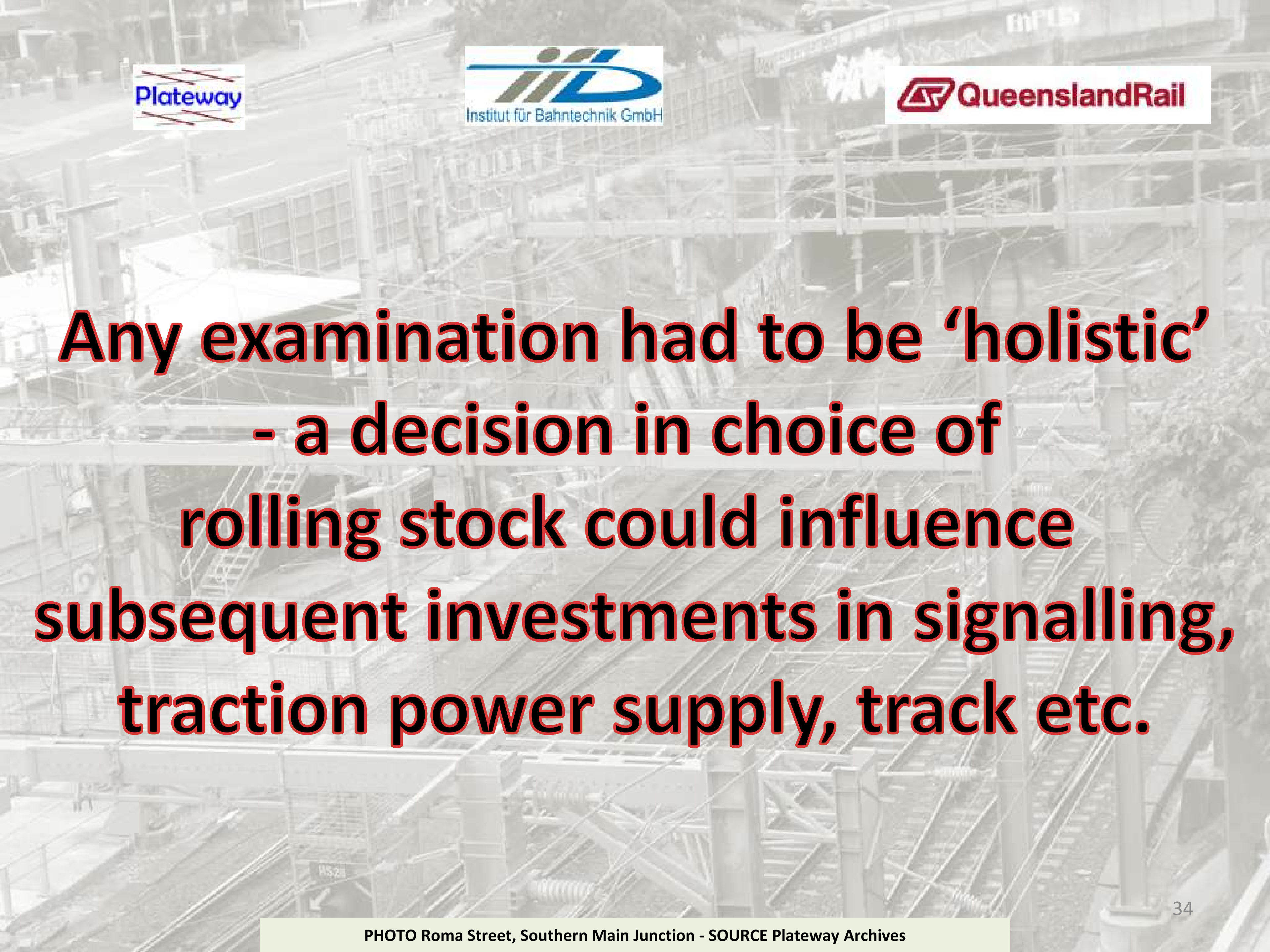
Queensland Rail decided to remove speculation from the decision making

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives



The approach was to create a scientific basis for examination of all the scenarios from ‘do nothing’ to ‘major project expenditure’

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives



Any examination had to be ‘holistic’ - a decision in choice of rolling stock could influence subsequent investments in signalling, traction power supply, track etc.

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

Queensland Rail opted for a solution based on computer modelling

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

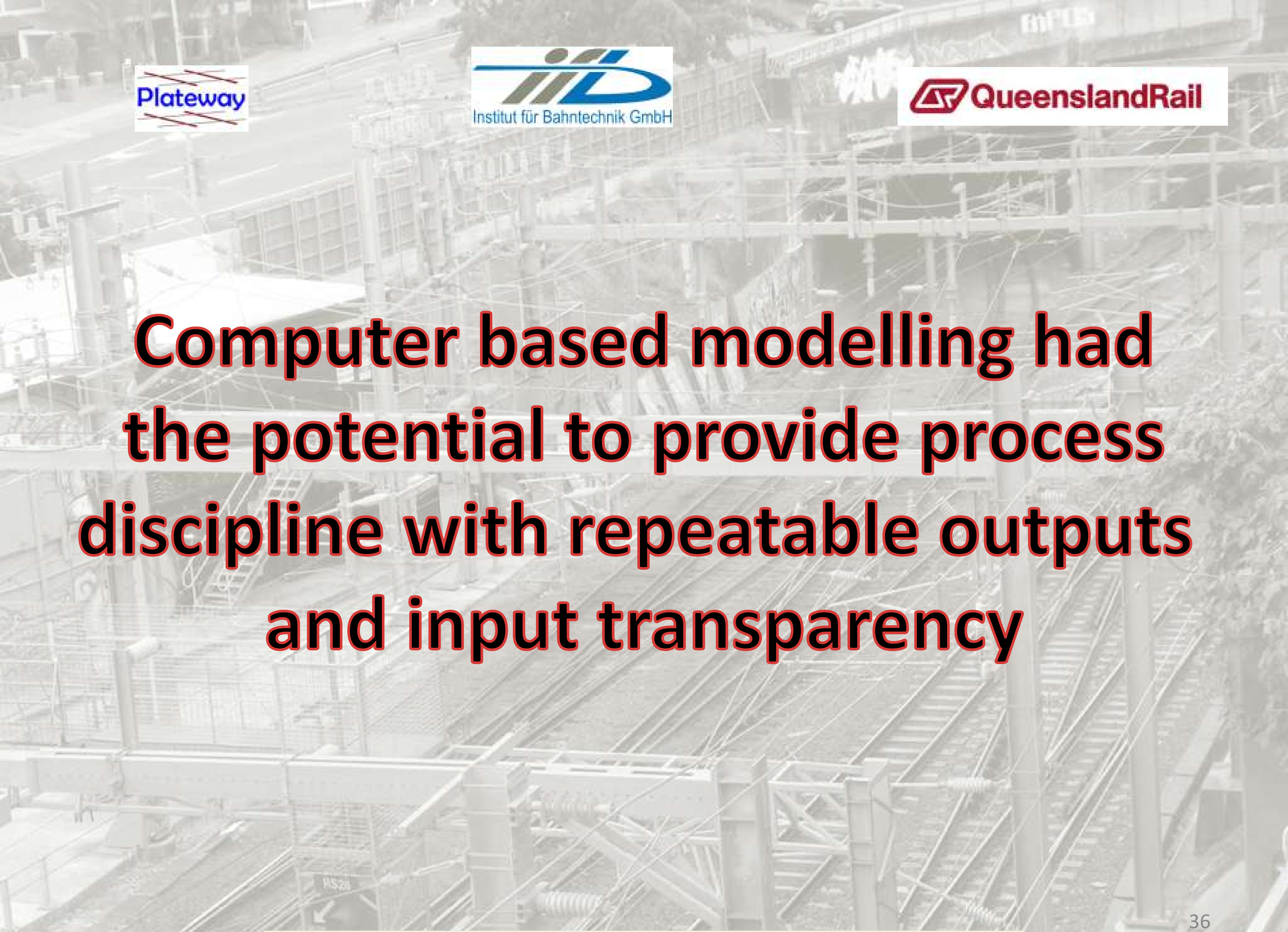


PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

Queensland Rail decided to seek bids for suppliers of software that could be used to create a 'holistic' model of the SEQ rail network

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

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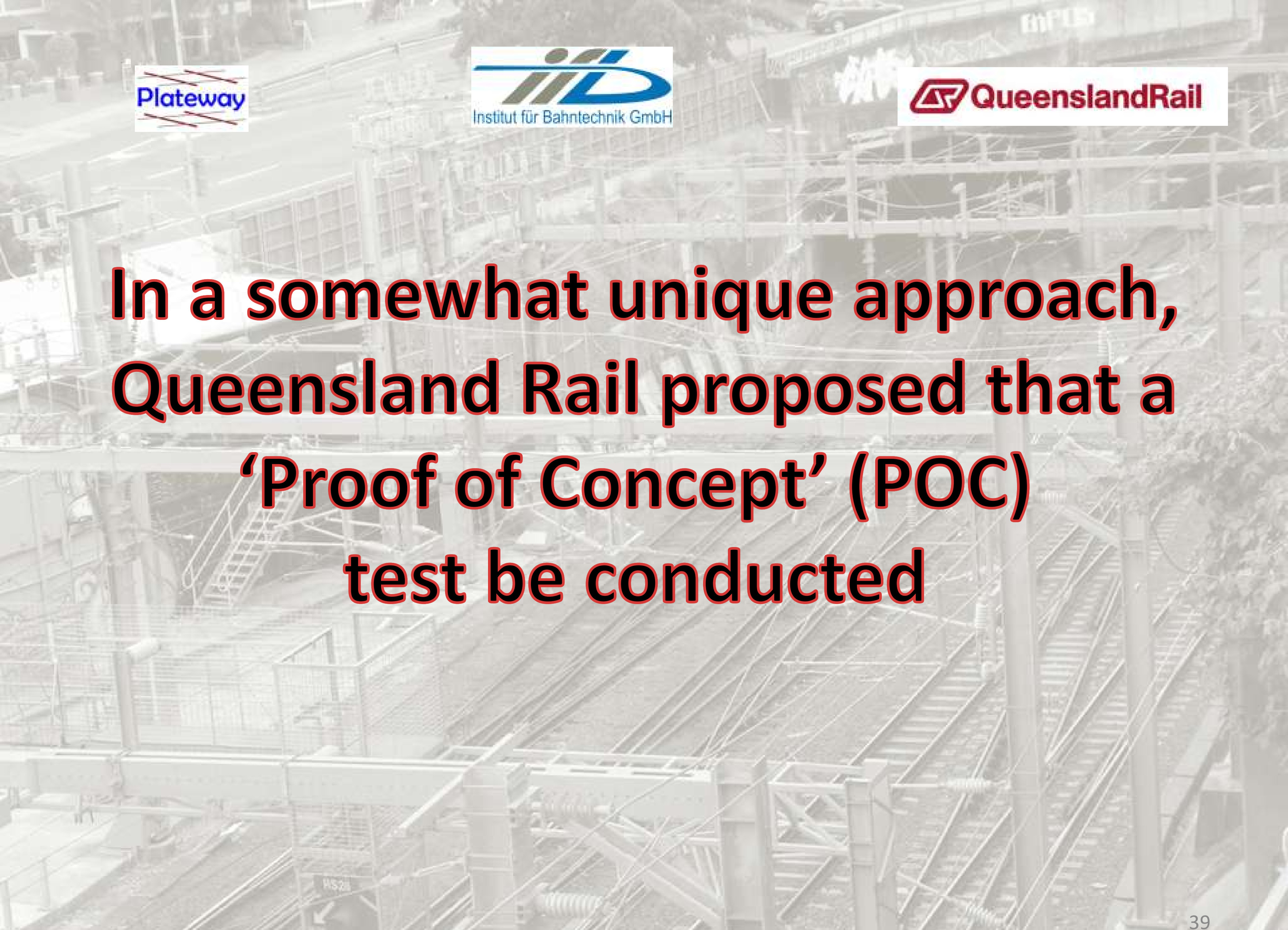
An Australian company, Plateway Pty. Limited was selected to provide the software based on established software solutions used in international applications

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives



In a somewhat unique approach, Queensland Rail proposed that a 'Proof of Concept' (POC) test be conducted

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

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If the software could be demonstrated to meet test criteria set by Queensland Rail, then Queensland Rail would proceed with an order for the software

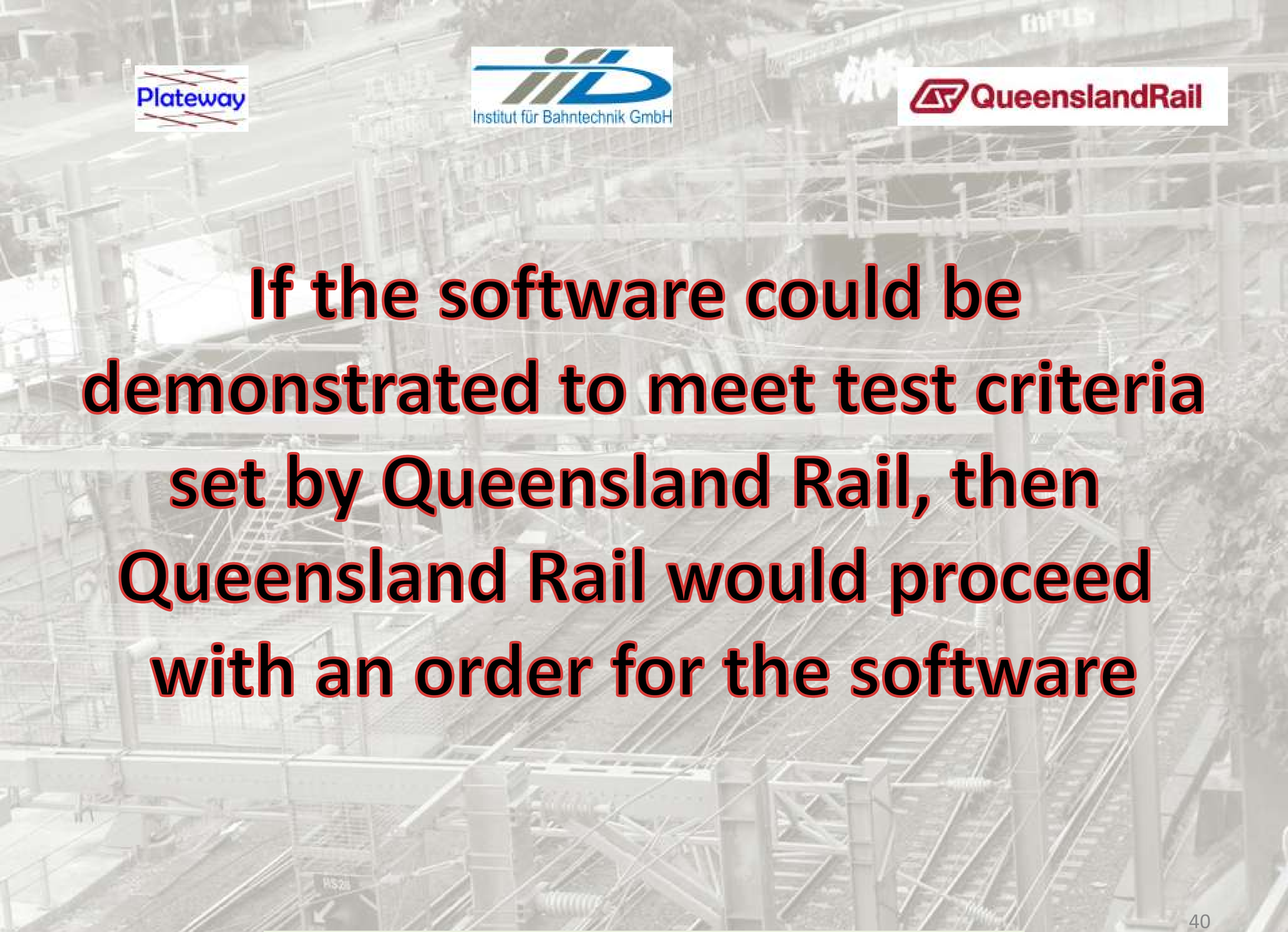

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

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QueenslandRail

If the software did not meet the test criteria then Queensland Rail would not proceed with an order for the software

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

The challenge was accepted

PHOTO Roma Street, Southern Main Junction - SOURCE Plateway Archives

Proof of Concept Test

PHOTO: Roma Street, Western approach adjacent to Feeder Station- SOURCE: Plateway Archives

Queensland Rail devised benchmarks for the Proof of Concept test (POC) based on operations on the Cleveland Line

PHOTO: Roma Street, Western approach adjacent to Feeder Station- SOURCE: Plateway Archives

The Cleveland Line

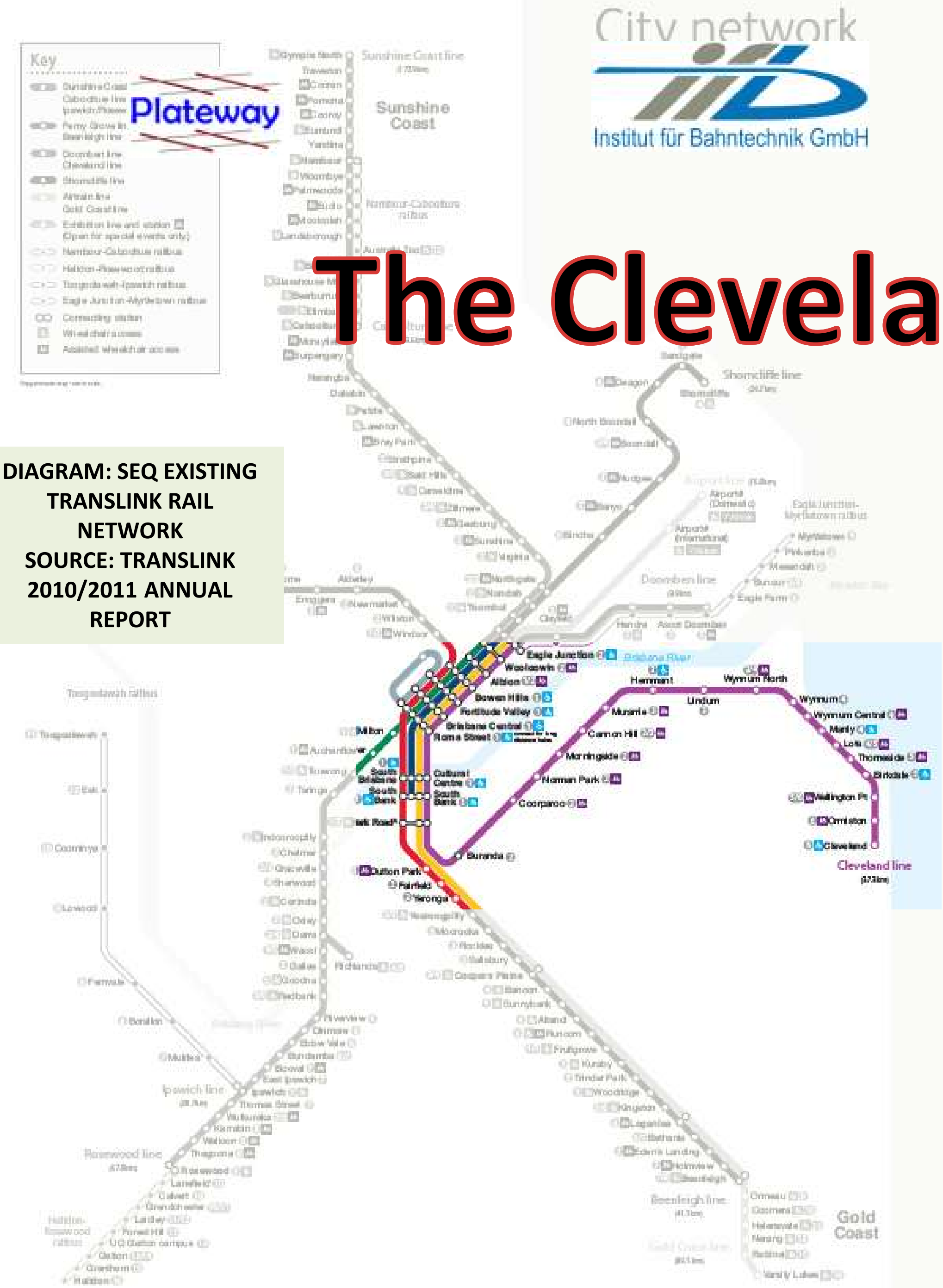
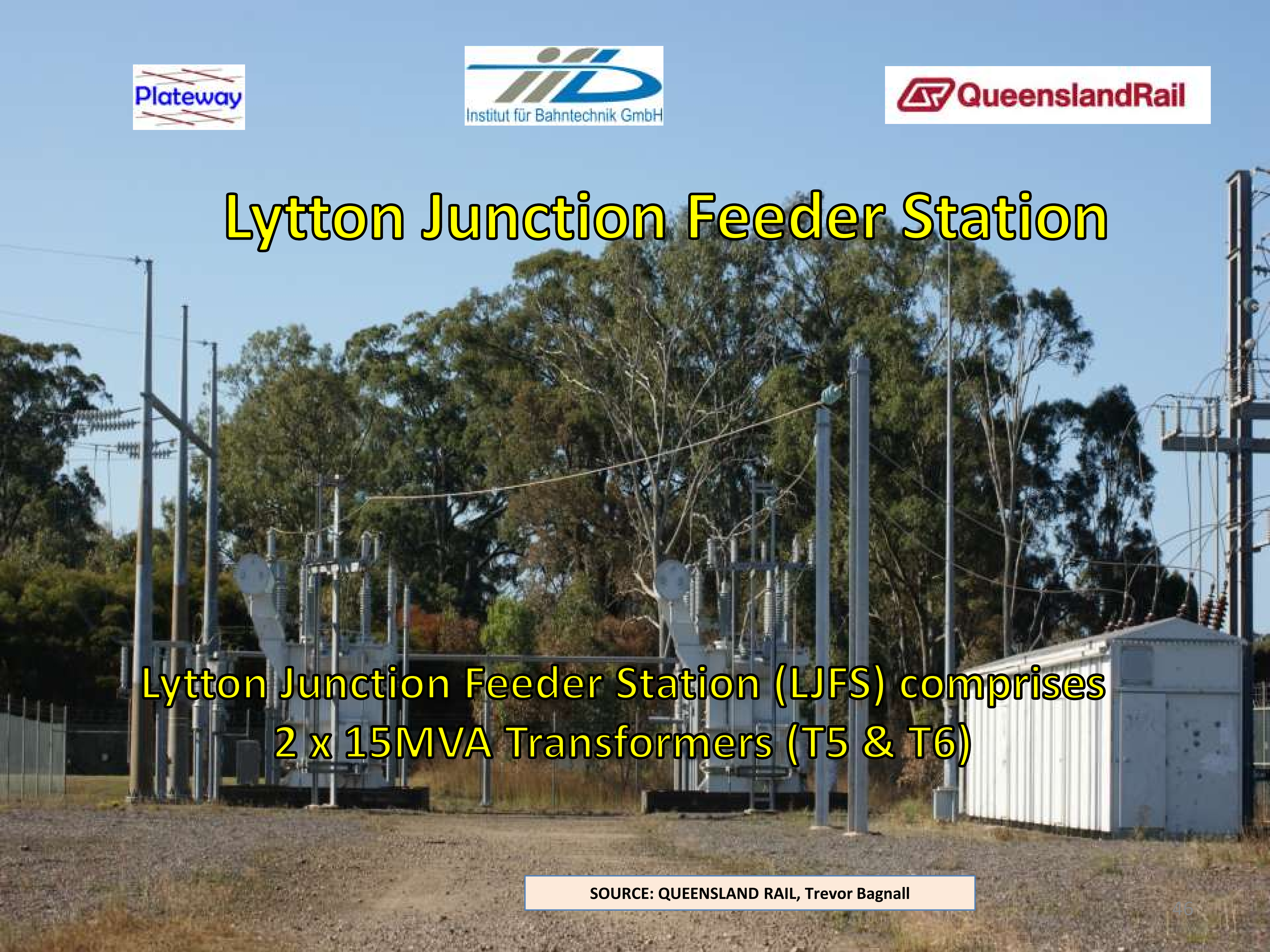


DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK 2010/2011 ANNUAL REPORT

- 32.3kms from branch datum at Park Road
- Double track Park Road to Manly
- Single track Manly to Cleveland

Lytton Junction Feeder Station



Lytton Junction Feeder Station (LJFS) comprises
2 x 15MVA Transformers (T5 & T6)

SOURCE: QUEENSLAND RAIL, Trevor Bagnall

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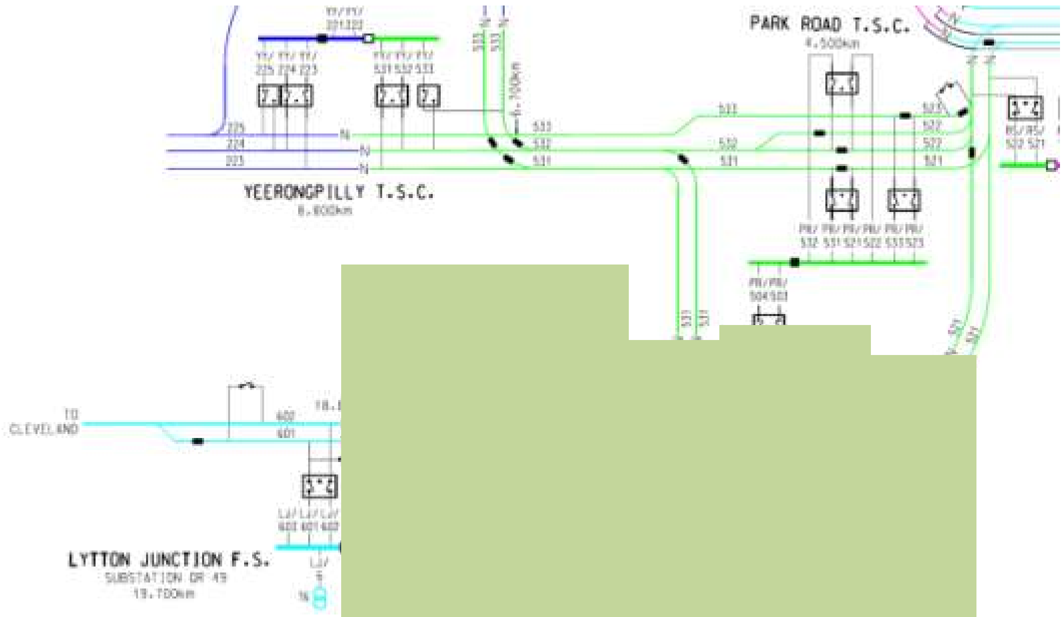
DIAGRAM: EXTRACT FROM SEQ RAIL NETWORK ELECTRICAL SECTIONING DIAGRAM SOURCE: QUEENSLAND RAIL



For the POC test Transformer LJFS – T5 supplied the double track section from Lytton Junction to Park Road

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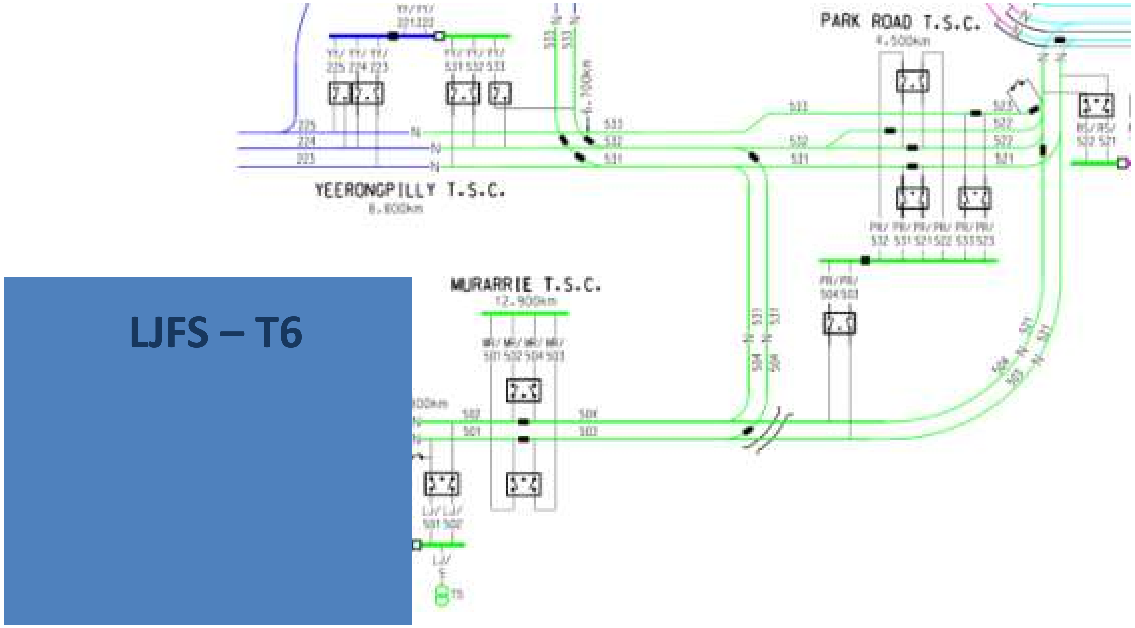
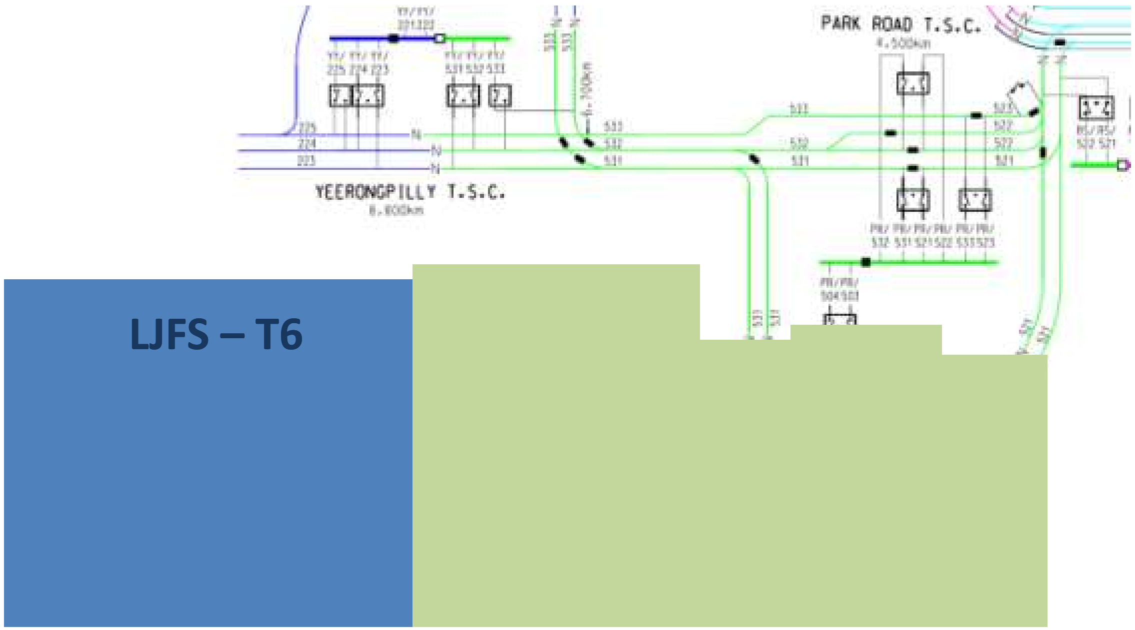
DIAGRAM:
EXTRACT FROM
SEQ RAIL
NETWORK
ELECTRICAL
SECTIONING
DIAGRAM
SOURCE:
QUEENSLAND RAIL



Transformer LJFS – T6 supplied the double track section from Lytton Junction to Manly and the single track section from Manly to Cleveland

DIAGRAM: EXTRACT FROM SEQ RAIL NETWORK ELECTRICAL SECTIONING DIAGRAM SOURCE: QUEENSLAND RAIL



South Coast Line section normally supplied from Lytton Junction FS was supplied from Roma Street FS during POC test

For the POC test, instrumentation was fitted at LJFS and at the electrical section extremities at Park Road and Cleveland

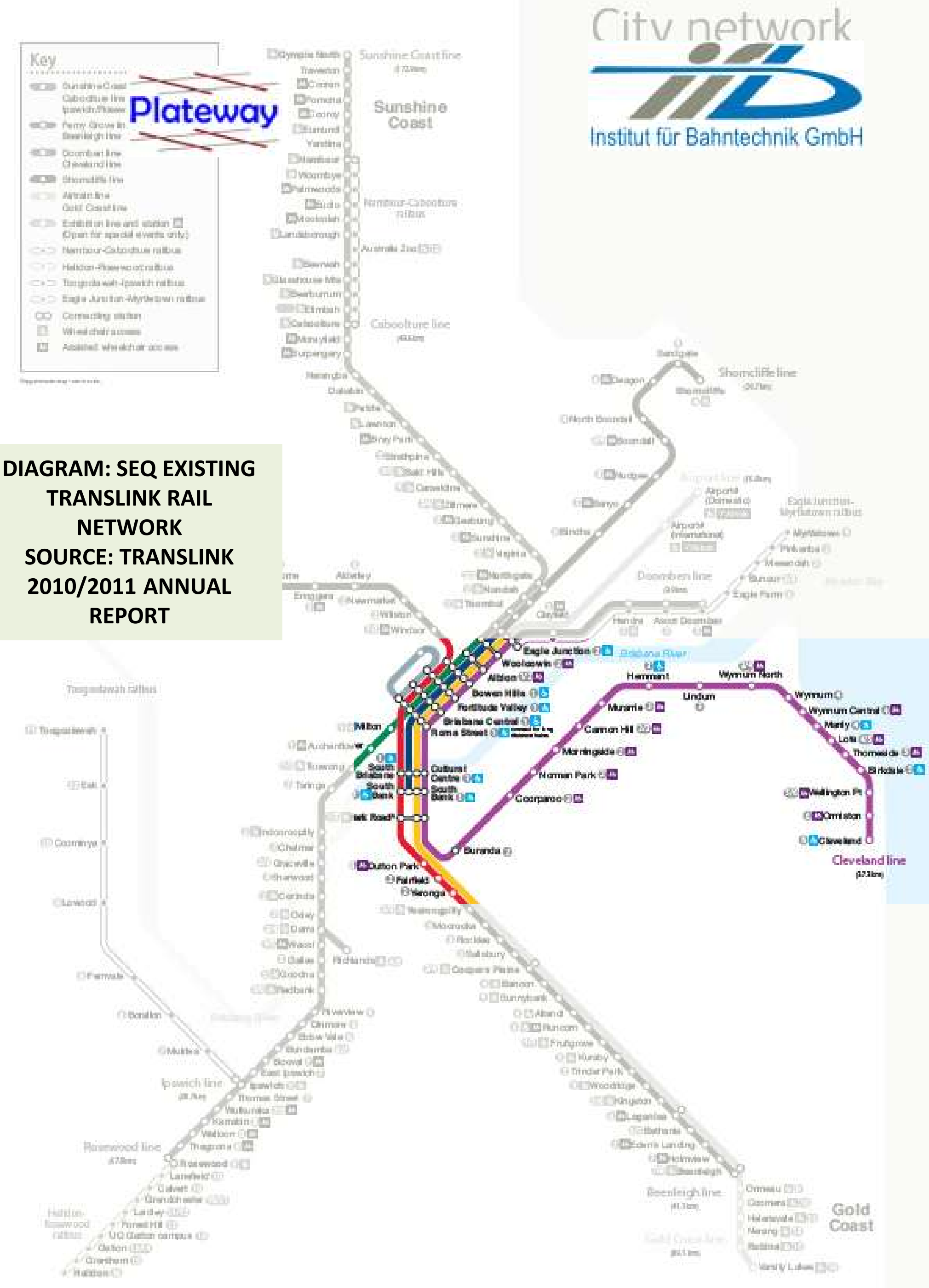


DIAGRAM: SEQ EXISTING TRANSLINK RAIL NETWORK
SOURCE: TRANSLINK 2010/2011 ANNUAL REPORT

Train operations on the Cleveland Line were monitored using data generated by the signalling system

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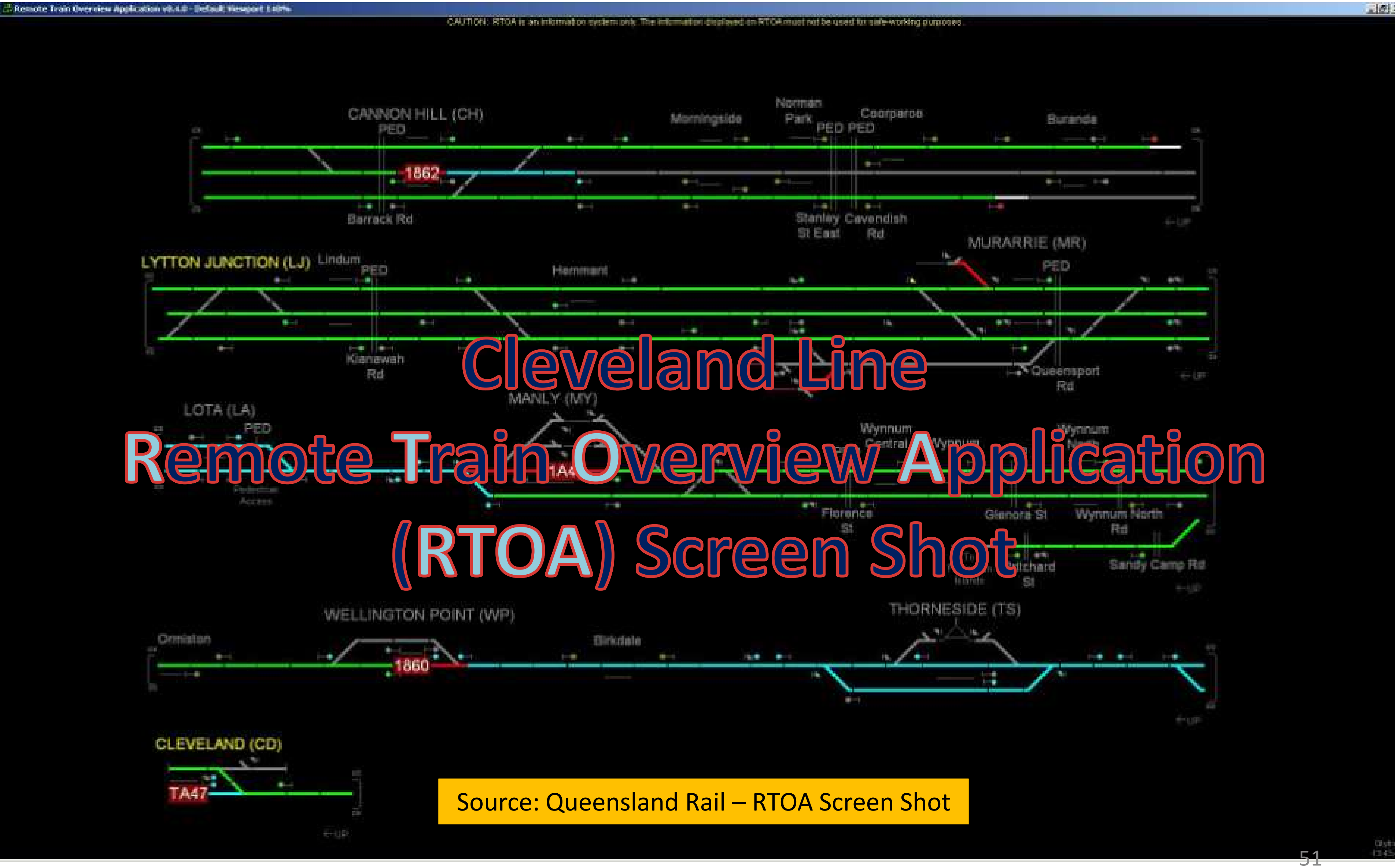
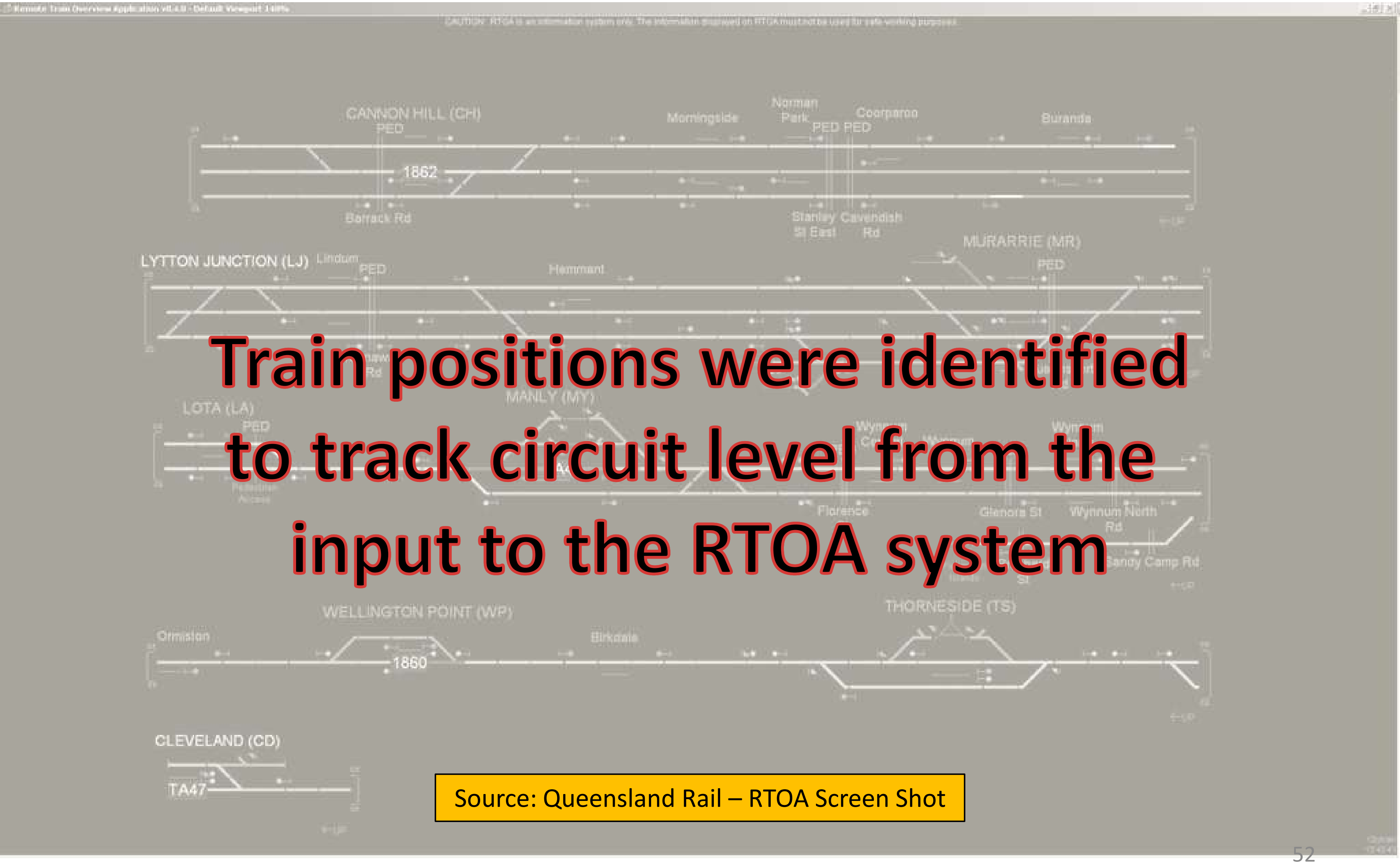
Cleveland Line

Remote Train Overview Application (RTOA) Screen Shot



Source: Queensland Rail – RTOA Screen Shot

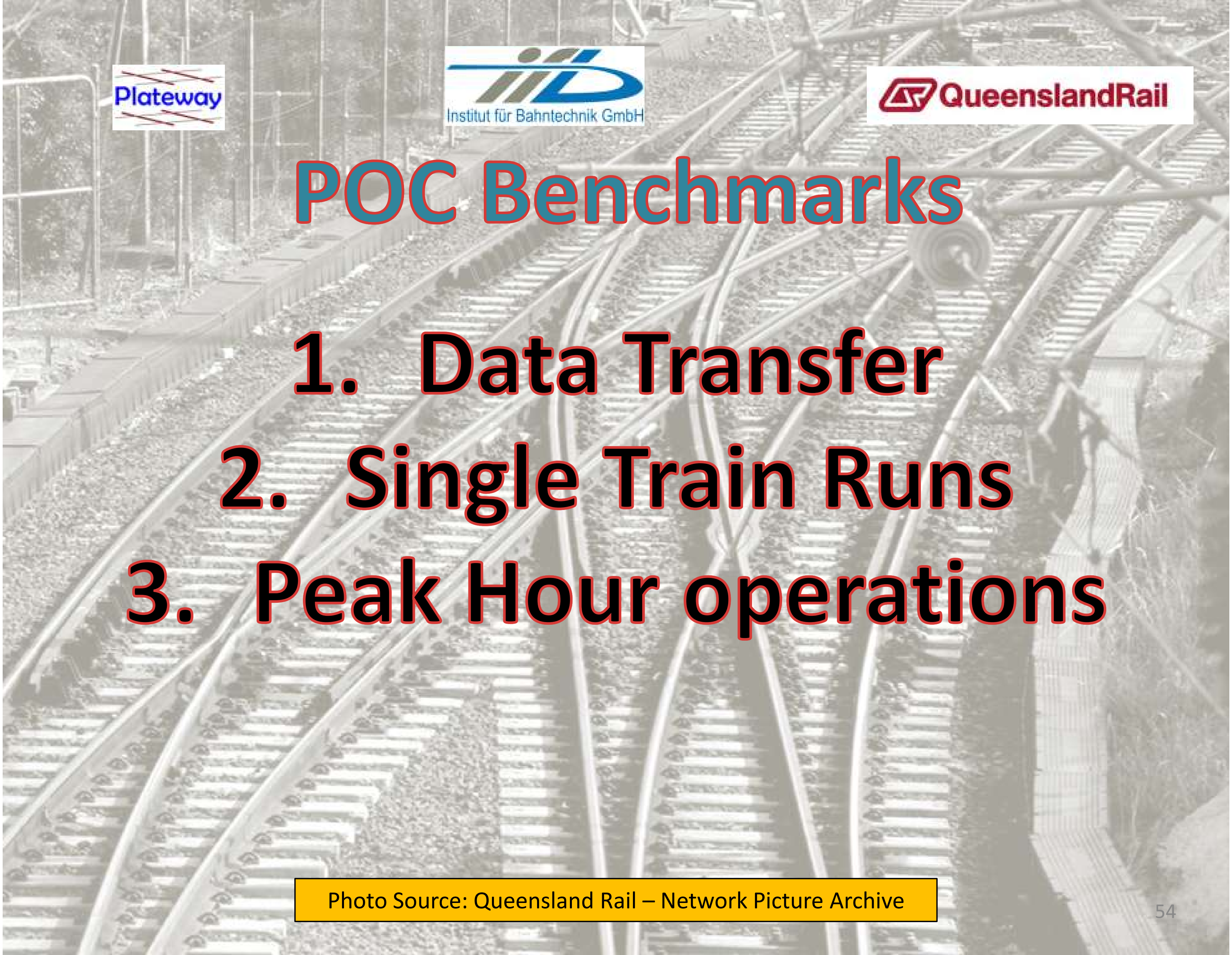
Train positions were identified to track circuit level from the input to the RTOA system



Source: Queensland Rail – RTOA Screen Shot

POC Benchmarks

Photo Source: Queensland Rail – Network Picture Archive



POC Benchmarks

1. Data Transfer
2. Single Train Runs
3. Peak Hour operations

Photo Source: Queensland Rail – Network Picture Archive

POC Benchmarks

1. Data Transfer

Demonstrate that the proposed software could exchange data electronically with the existing Queensland Rail Simulation systems

Photo Source: Queensland Rail – Network Picture Archive

POC Benchmarks

1. Data Transfer

The data transfer capability from the existing Queensland Rail simulation tools for Timetables and Infrastructure was demonstrated in the first days of the project

Photo Source: Queensland Rail – Network Picture Archive

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POC Benchmarks

2. Single Train Runs

Benchmark Summary	Result
Operate instrumented test trains from Park Road to Cleveland & return (approx. 3 return trips with the first trip for calibration purposes)	
Maximum variation between actual and simulated train run times to be less than 2 minutes	
The simulated energy for each single train run would have a variation of less than 8% of that measured at Lytton Junction Feeder Station busbars.	

Photo Source: Queensland Rail – Network Picture Archive

POC Benchmarks

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Photo Source: Queensland Rail – Network Picture Archive

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POC Benchmarks

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Photo Source: Queensland Rail – Network Picture Archive

POC Benchmarks

3. Peak Hour operations

Benchmark Summary	Result
5 days of morning peak (6am to 10am) on the Cleveland Line	
Train Graph used for comparison between actual and simulated train running for each of the 5 days.	
The simulated energy for each day will have a variation of less than 10% of that measured at Lytton Junction Feeder Station busbars.	

Photo Source: Queensland Rail – Network Picture Archive

POC Benchmarks

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Photo Source: Queensland Rail – Network Picture Archive

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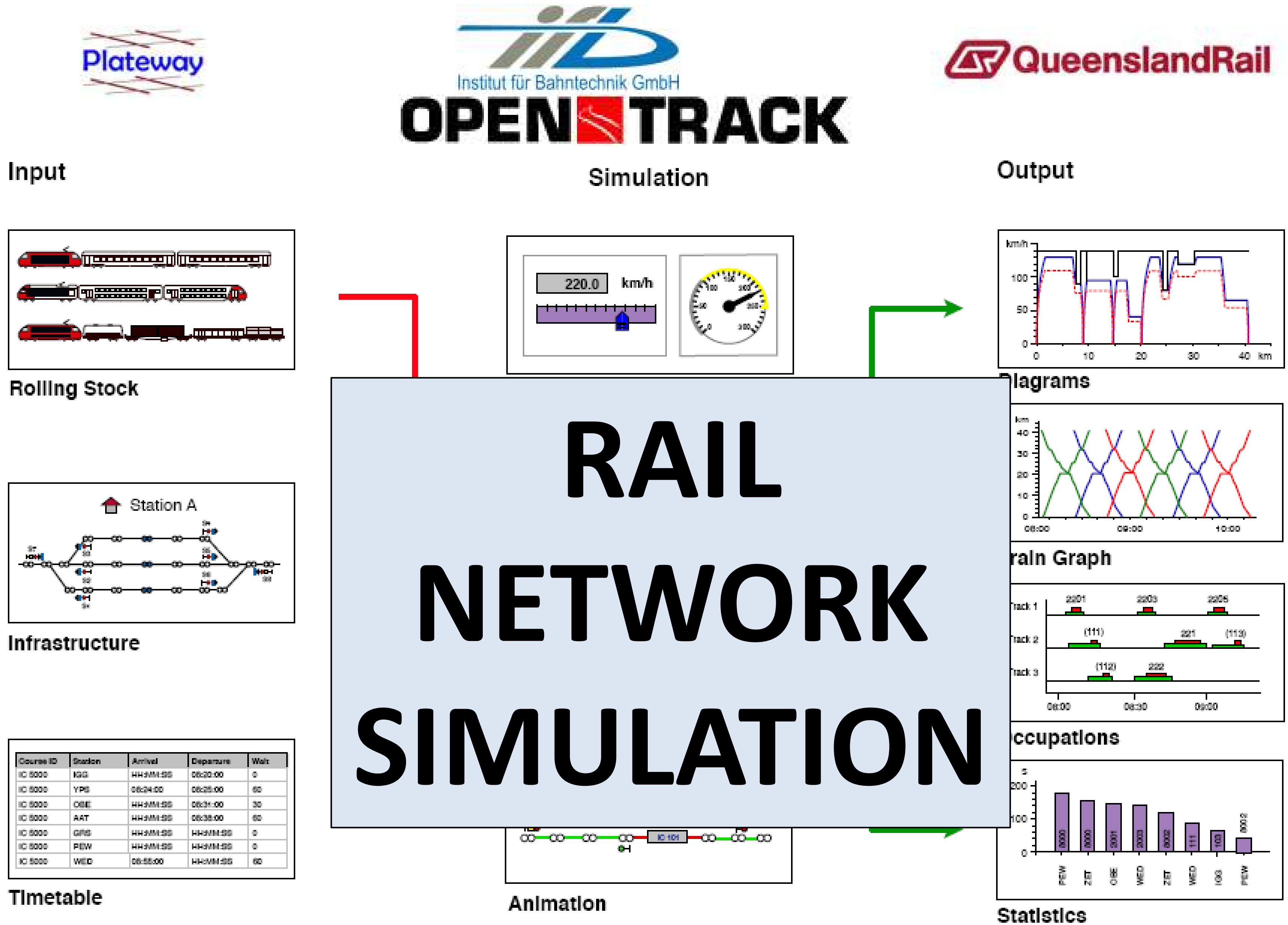
The Software solution chosen by Queensland Rail for the holistic Rail Network Simulation

Photo Source: Queensland Rail – Network Picture Archive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OPEN TRACK
QueenslandRail
Input
Simulation
Output
Rolling Stock
Station A
Infrastructure
Timetable
220.0 km/h
Animation
Diagrams
Train Graph
Occupations
Statistics
RAIL
NETWORK
SIMULATION

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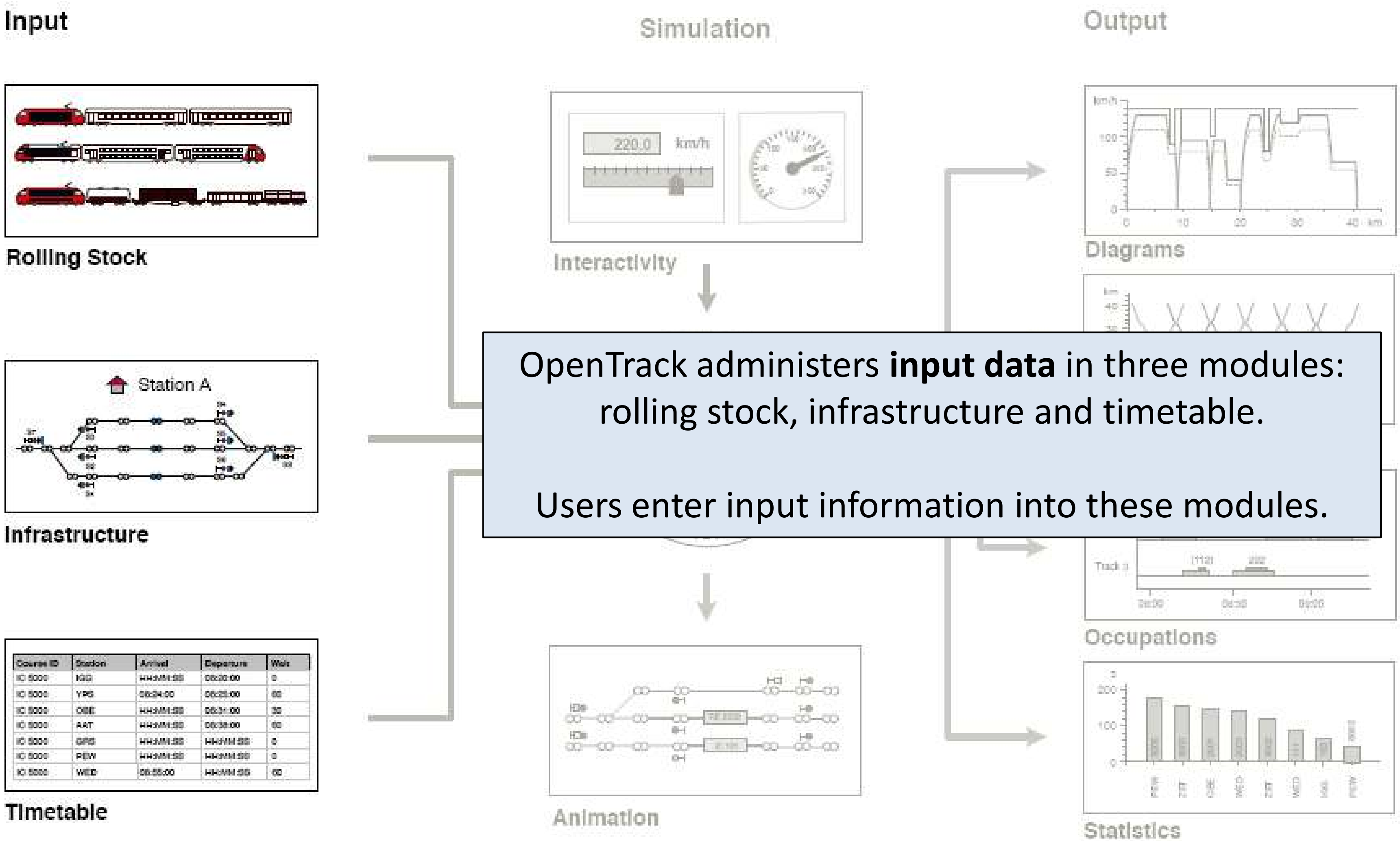

OpenTrack administers **input data** in three modules: rolling stock, infrastructure and timetable.

Users enter input information into these modules.

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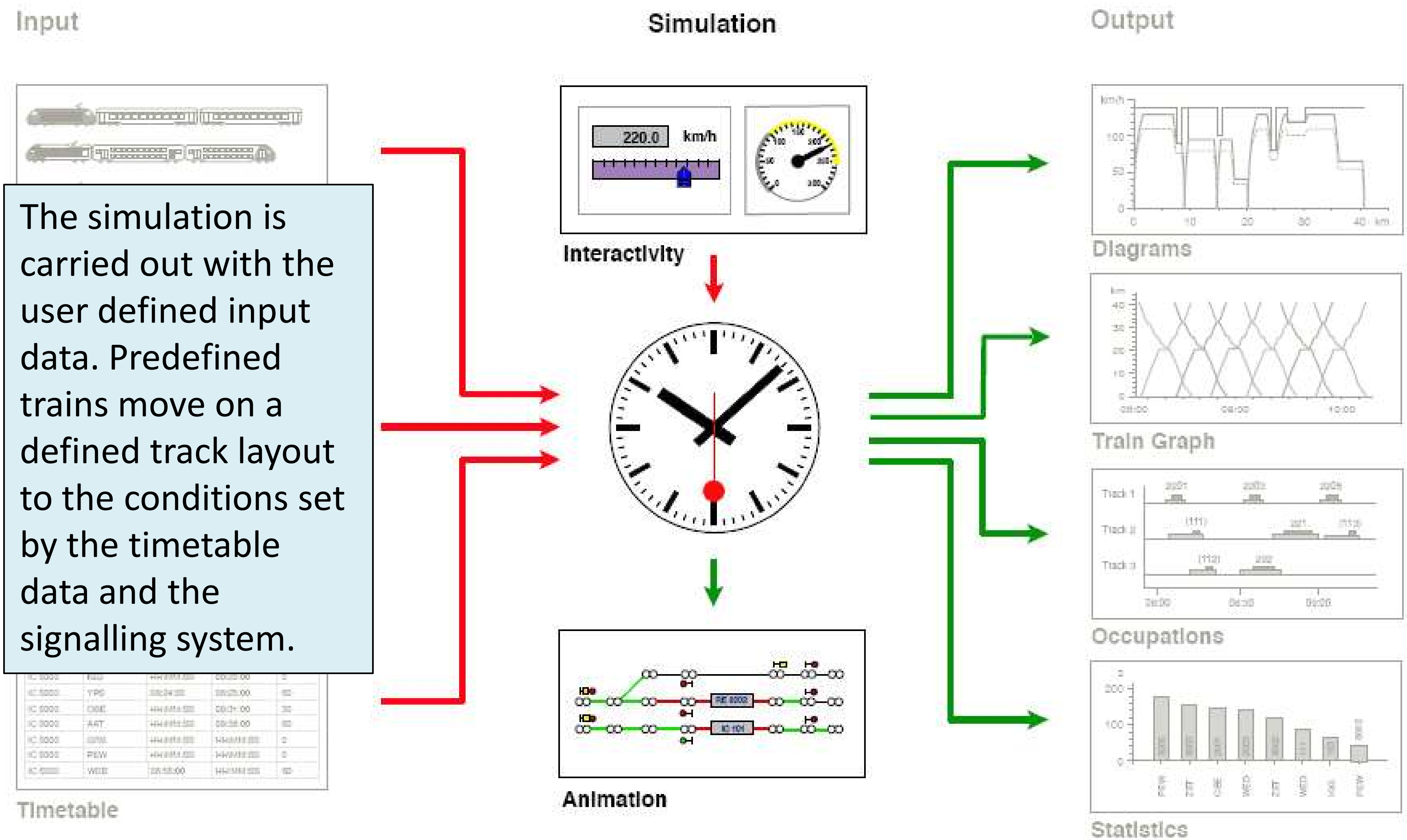
OPEN TRACK

QueenslandRail



The simulation is carried out with the user defined input data. Predefined trains move on a defined track layout to the conditions set by the timetable data and the signalling system.

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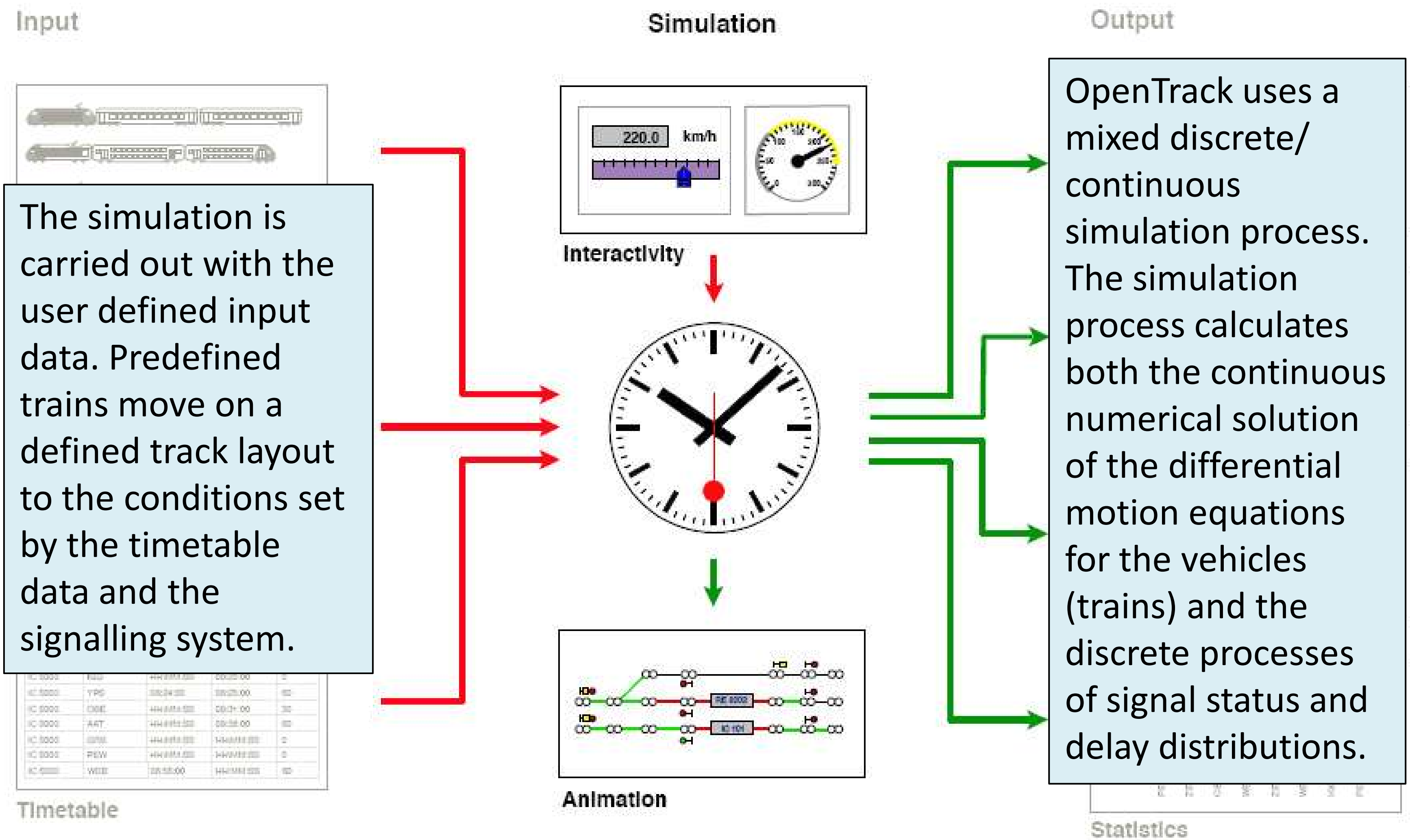
OPEN TRACK

QueenslandRail



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OpenTrack uses a mixed discrete/ continuous simulation process. The simulation process calculates both the continuous numerical solution of the differential motion equations for the vehicles (trains) and the discrete processes of signal status and delay distributions.

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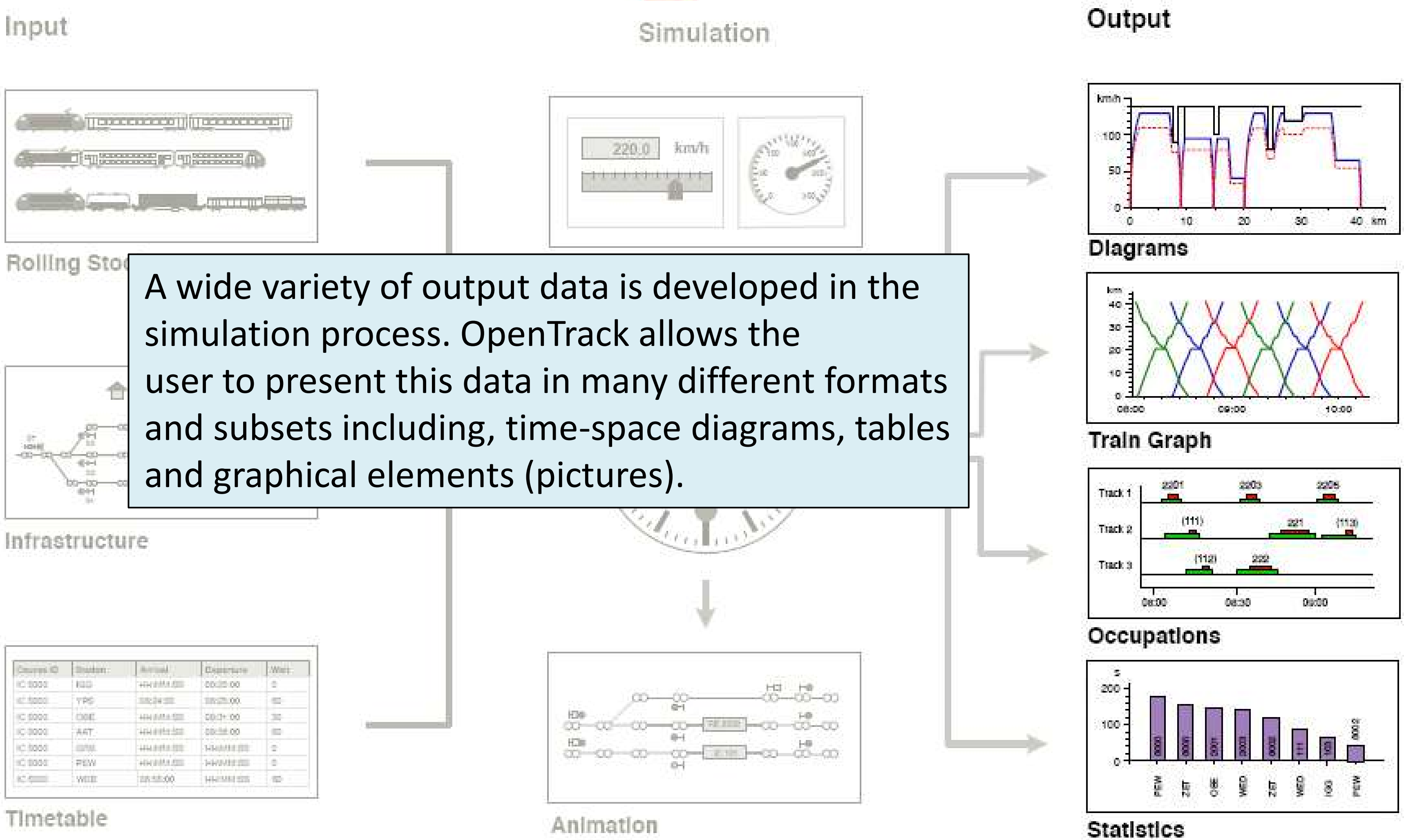

A wide variety of output data is developed in the simulation process. OpenTrack allows the user to present this data in many different formats and subsets including, time-space diagrams, tables and graphical elements (pictures).

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Simulation Sequence per Time Step

Tra

R

OPENPOWERNET RAIL ELECTRICAL NETWORK SIMULATION

OpenPowerNet

Line Voltage, Requested Effort

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Separation of Simulation Tasks

Railway Operation

- Line routing and alignment
- Track layout
- Signalling system
- Train data
- Timetable
- Connecting conditions
- Operating rules

OPENTRACK

Plug-in

Load Flow and Energy

- Train propulsion data
- Power grid parameter
- Substation arrangement
- Feeder lines and cables
- Catenary system
- Earthing system
- Switch status

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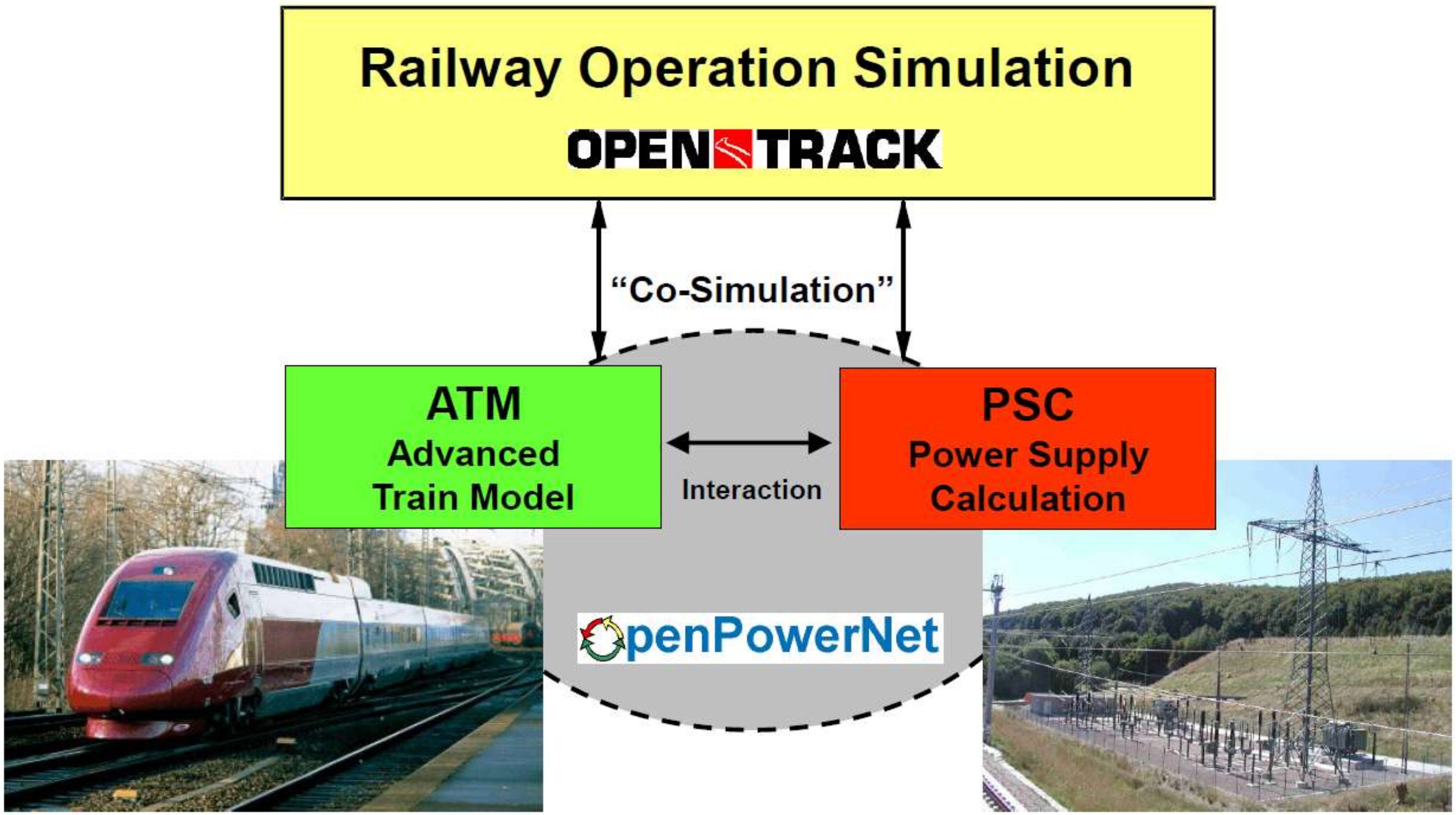
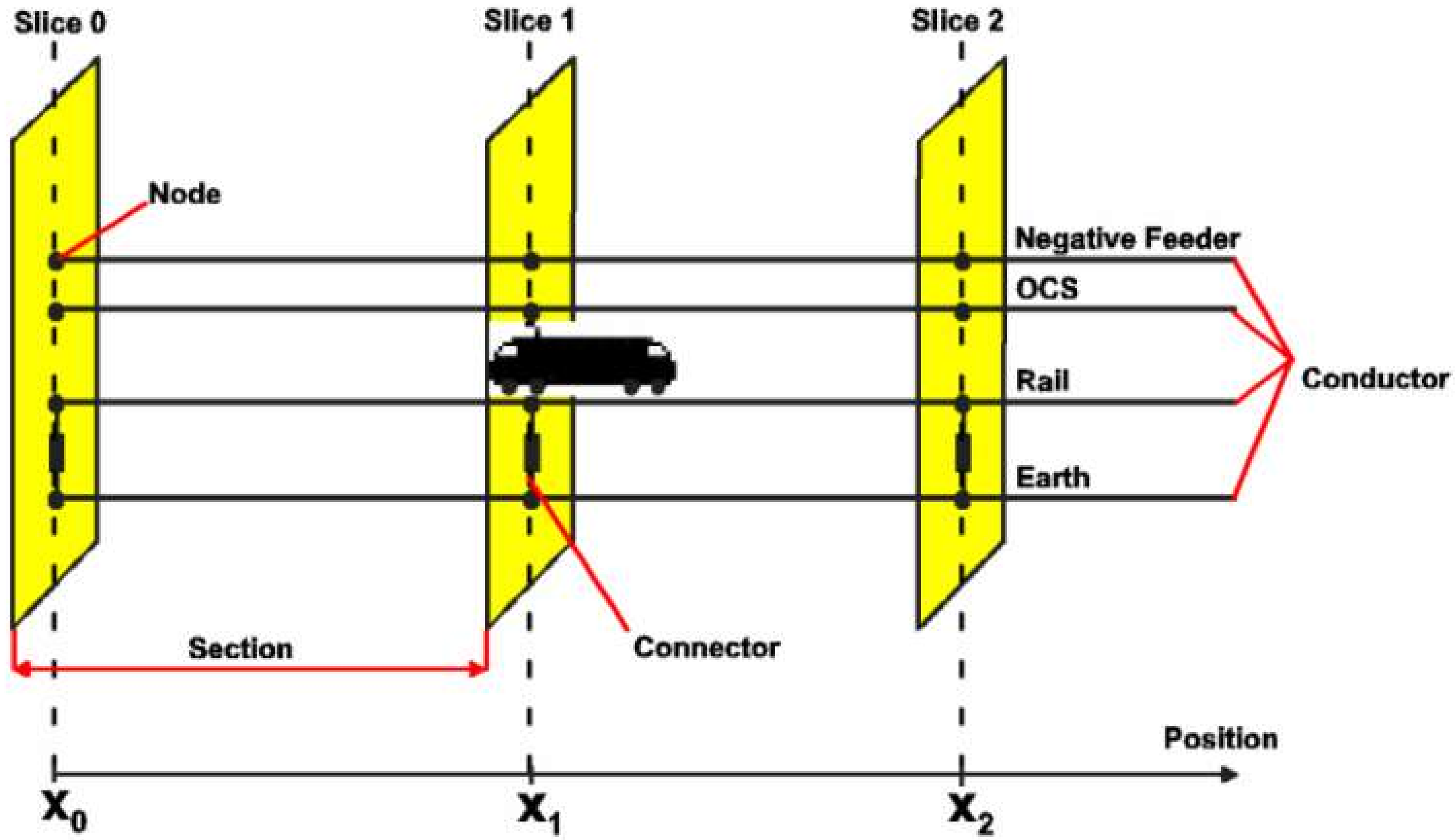


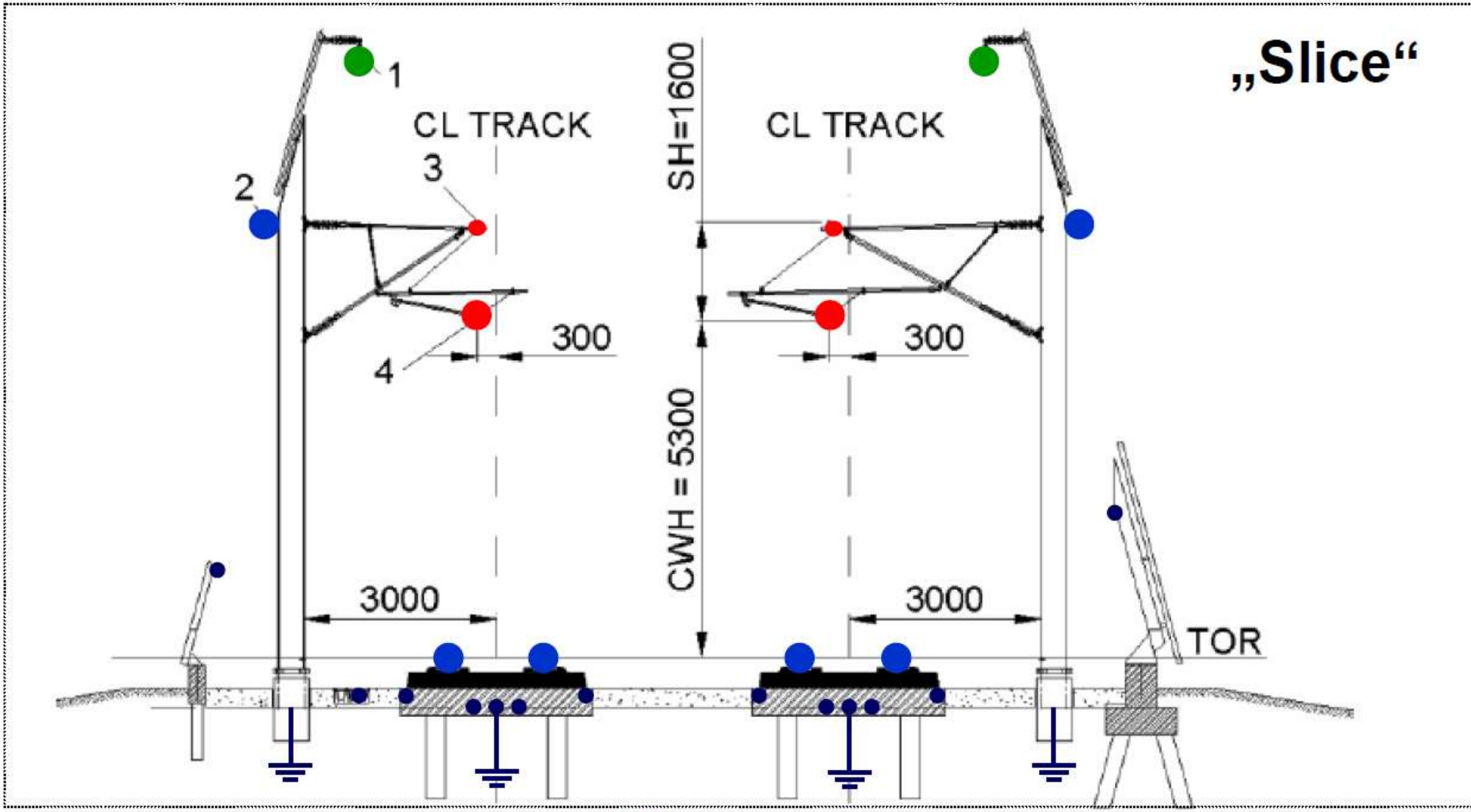
Propulsion Technology

Power Supply System

Sequence of Slices

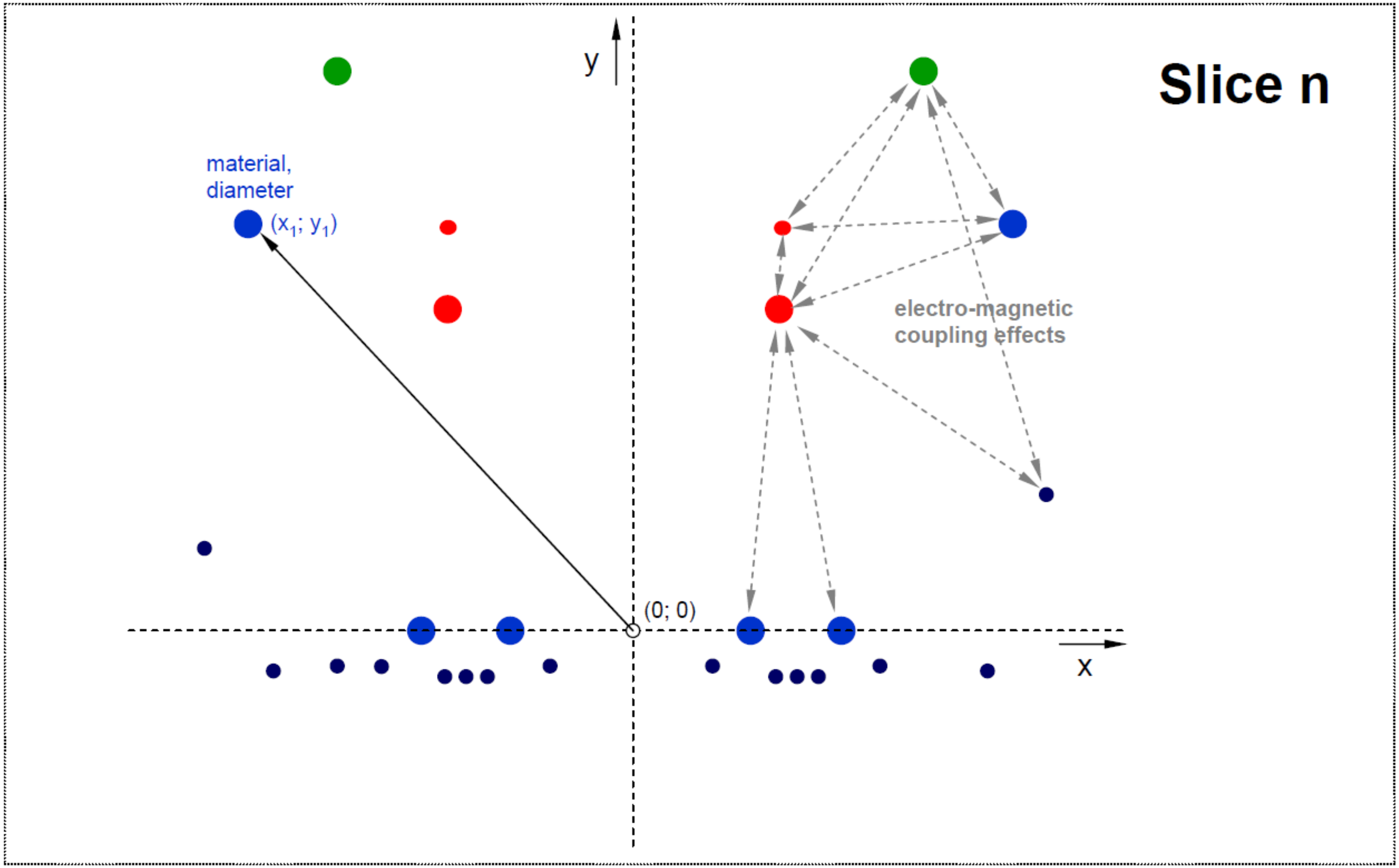


Catenary Arrangement and Conductor Model



CWH Contact wire height
SH System height
Negative Feeder
Return conductor
Messenger wire
Contact wire

Catenary Arrangement and Conductor Model



POC Single Train Runs
January 30th and 31st 2012

Photo Source: Plateway Archives

Plateway

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QueenslandRail

The single train test runs were after the last and before the first, passenger train service

Photo Source: Plateway Archives

All single train runs were carried out with SMU 260 Class rolling stock in 2 x 3 Car configurations

The SMU 260 class was chosen because of the onboard instrumentation and data logging capability.

The schedule for the test trains were based on normal service times.

Photo Source: Plateway Archives

Plateway

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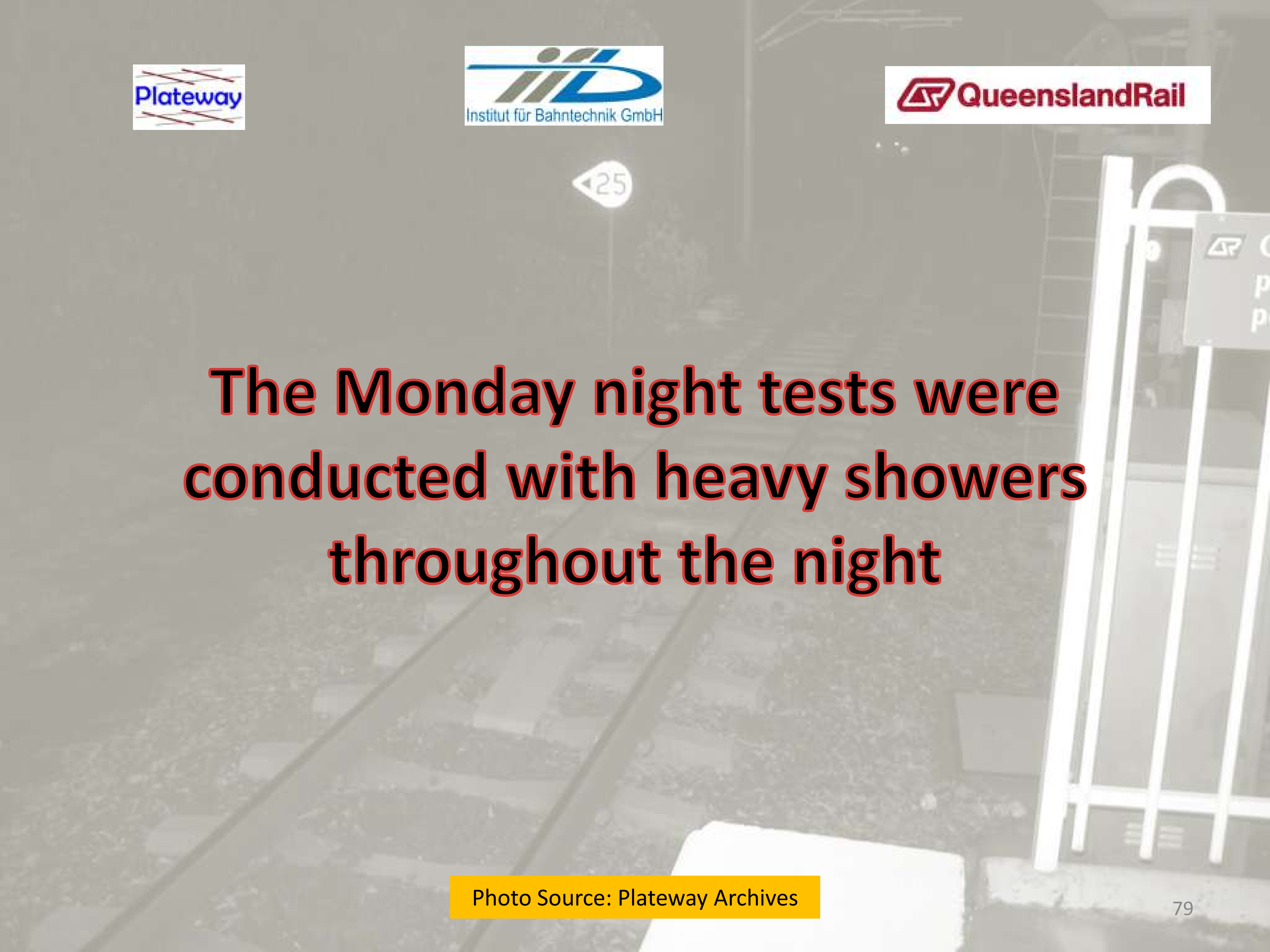

The Monday night tests were conducted with heavy showers throughout the night

Photo Source: Plateway Archives

Plateway

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The Tuesday night tests were conducted with mainly dry track with a light shower prior to our trip on the section from Manly to Cleveland

Photo Source: Plateway Archives

Plateway

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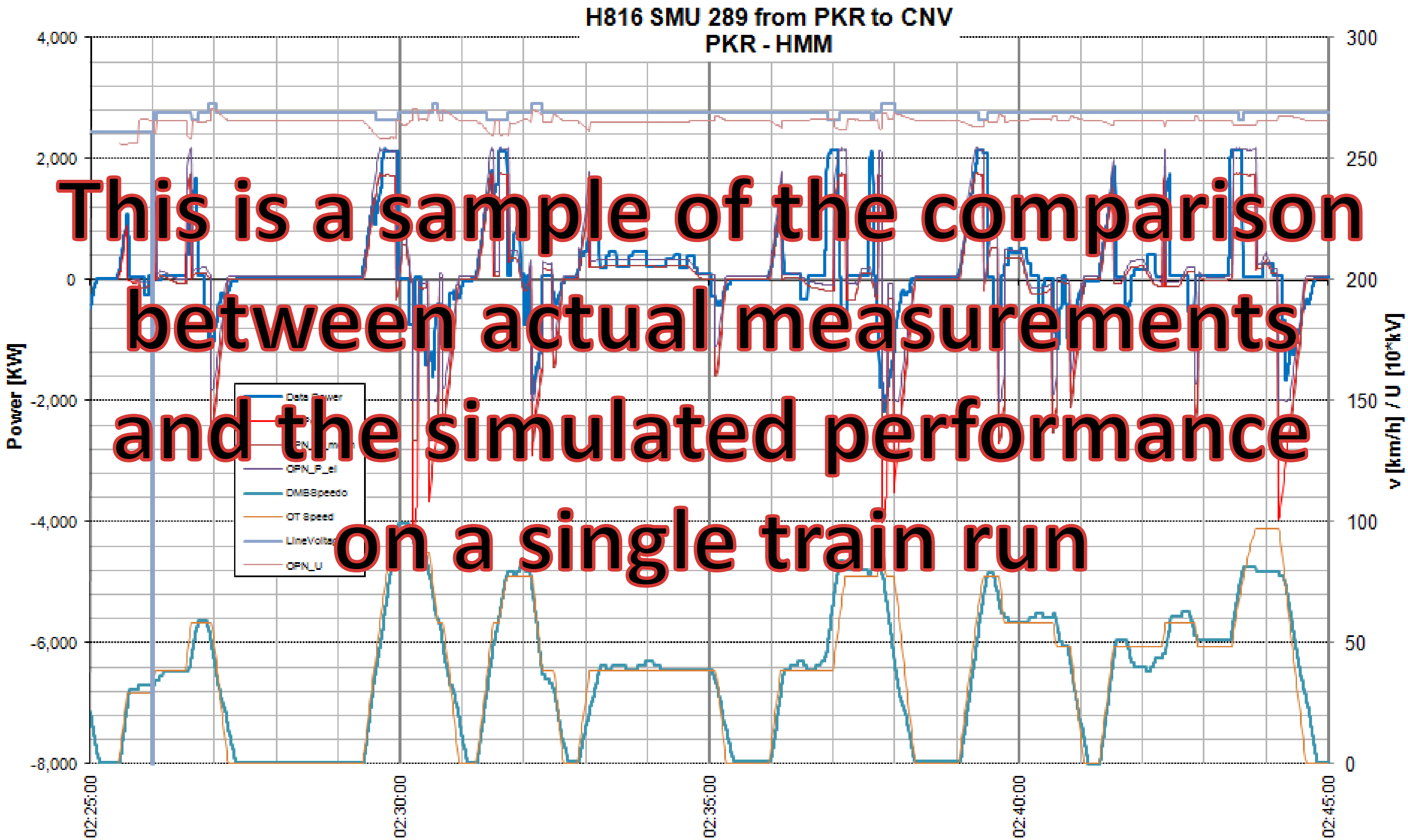
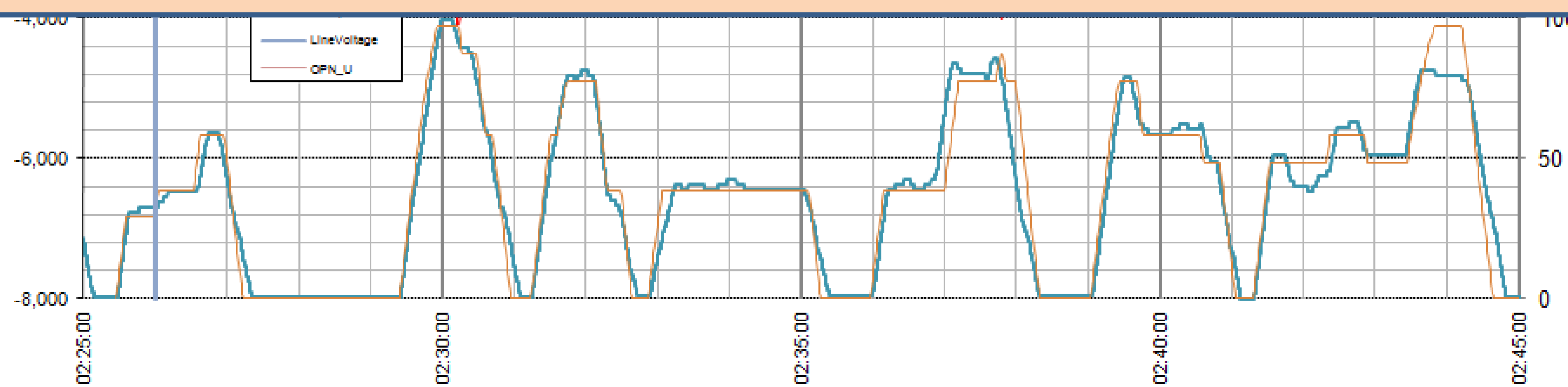
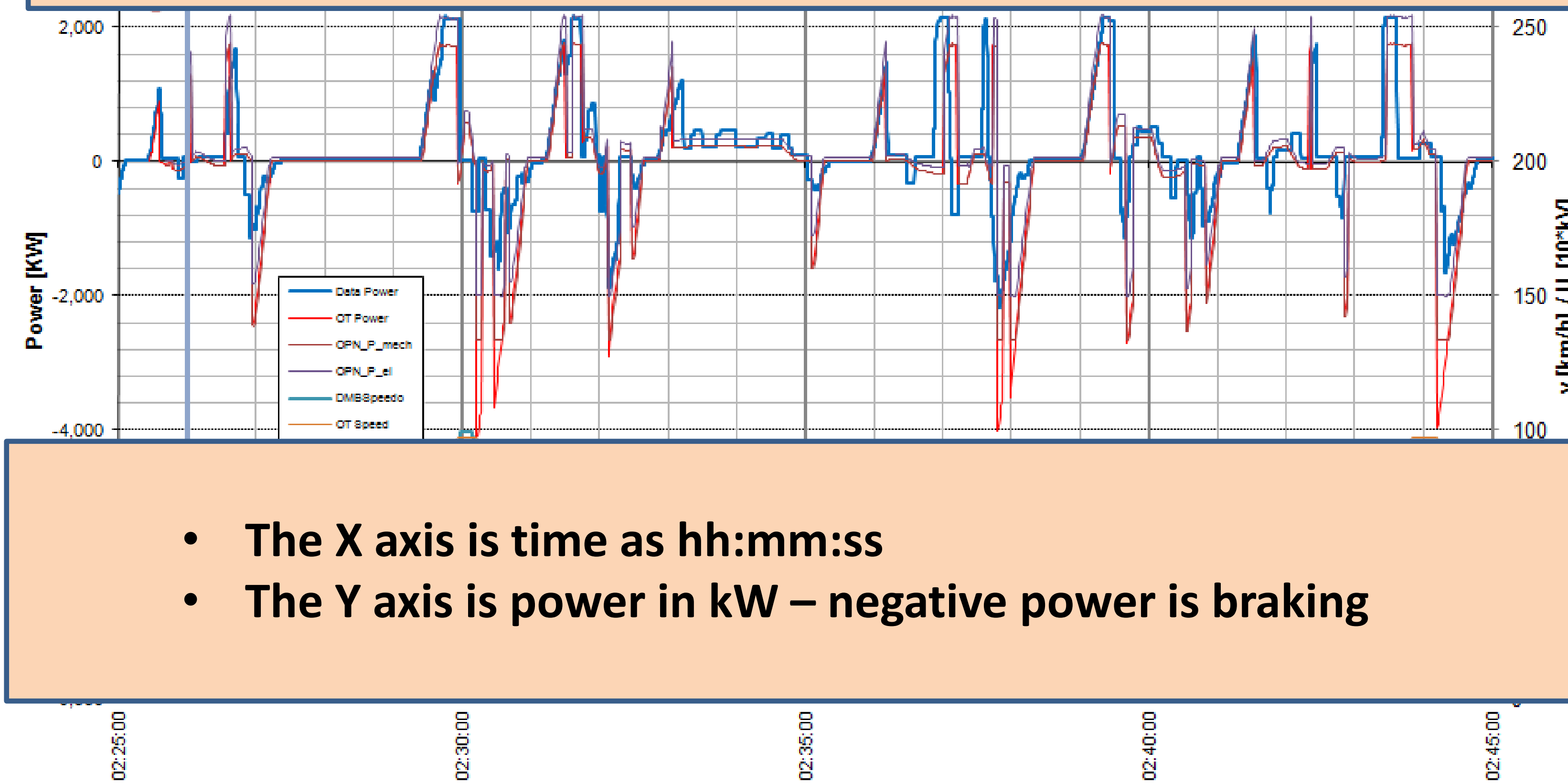


This is a sample of the comparison between actual measurements and the simulated performance on a single train run

- The section graphed is from Park Road to Hemmant
- The X axis is time as hh:mm:ss
- The Y axis is speed in km/h
- The brown trace is the simulated speed from OpenTrack
- The aqua trace is the speed taken from the train data logger

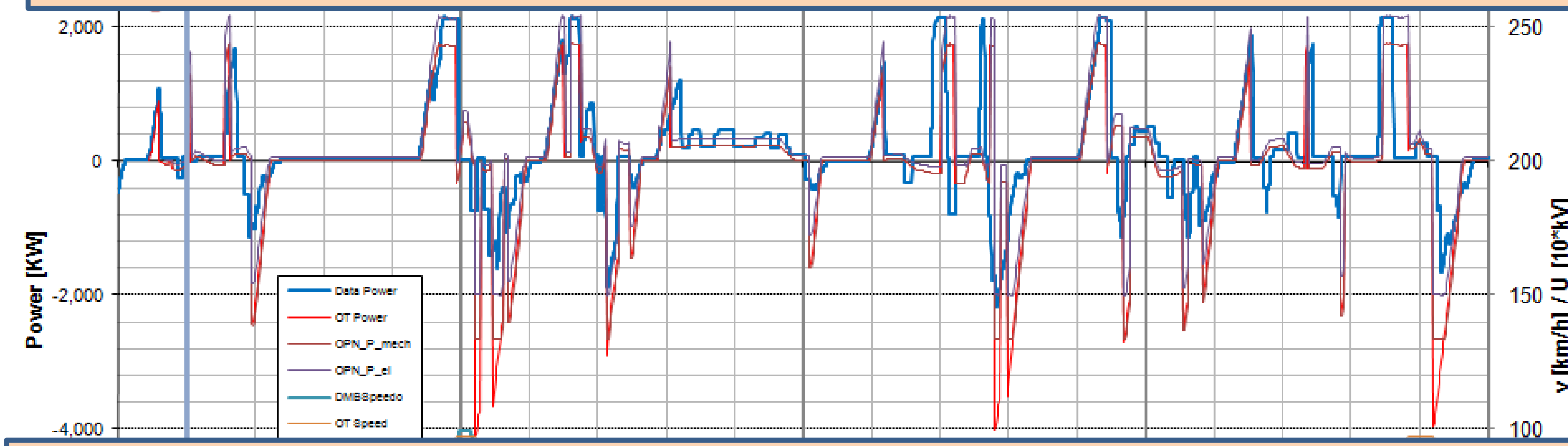


- The Blue trace is the Power from the train data logger
- The Red trace is the Power requested by Open Track



- The X axis is time as hh:mm:ss
- The Y axis is power in kW – negative power is braking

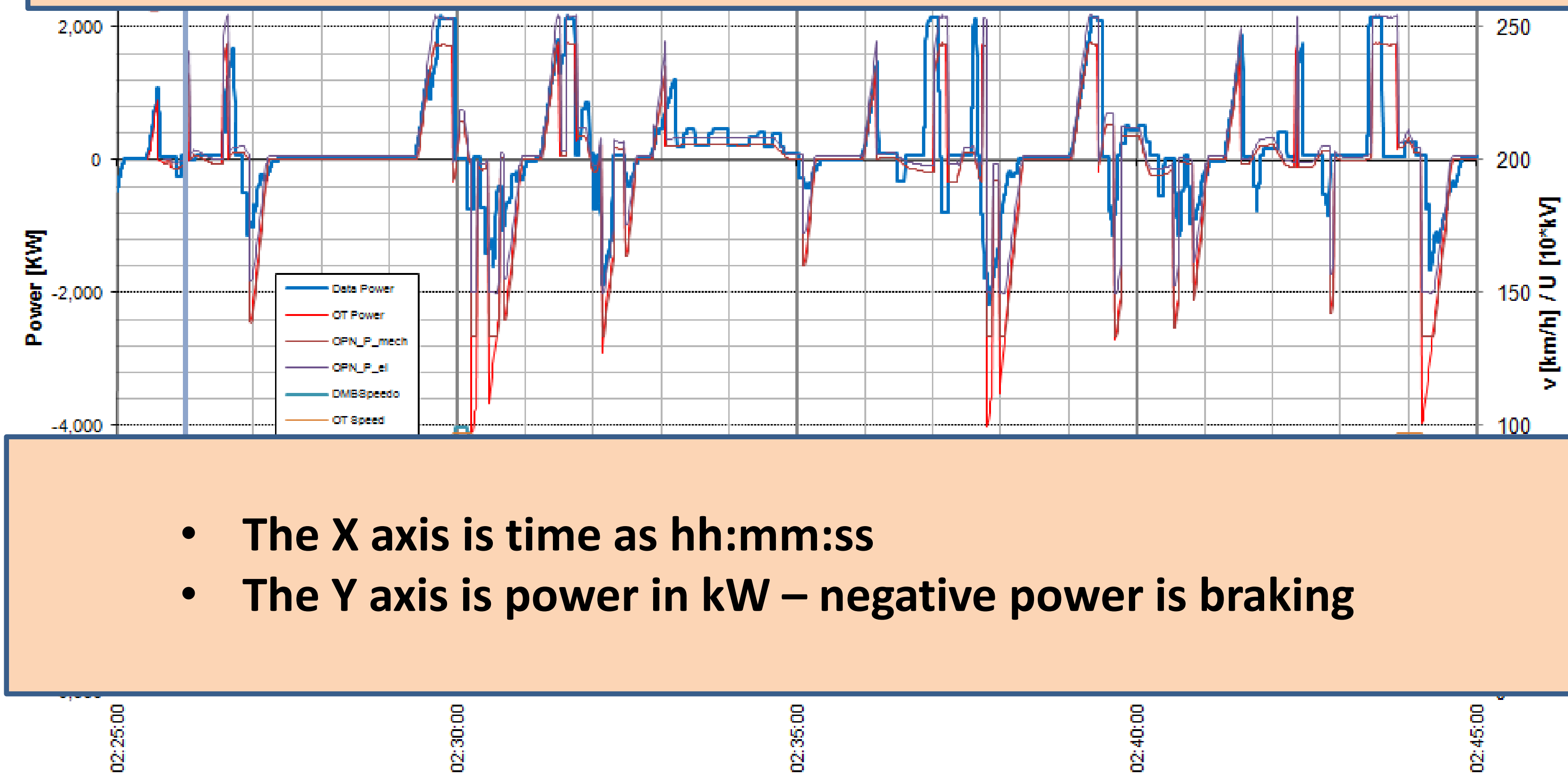
- **The Blue trace is the Power from the train data logger**
- **The Brown trace is the Mechanical Power (for Traction) delivered by OpenPowerNet**



- **The X axis is time as hh:mm:ss**
- **The Y axis is power in kW – negative power is braking**

02:25:00
02:30:00
02:35:00
02:40:00
02:45:00

- The Blue trace is the Power from the train data logger
- The Purple trace is the Electrical Power (Traction + ‘Hotel’) delivered by OpenPowerNet



- The X axis is time as hh:mm:ss
- The Y axis is power in kW – negative power is braking

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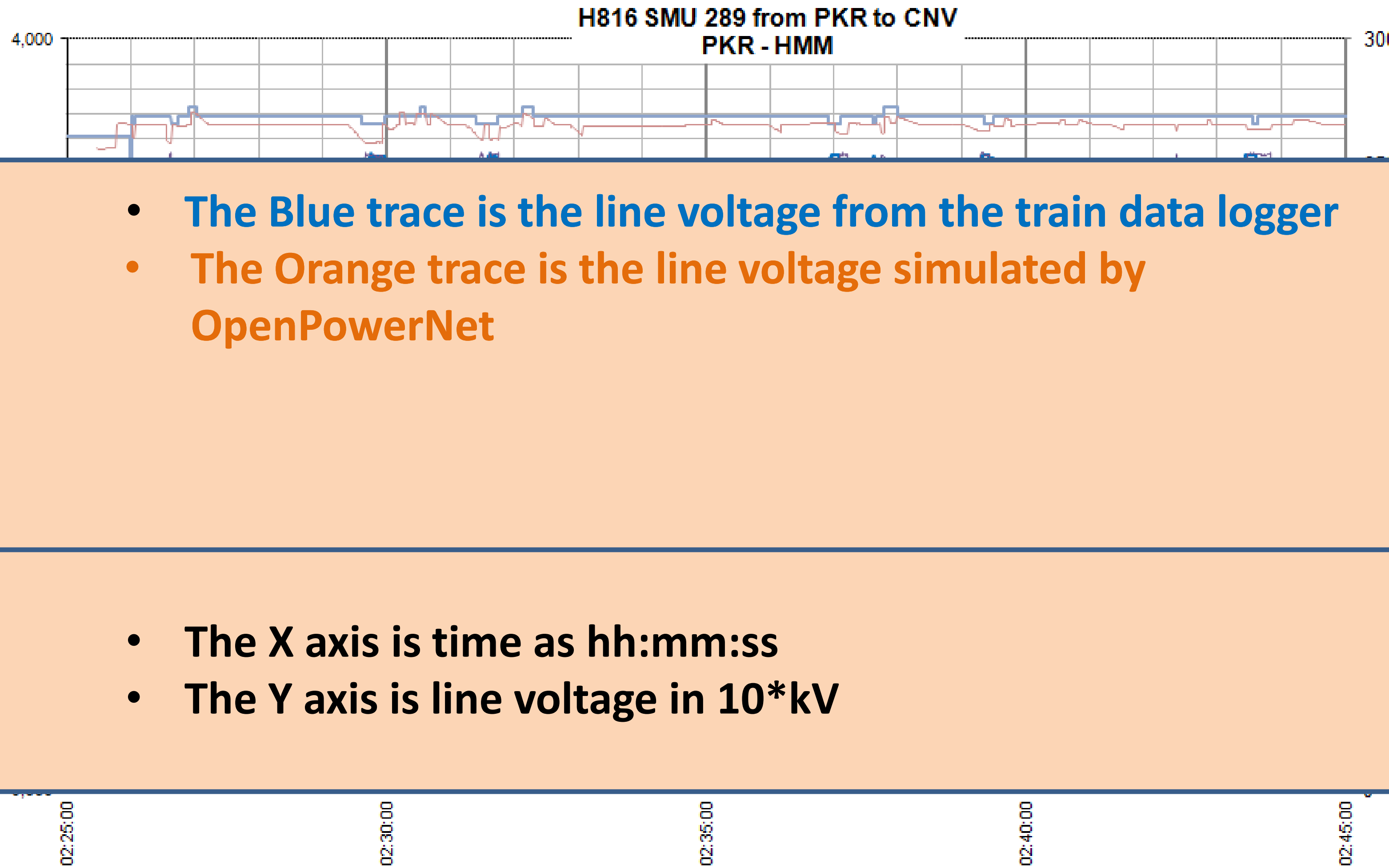

- The Blue trace is the line voltage from the train data logger
- The Orange trace is the line voltage simulated by OpenPowerNet

- The X axis is time as hh:mm:ss
- The Y axis is line voltage in 10*kV

Single Train Run Results

Benchmark Summary	Result
Operate instrumented test trains from Park Road to Cleveland & return (approx. 3 return trips with the first trip for calibration purposes)	H816 – All stations PKR to CNV (wet) H017 – All stations CNV to MNY then express to PKR (wet) H818 – Express PKR to MNY then all stations to CNV (dry) H019 – All stations CNV to PKR (dry)
Maximum variation between actual and simulated train run times to be less than 2 minutes	H816 – 23s maximum deviation H017 – 22s maximum variation H818 – 14s maximum variation H019 – 17s maximum variation
The simulated energy for each single train run would have a variation of less than 8% of that measured at Lytton Junction Feeder Station busbars.	H816 – 3.9% variation H017 – Not available H818 – 0.1% variation H019 – 4.5% variation

Photo Source: Queensland Rail – Network Picture Archive

Plateway

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Single Train Run Results

<table>
<tr><th>Benchmark Summary</th><th>Result</th></tr>
<tr><td colspan="2">All measured energy readings for the single train runs were taken from the train instrumentation as the instrumentation at Lytton Junction Feeder Station could not discriminate between consumed and regenerated (during braking) energy.

The Data Logger readings for Run H017 were not available due to problems associated with transferring the energy readings from the train computer</td></tr>
<tr><td>The simulated energy for each single train run would have a variation of less than 8% of that measured at Lytton Junction Feeder Station busbars.</td><td>H816 – 3.9% variation
H017 – Not available
H818 – 0.1% variation
H019 – 4.5% variation</td></tr>
</table>

Photo Source: Queensland Rail – Network Picture Archive

Plateway   Institut für Bahntechnik GmbH   QueenslandRail

Single Train Run Results

Benchmark Summary	Result
Operate instrumented test trains from Park Road to Cleveland & return (approx. 3 return trips with the first trip for calibration purposes)	H816 – All [redacted] to CNV (wet) H017 – All s[redacted]V to MNY then express to [redacted] H818 – Exp[redacted] MNY then all stations to [redacted] H019 – All stations CNV to PKR (dry)
Maximum variation between actual and simulated train run times to be less than 2 minutes	H816 – 23s [redacted]eviation H017 – 22s [redacted]ariation H818 – 14s [redacted]ariation H019 – 17s [redacted]ariation
The simulated energy for each single train run would have a variation of less than 8% of that measured at Lytton Junction Feeder Station busbars.	H816 – 3.9% [redacted] H017 – Not a[redacted] H818 – 0.1% [redacted] H019 – 4.5% [redacted]

Photo Source: Queensland Rail – Network Picture Archive

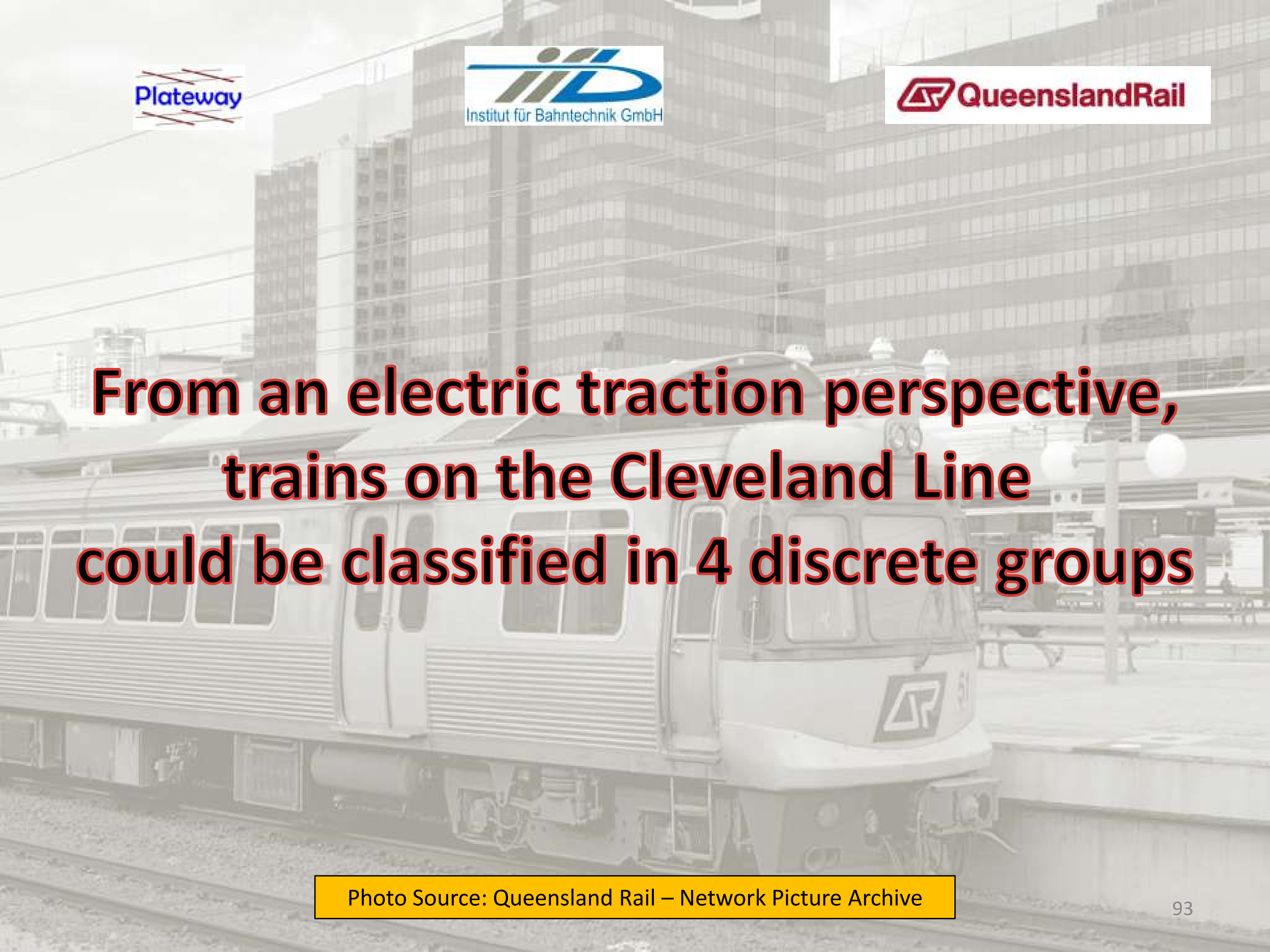
Photo Source: Queensland Rail – Network Picture Archive

With the single train test runs, all trains were formed with the same generation of rolling stock i.e. SMU260 class

Photo Source: Queensland Rail – Network Picture Archive

With peak hour operations, the train consists forming scheduled services varied on a daily basis

Photo Source: Queensland Rail – Network Picture Archive



From an electric traction perspective, trains on the Cleveland Line could be classified in 4 discrete groups

Photo Source: Queensland Rail – Network Picture Archive

The first group are trains with Regenerative braking formed by SMU or IMU units

These trains are shown in Blue on the Train Diagram

Photo Source: Queensland Rail – Network Picture Archive

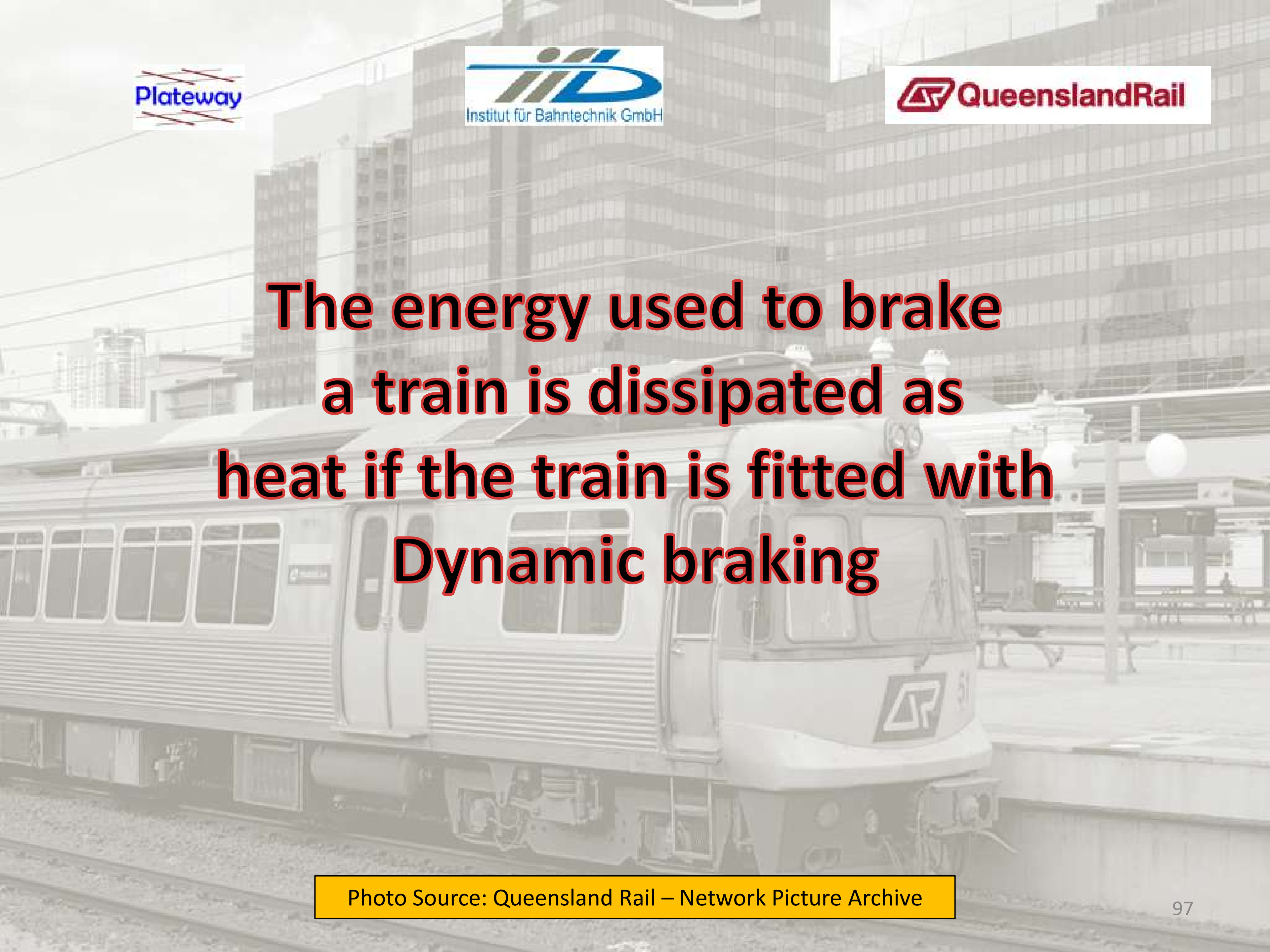
The energy used to brake a train can be recovered as Electrical energy if the train is fitted with Regenerative braking

Photo Source: Queensland Rail – Network Picture Archive

The second group are trains with Dynamic braking formed by EMU 8 motor units similar to the EMU51 shown in the slide background

These trains are shown in Orange on the Train Diagram

Photo Source: Queensland Rail – Network Picture Archive



The energy used to brake a train is dissipated as heat if the train is fitted with Dynamic braking

Photo Source: Queensland Rail – Network Picture Archive

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The third group are trains with Dynamic braking formed by EMU 6 motor units

These trains are shown in Green on the Train Diagram

Photo Source: Queensland Rail – Network Picture Archive

The fourth group are trains with Dynamic braking formed by
An EMU 6 motor 3 car unit +
An EMU 8 motor 3 car unit

These trains are shown in Purple on the Train Diagram

Photo Source: Queensland Rail – Network Picture Archive

	Monday	Tuesday	Wednesday	Thursday	Friday
EMU 6M	1	4	2	4	2
EMU 8M	15	17	11	18	15
EMU 6M + 8M	6	1	8	7	0
EMU Subtotal	22	22	21	29	17
Dynamic Brake %	52%	52%	50%	69%	40%
SMU/IMU	20	20	21	13	25
Regenerative Brake %	48%	48%	50%	31%	60%
Total	42	42	42	42	42

POC 5 Day Test Cleveland Line Morning Peak train composition

Another variable that can influence train performance is driving style

Photo Source: Queensland Rail – Network Picture Archive

The timetable is the same for each day but the train consist and the allocated train crew may vary

Photo Source: Queensland Rail – Network Picture Archive

Variations in passenger behaviour between a wet and dry day and allowance for ‘incidents’ mean that the timetable has some capacity to absorb disturbances

Photo Source: Queensland Rail – Network Picture Archive

This also means that the train crew have some capacity to vary the train performance to match operating reality

Photo Source: Queensland Rail – Network Picture Archive

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The network simulator can calculate the behaviour of each train based on the **laws of physics**

Actual operational reality and thus the simulator, must also replicate the variability of **human behaviour**

Photo Source: Queensland Rail – Network Picture Archive

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The simulator settings that reflect reality can only be made after a close study of actual operations

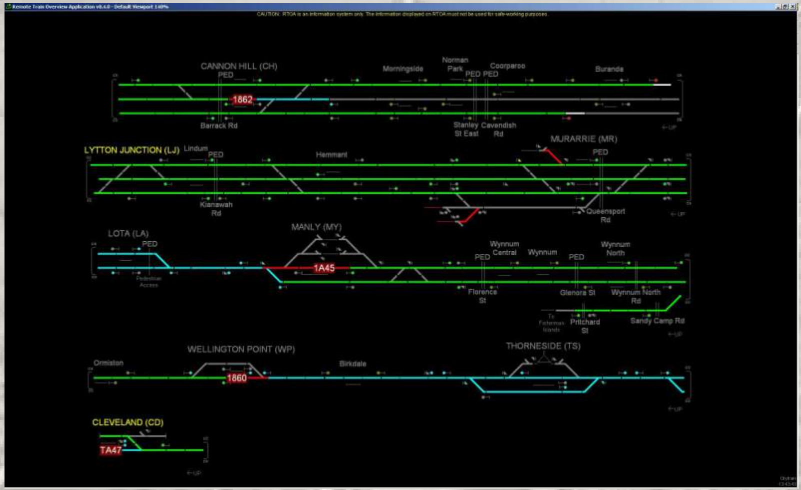

Photo Source: Queensland Rail – Network Picture Archive

Some of the settings can be made based on measured data such as passenger loading per station and per service

Photo Source: Queensland Rail – Network Picture Archive

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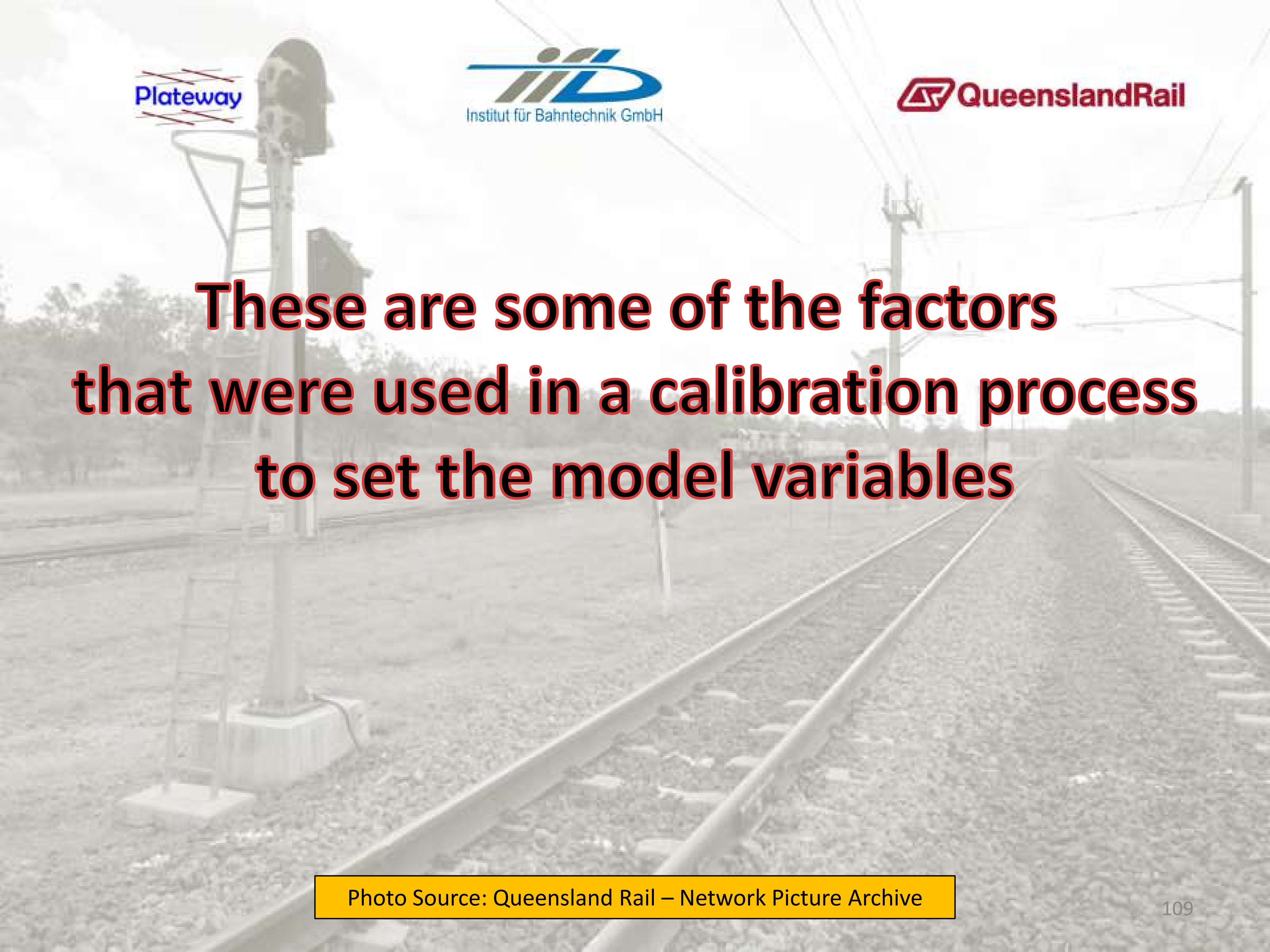
Passenger loadings will influence the mass of the train and hence the traction power demand depending on the time of day, the catchment of each station and the journey profile

Photo Source: Queensland Rail – Network Picture Archive



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These are some of the factors that were used in a calibration process to set the model variables

Photo Source: Queensland Rail – Network Picture Archive

For each of the 5 days a train diagram was produced based on the actual operations, for the morning peak

Photo Source: Queensland Rail – Network Picture Archive

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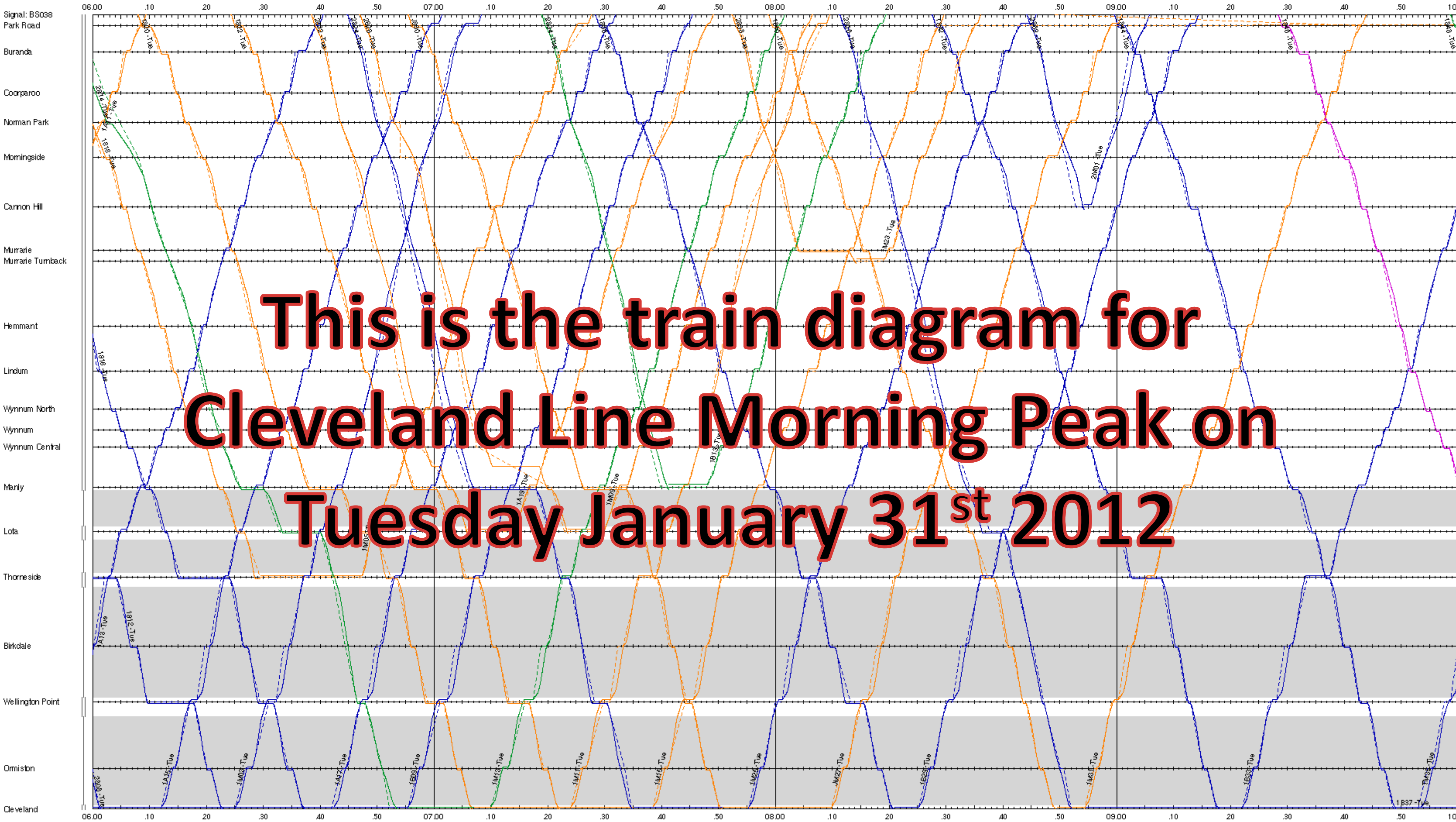
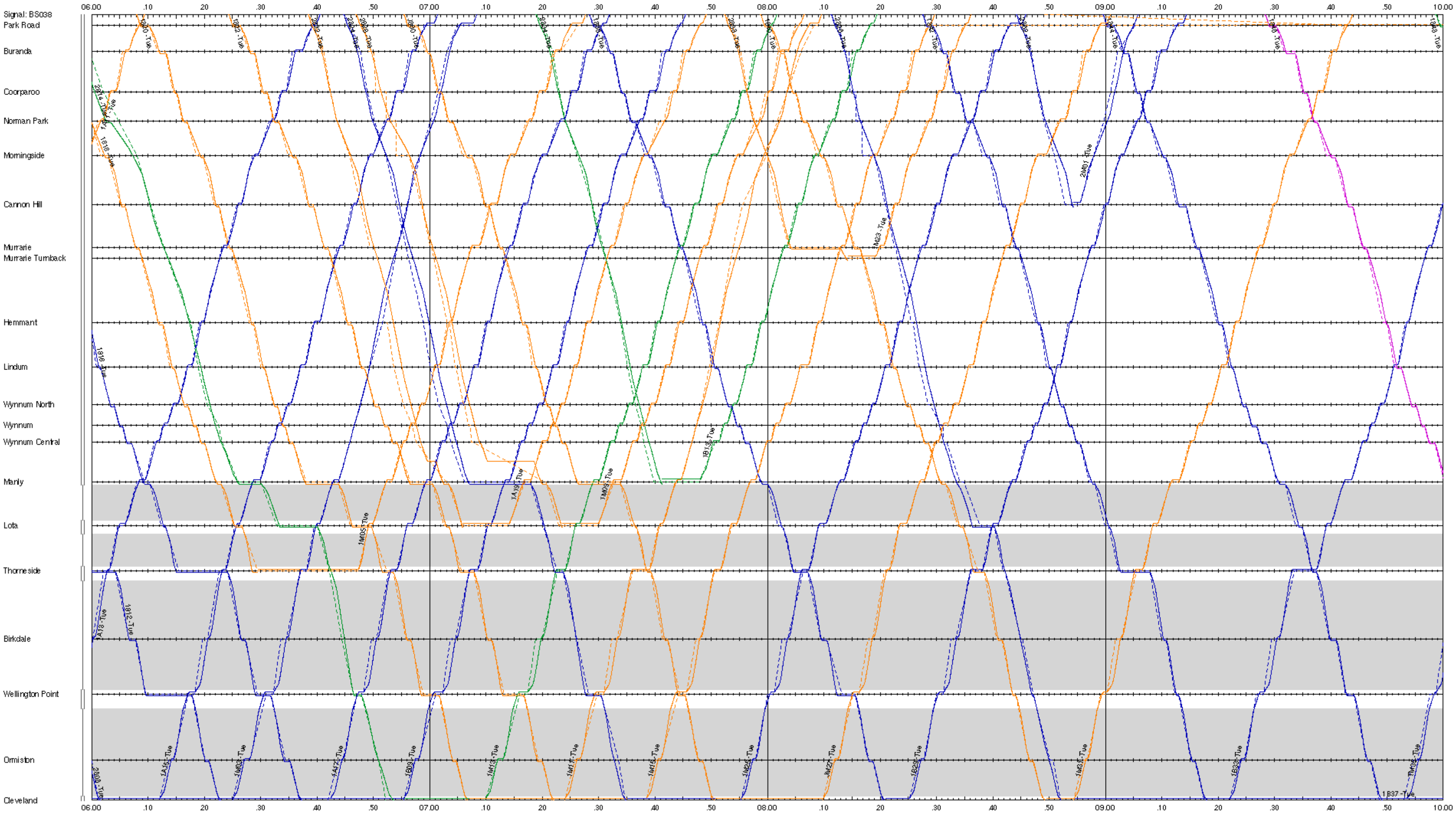
Signal: BS038 - Cleveland



This is the train diagram for Cleveland Line Morning Peak on Tuesday January 31st 2012

Solid Lines simulated operations, Dashed lines actual operations from RTOA system

Signal: BS038 - Cleveland



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In addition to the train operation data, the co-simulation generates data relevant to the traction power supply

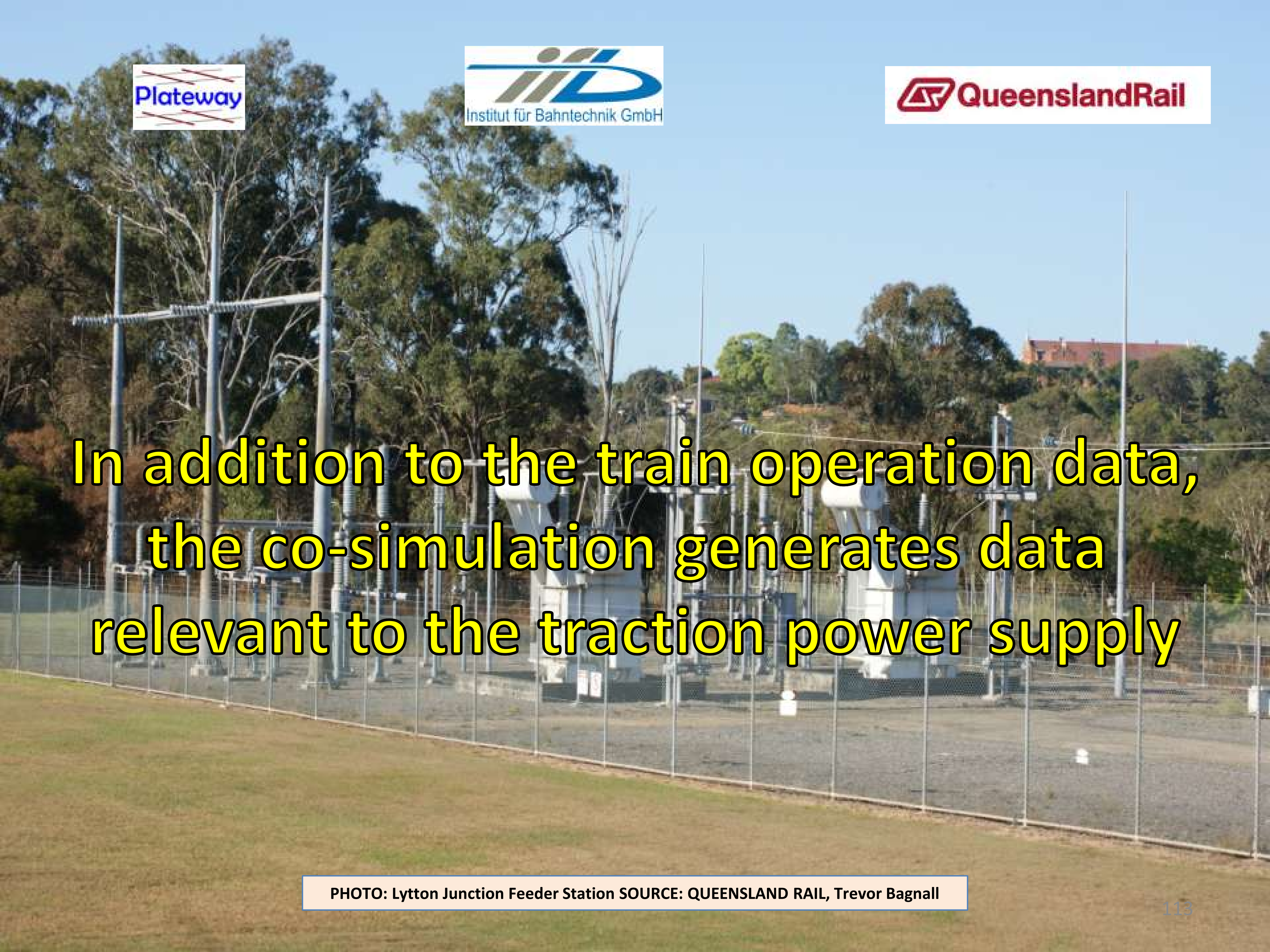
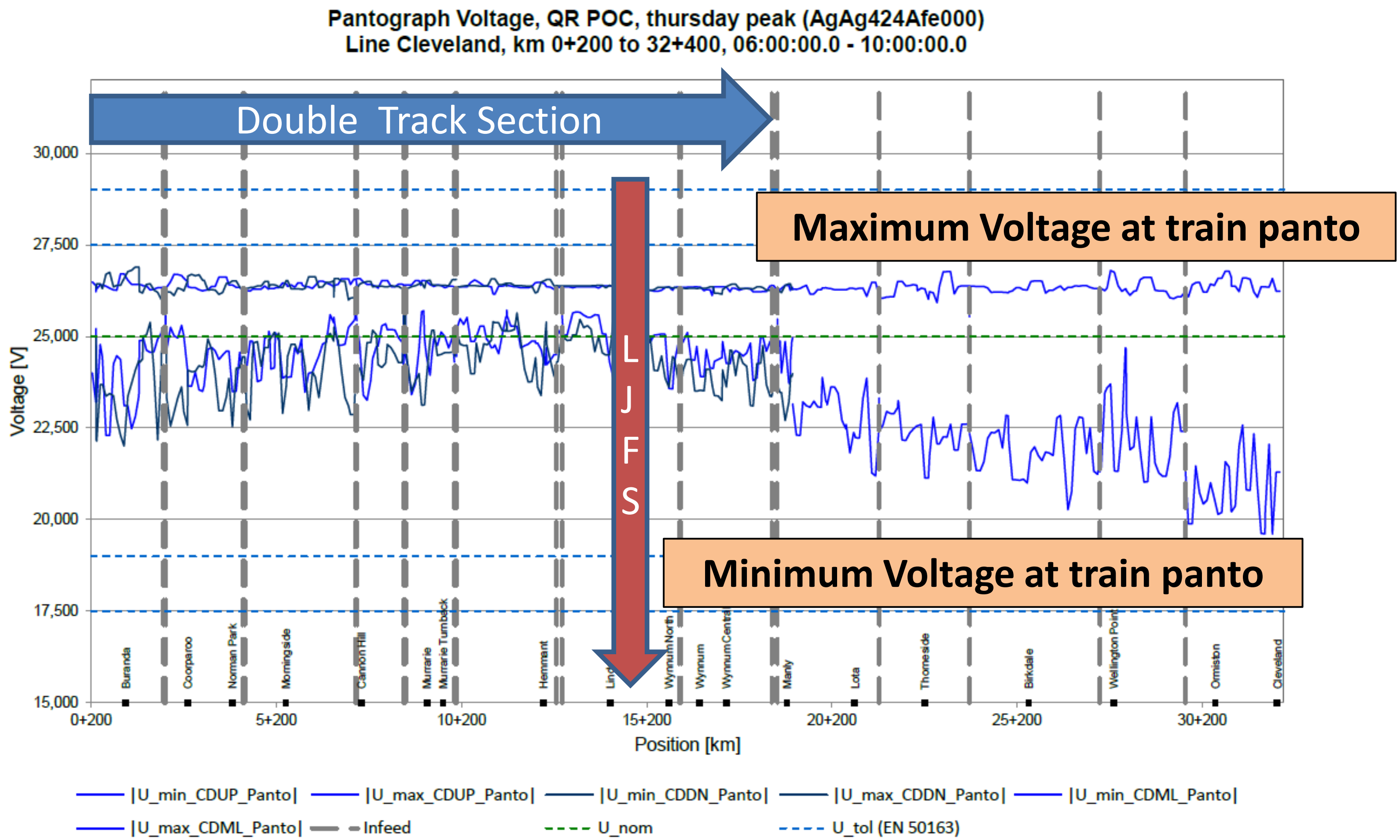
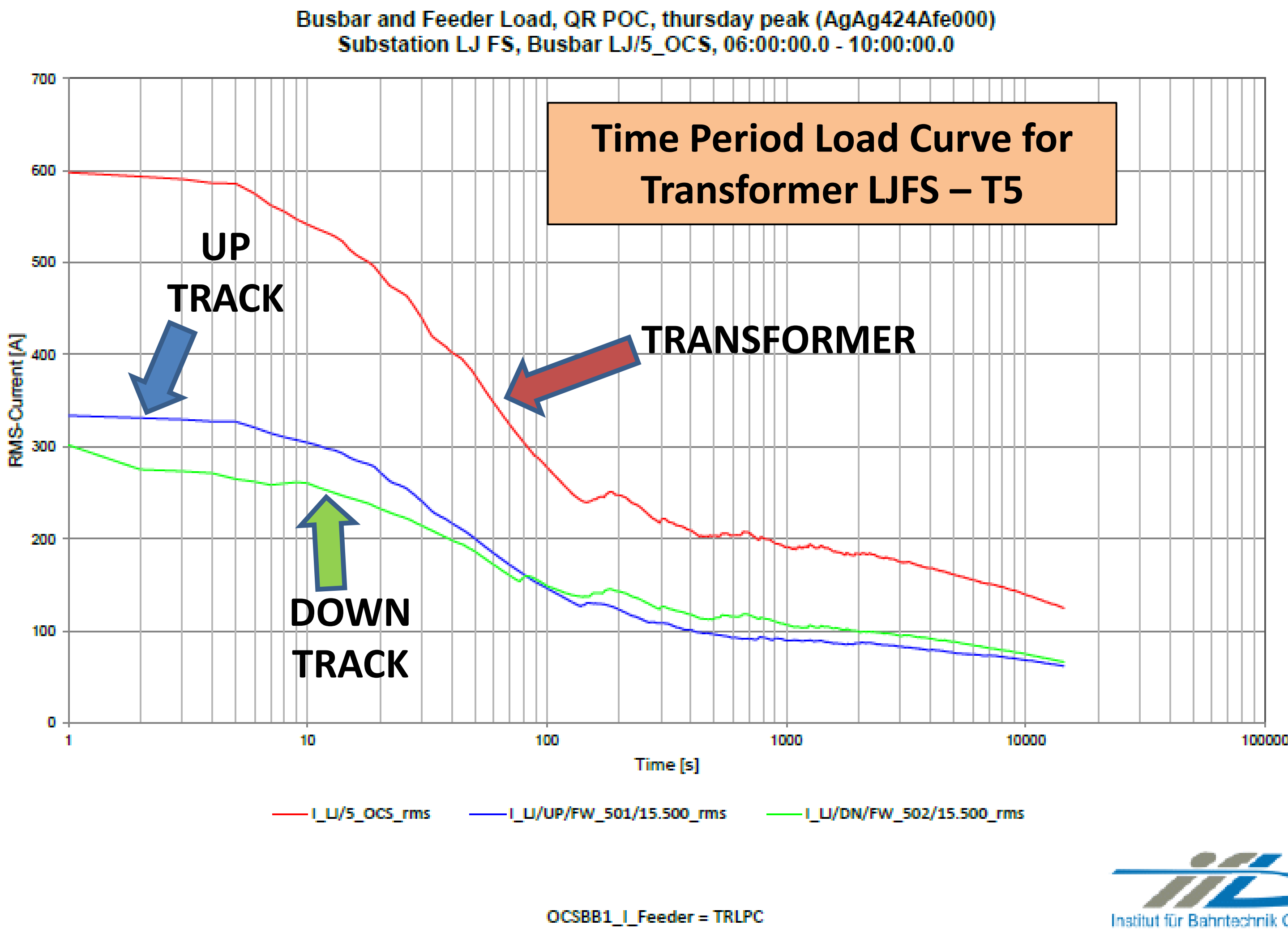


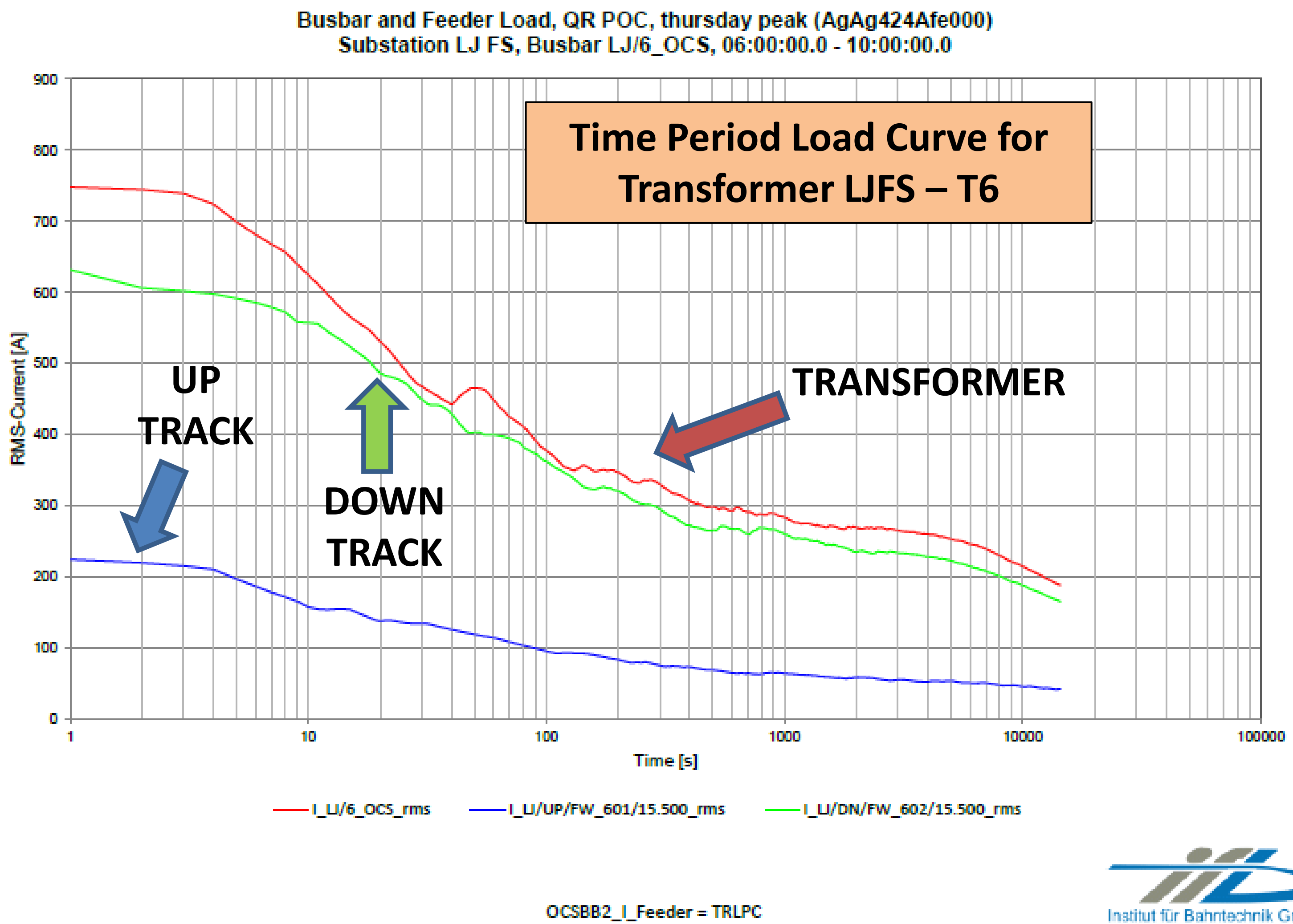
PHOTO: Lytton Junction Feeder Station SOURCE: QUEENSLAND RAIL, Trevor Bagnall



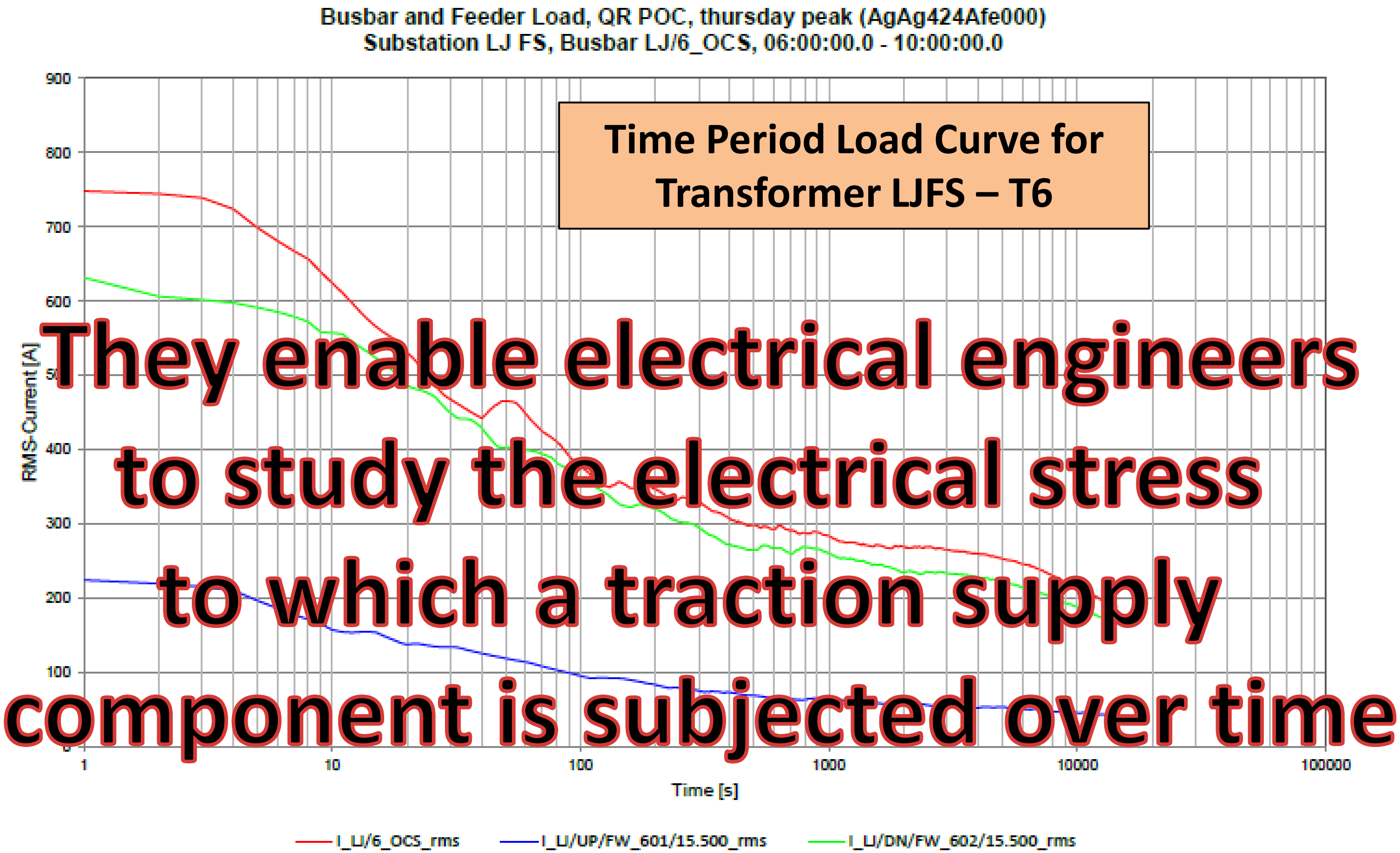
Pantograph Voltage, QR POC, thursday peak (AgAg424Afe000)
Line Cleveland, km 0+200 to 32+400, 06:00:00.0 - 10:00:00.0
Double Track Section
Maximum Voltage at train panto
Minimum Voltage at train panto
L J F S
Voltage [V]
Position [km]
|U_min_CDUP_Panto|
|U_max_CDUP_Panto|
|U_min_CDDN_Panto|
|U_max_CDDN_Panto|
|U_min_CDML_Panto|
|U_max_CDML_Panto|
Infeed
U_nom
U_tol (EN 50163)

U_Panto = f(s)


Busbar and Feeder Load, QR POC, thursday peak (AgAg424Afe000)
Substation LJ FS, Busbar LJ/5_OCS, 06:00:00.0 - 10:00:00.0
Time Period Load Curve for Transformer LJFS – T5
UP TRACK
TRANSFORMER
DOWN TRACK
RMS-Current [A]
Time [s]
I_LJ/5_OCS_rms
I_LJ/UP/FW_501/15.500_rms
I_LJ/DN/FW_502/15.500_rms
OCSBB1_I_Feeder = TRLPC



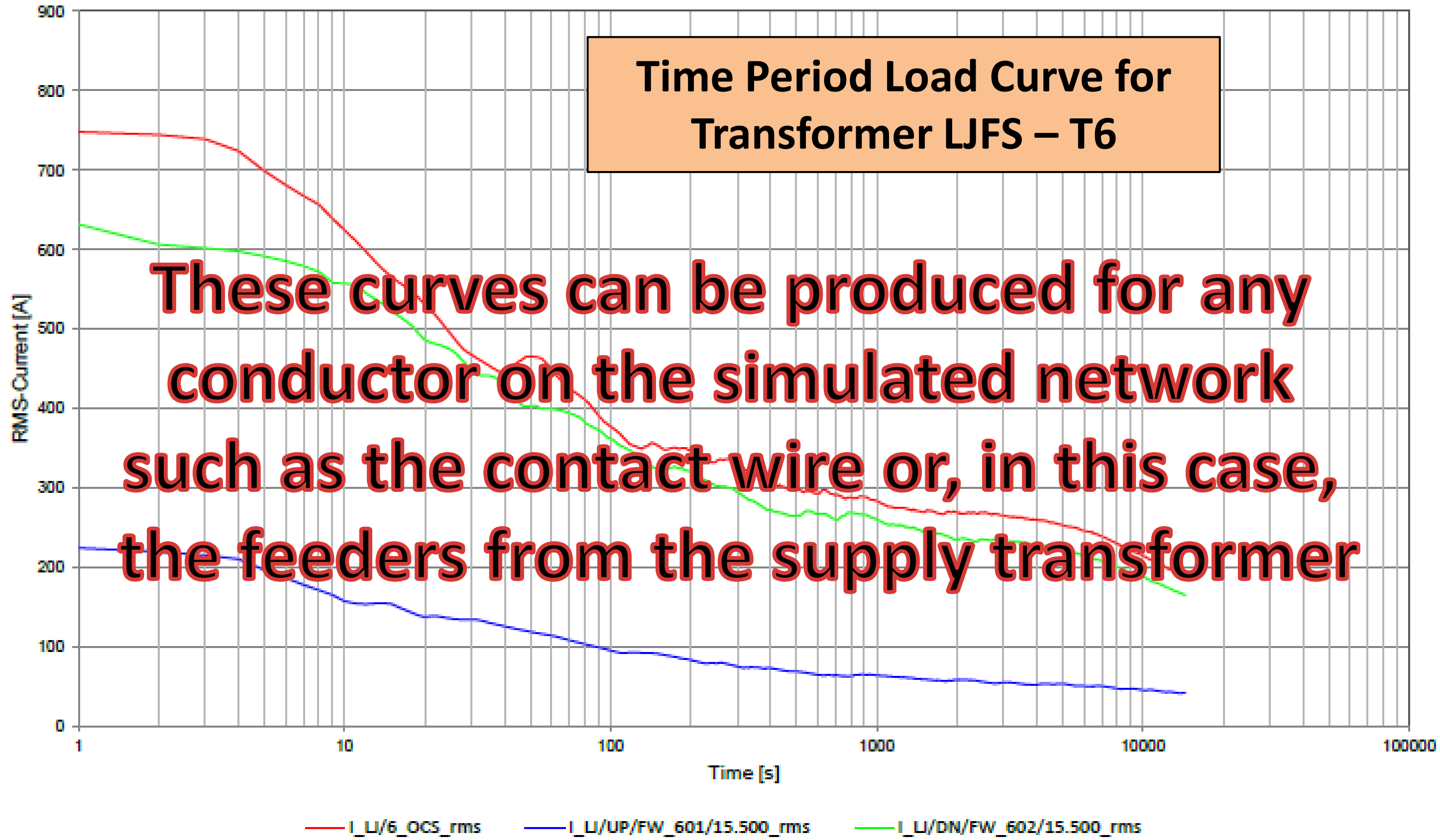
Busbar and Feeder Load, QR POC, thursday peak (AgAg424Afe000)
Substation LJ FS, Busbar LJ/6_OCS, 06:00:00.0 - 10:00:00.0
Time Period Load Curve for Transformer LJFS – T6
UP TRACK
DOWN TRACK
TRANSFORMER
RMS-Current [A]
900
800
700
600
500
400
300
200
100
0
1
10
100
1000
10000
100000
Time [s]
I_LJ/6_OCS_rms
I_LJ/UP/FW_601/15.500_rms
I_LJ/DN/FW_602/15.500_rms
OCSBB2_I_Feeder = TRLPC



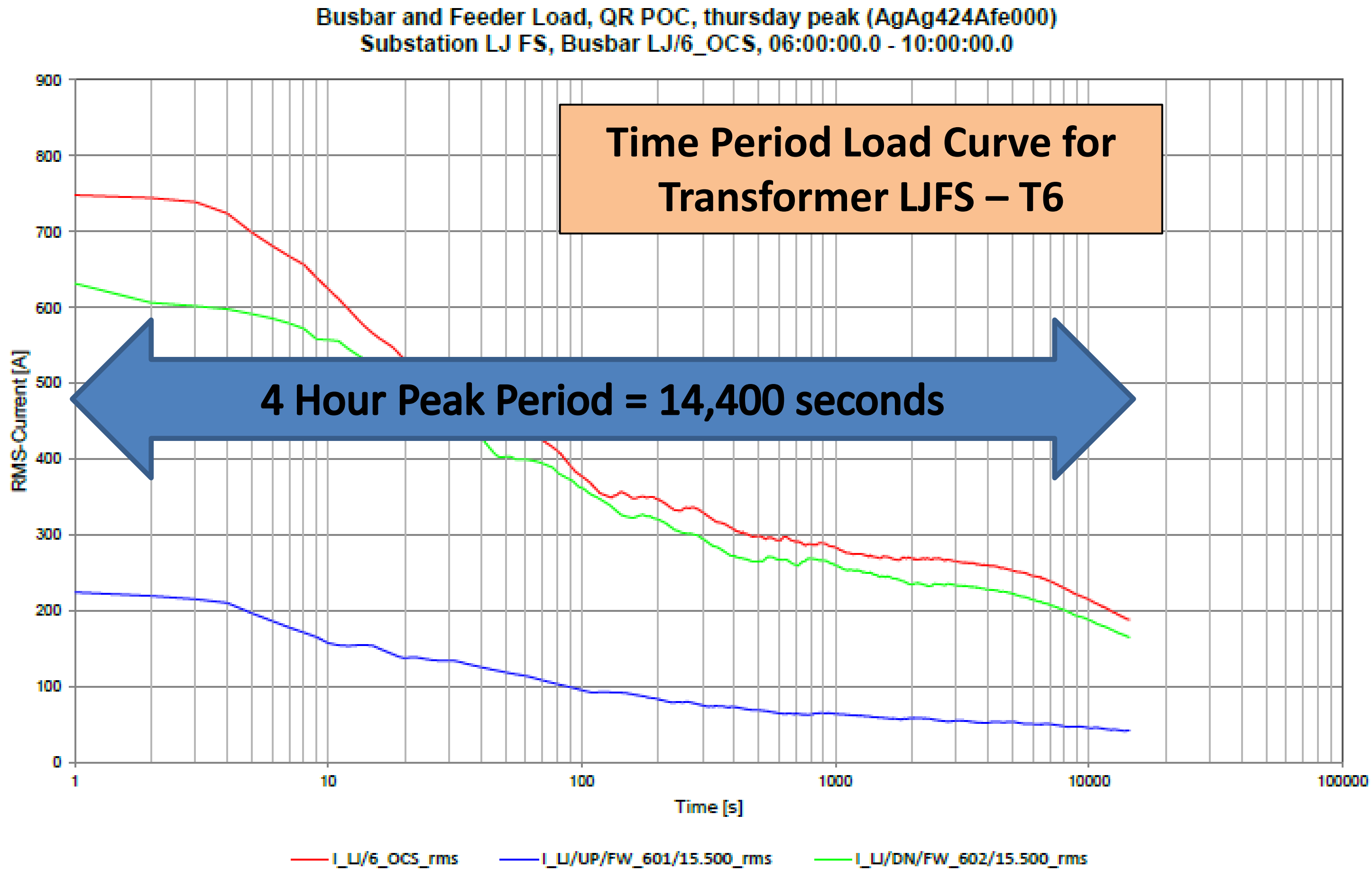
They enable electrical engineers to study the electrical stress to which a traction supply component is subjected over time

OCSBB2_I_Feeder = TRLPC

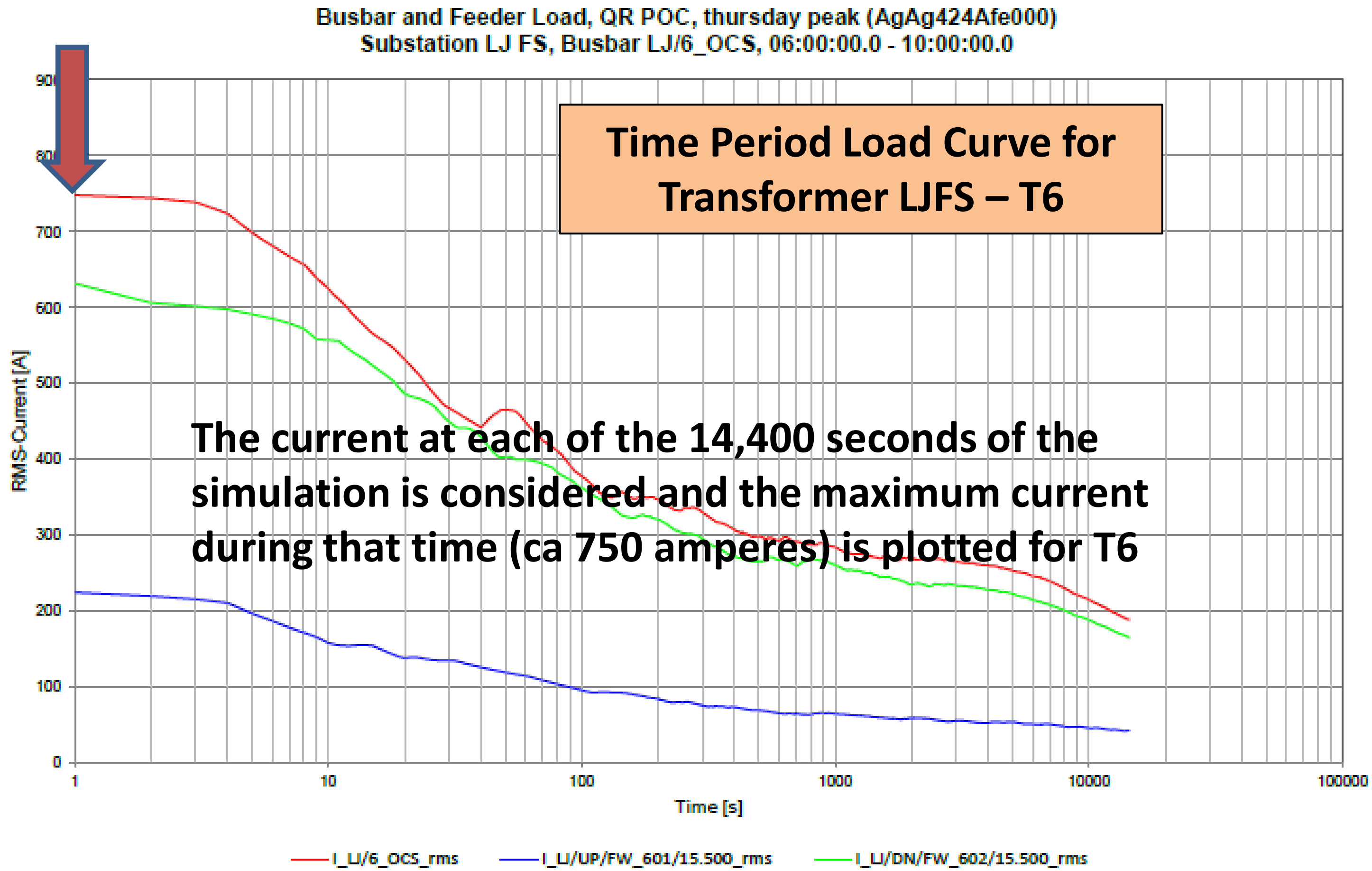
Busbar and Feeder Load, QR POC, thursday peak (AgAg424Afe000)
Substation LJ FS, Busbar LJ/6_OCS, 06:00:00.0 - 10:00:00.0



OCSBB2_I_Feeder = TRLPC



OCSBB2_I_Feeder = TRLPC

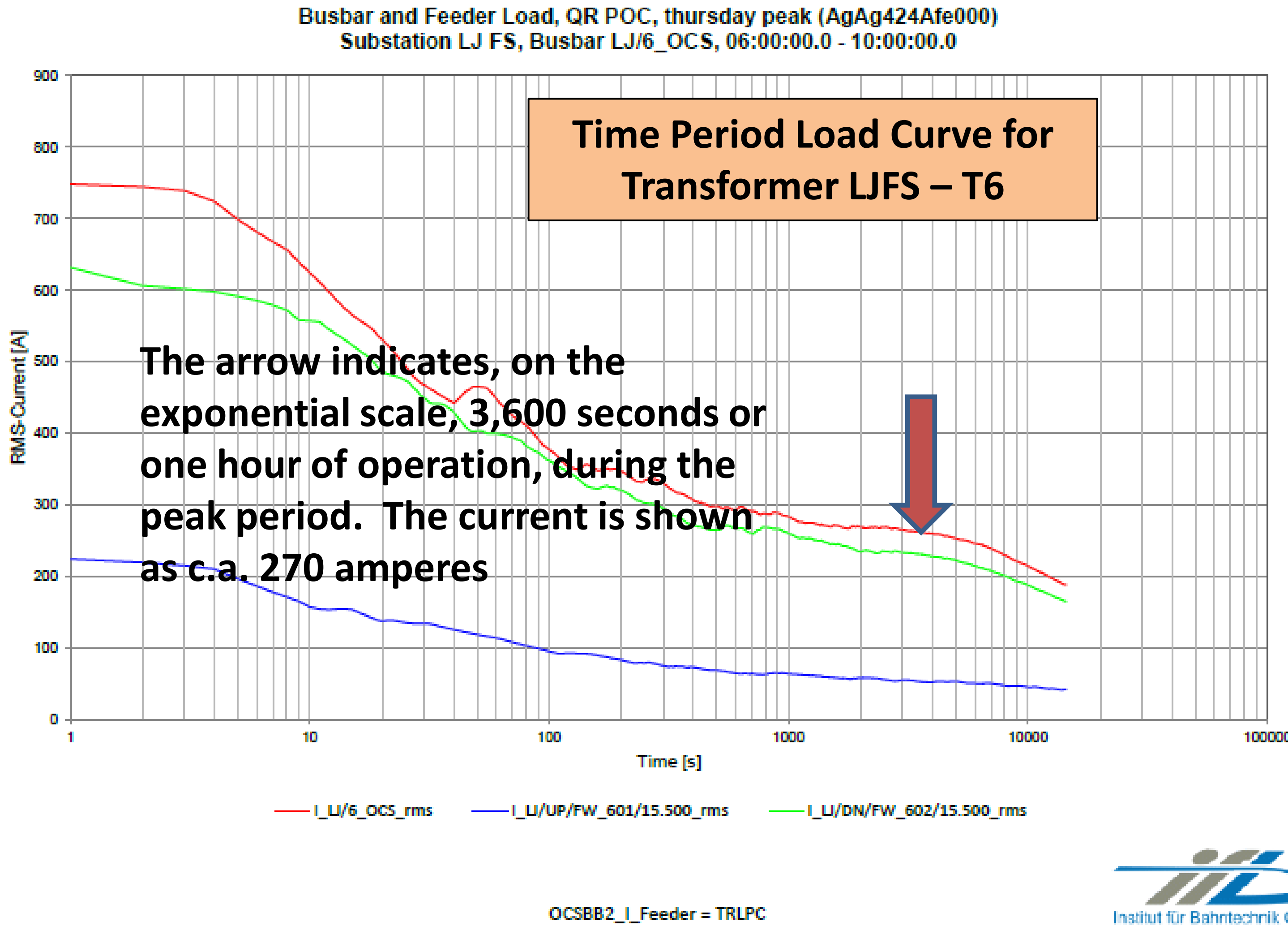


Time Period Load Curve for Transformer LJFS – T6

The current at each of the 14,400 seconds of the simulation is considered and the maximum current during that time (ca 750 amperes) is plotted for T6

OCSBB2_I_Feeder = TRLPC

Time Period Load Curve for Transformer LJFS – T6



The arrow indicates, on the exponential scale, 3,600 seconds or one hour of operation, during the peak period. The current is shown as c.a. 270 amperes

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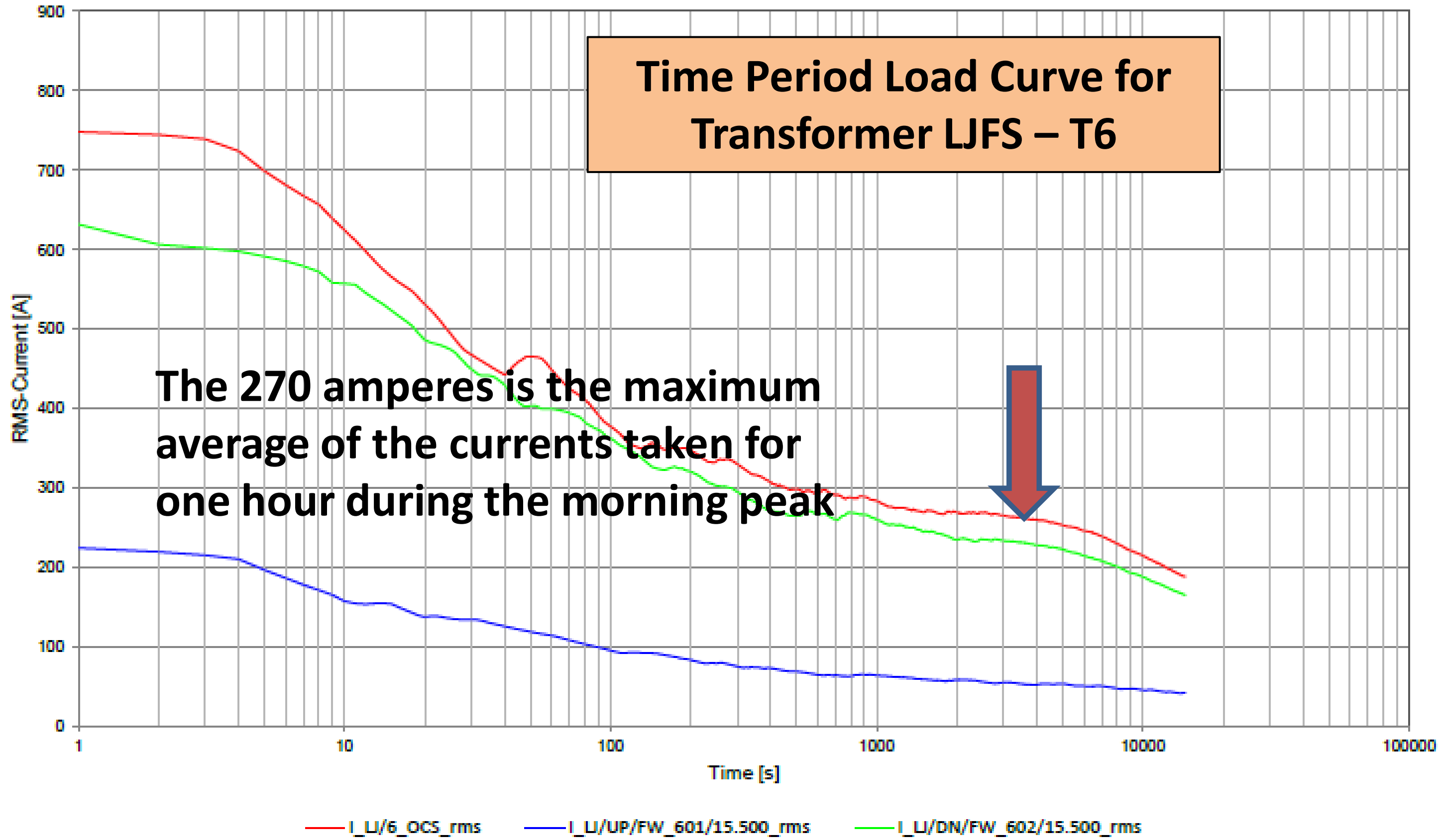
Busbar and Feeder Load, QR POC, thursday peak (AgAg424Afe000)
Substation LJ FS, Busbar LJ/6_OCS, 06:00:00.0 - 10:00:00.0



Time Period Load Curve for Transformer LJFS – T6

The 270 amperes is the maximum average of the currents taken for one hour during the morning peak

OCSBB2_I_Feeder = TRLPC

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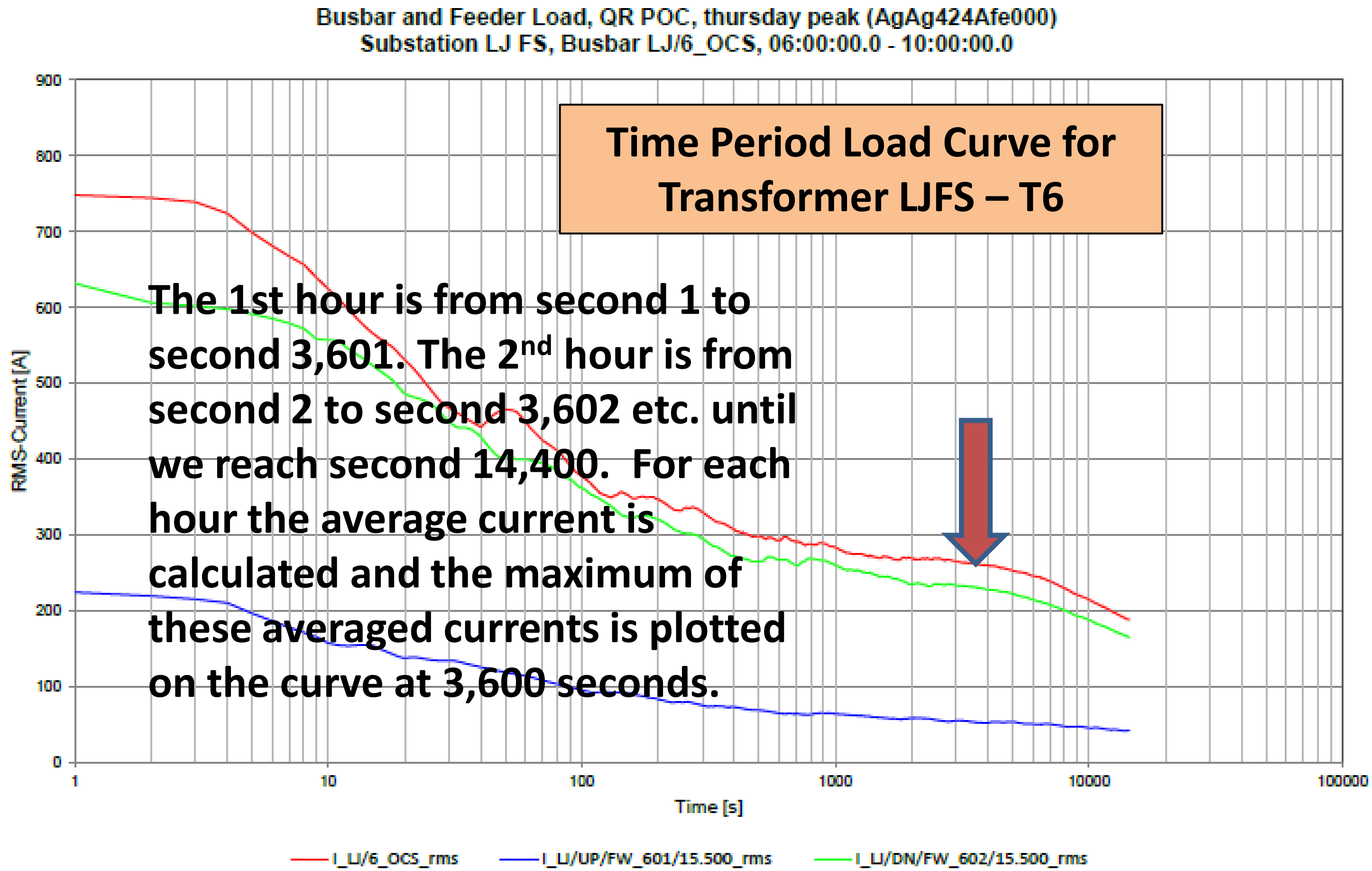
Time Period Load Curve for Transformer LJFS – T6



The 1st hour is from second 1 to second 3,601. The 2nd hour is from second 2 to second 3,602 etc. until we reach second 14,400. For each hour the average current is calculated and the maximum of these averaged currents is plotted on the curve at 3,600 seconds.

OCSBB2_I_Feeder = TRLPC

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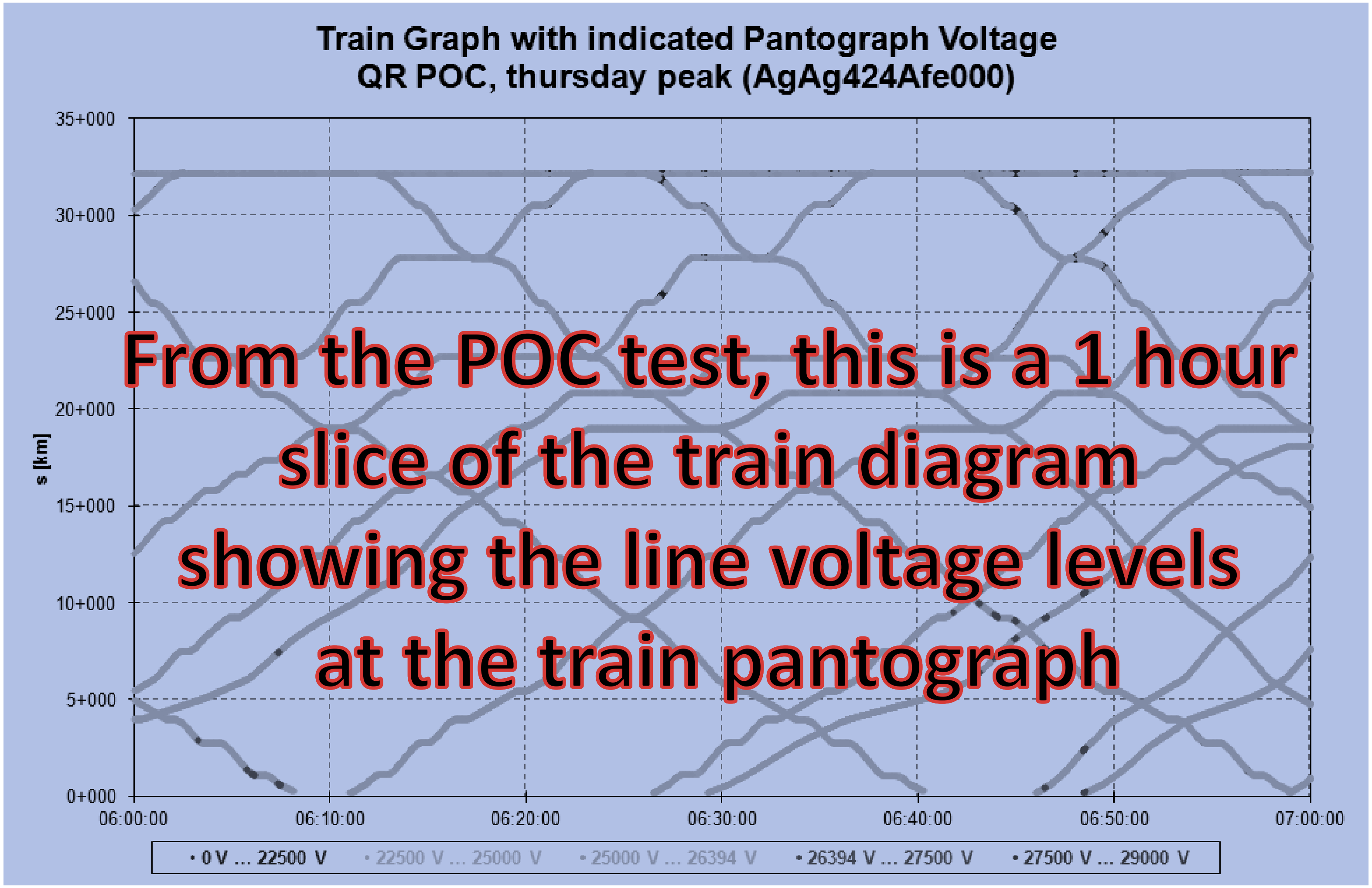
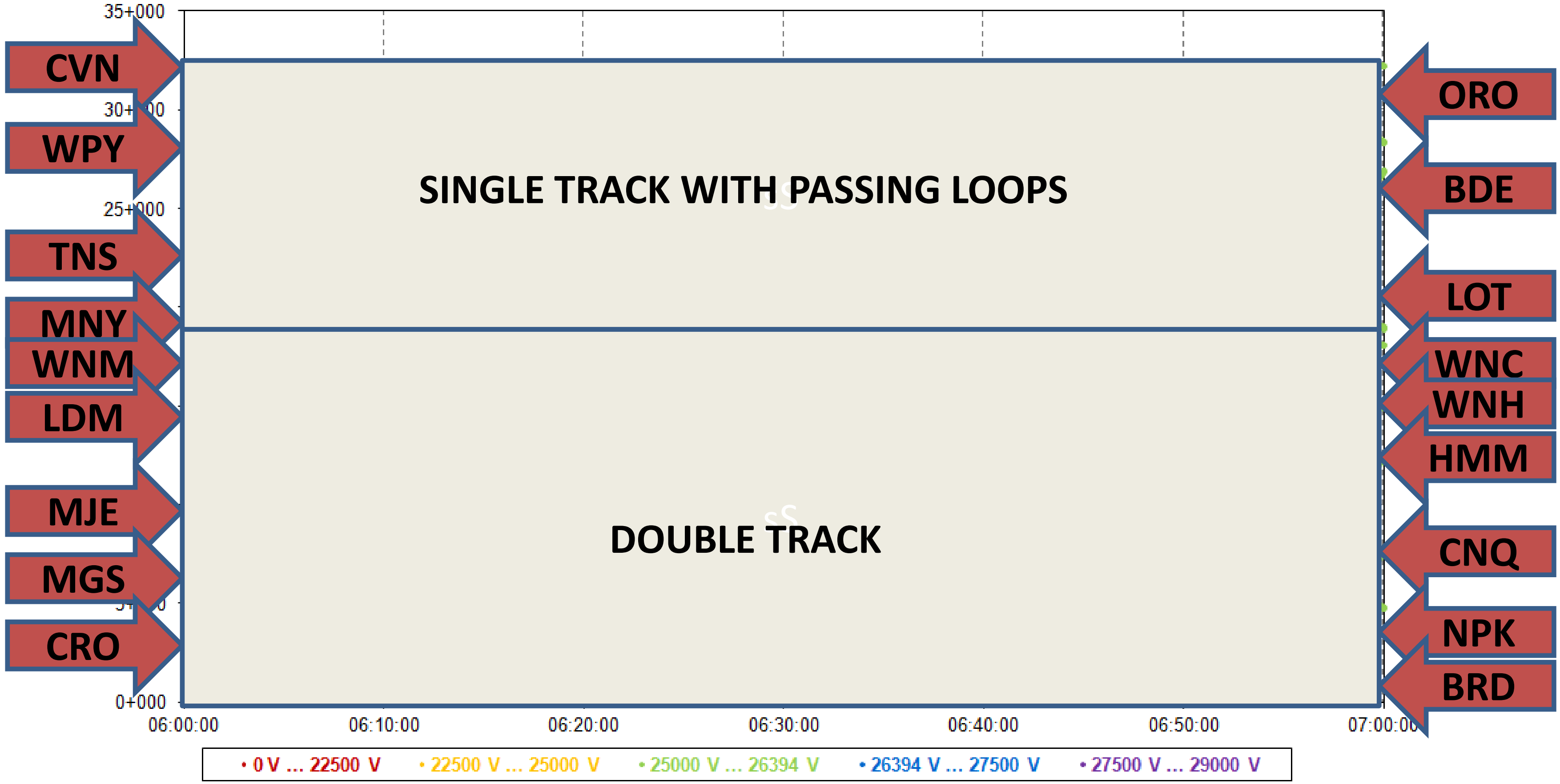
The holistic simulation also provides other possibilities to examine network performance under 'normal' or 'disturbed' operating conditions

Photo Source: Queensland Rail – Network Picture Archive

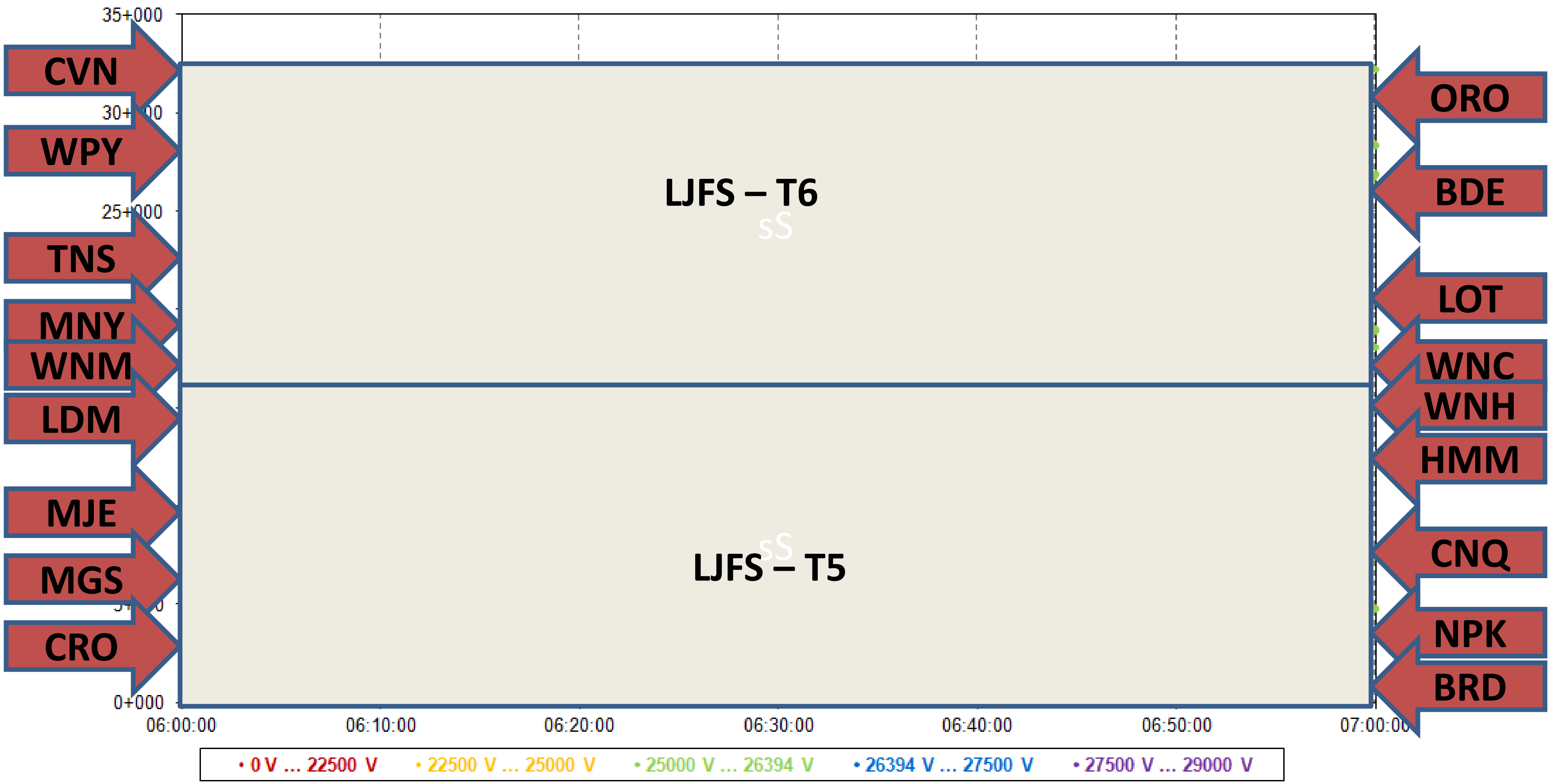


From the POC test, this is a 1 hour slice of the train diagram showing the line voltage levels at the train pantograph

Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



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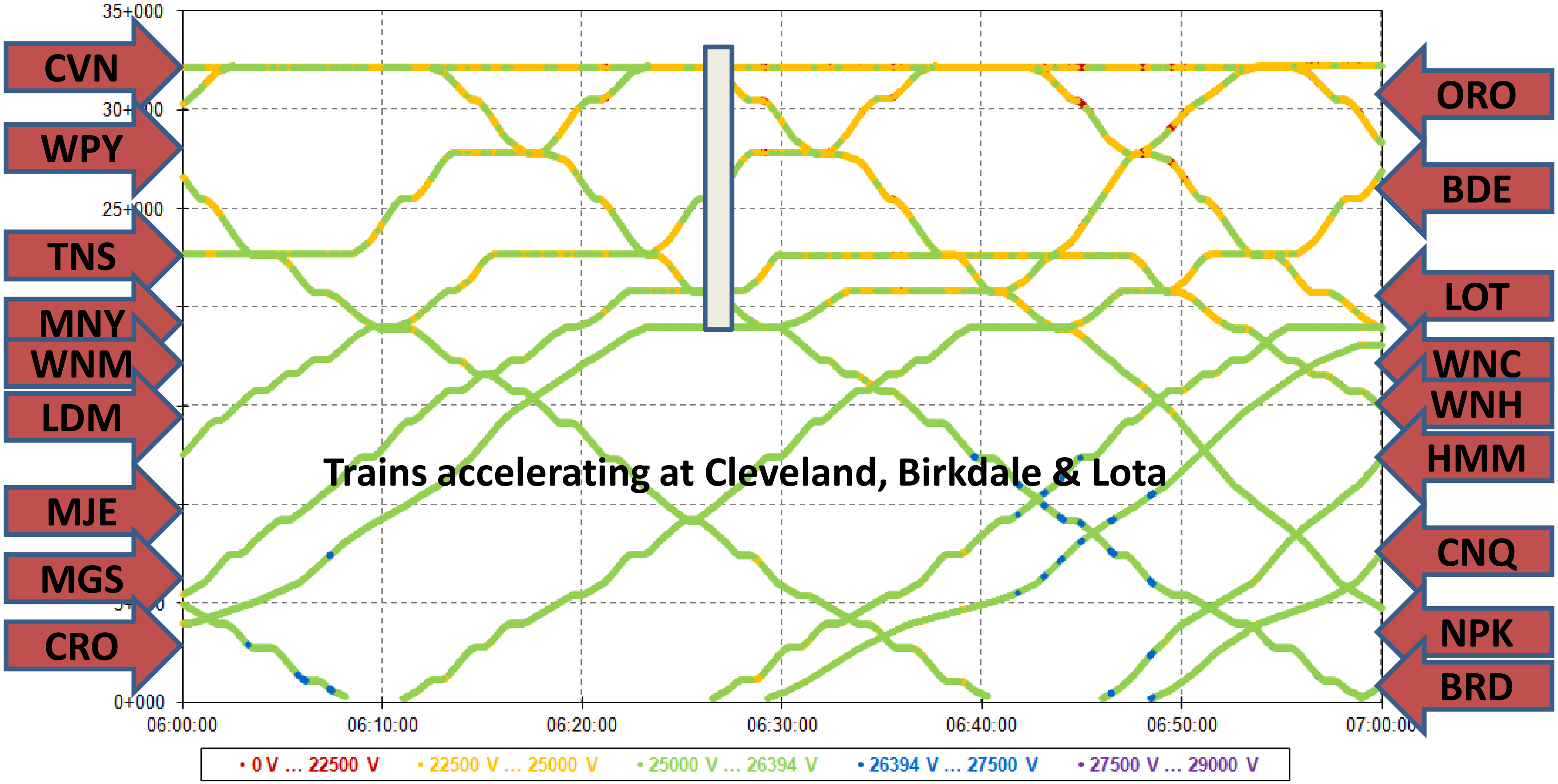
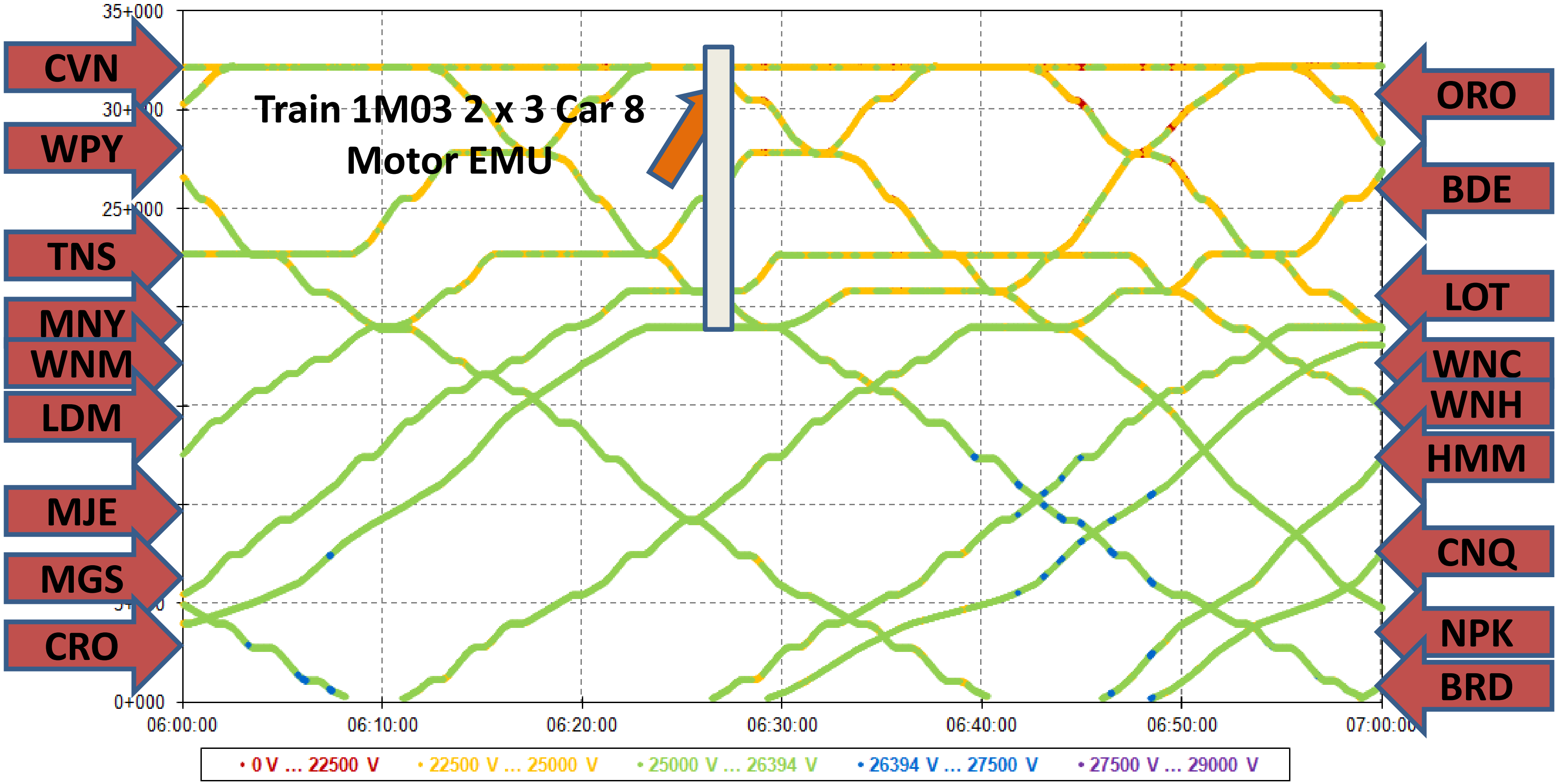
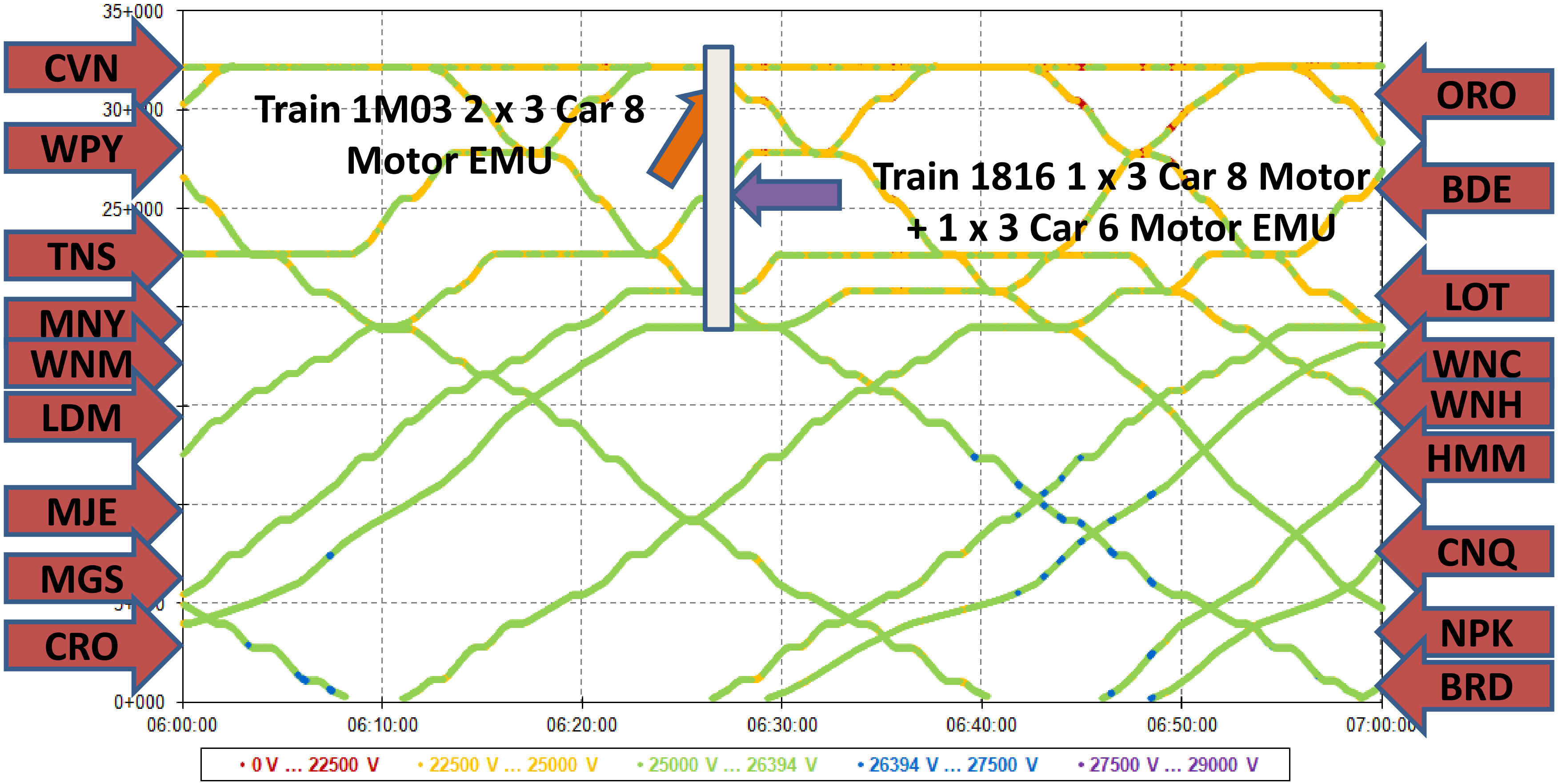
Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



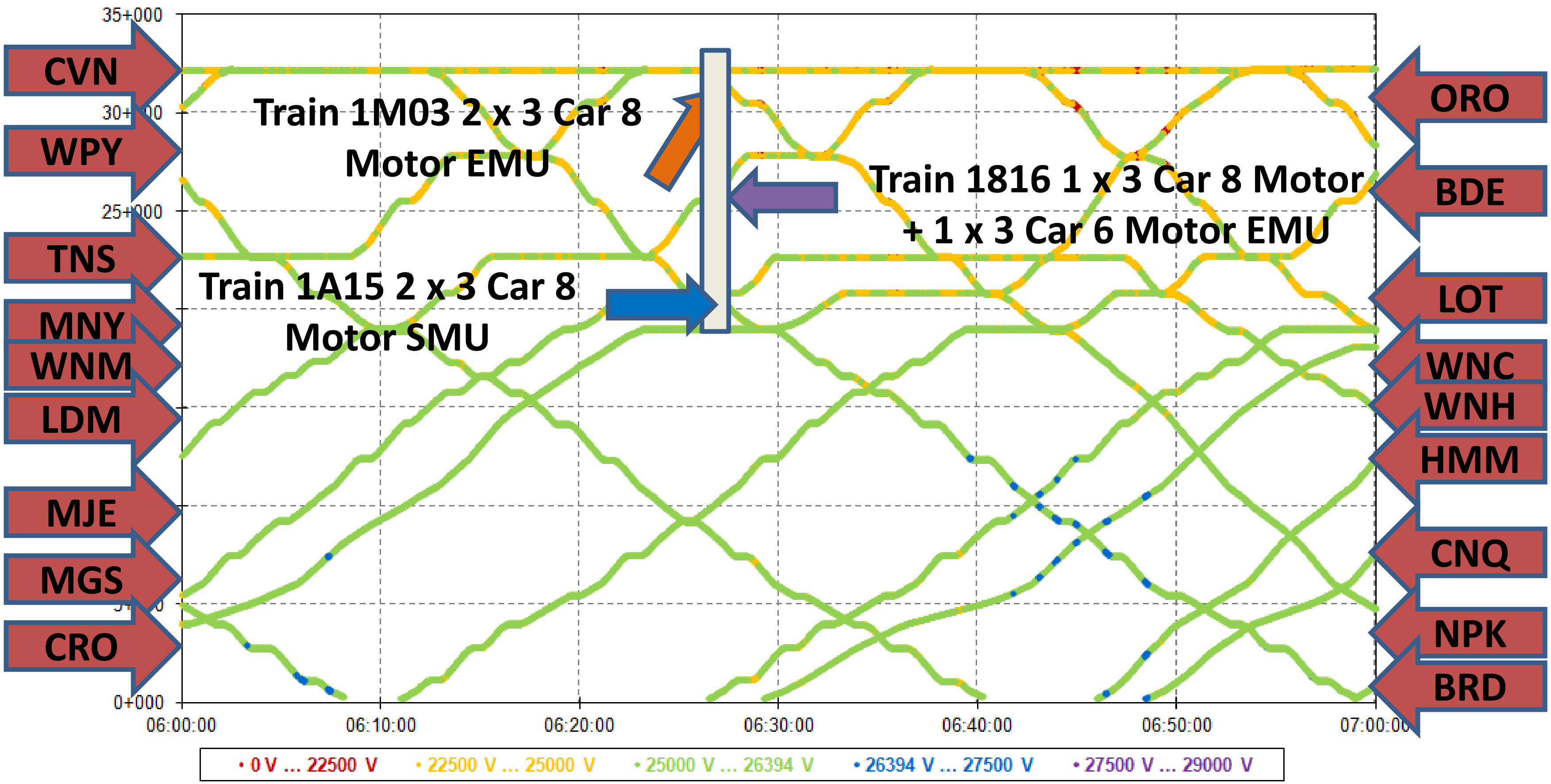
Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



Train Graph with indicated Pantograph Voltage
QR POC, thursday peak (AgAg424Afe000)



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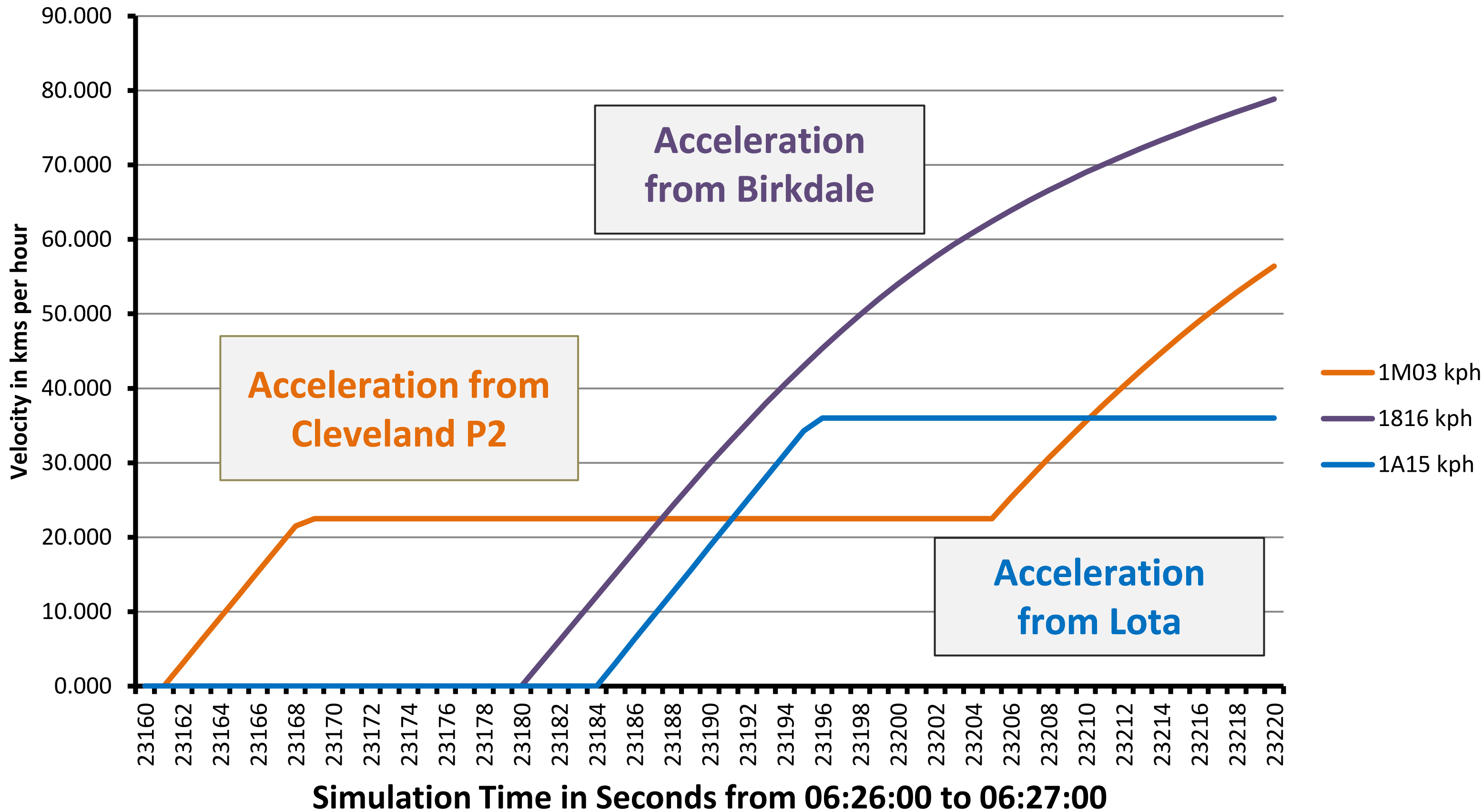
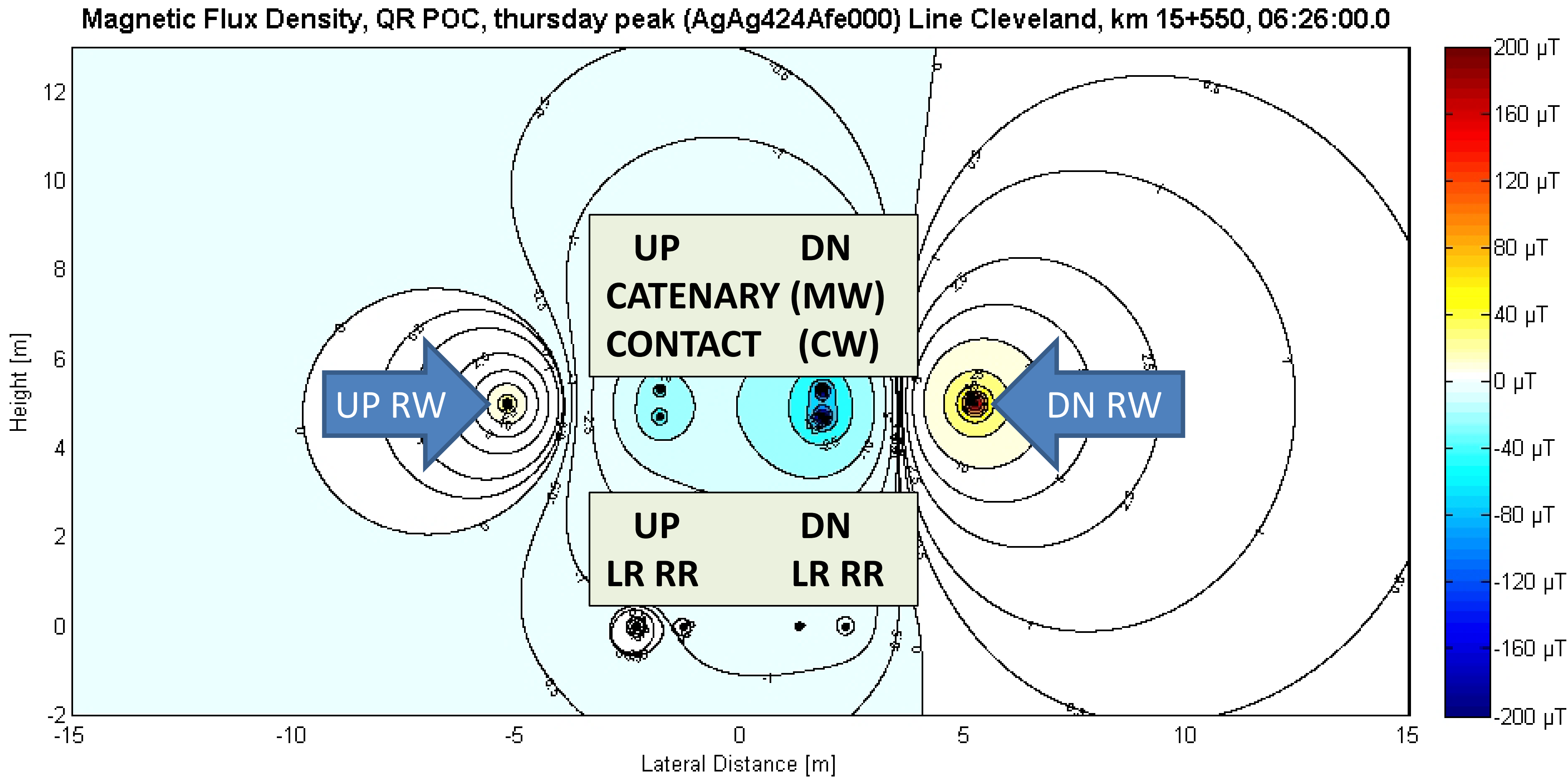
Train Velocity against Simulation Time in Seconds

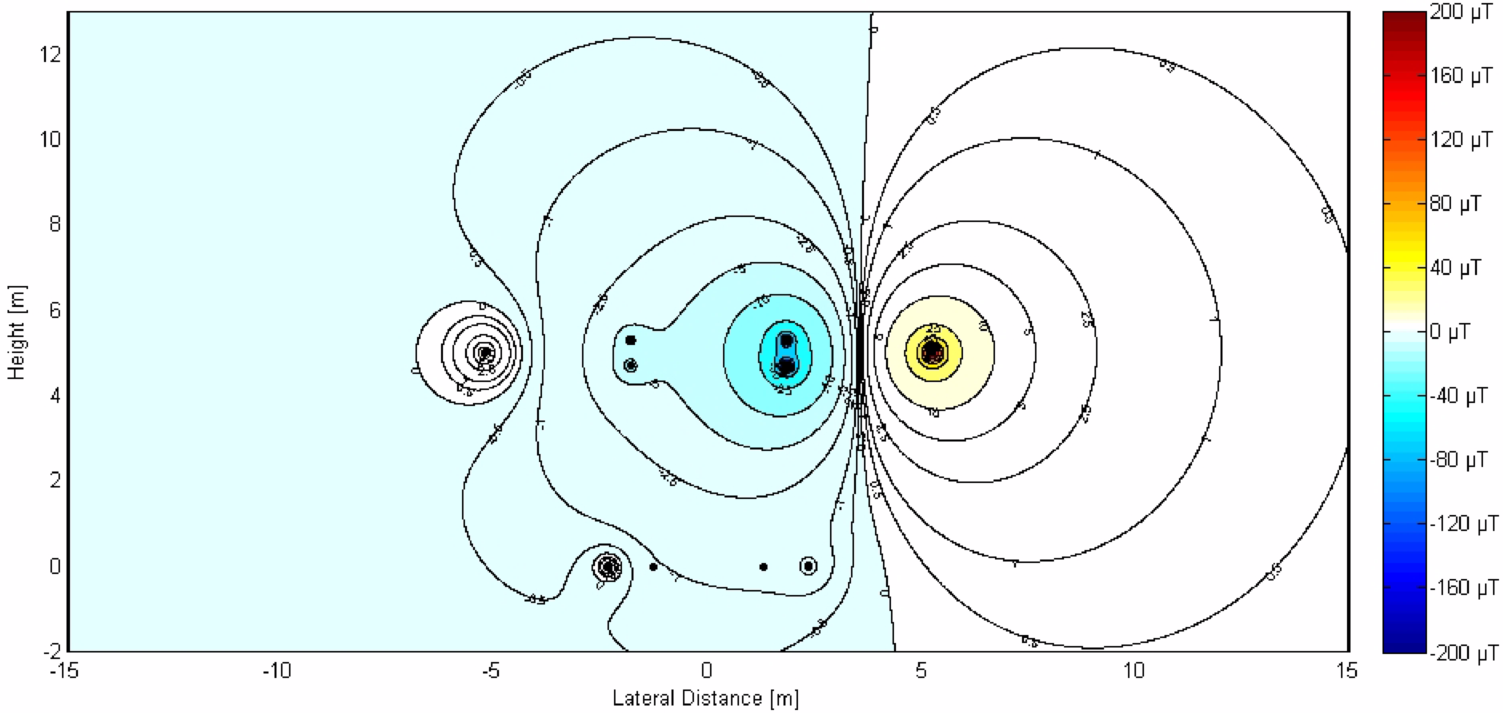




UP = Direction Park Road to Cleveland **DN = Direction Cleveland to Park Road**

RW = Return Wire **LR = Left Rail** **RR = Right Rail**

Magnetic Flux Density, QR POC, tuesday peak (AiAg432Afe000) Line Cleveland, km 15+550, 06:37:15.0

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Plateway
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POC 5 Day Peak Results

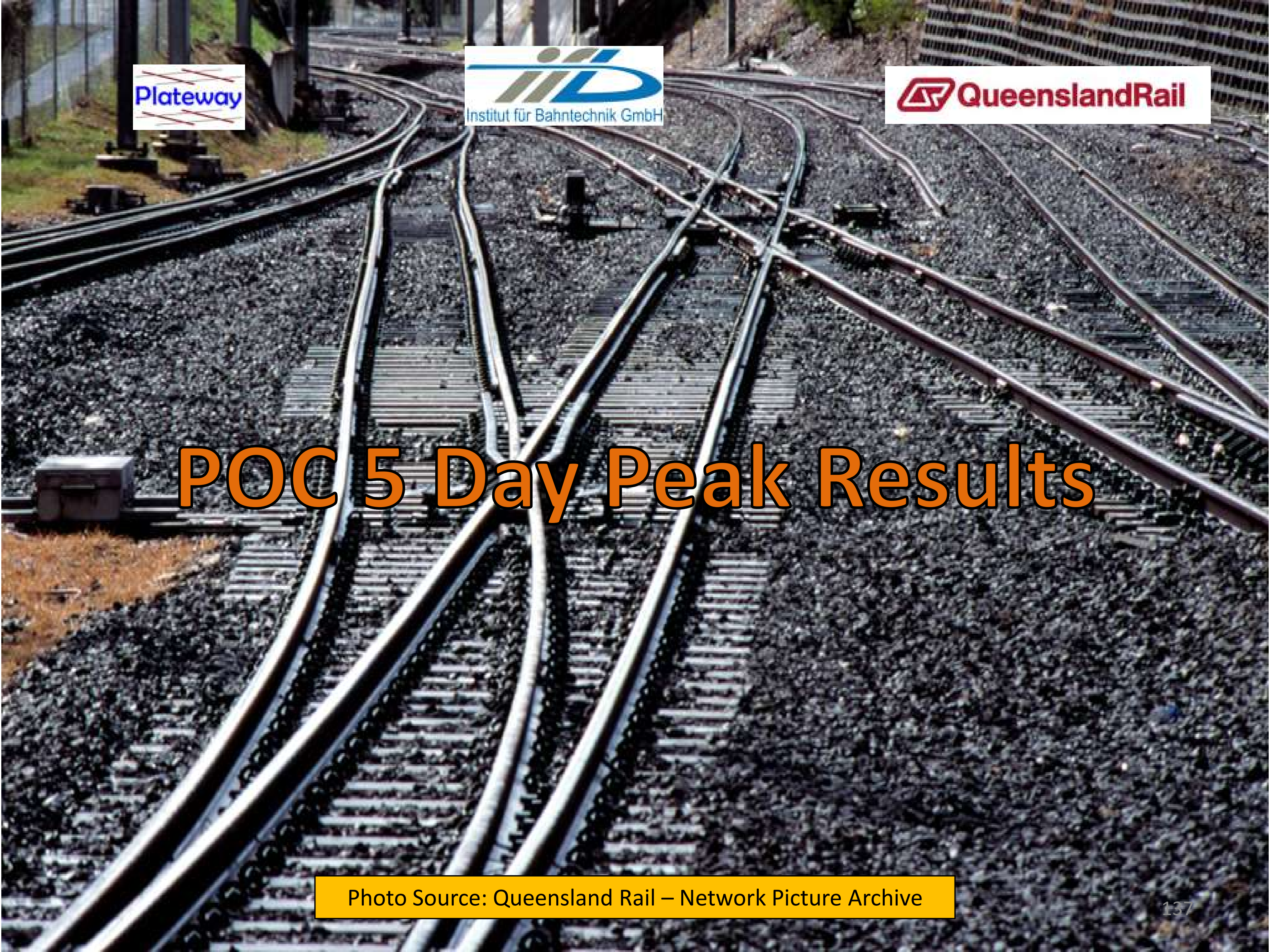

Photo Source: Queensland Rail – Network Picture Archive

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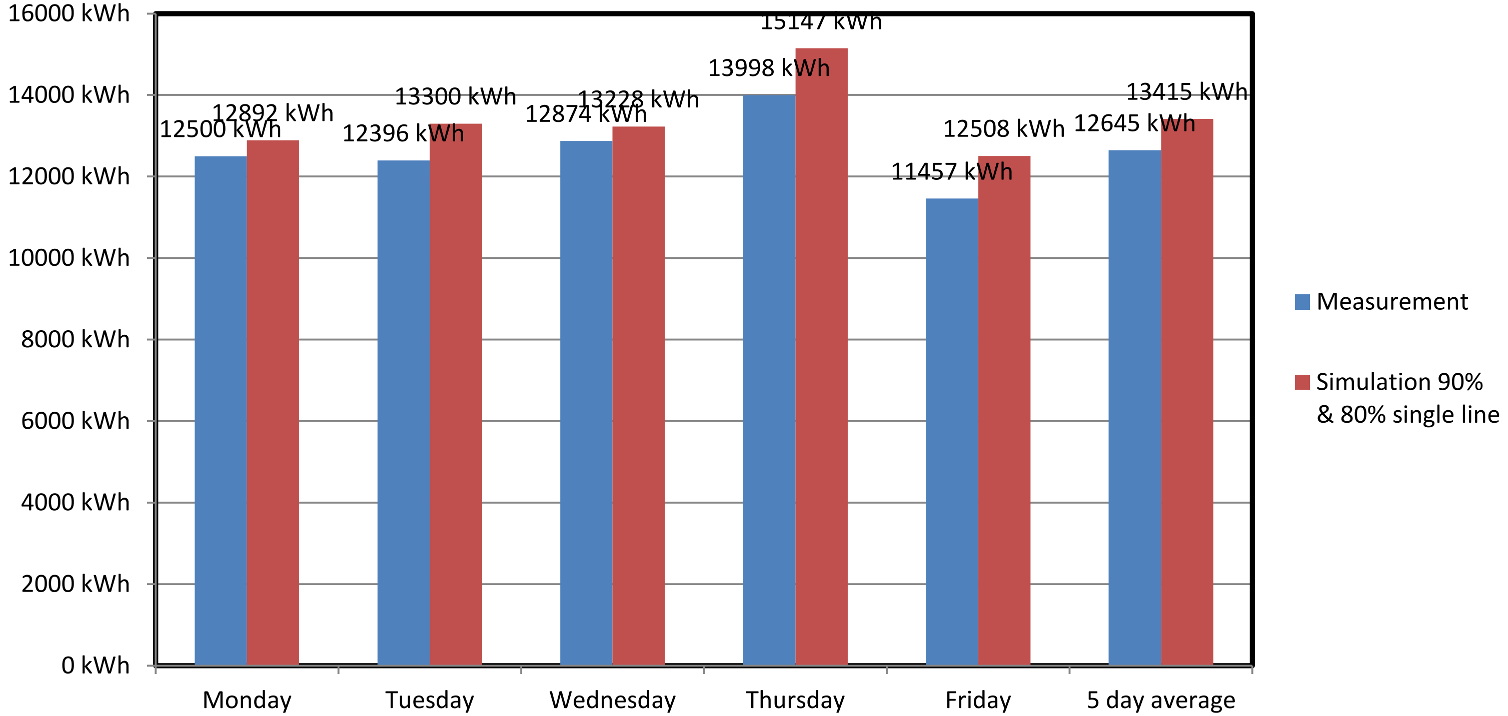
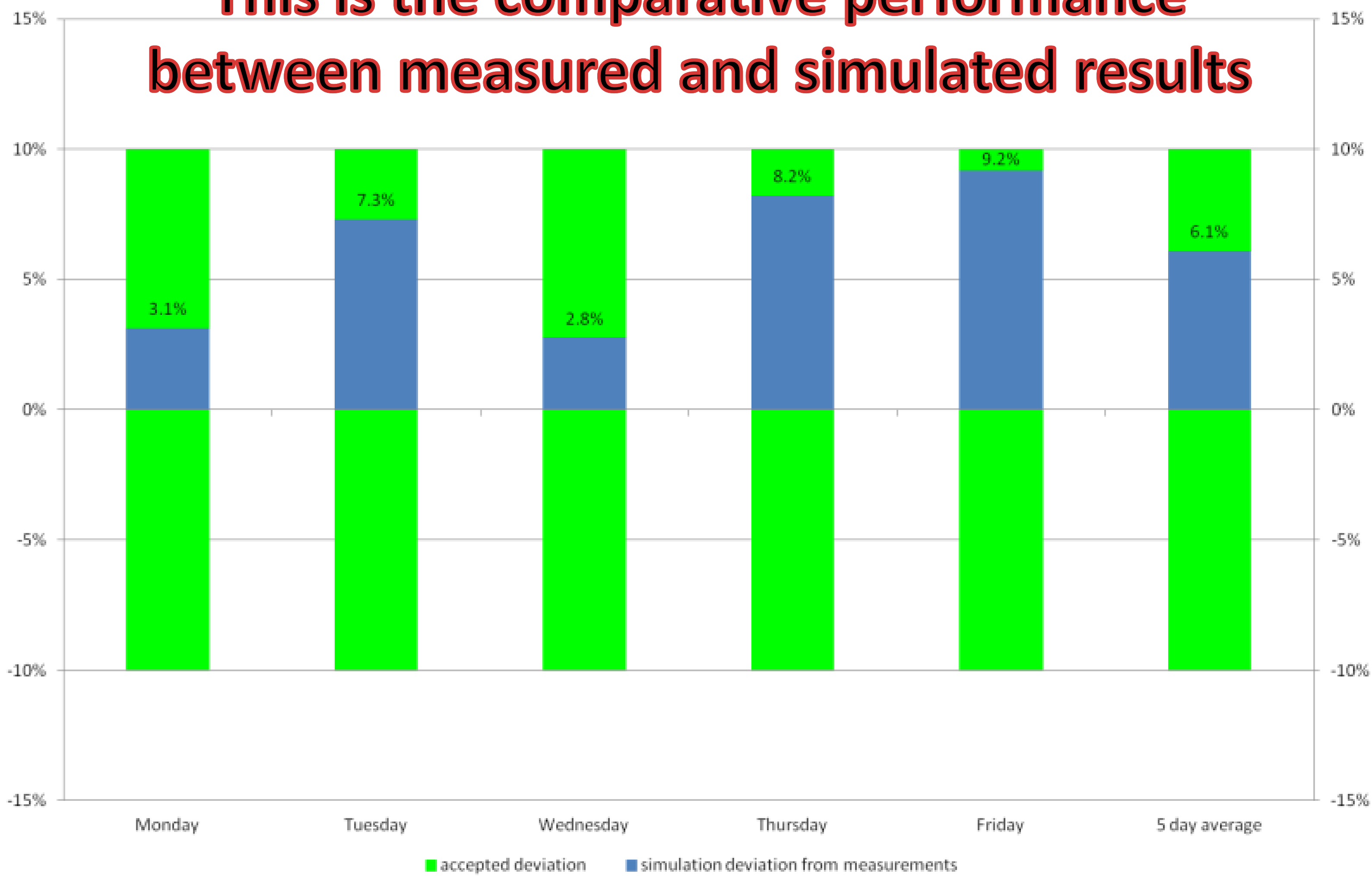
Benchmark Summary	Result
5 days of morning peak (6am to 10am) on the Cleveland Line	Co – simulation between OpenTrack and OpenPowerNet conducted for each of the 5 days of morning peak operations. Outputs tabled to Queensland Rail
Train Graph used for comparison between actual and simulated train running for each of the 5 days.	Train graphs produced for each of the 5 days showing the simulated against actual operations for the morning peak. Graphs handed to Queensland Rail and compared with actual operations (RTOA)
The simulated energy for each day will have a variation of less than 10% of that measured at Lytton Junction Feeder Station busbars.	The simulated results were handed to Queensland Rail

Photo Source: Queensland Rail – Network Picture Archive

QueenslandRail Proof of Concept
energy consumption at Lytton Junction Feeding Station
30.01.2012 - 03.02.2012 6am-10am Cleveland to Park Road



This is the comparative performance between measured and simulated results



Benchmark Summary	Result
5 days of morning peak (6am to 10am) on the Cleveland Line	Co – simul[redacted]een OpenTrack and OpenPowe[redacted]ucted for each of the 5 days[redacted] peak operations. Outputs ta[redacted]eensland Rail
Train Graph used for comparison between actual and simulated train running for each of the 5 days.	Train graph[redacted]d for each of the 5 days show[redacted]ulated against actual ope[redacted]the morning peak. Graphs ha[redacted]eensland Rail and compared [redacted] operations (RTOA)
The simulated energy for each day will have a variation of less than 10% of that measured at Lytton Junction Feeder Station busbars.	The simula[redacted]were handed to Queenslan[redacted]

Photo Source: Queensland Rail – Network Picture Archive

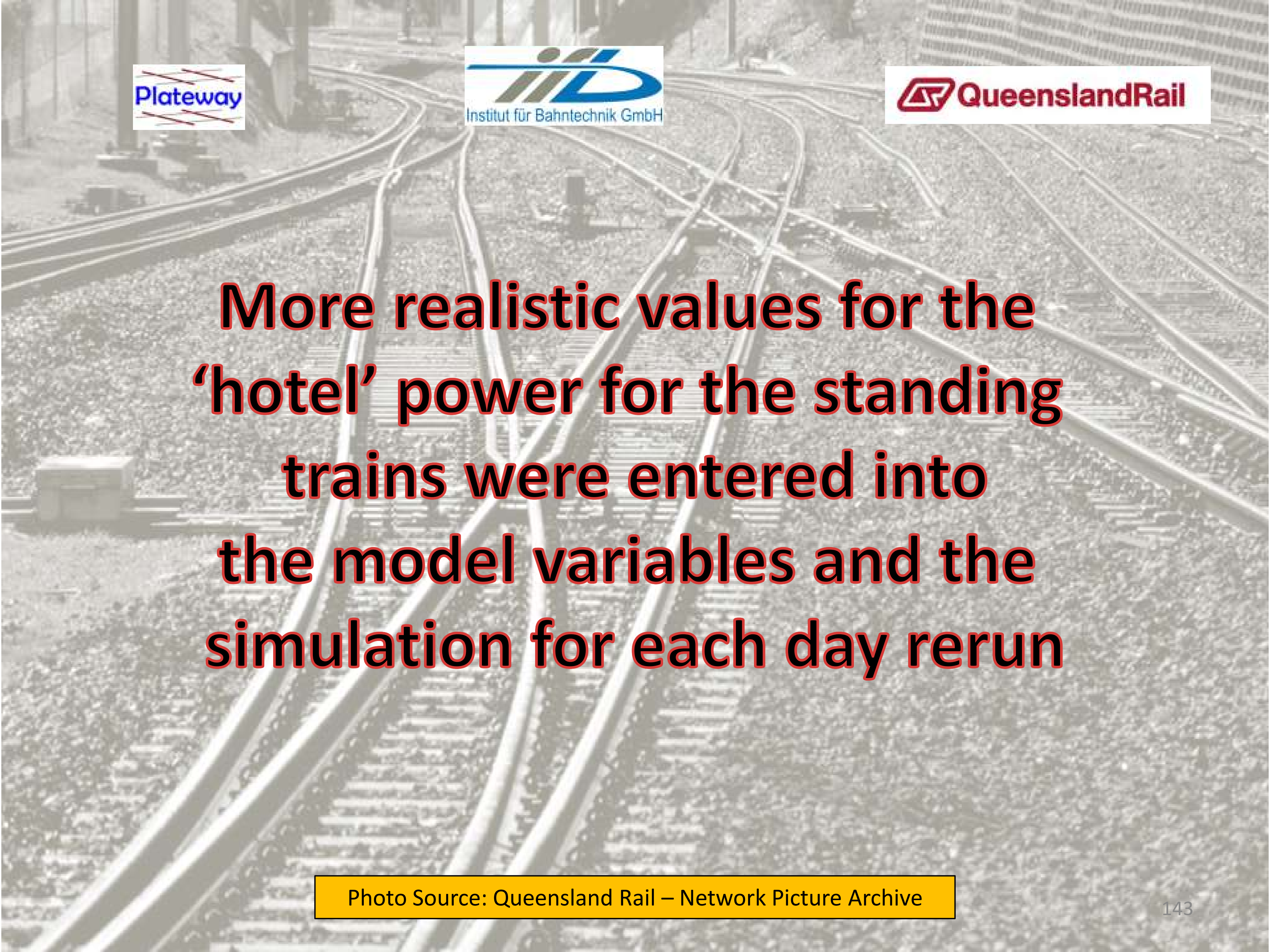
Plateway

Institut für Bahntechnik GmbH

QueenslandRail

When Queensland Rail tabled their measured results it was clear that the simulated ‘hotel’ power i.e. airconditioning, lighting etc. of the trains standing at Cleveland terminus had been overestimated

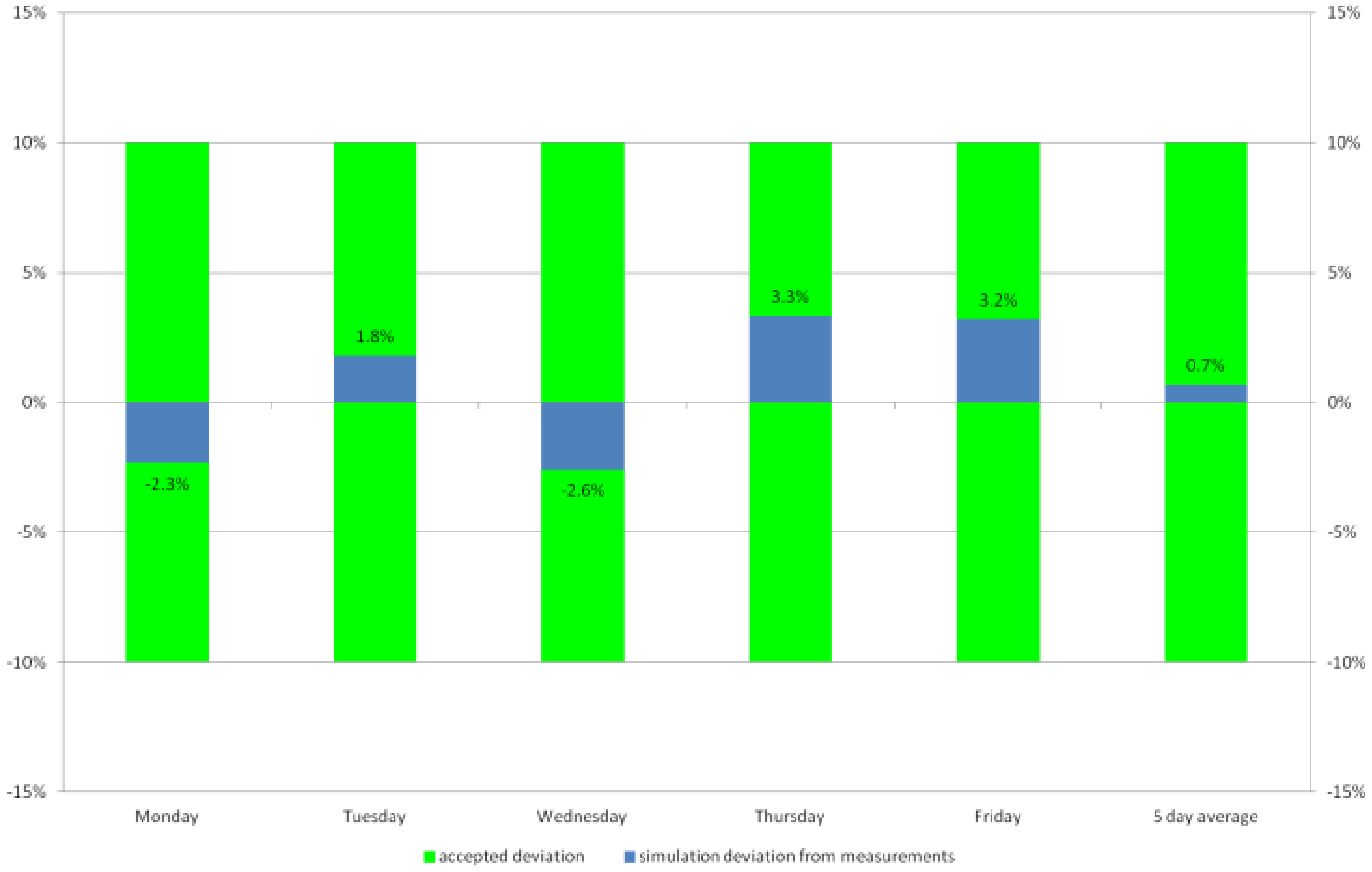
Photo Source: Queensland Rail – Network Picture Archive



More realistic values for the ‘hotel’ power for the standing trains were entered into the model variables and the simulation for each day rerun

Photo Source: Queensland Rail – Network Picture Archive

This is the revised comparative performance between measured and simulated results



Thanks to Queensland Rail & Plateway for permission to share the POC test results with you & to the Queensland Rail, Plateway & IFB Dresden personnel that made it a success

PHOTO: Murarrie Curve – SOURCE: Queensland Rail Trevor Bagnall