SYDNEY LIGHT RAIL PROJECT

Presentation to the

Bruno PETIN

28 April 2016

ALSTOM
Designing fluidity

Agenda

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Agenda

1. Introduction
2. **Project Overview and Organisation**
3. Focus on System Engineering
4. Focus on APS
5. Focus on HESOP
6. Focus on Citadis X05
7. Focus on EMC Studies
8. Focus on Sustainability
9. Other Engineering Challenges

Project Overview and Organisation

NSW GOVERNMENT | Transport for NSW

ALTRAC LIGHT RAIL

Sydtrack Design & Construct JV

Operations & Maintenance

acciona

Civil Works

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Rolling Stocks and Systems Maintenance

transdev

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Sydtrac - Acciona and Alstom

- Acciona has been operating in Australia since 2002. Globally it has approx. 32,000 employees in 30 countries and is headquartered in Madrid, Spain
- Acciona's capabilities are focused globally on engineering, financing, constructing and operating solutions. Its core businesses include:
  - Renewable Energy
  - Water
  - Infrastructure
- Alstom has a presence in over 60 countries with approx. 32,000 employees worldwide.
- Global leader in rolling stock manufacturing and rail infrastructure
- Alstom specialise in:
  - The TGV high speed train
  - The Tilting Pendolino trains
  - Citadis trams
  - Hi-tech Metropolis metro trains and world leading signalling technologies

Scope of works

- 12 km :
  - Central : 6 km (CBD + Central to Robertson Road Junction)
  - Two 3 km branches :
    - Randwick
    - Kingsford
- 10 Substations
- 2 x 1600 m of APS
- Depots :
  - Stabling – Randwick
  - Depot – Rozelle (on IWLR)
- One integrated OCC (for both CSELR – IWLR)
- 60x Citadis 305 in double units

A small video from TfNSW

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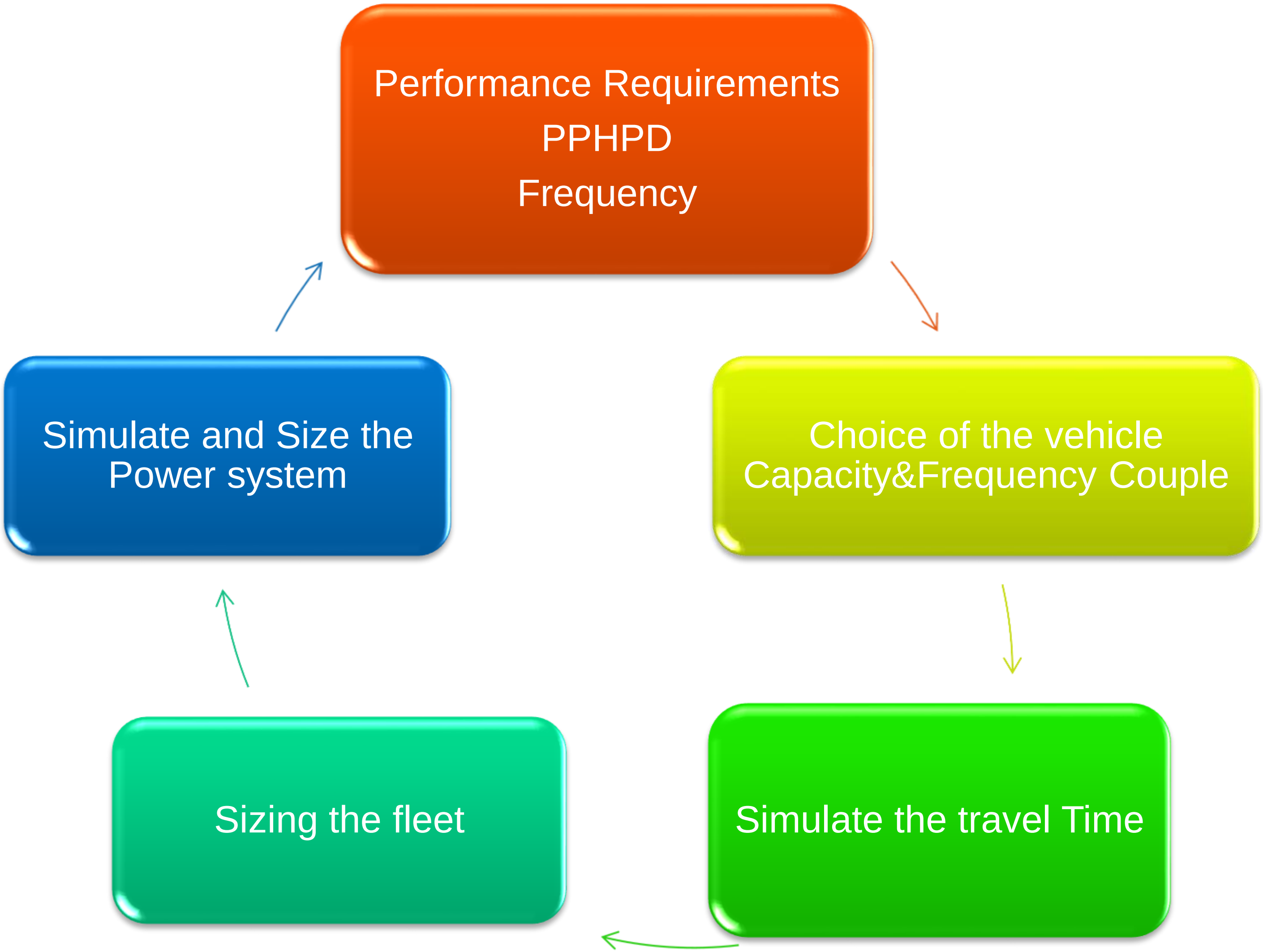
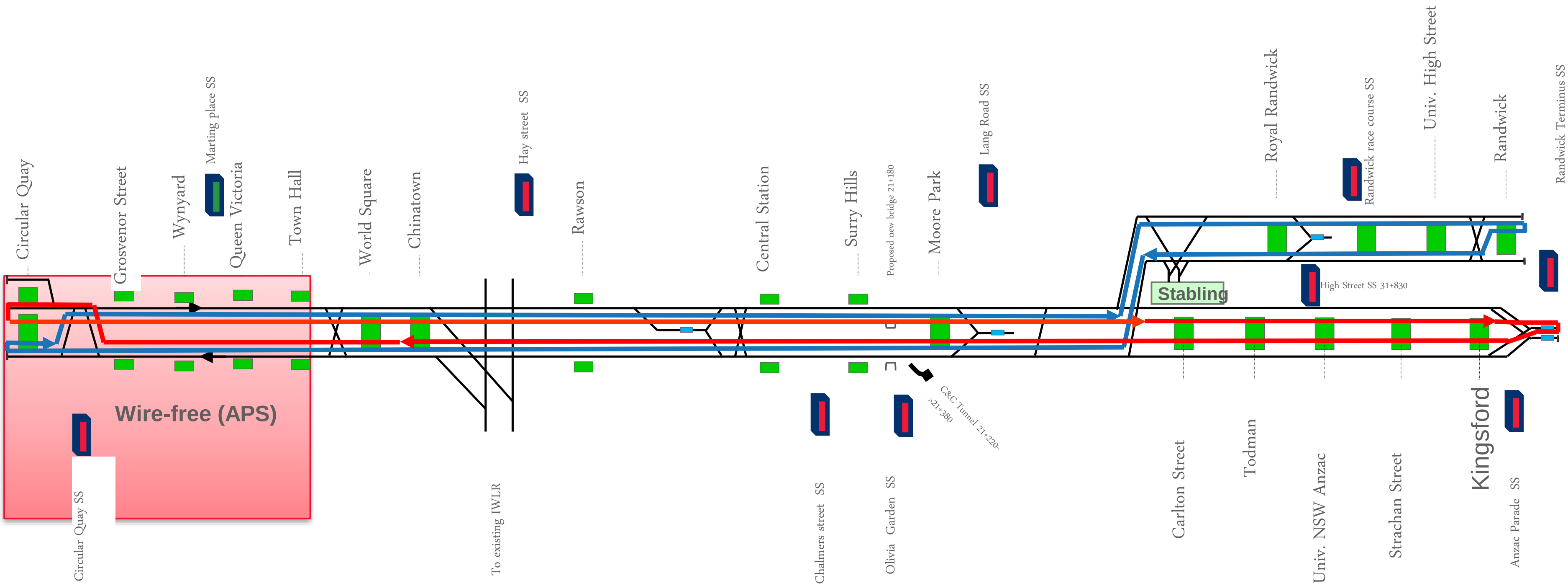
Agenda

System Engineering – How do we size a System?



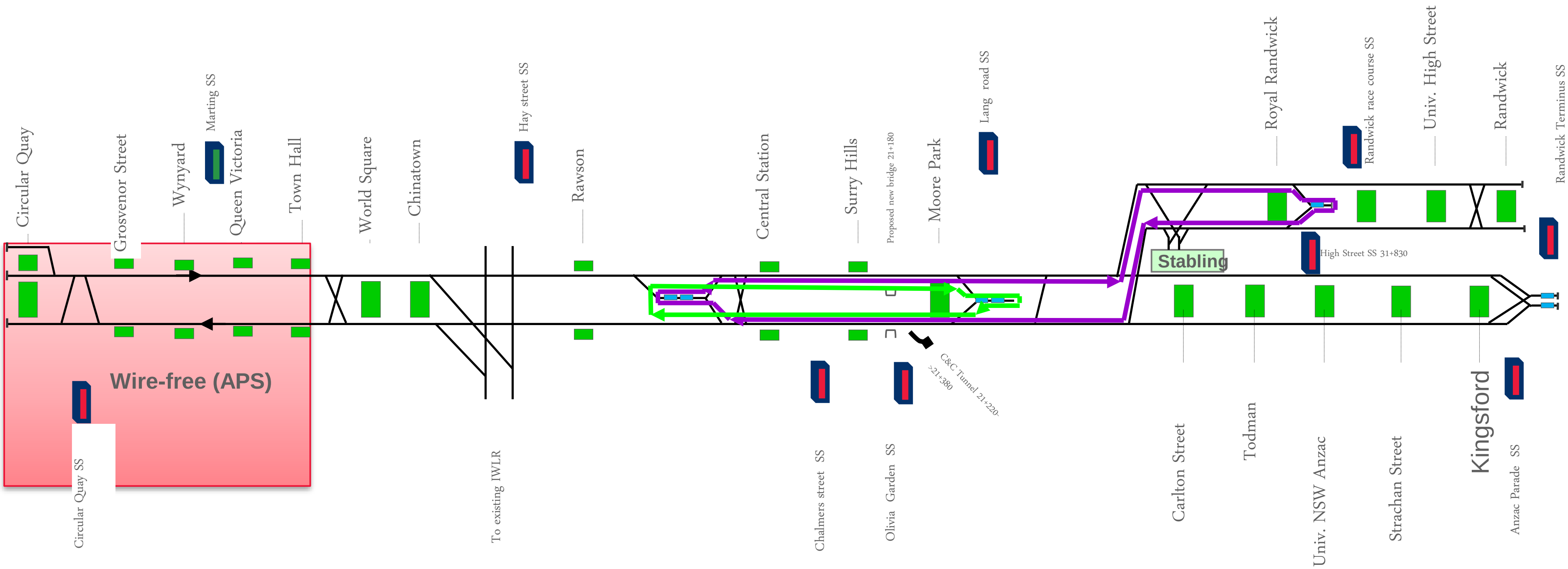
CSELR – Normal Operation

- Normal operation consists of two services :
  - **Between Circular Quay and Randwick**
  - **Between Circular Quay and Kingsford**
- Capacity requested :
  - **9000 pphpd in the common trunc**
  - **4500 pphpd on each branch**



CSELR – Special services

- Special services are identified as follow :
  - In addition to Normal Operation :
    - **Central station and Moore Park – 10800 pphpd**
    - **Central station and Royal Randwick Racecourse – 7500 pphpd**
  - Without other operation :
    - **Central station and Moore Park – 13480 pphpd**



Crushing the numbers

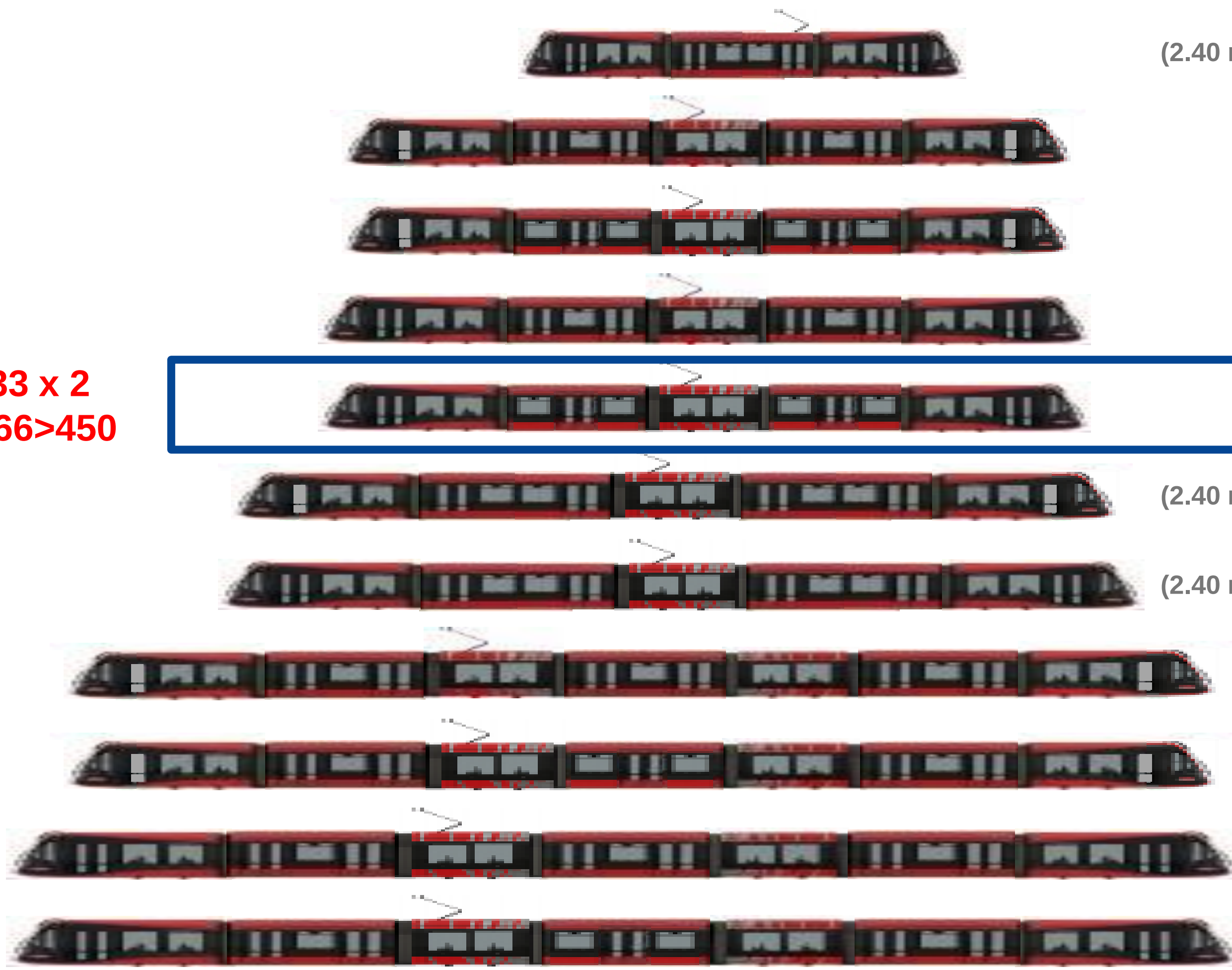
- 9000 PPHPD = Capacity of the Tram x Number of trams per hour

>=3 Min in Trams

Capacity >= 9000/(60/3) = 450 Passengers

Choice of the right Vehicle

WITH CITADIS X05



(2.40 m only)

24M VERSION (CITADIS 205)

233 x 2 = 466>450

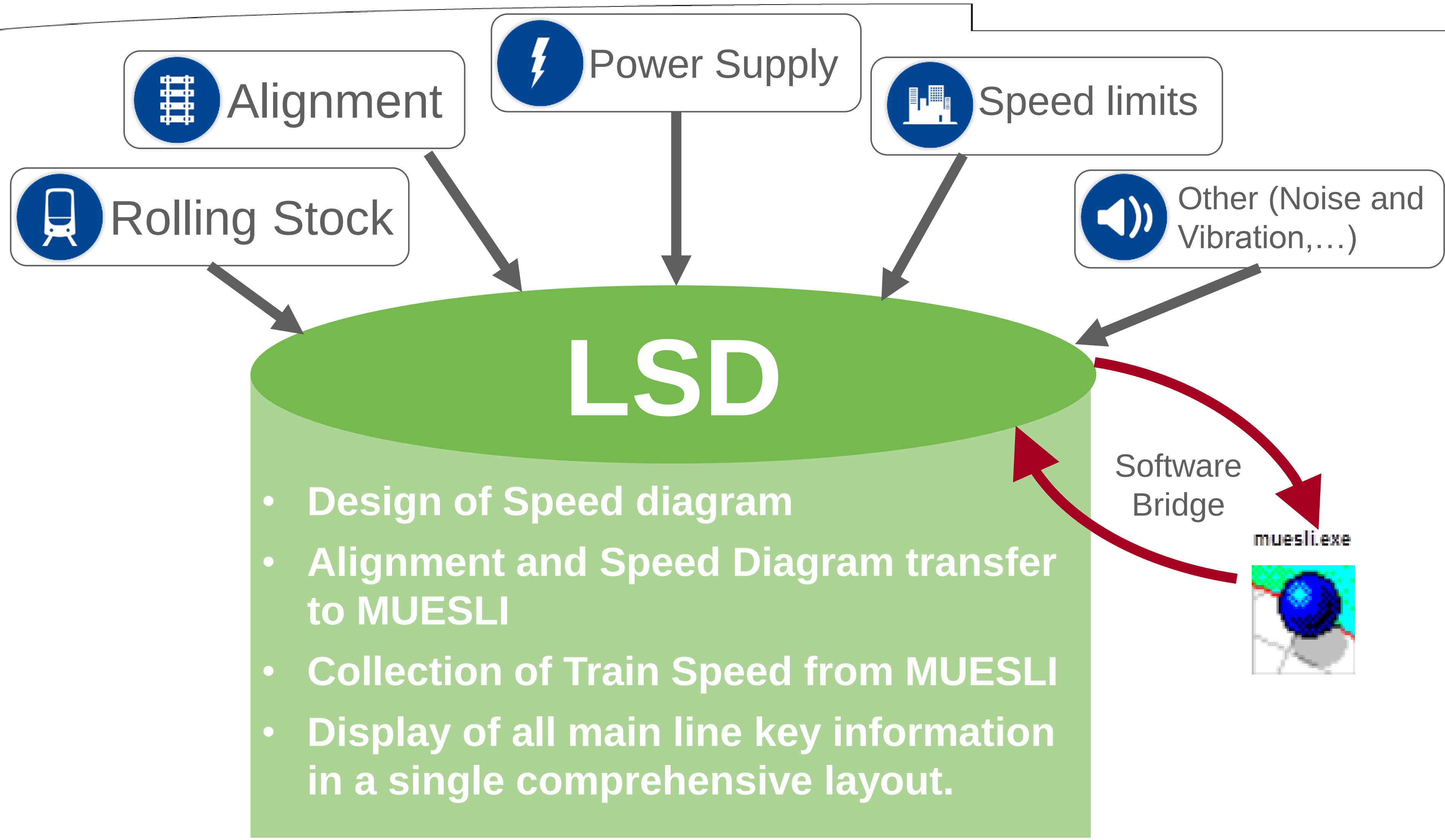
(2.40 m only)

(2.40 m only)

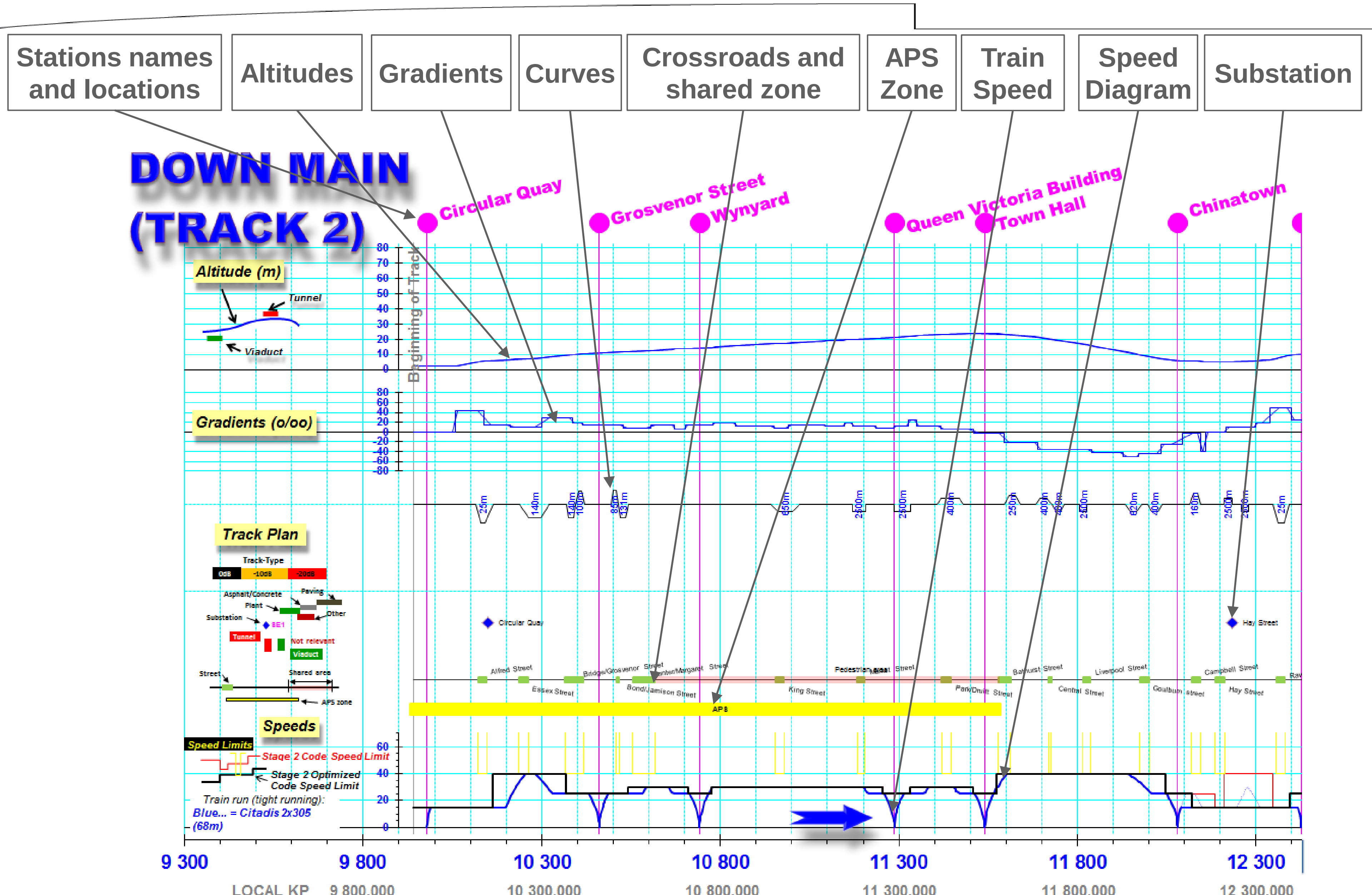
32 TO 37M VERSIONS (CITADIS 305)

43 TO 45 M VERSIONS (CITADIS 405)

Simulating the speed profile and Travel time with Muesli



Simulating the speed profile and Travel time with Muesli



Sizing the Fleet

Round Trip time = Travel Time A to B + Travel Time B to A + Turnback time at A + Turnback time B

Fleet Requirement = Round Trip Time / Headway

Fleet Size = Fleet Requirement + Hot Spare + Maintenance allowance

For SLR :

Round Trip Time = 88min on each branch

Headway = 8 min start (6 min 30 s ultimate) on each branch

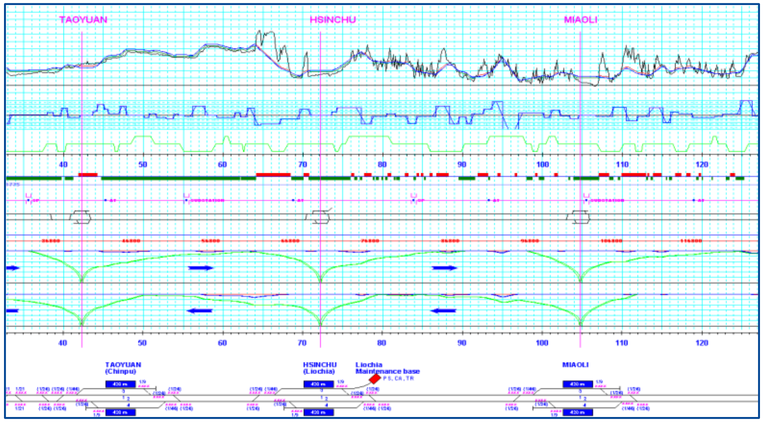
Fleet requirement = 11 per branch

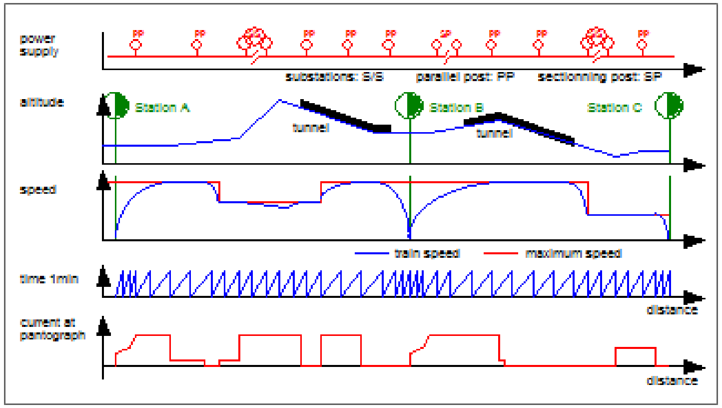
Fleet size = 2 x 11 + 3 = 25 (30 ultimate)

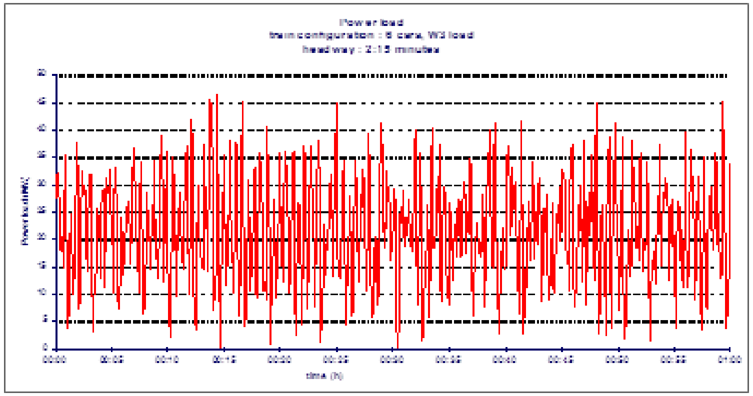
Sizing the Traction Power supply system

Power supply architecture definition

- Simulations with ELBAS software
- Optimization of Power Scheme
- Analysis of HESOP performance

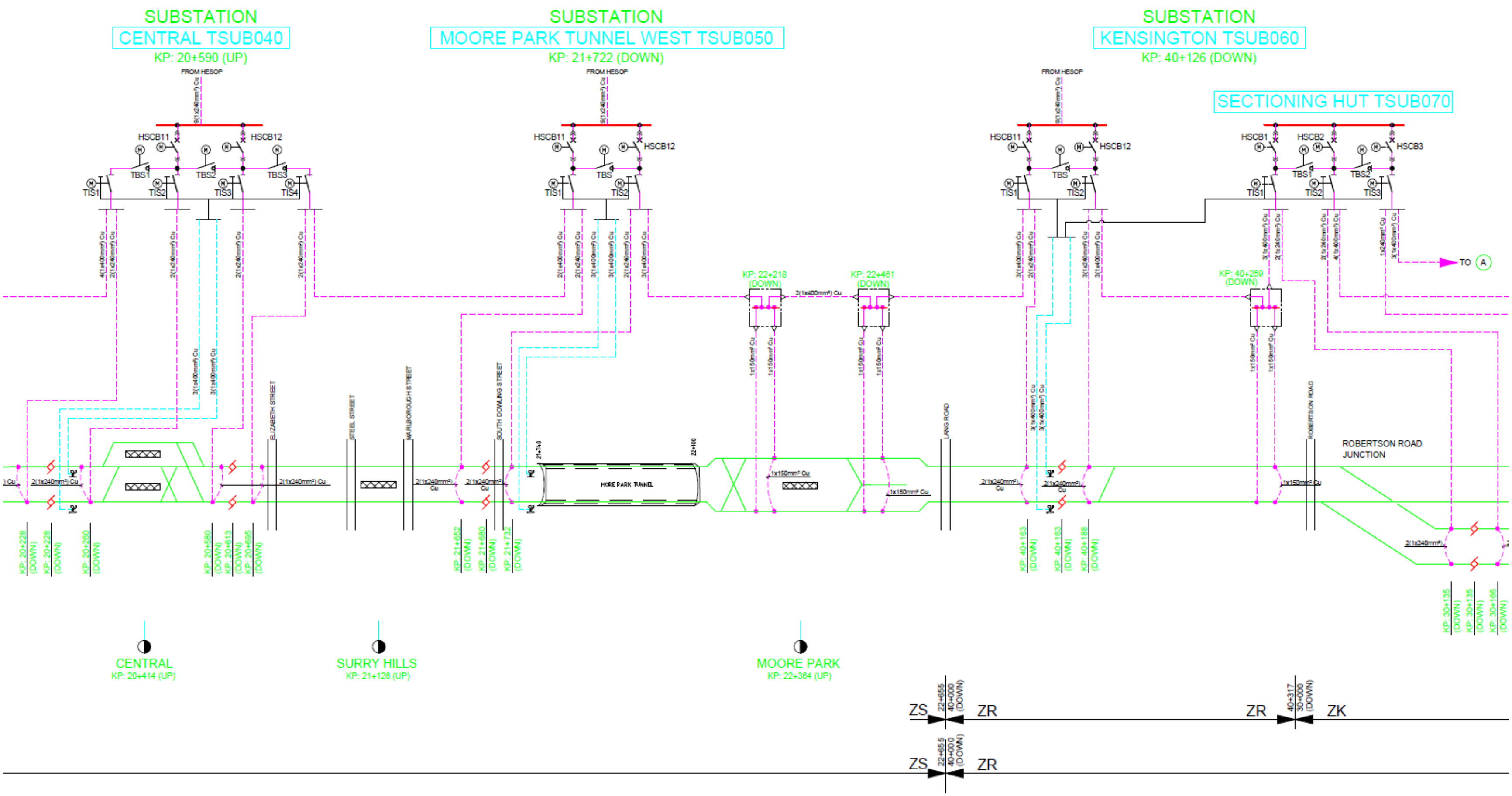






Simulate to optimize architecture

To Achieve this via recurrent design



Agenda

Wireless trams : no overhead contact line

APS projects locations

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George street in a couple of years

Catenary-less solutions: 3 steps to choose

1. PROJECT LOCATION

Very hot temperature

Recommended solution: APS

Reason: behavior and reduced life time of on-board energy storage solution with very high temperature

Nordic countries with hard winter conditions

Recommended solution: full on board autonomy

Reason: avoid de-icing product and ice cleaner necessary with APS or other system with collecting shoe

2. SPECIFIC PROJECT REQUIREMENT

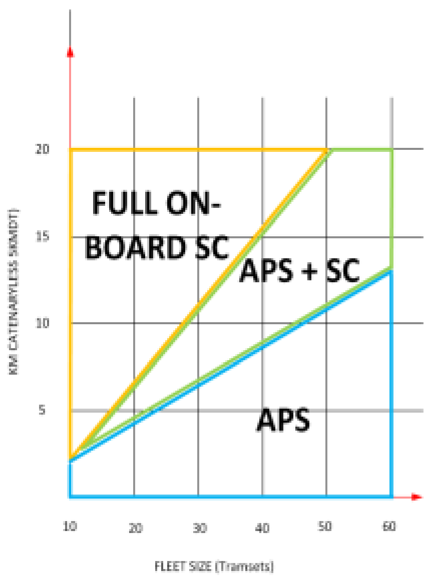
Severe slopes or long stops due to traffic jams

Recommended solution: APS or APS with on-board supercap

Reason: on-board solutions cannot cope with huge amount of energy

If solution not defined after steps 1 & 2, all solutions are feasible

3. CAPEX AND OPEX COSTS ANALYSIS



Smaller the fleet size and long catenary-less section: on-board technology is the best solution

Big fleet size and short catenary-less section: APS technology is the best solution

APS basic principles: Movie

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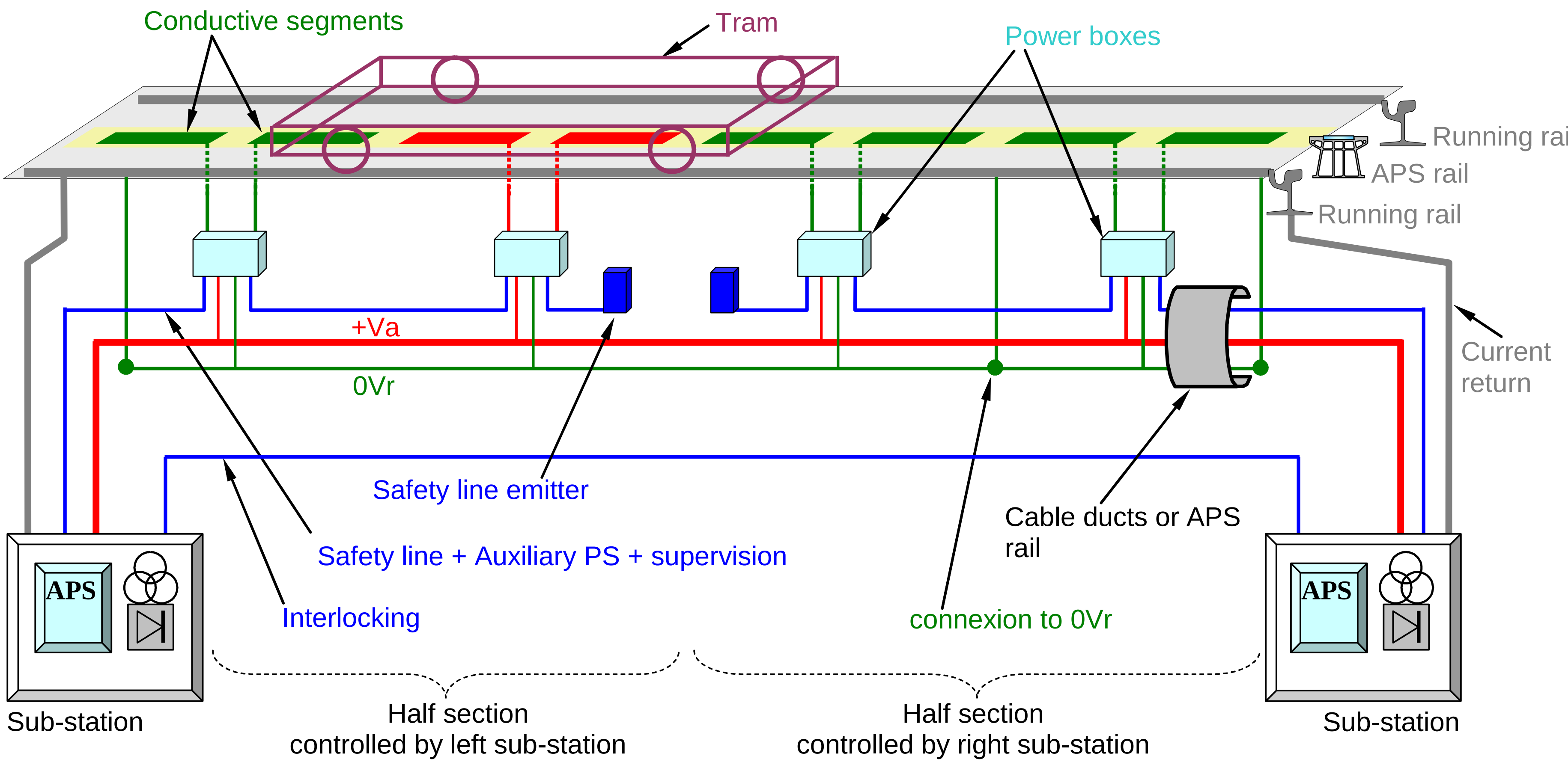
APS – Simplified architecture



APS MAIN COMPONENTS

On-board equipment

Battery Cubicle

- Allows train motion in case of loss of power on the APS rail

- Includes a battery charger 6 kVA and the battery (15 A.h)

Main Switch Cubicle

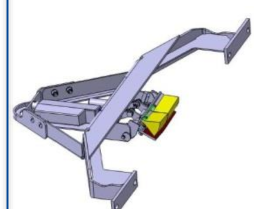
- Allows switching the power source from APS rail to OHW or Battery

- Includes the APS safety emitter

Collector shoe

- Collect the traction current from the APS rail (physical contact)

- Include the APS coded signal antennae



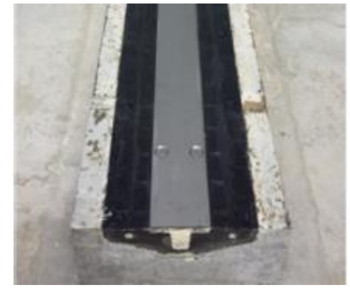
Brush

- A bumper to eject objects such cans

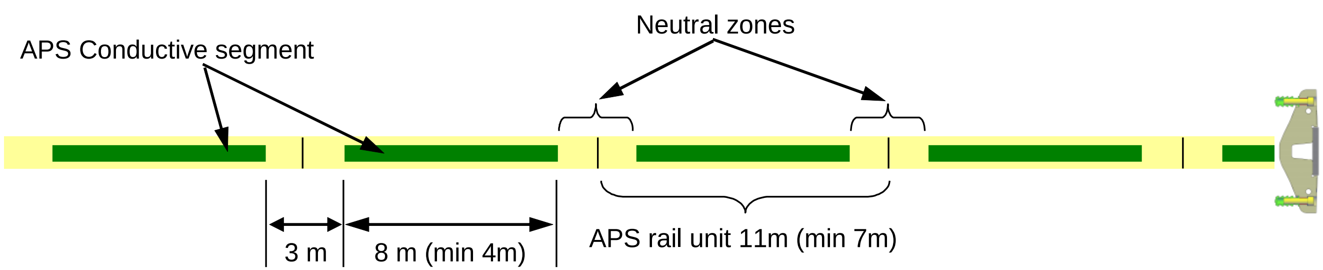
- A brush to clean the rail from sand and smaller objects

APS MAIN COMPONENTS

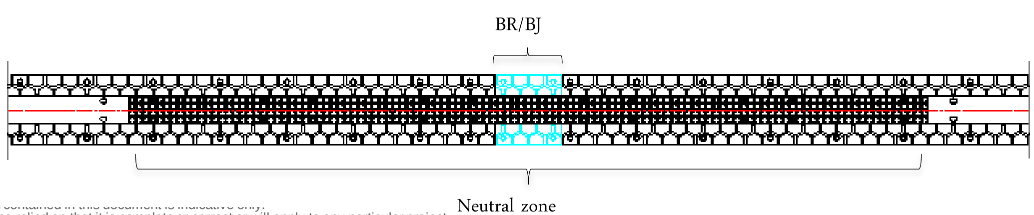
Mechanical equipment (installed by CW)



- **APS rail**
  - Insulated support frame (rubber beam)
  - Conductive segment
  - Neutral zone



- **Branching box / Box for Junction**
  - Box for Junction ensures mechanical connection between two APS rails.
  - Branching box ensures the same functions as a BJ but also ensures connections to the electrical equipment inside the APS manhole.

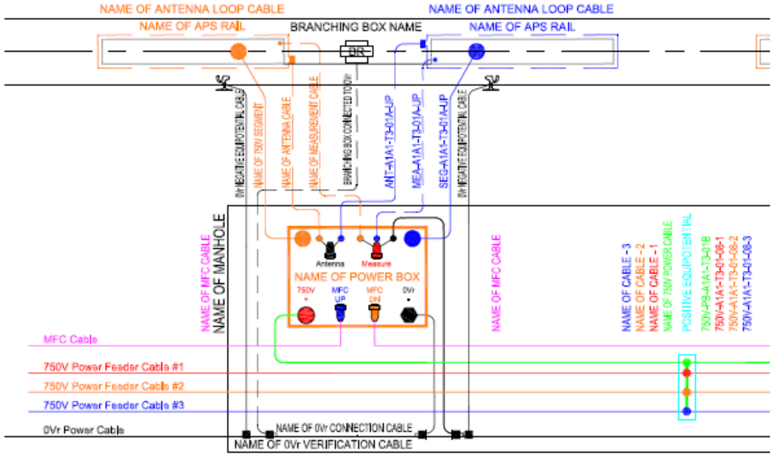


APS MAIN COMPONENTS

Electrical equipment

- **APS cabinet**
  - Installed inside each APS Traction Power Substation and interfacing with the High Speed Circuit Breaker.

- **APS power box**
  - Located in the APS manhole and supplying one or two APS conductive segments.
- **APS rail antenna**
  - Detection loop connected to the PB are embedded in the APS rail support frame in order to receive the coded signal sent by the tramway.

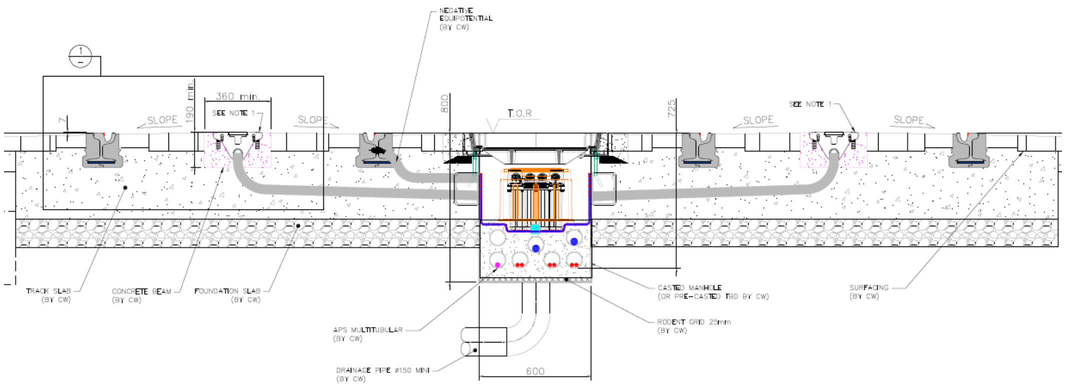


- **Cables**
  - Feeders cables and positive equipotential boxes,
  - MFC cables (Safety line + 230Vac + Communication),
  - 0vr cables,
  - Antenna cables,
  - Safety interlocking line between APS cabinets in TPS
- **End of line emitter**
  - Supply and monitor the safety line.

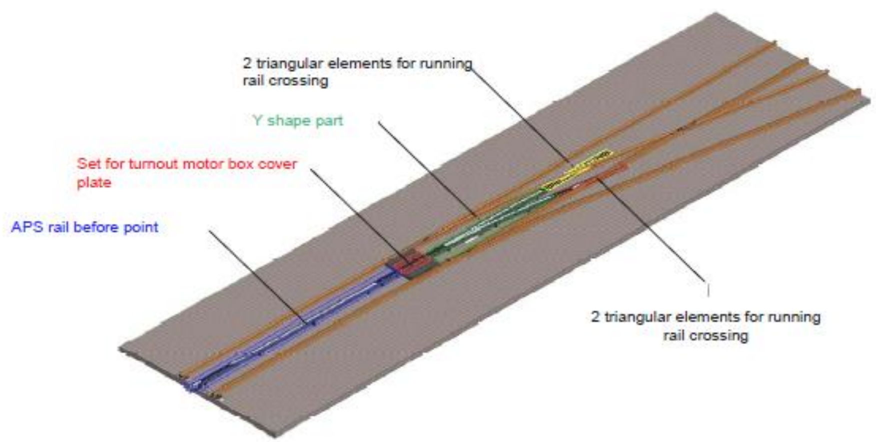
APS MAIN COMPONENTS

Mechanical equipment (installed by CW)

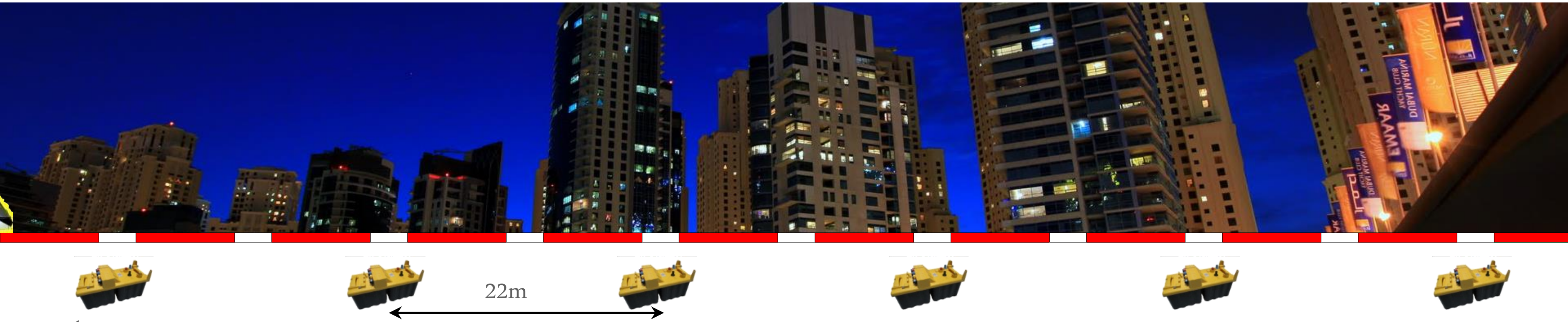
- **APS manhole**
  - Pit installed along the track which contains APS trackside electrical equipment.



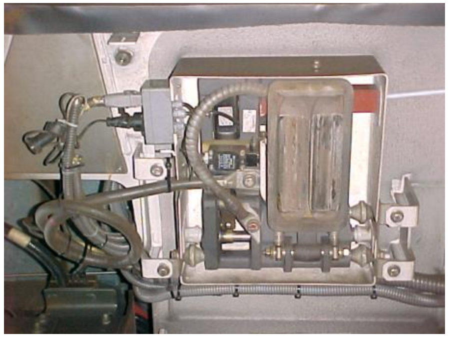
- **APS turnout**
  - Specific APS parts designed to fit with turnout configuration.

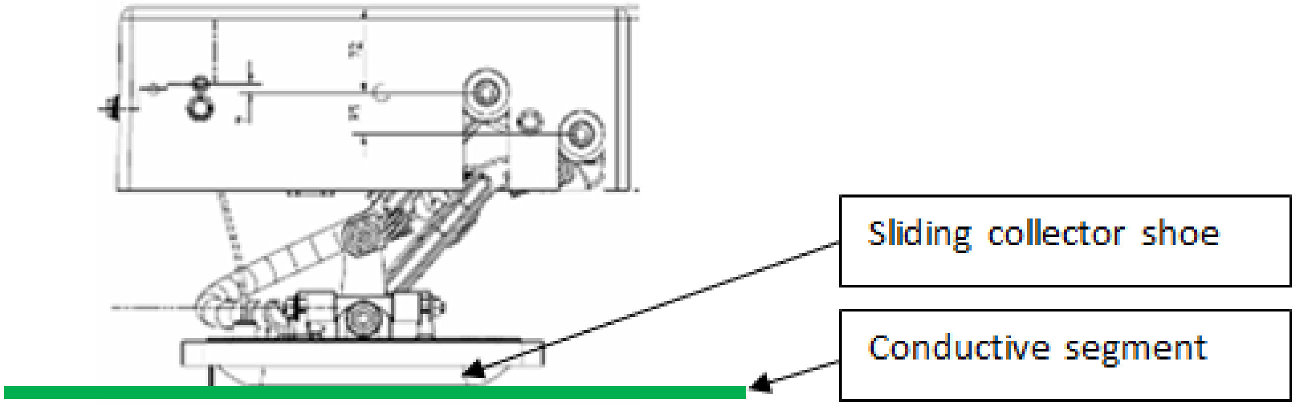


APS basic principles: Summary

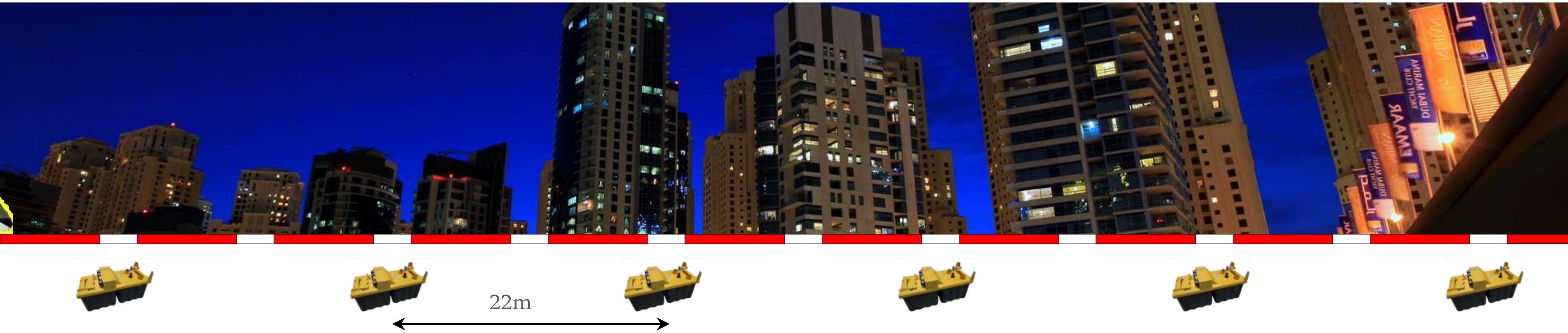


- ✓ The tram is powered through two collector shoes sliding on a third rail (APS rail).





APS basic principles: Summary

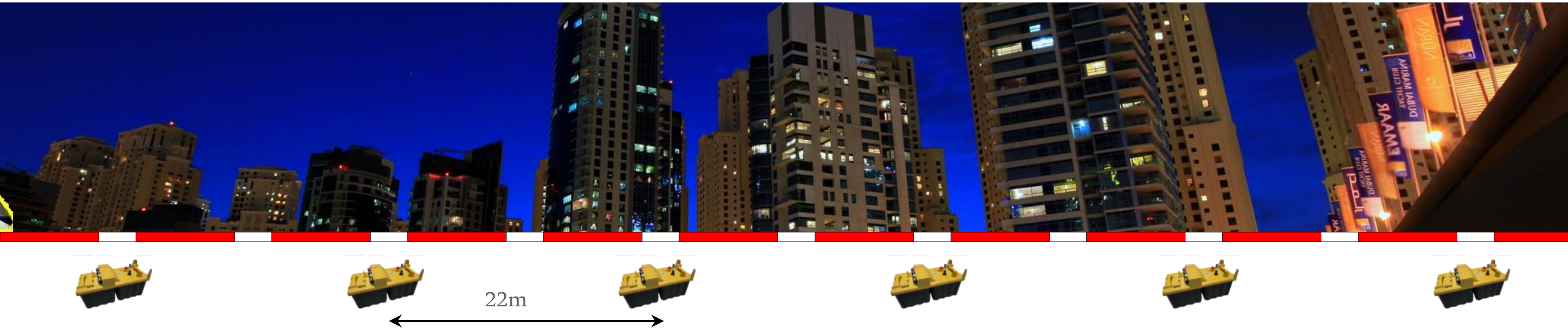


- ✓ The standard APS rail is segmented every 11m: 8m conductive segment / 3m neutral zone.

- ✓ Spacing between collector shoes is **slighlty higher than 3m:**
- ➔ At least one collector shoe is in contact with the conductive segment.
- ➔ No power loss while crossing 3m long standard neutral zones.

APS Collector shoes

APS basic principles: Summary



- ✓ The tramway sends a coded signal to the ground to announce its presence.
- ✓ The tramway safe detection is managed by an electronical unit called « Power Box ».
- ✓ Once the tramway is safely detected, the conductive segment potential is set to 750V by the Power Box.
- ✓ After the tram passage, the segment is connected to the running rail potential by the Power Box.
- ✓ Tramways are 33m long, covering every powered segments.

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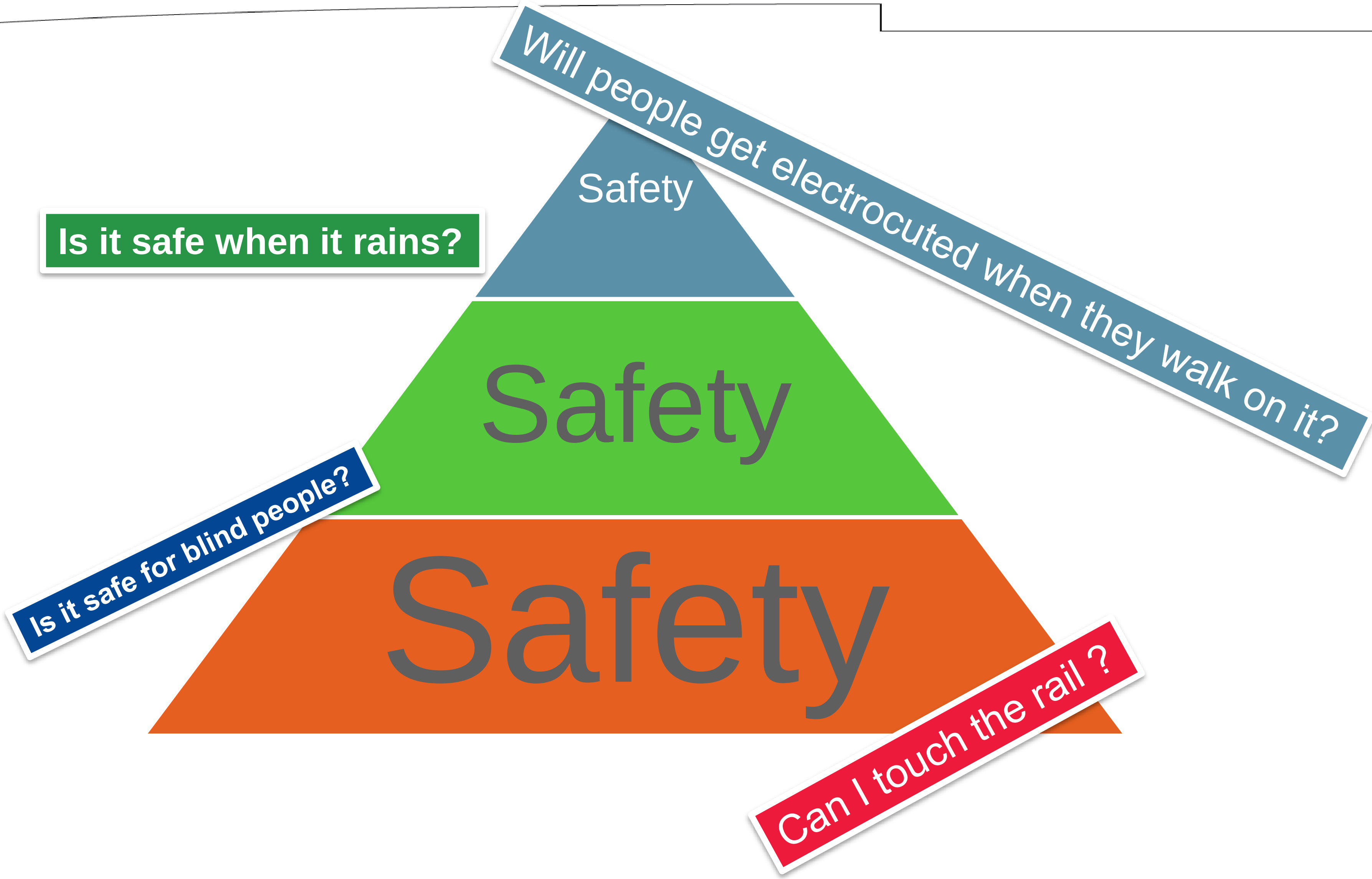
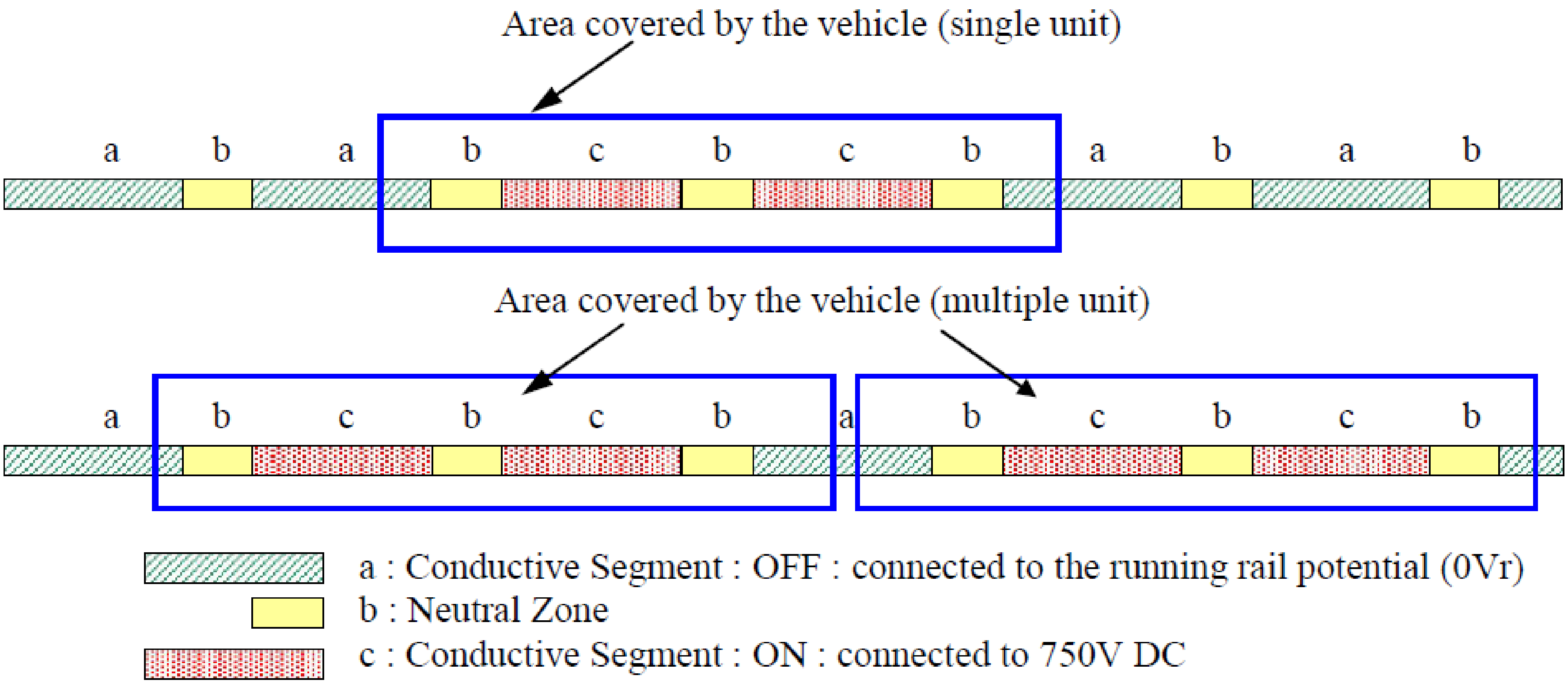
What is APS main Engineering Challenge?



APS basic principles: APS Rail segments

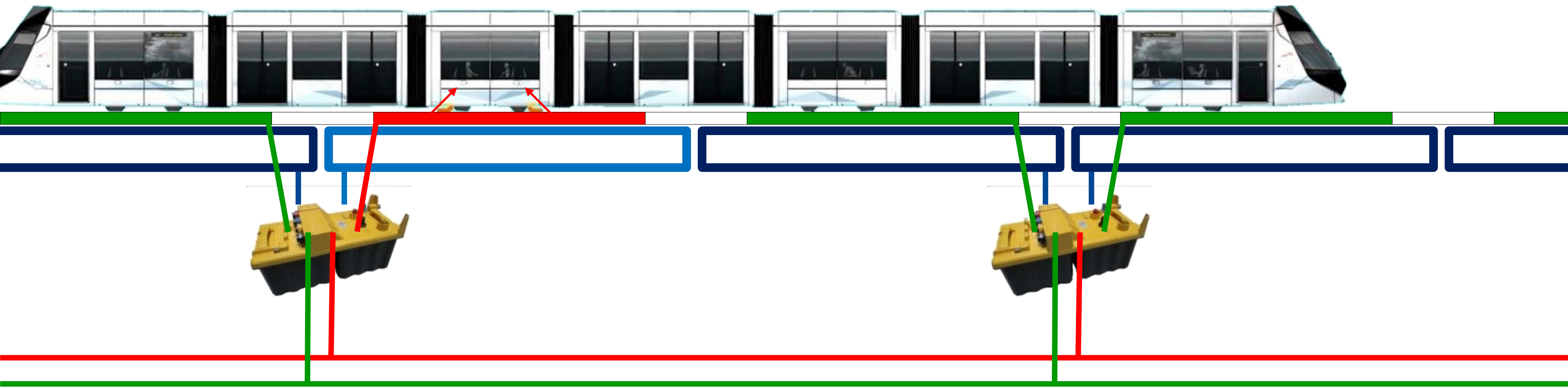


APS Basic Principle: Power Moving Bloc

Both collector shoes are on the same conducting segment

Return current via the running rail

Presence detection loop detects both presence detection signals generated at the level of the collection shoes

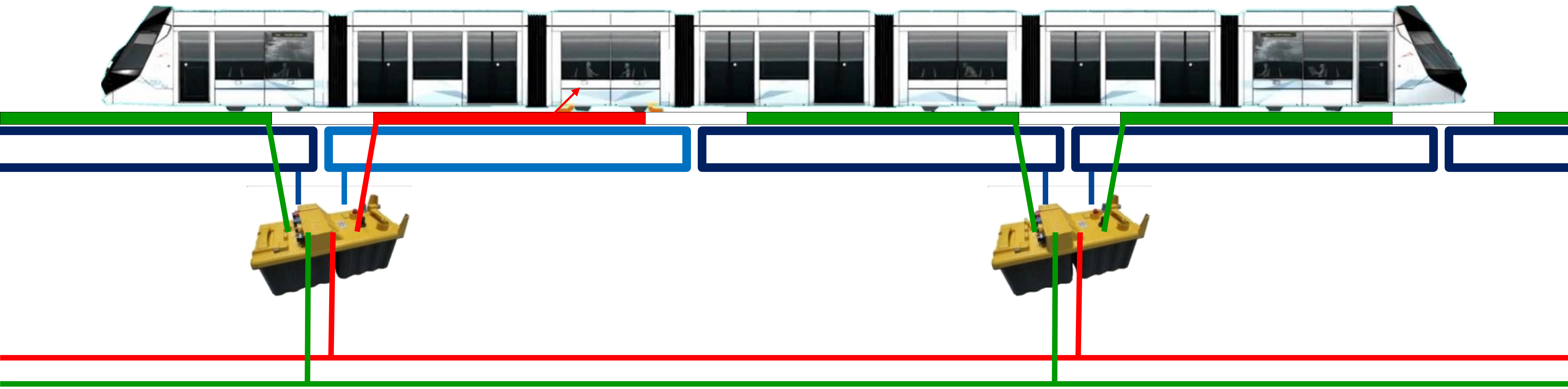


APS Basic Principle: Power Moving Bloc

The leading collector shoe leaves the active conducting rail

The trailing collector shoe is still on the conducting rail and supplies power to the tram

Return current via the running rail



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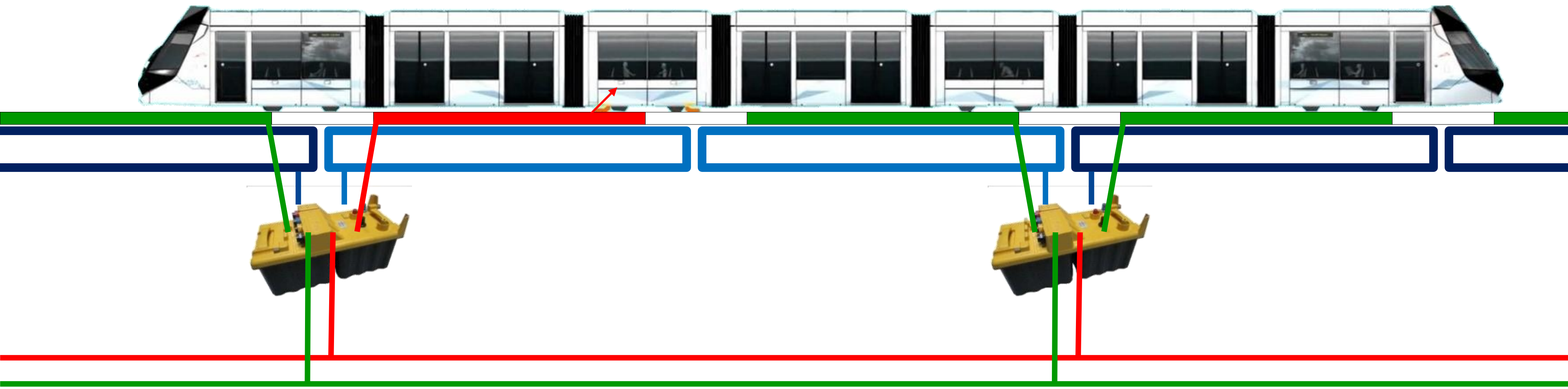
APS Basic Principle: Power Moving Bloc

The leading collector shoes activates the detection loop of the next APS zone

The associated contactor in the APS box is closed at no load



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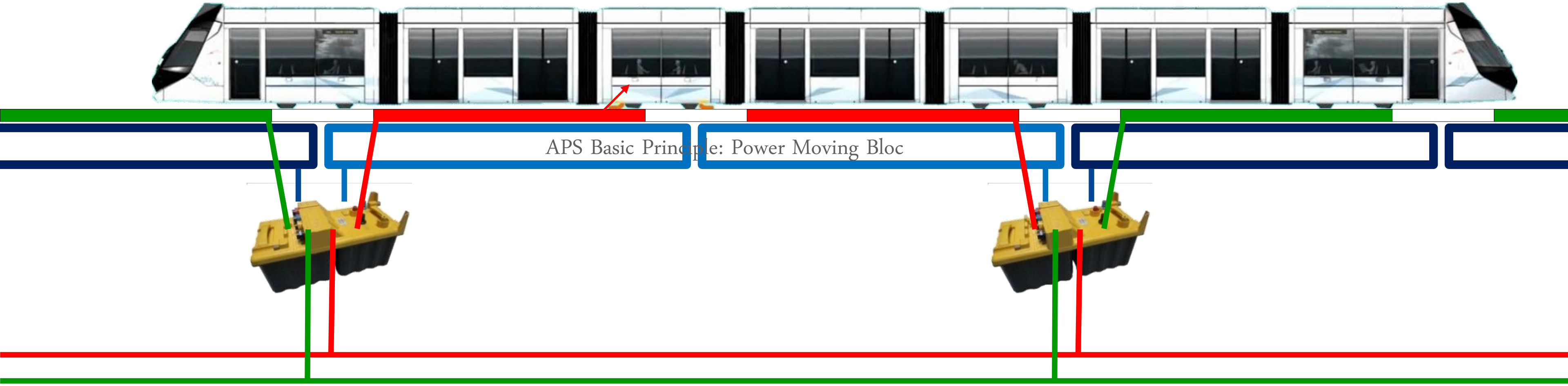
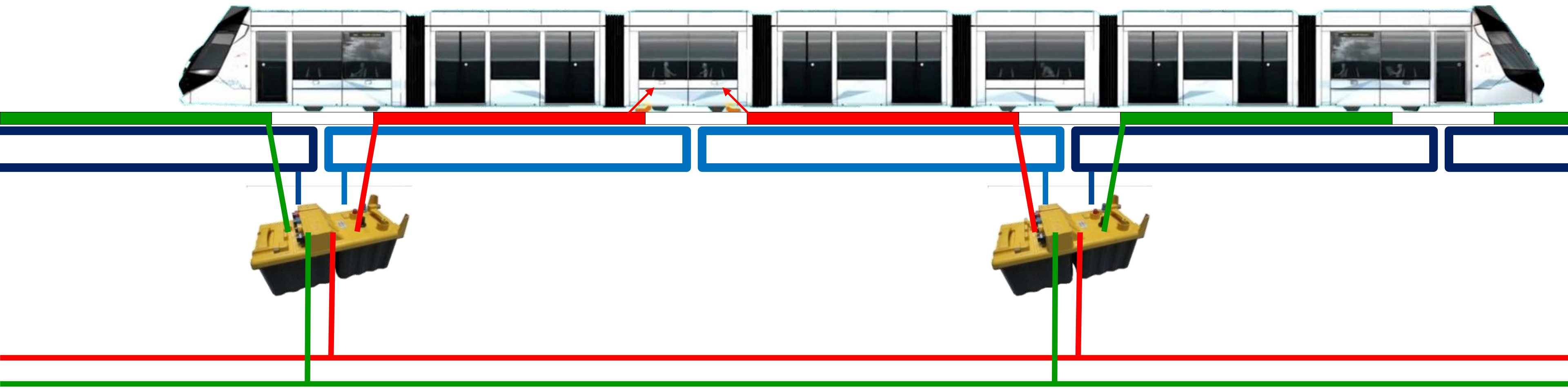
APS Basic Principle: Power Moving Bloc

The next conductive segment is energized at no load



APS Basic Principle: Power Moving Bloc

As the leading collector shoe reaches the energised conducting segment, power flows from the power box to the tram through both shoes



APS Basic Principle: Power Moving Bloc

The rear collector shoes leaves the rear conducting segment that stays energized as the rear shoe is still over the associated conducting segment presence detection loop

Power flows only through the leading brush

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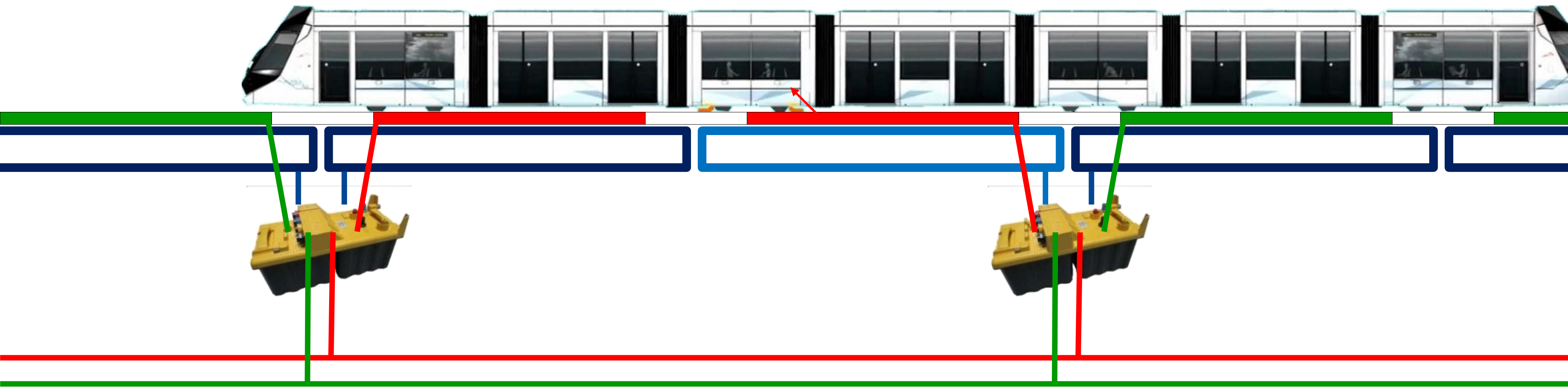
APS Basic Principle: Power Moving Bloc

The detection loop associated to the rear segment no longer detects the rear shoes
The loss of detection signal triggers the closing of the associated contactor at no load.



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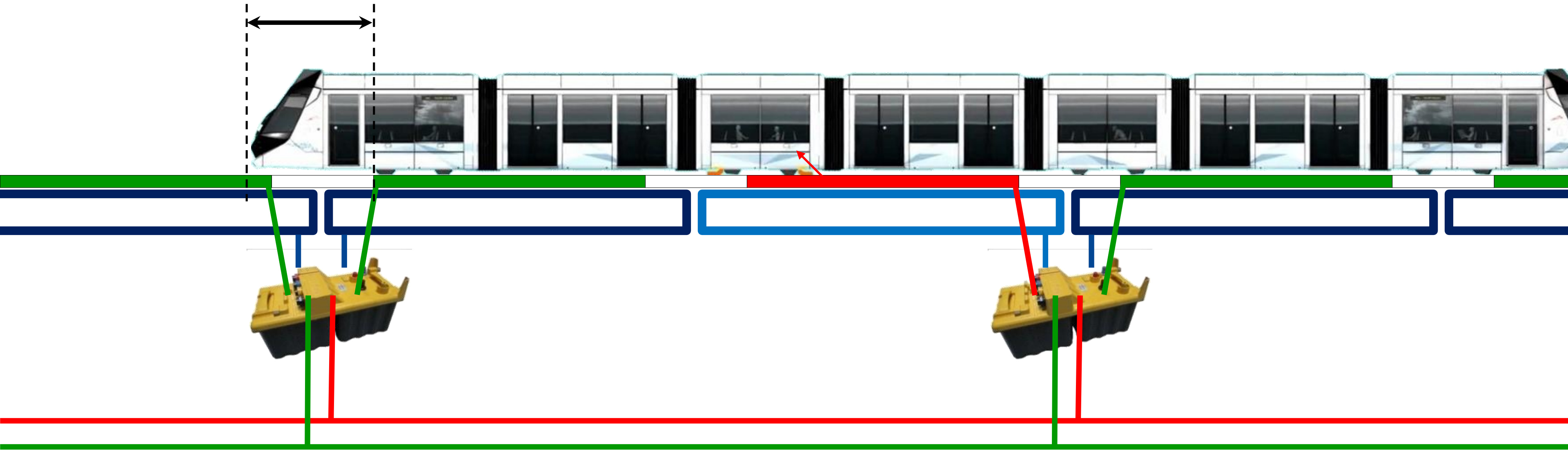
APS Basic Principle: Power Moving Bloc

The rear conducting segment is no longer powered and is connected to the running rail

The tram still protects the segment



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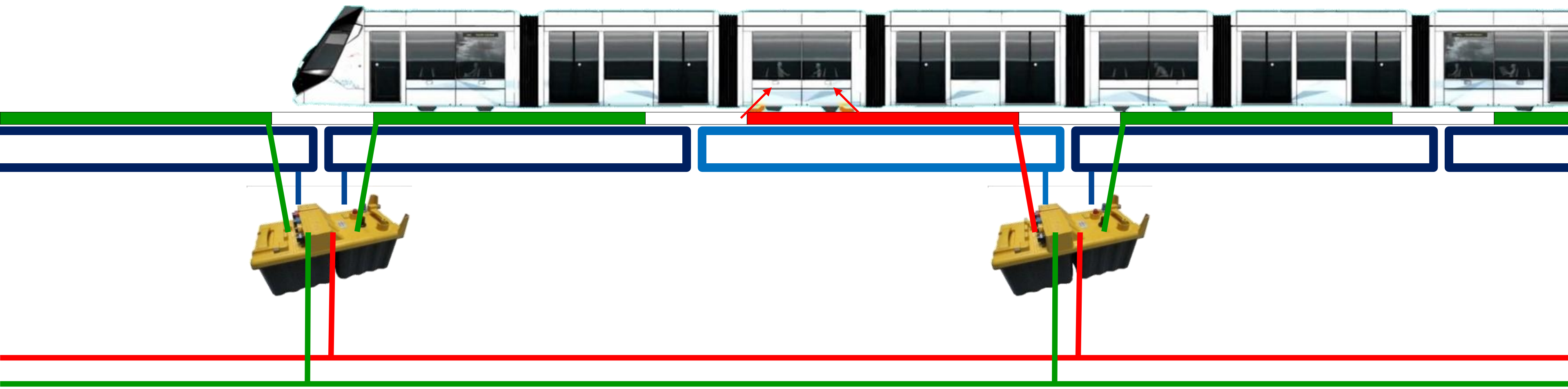
APS Basic Principle: Power Moving Bloc

Both collector shoes are on the same conducting segment

Return current via the running rail

Presence detection loop detects presence both detection signals



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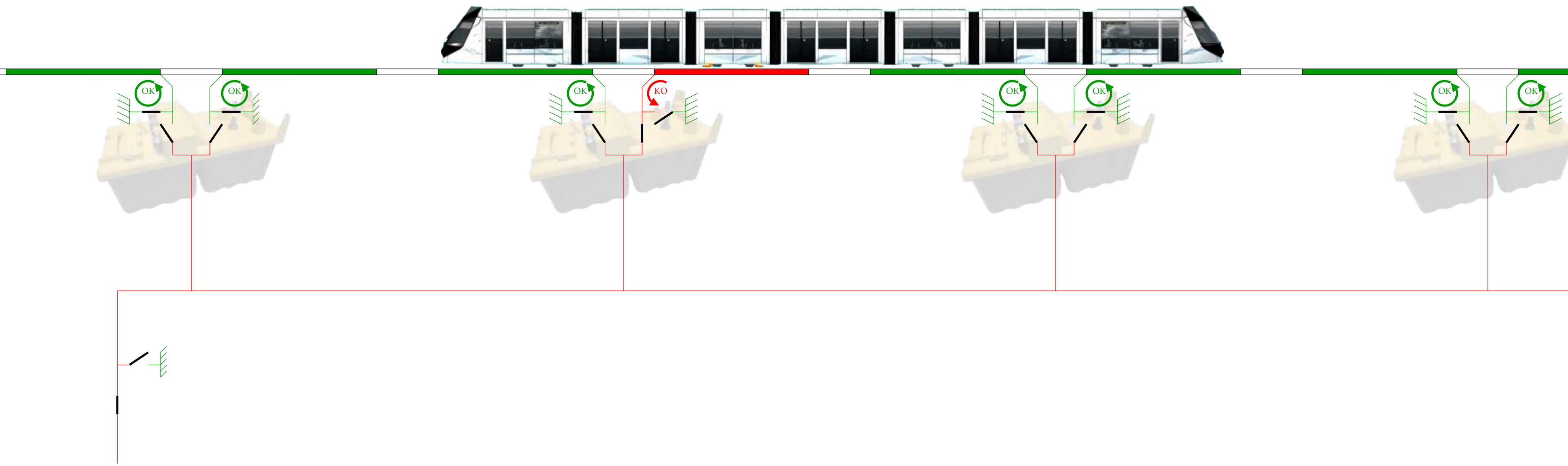
APS embedded safety

✓APS system has been designed to:

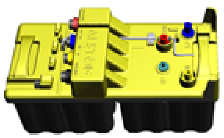
- ensure a full safety when an unwanted event occurs.
- maintain the operation in most of the cases.

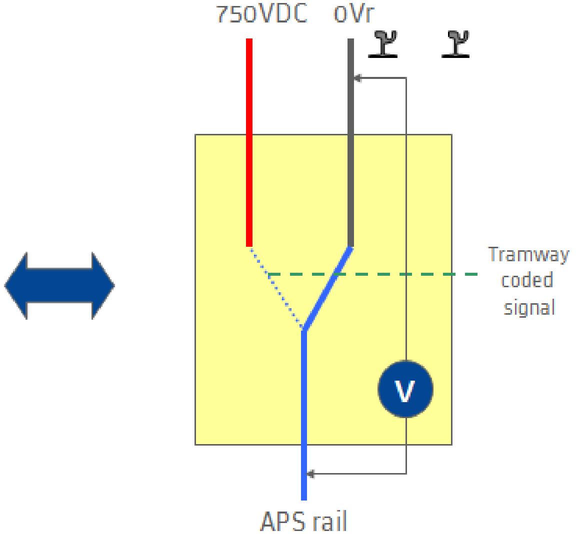


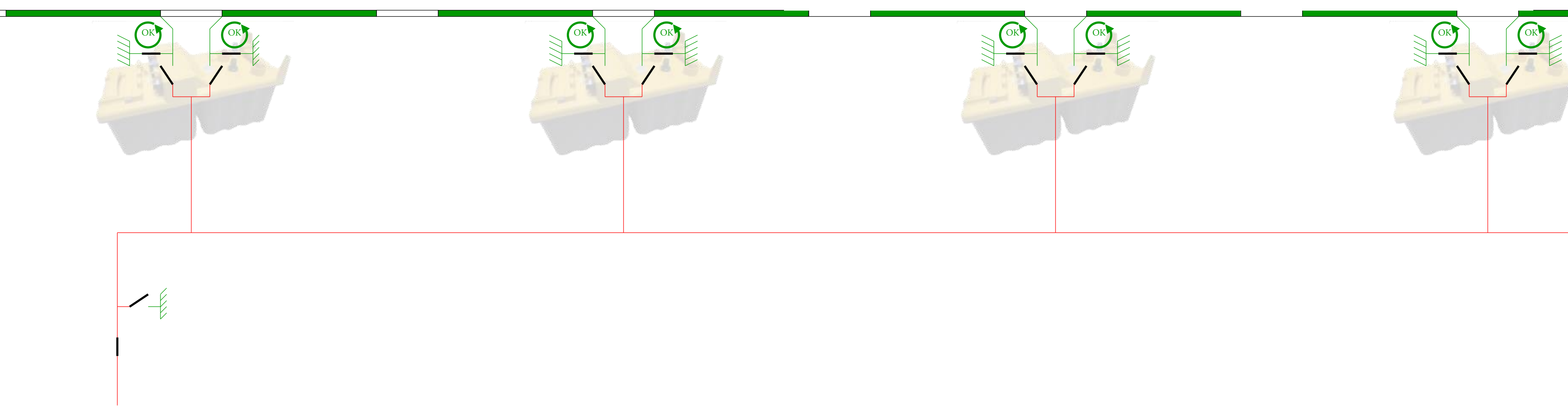
APS embedded safety : Nominal mode

✓Each Power Box continuously and safely checks its connection to the running rail potential (OVr).

✓Use of static relays (no risk of spontaneous closure)

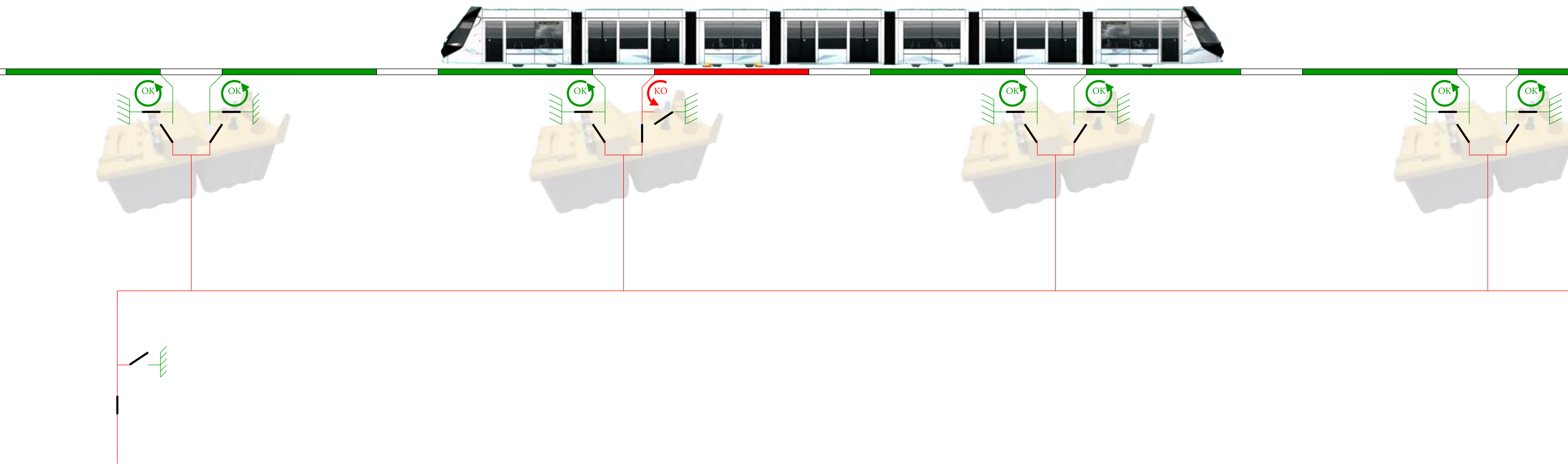






APS embedded safety : Nominal mode

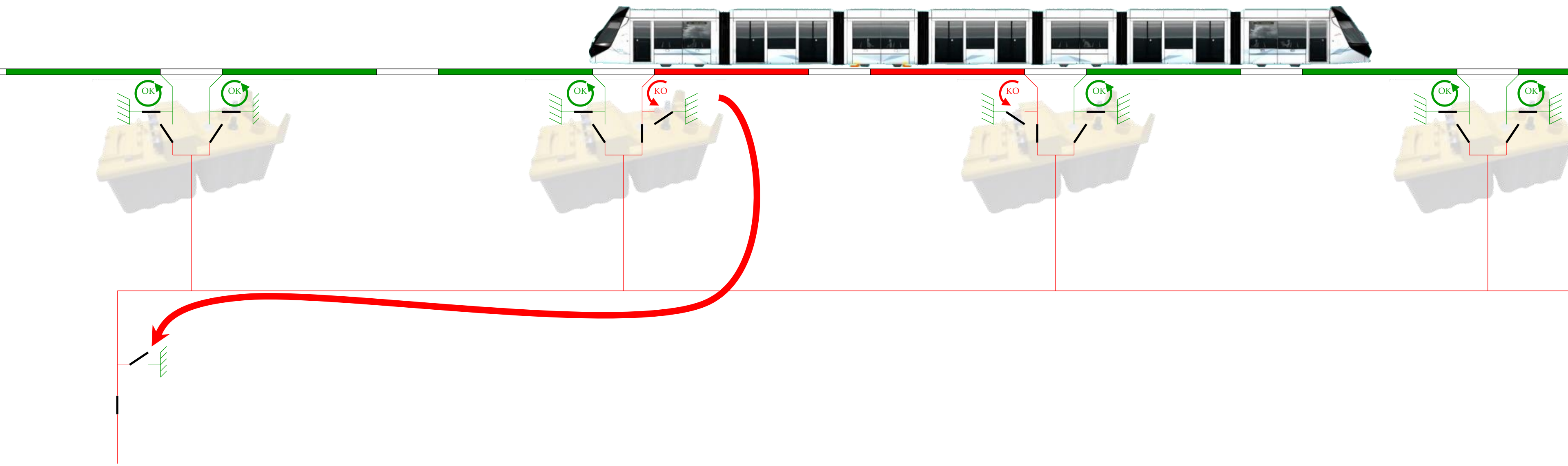
✓A Power Box not connected to the running rail potential (Ovr) when the tramway is detected (safety detection) is a nominal mode.



APS embedded safety: Unwanted event management

✓A Power Box not connected to the running rail potential when the tramway is not anymore detected is an unwanted event.

✓The unwanted event is immediately reported upstream to the APS cabinet in the substation.



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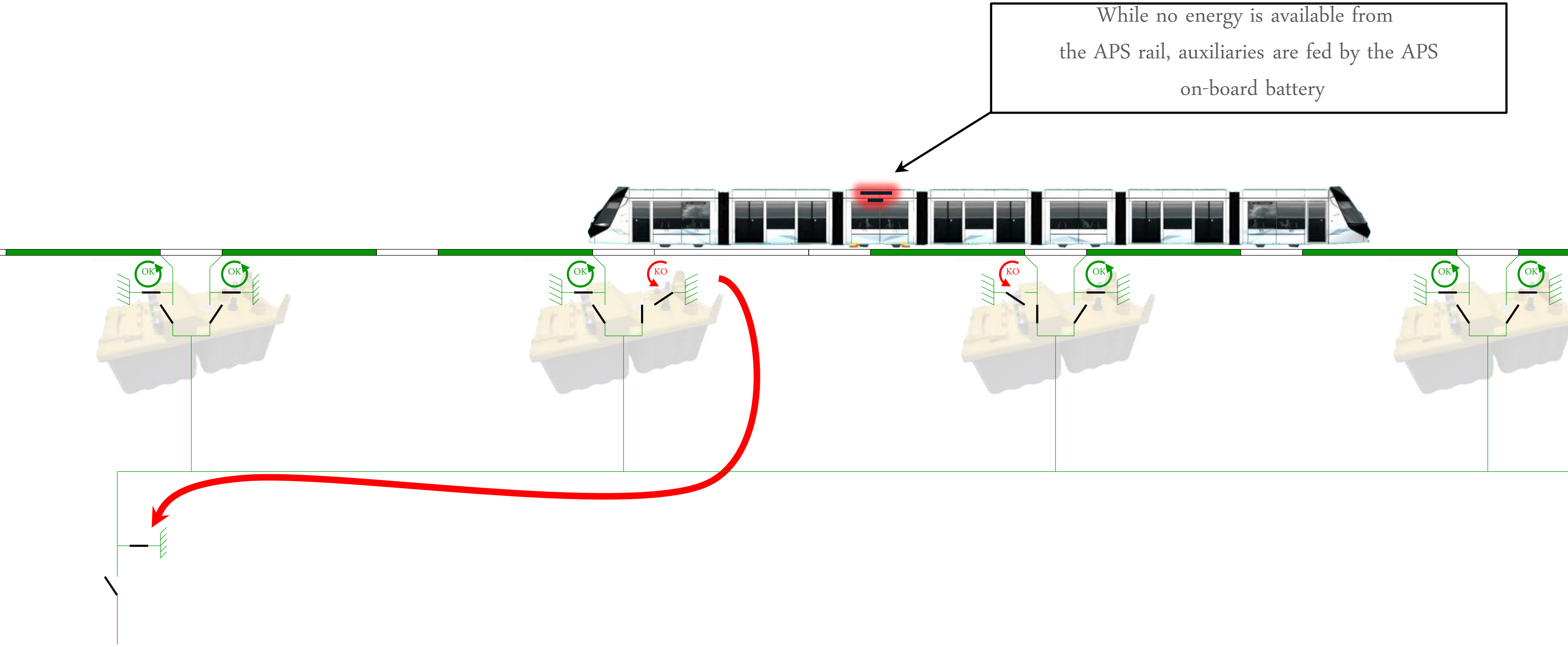
APS embedded safety: Unwanted event management

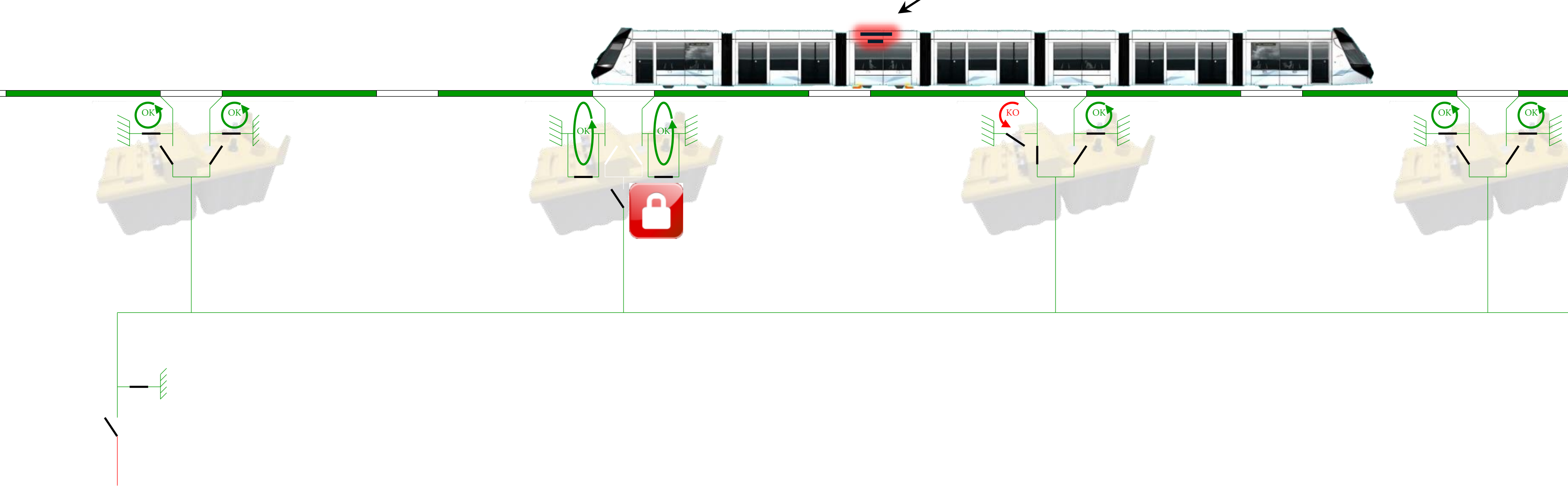
✓The total section is unpowered and set in a safe status.



APS embedded safety: Unwanted event management

✓Automatically, the static relay inside the Power Box switches to the running rail potential and is locked in this position. This status is called “Power Box isolated”.

While no energy is available from the APS rail, auxiliaries are fed by the APS on-board battery



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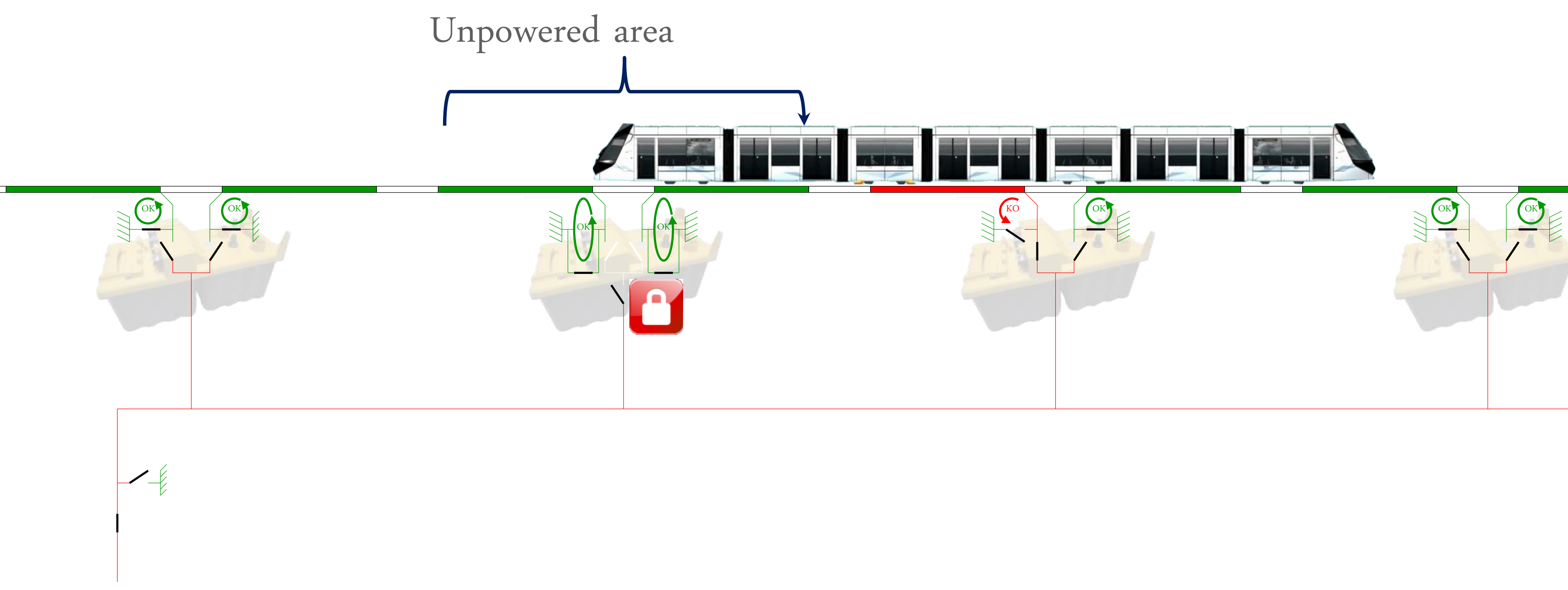
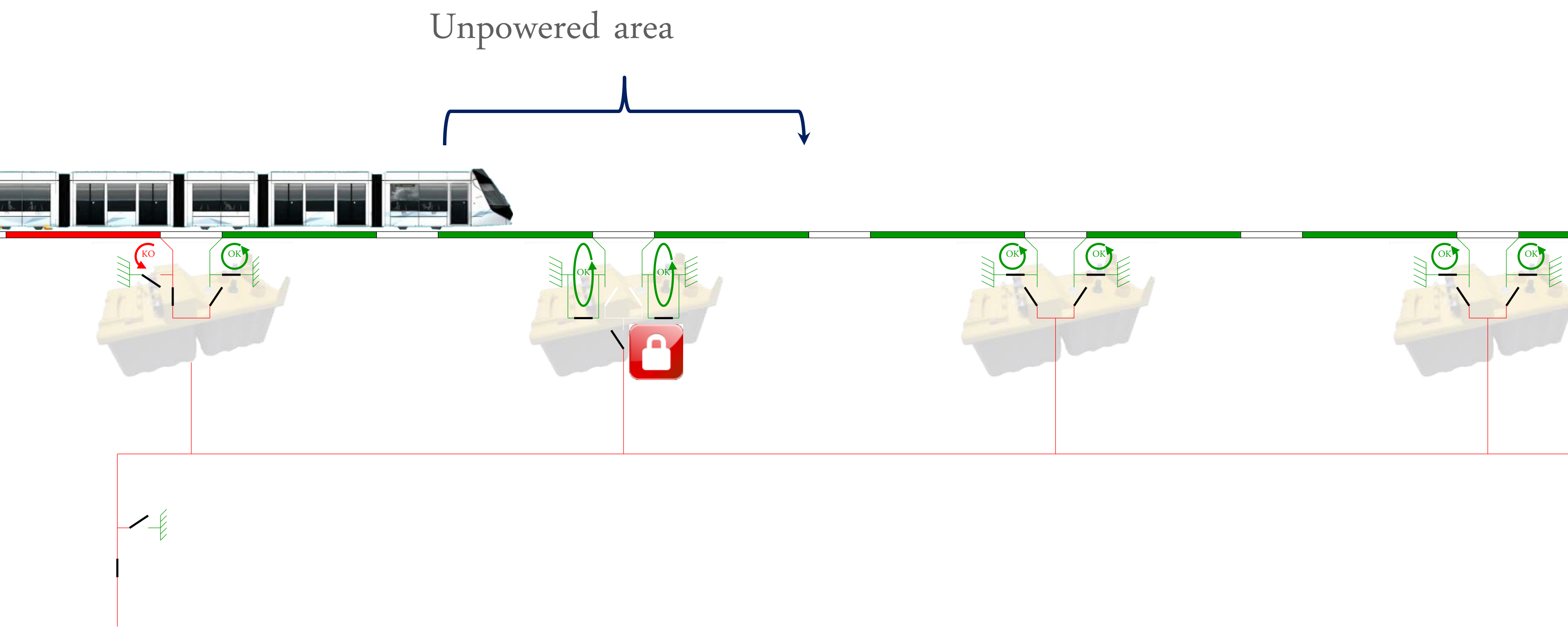
APS embedded safety: Unwanted event management

- ✓ The electrical section is then re-energised to the 750V.
- ✓ The operation resumes with an isolated power box.



APS embedded safety: Unwanted event management

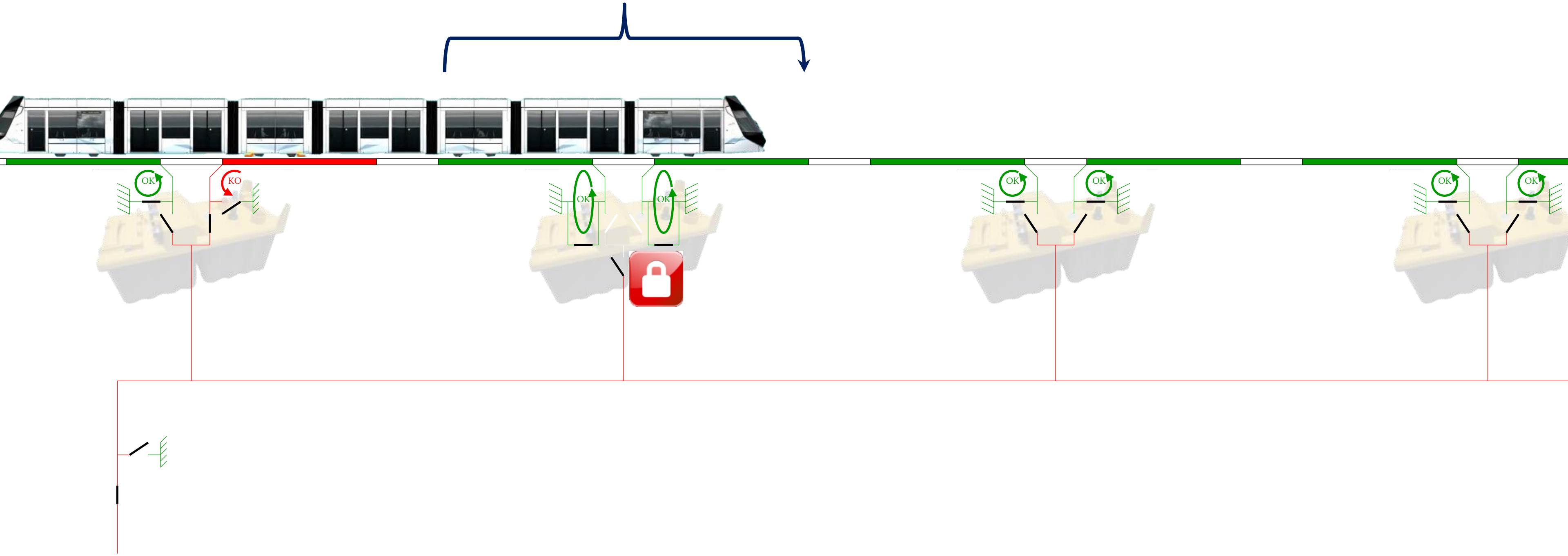
✓ Next trams will proceed on momentum with auxiliaries supplied by **battery** on this isolated Power Box until its replacement.



APS embedded safety: Unwanted event management

✓ Next trams will proceed on momentum with auxiliaries supplied by **battery** on this isolated Power Box until its replacement.

Unpowered area



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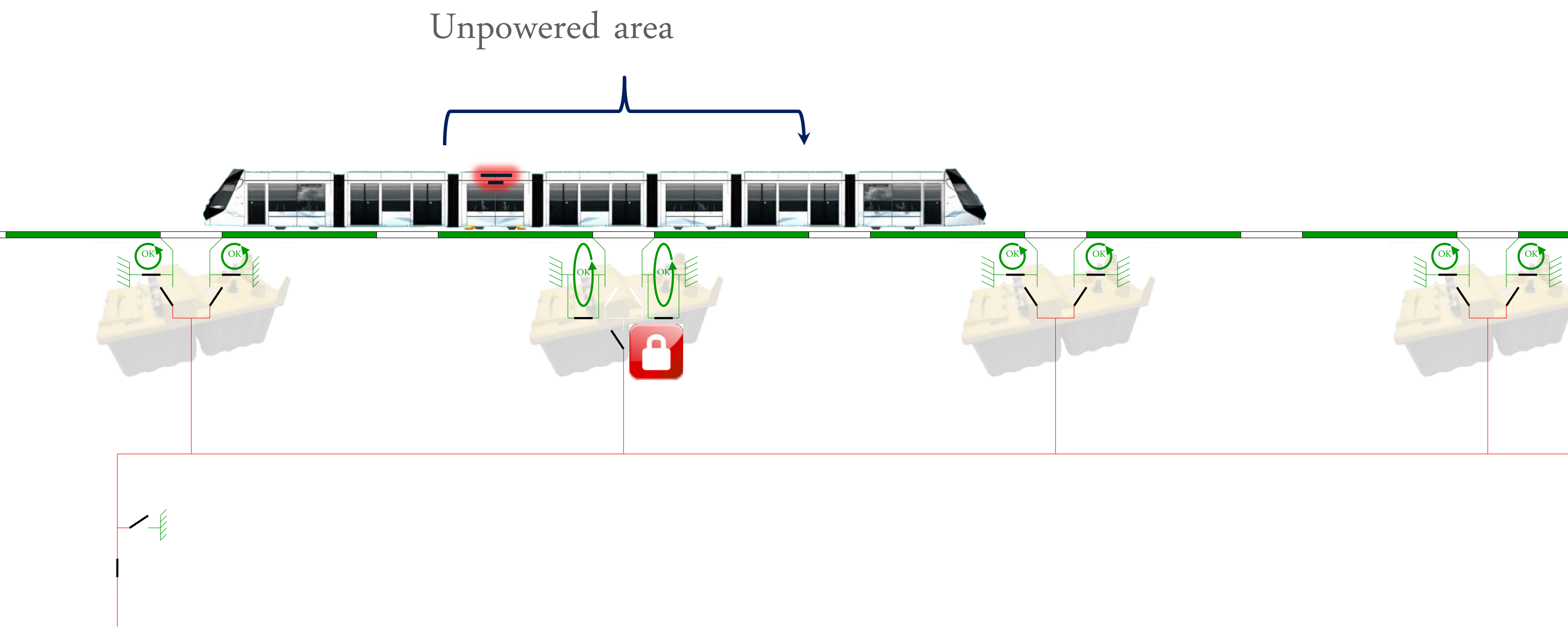
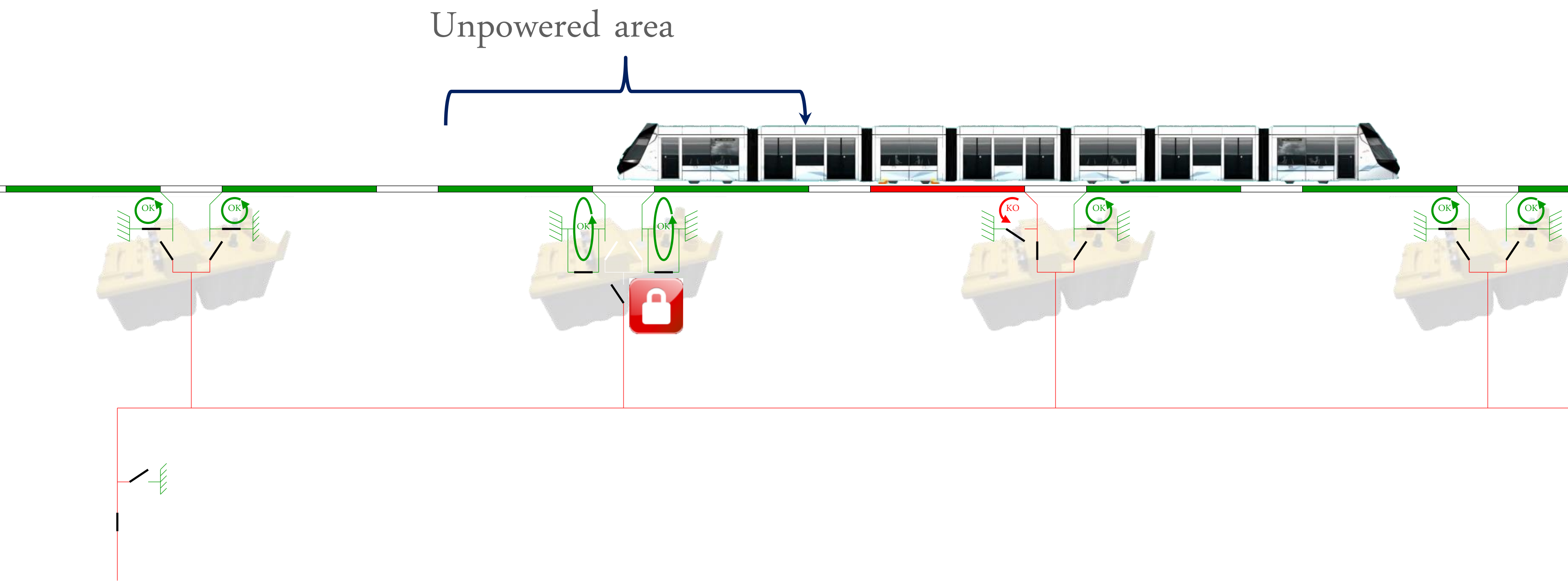
APS embedded safety: Unwanted event management

- ✓ Next trams will proceed on momentum with auxiliaries supplied by **battery** on this isolated Power Box until its replacement.



APS embedded safety: Unwanted event management

- ✓ Next trams will proceed on momentum with auxiliaries supplied by **battery** on this isolated Power Box until its replacement.
- ✓ As soon as the train is back on an powered segment, it switches automatically back to APS mode.



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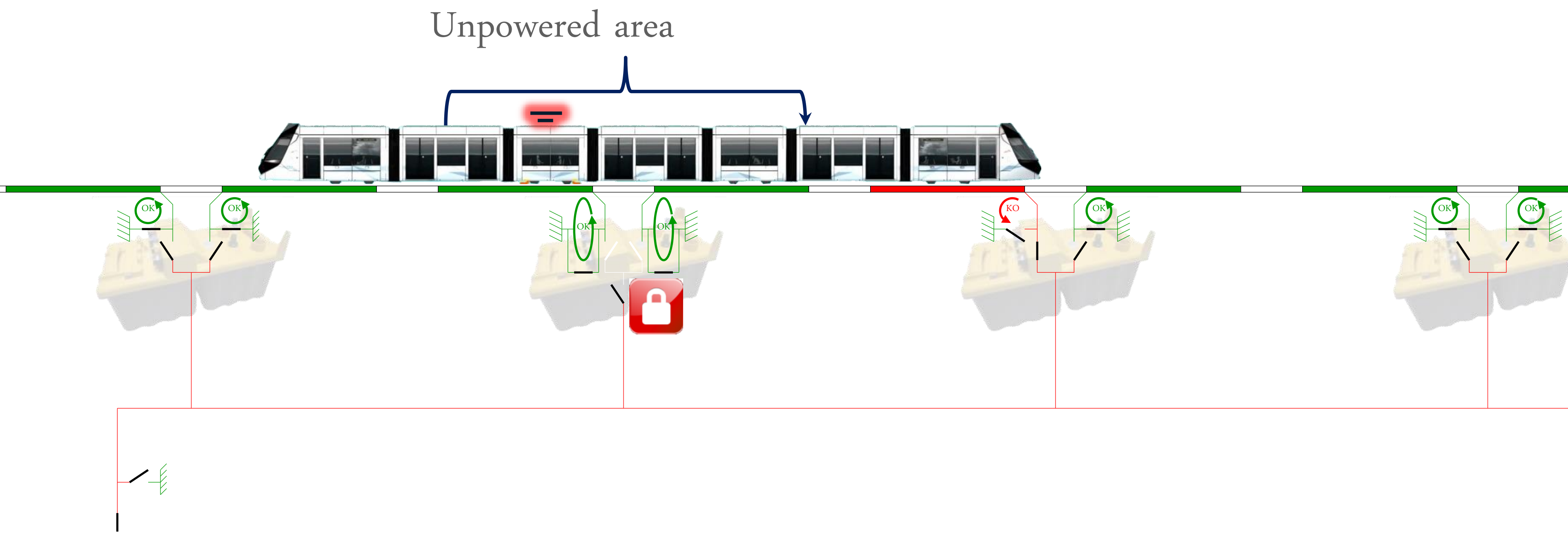
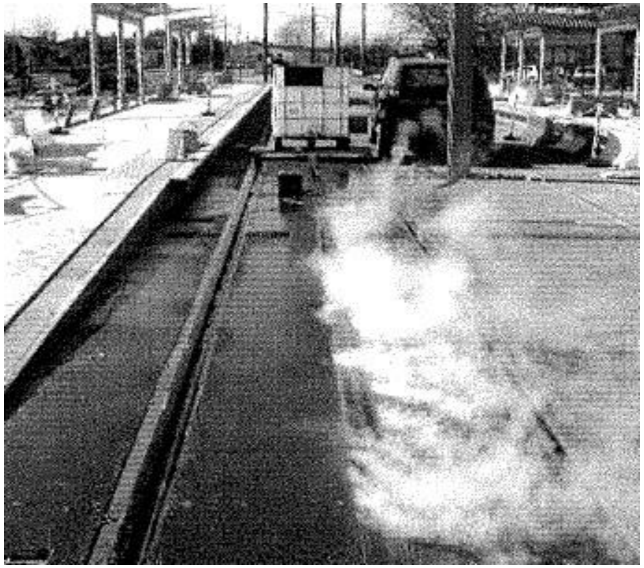
APS embedded safety: Unwanted event management

- ✓ If a train is stopped in a de-energised area, the driver can use the battery for traction to exit the critical area (degraded mode)



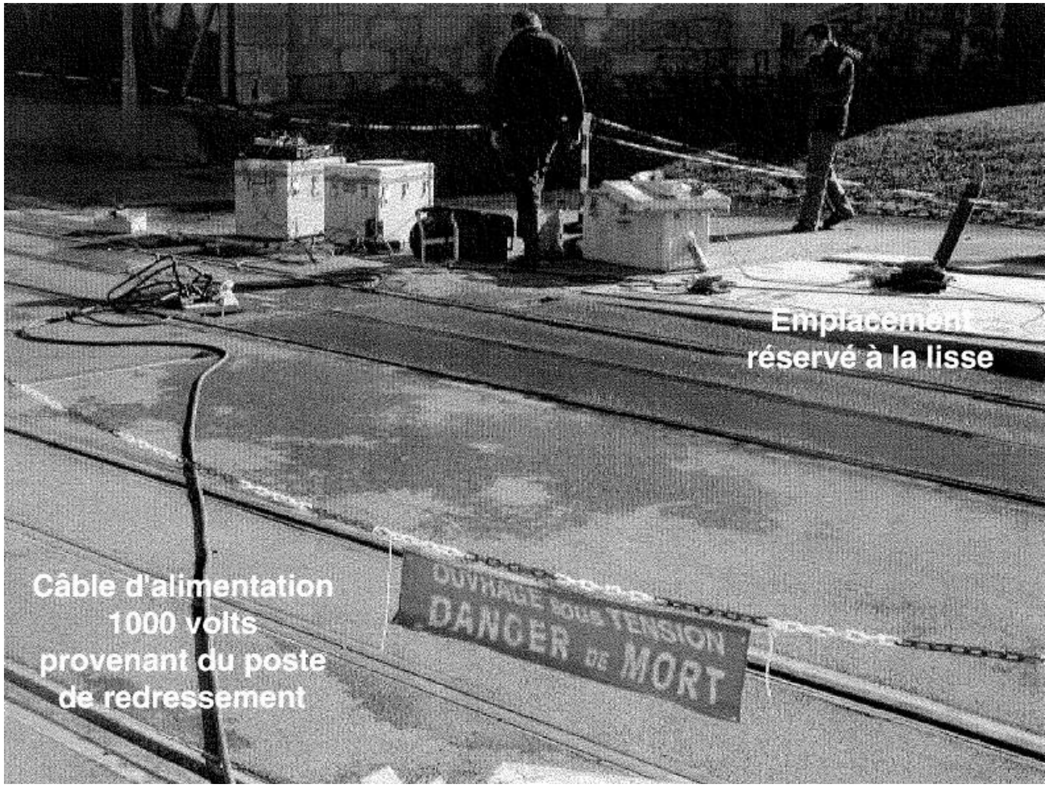
APS remains safe with waterlogged platform

- Measurement performed on different type of :
  - Dry asphalt
  - Wet asphalt
  - Wet Grass
  - Etc…



Fogging near the APS rail

- Test Area Set-up



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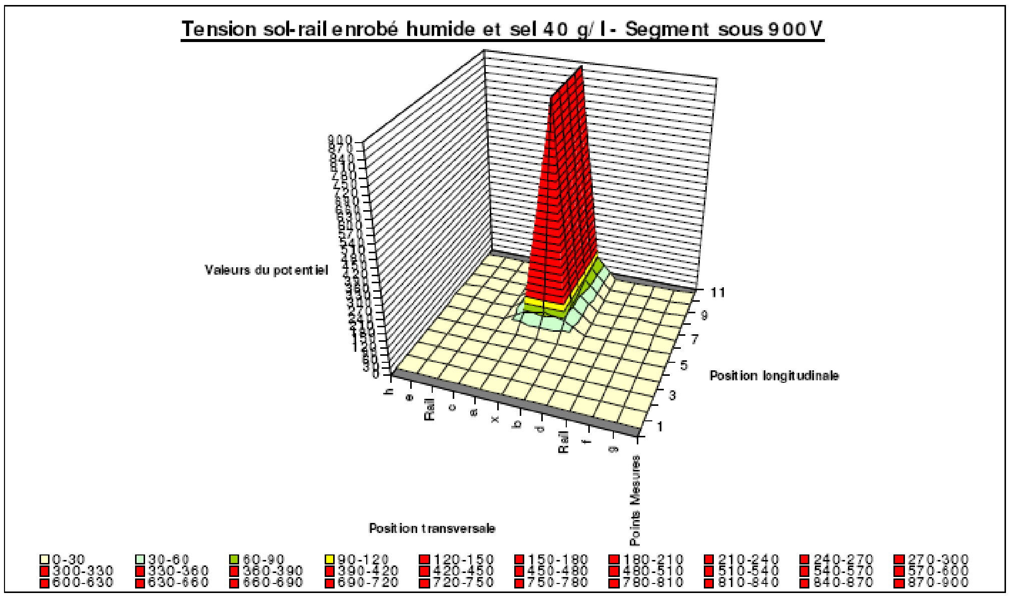
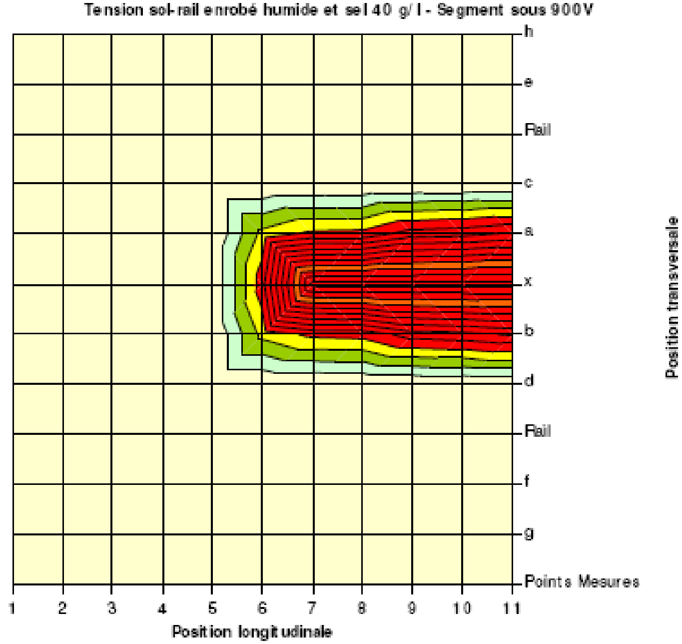
APS remains safe with waterlogged platform

Result on wet asphalt and 40g/l salt (equivalent sea water)

Tension à Vide Uo - conditions d'essais : **Enrobé humide et sel à 40 g/l** Alimentation: 900 volts											
Points Mes	0	1	2	3	4	5	6	7	8	9	10
g							8,35	1,34	1,38	1,53	1,42
f							6,08	7,08	2,08	2,6	2,18
Rail		0	0	0	0	0	0	0	0	0	0
d											
b						50	63,9	65	82	85	92
x		3		5,04		70	900	900	900	900	900
a						50	63,9	65	82	85	92
c											
Rail		0	0	0	0	0	0	0	0	0	0
e							6,08	7,08	2,08	2,6	2,18
h							8,35	1,34	1,38	1,53	1,42

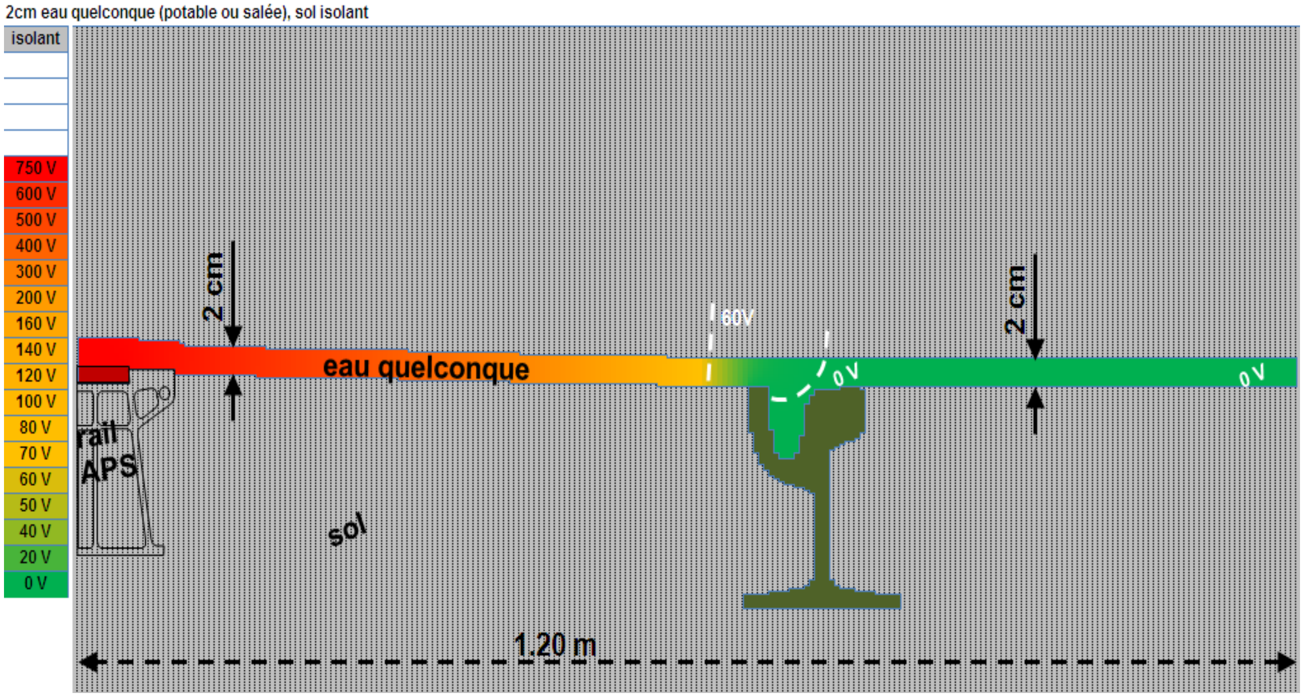
> 120V = Red zone
90 to 120V = Yellow zone
60 to 90V = Green zone
< 60V = Light blue zone





APS remains safe with waterlogged platform

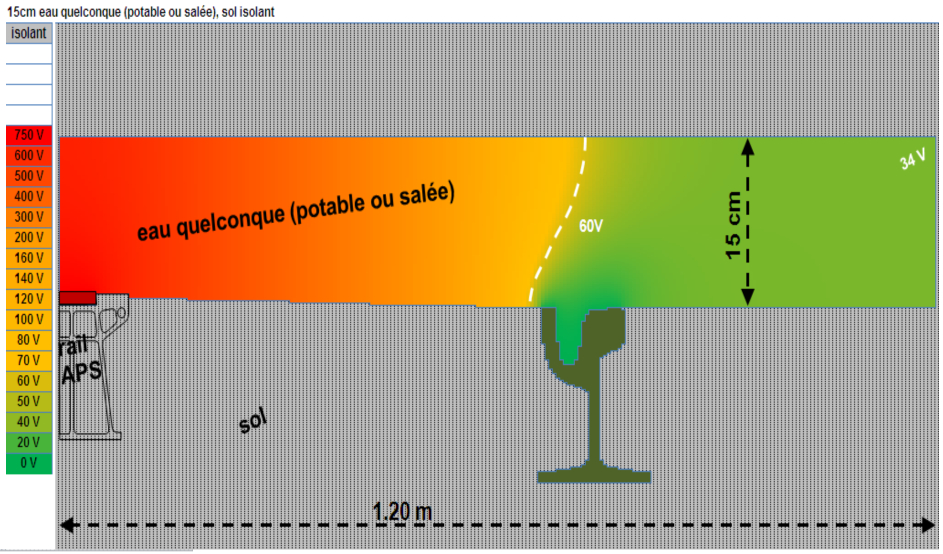
Simulation with 2cm of some water (Drinkable or salty)



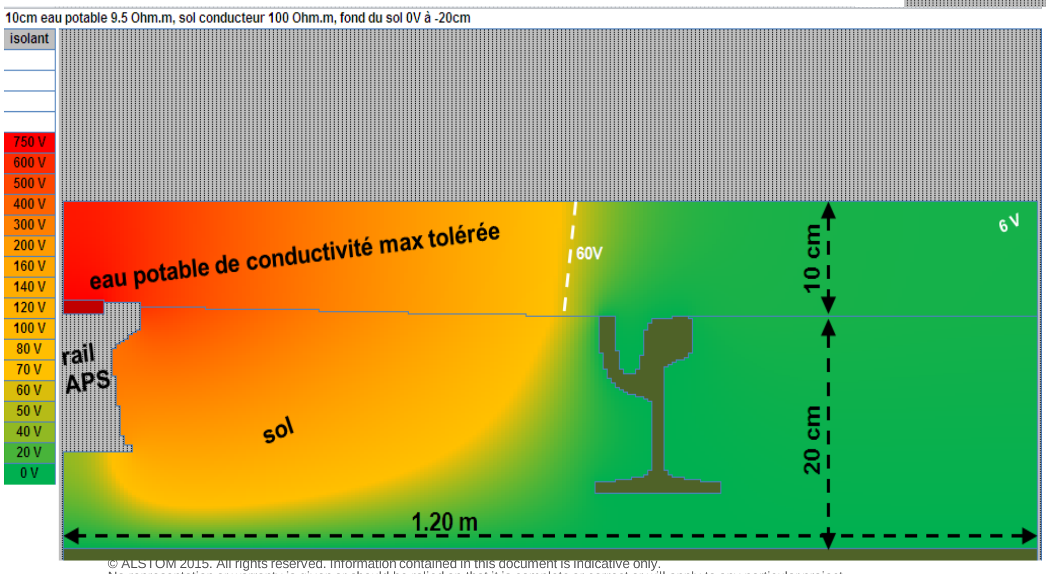
APS remains safe with waterlogged platform

Other simulations with :

- 15cm of some water
- Insulated ground



- 10cm of drinkable water 9.5 Ω.m
  - Conductive ground 100 Ω.m
  - Underground 0V at -20cm



Agenda

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A small Video on HESOP

VIDEO_Hesop - Sous-station de traction réversible 543a42efc18d17d8_560_496_64_512_288_25_baseline_1.mp4

What is HESOP?
Definition

- An advanced reversible substation with a single converter both rectifier & inverter
- For DC networks from 600V to 1500V and from 900kW to 4MW (urban & suburban)

Main advantages :

- To **capture recoverable energy** in braking mode
- To provide dynamic voltage regulation **to optimize power use** in traction mode

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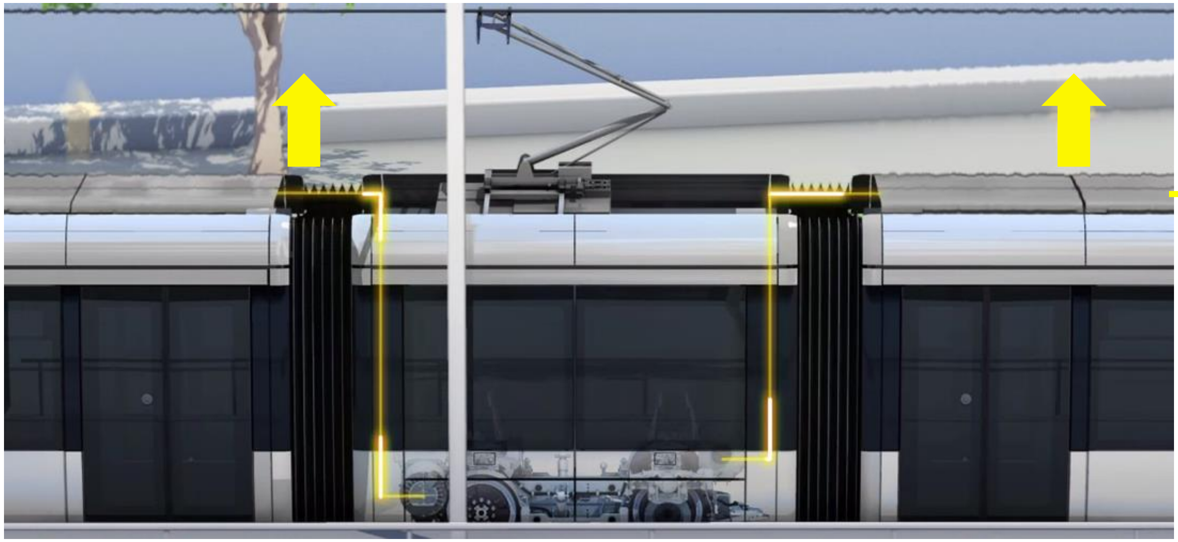
What is HESOP?
How is Energy lost?

- During braking, electric motors in a train behave like generators, transforming movement into electricity, or 'braking energy'
- Some of this energy is used by the train itself and by trains running nearby, but the rest is lost.



Brake resistors

Braking energy dissipated into the on-board resistors

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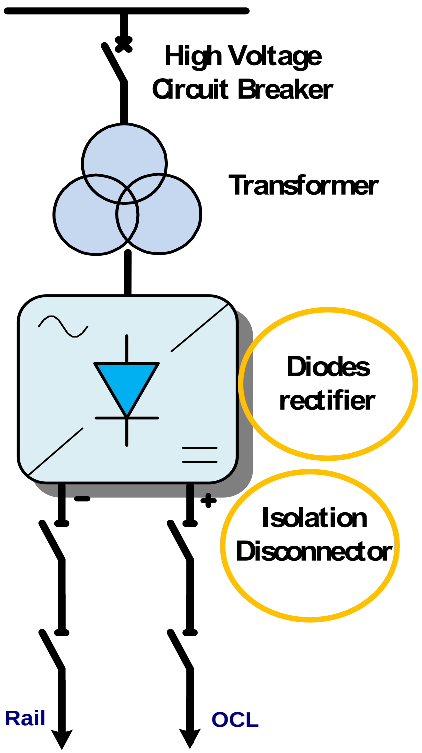
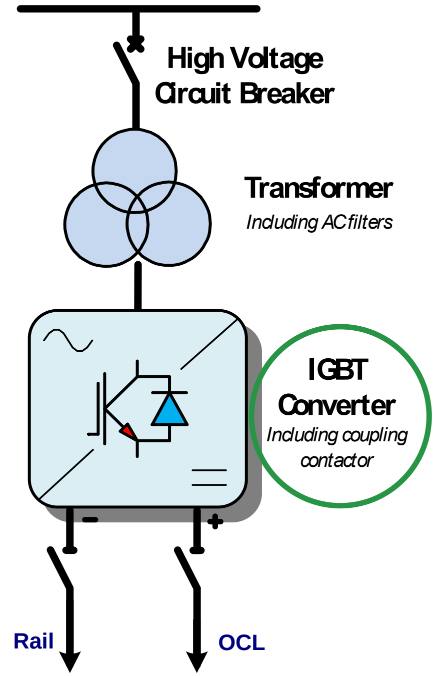
What is HESOP?
Different Architecture

Classic substation



HESOP substation



IGBT : Insulated-Gate Bipolar Transistor

- No energy recovery
- No traction optimization

- **99%** braking energy recovery
- Traction optimization

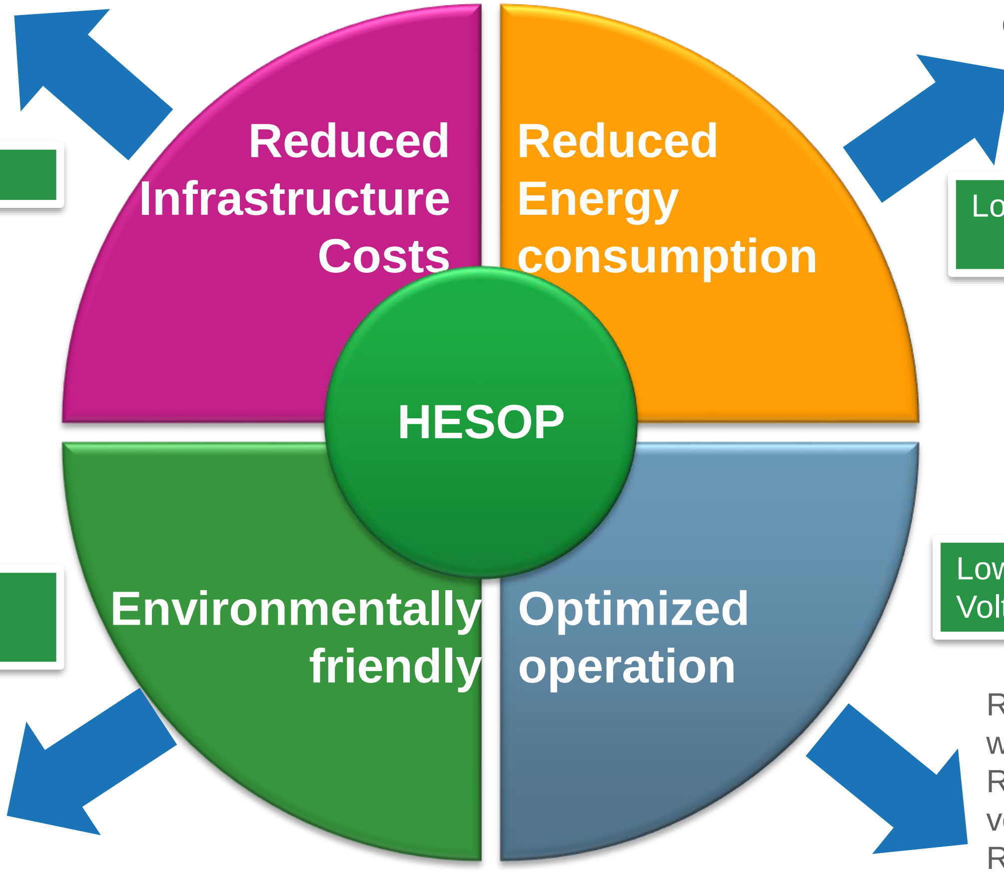
Why HESOP is adapted to Sydney

SLR = High Capacity System
HESOP Optimises the use of substations

~ 20 Less substations

99 % Braking energy recoverable

Very High Sustainability Target
Re-Generation TfNSW requirement



Very High Sustainability Target
Good for OPEX

Low Harmoniscs

Low Harmoniscs
Voltage Regulation

Reduced Harmonics, in line with Ausgrid requirements
Reduced susceptibility to AC voltage fluctuation
Reduced use of Mechanical brakes

Agenda

1. Introduction
2. Project Overview and Organisation
3. Focus on System Engineering
4. Focus on APS
5. Focus on HESOP
6. **Focus on Citadis X05**
7. Focus on EMC Studies
8. Focus on Sustainability
9. Other Engineering Challenges

X05 : A LITTLE VIDEO

X05-FINAL_OK_DF.avi

More than 2200 Citadis sold worldwide with 1700 in service

FRANCE
22 cities – 1005 trams

AFRICA
Algiers – 41 trams
Casablanca – 124 trams
Constantine – 51 trams
Mostaganem – 25 trams
Oran – 58 trams
Ouargla – 23 trams
Rabat – 44 trams
Sidi Bel Abbes – 30 trams
Tunis – 55 trams

MIDDLE EAST
Dubai– 11 trams
Istanbul – 37 trams
Jerusalem – 46 trams
Lusail - 35 trams

SOUTH AMERICA
Cuenca – 14 trams
Rio de Janeiro – 32 trams
Buenos Aires – 1 tram

EUROPE
Barcelona – 41 trams
Dublin – 73 trams
Jaen – 5 trams
Kassel – 28 trams
Madrid – 47 trams
Murcia – 11 trams
Nottingham – 22 trams
Rotterdam – 113 trams
St Petersburg – 4 trams
Tenerife – 26 trams
The Hague – 72 trams

ASIA
Shongjiang – 30 trams

AUSTRALIA
Adelaide – 6 trams
Melbourne – 41 trams
Sydney – 60 trams

X05 IN SYDNEY – WHAT IS SPECIFIC?

HVAC : high performance Cabin and Passenger area units

Carbody :
5 passenger cars, low floor
6 double doors per side

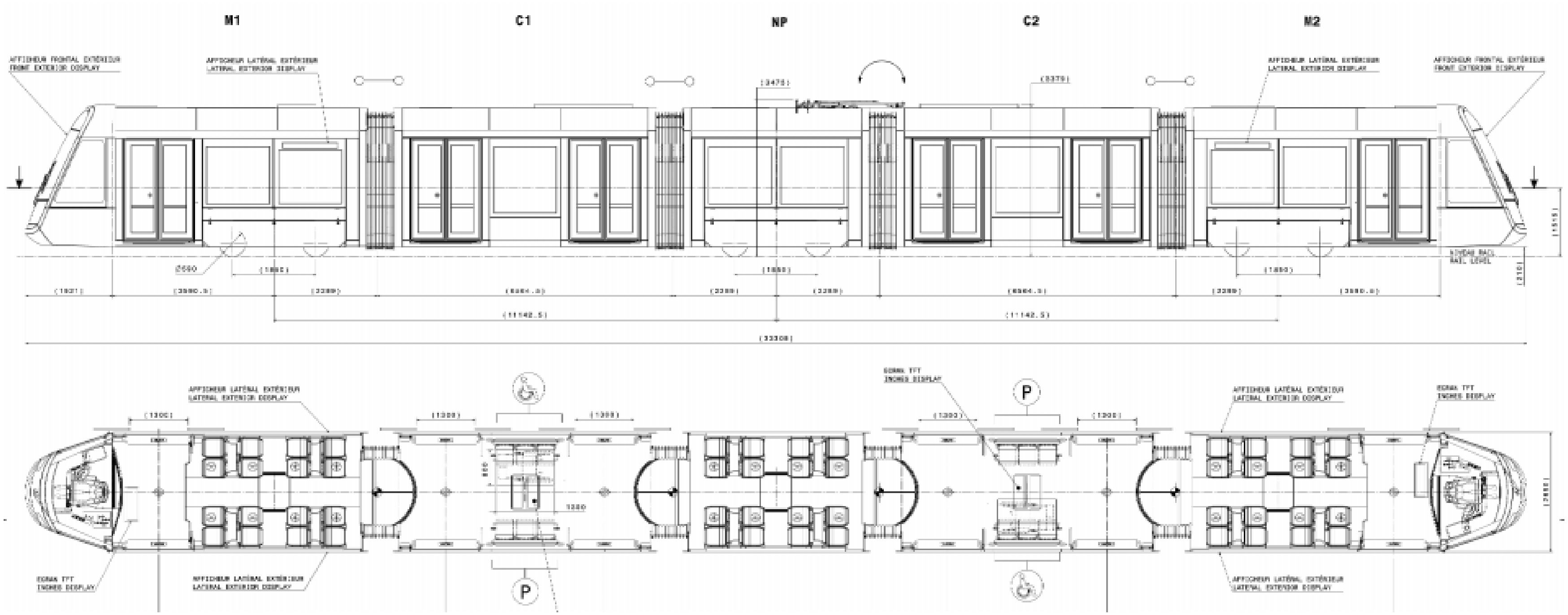
Fireprotection:
Passenger areas with Smoke detection

High Capacity:
Operation in double unit
68 m long
>450 passengers

Accessibility
Inductive loop in suspended modules
Compliance with Disability Standards for accessiblepublic transport

Traction System :
Compatible for
-OHW / pantograph
-APS / track captation

X05 SYDNEY – DETAILED LAYOUT

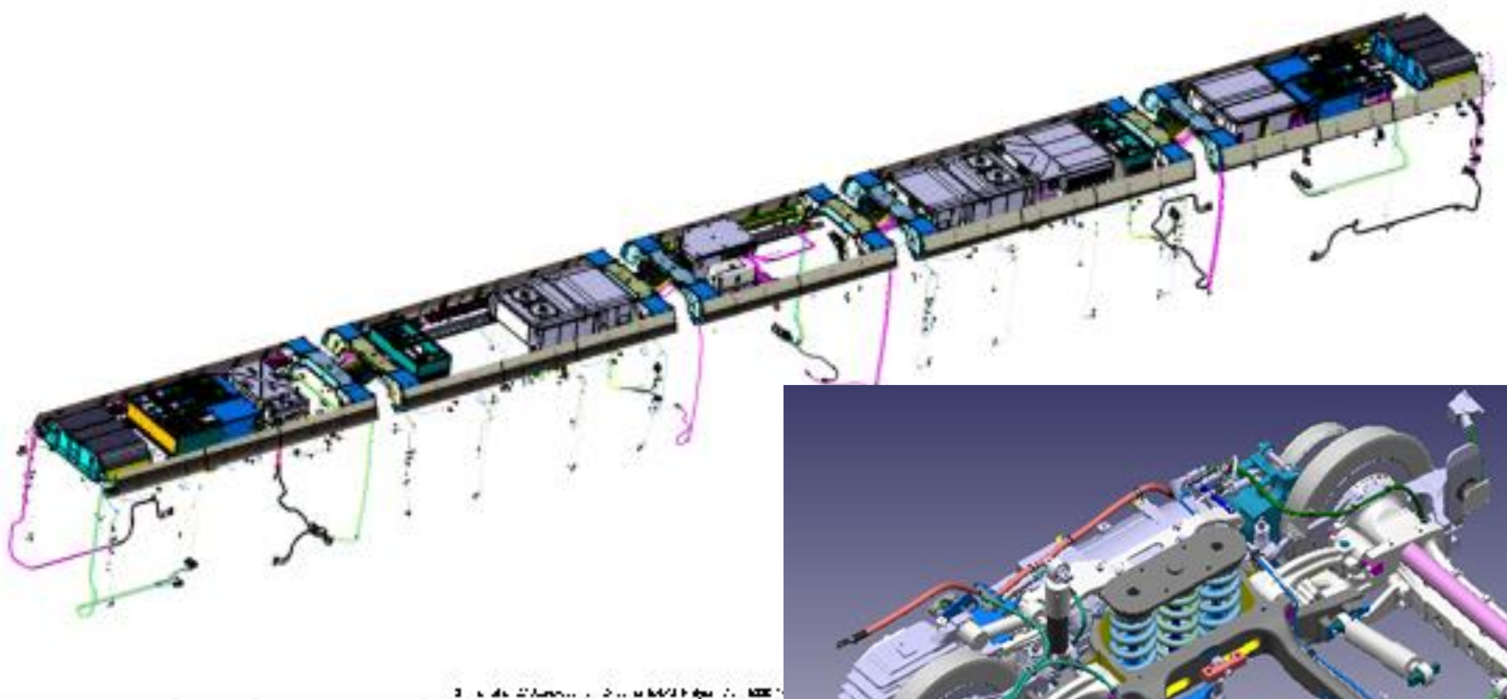


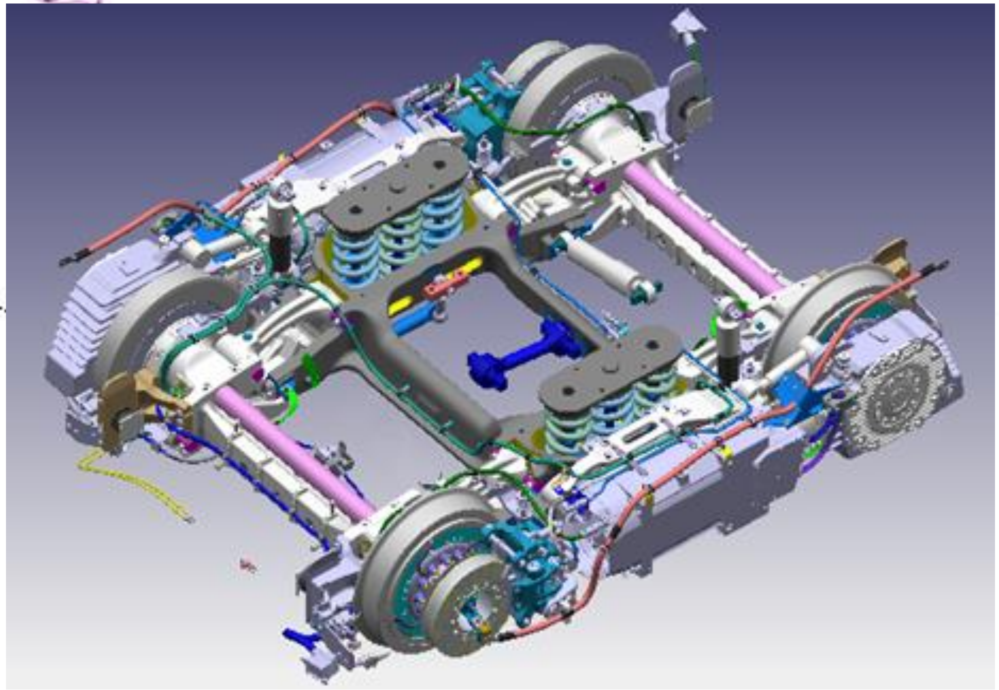
			AW3 Load (4p/m²)		AW4 Load (6p/m²)	
	Seats	Passenger Surface Area (m²)	Standees	**Total**	Standees	**Total**
Tip-up seats Up position	48	46.25	185	**233**	277	**325**
Tip-up seats Down position	60	42.79	171	**231**	256	**316**

HOW DOES IT LOOK LIKE INSIDE?

HOW DOES IT LOOK LIKE INSIDE?

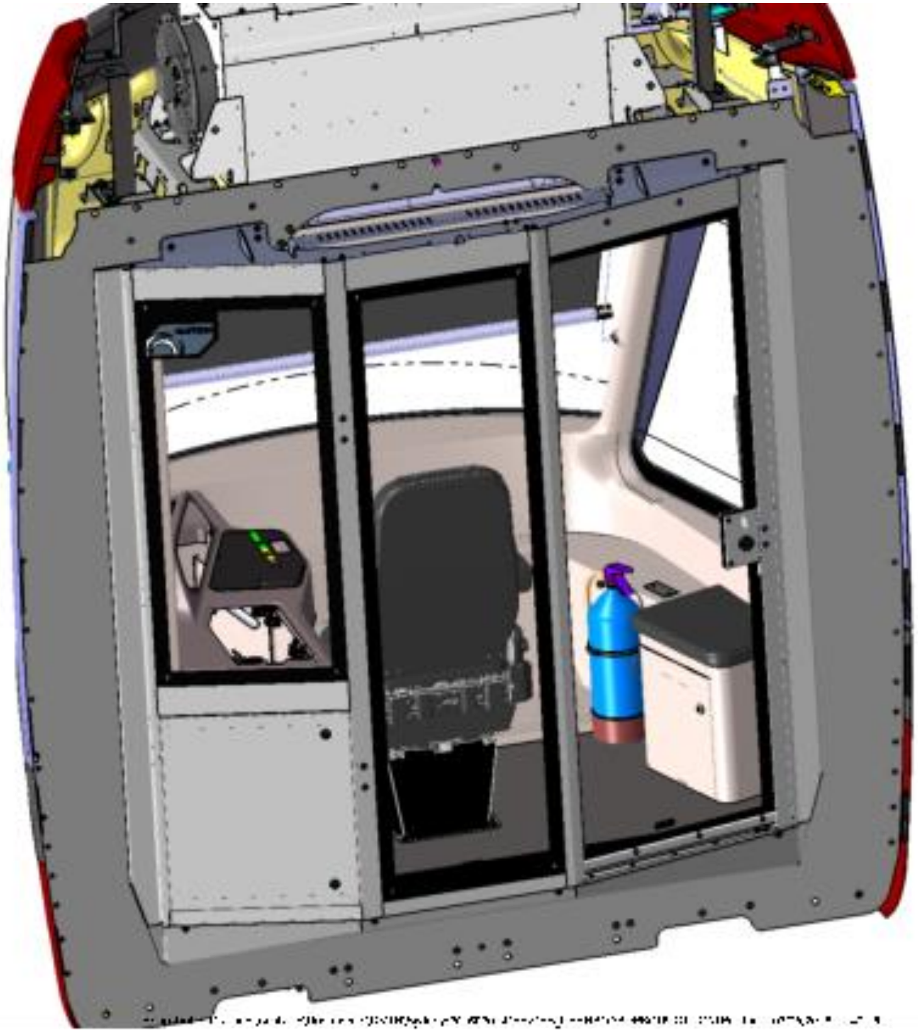
EXTENSIVE 3D MODELLING USE





BUT ALSO FOR THAT

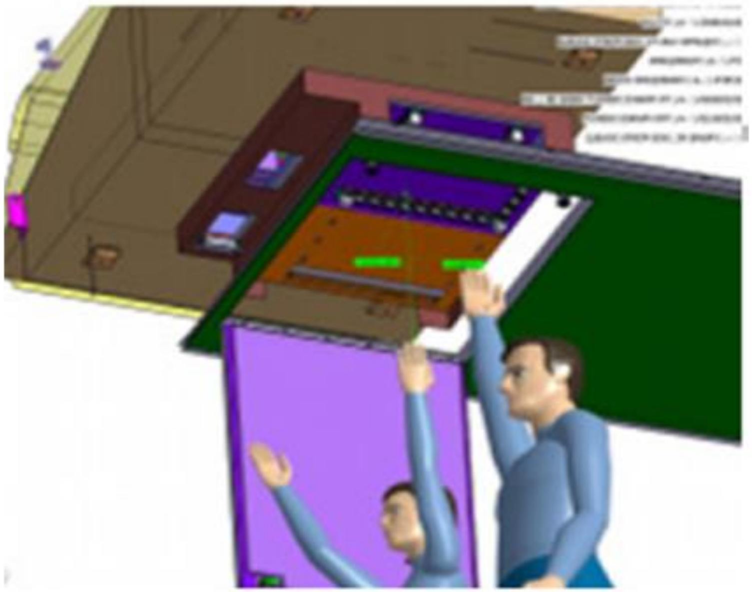
EXTENSIVE 3D MODELLING USE

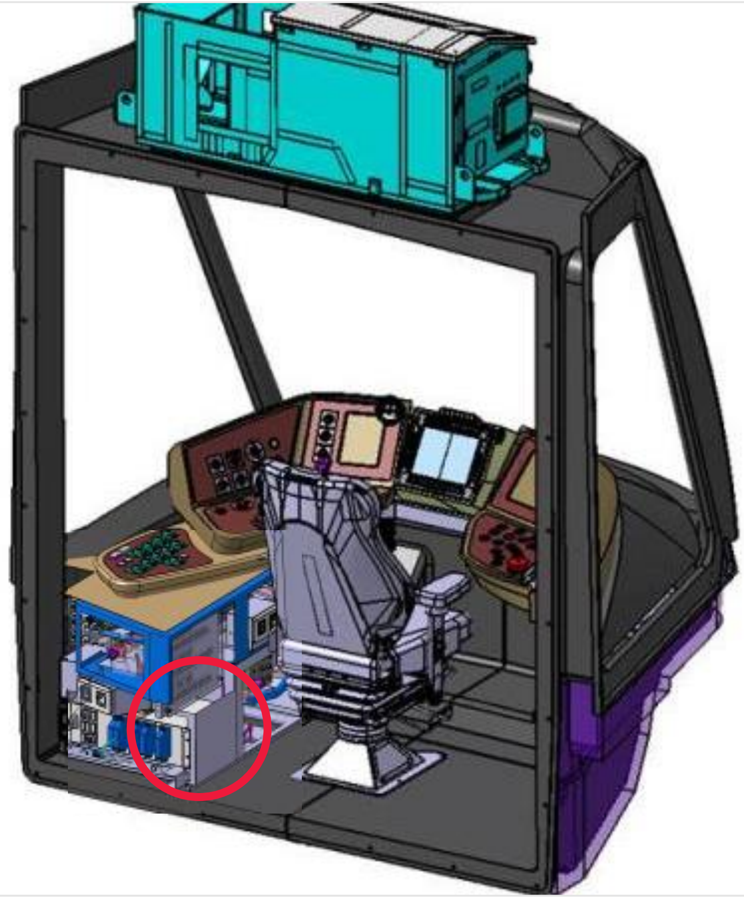


- SPACE PROOFING
- ACCESSIBILITY
- CONSTRUCTION SEQUENCES

74

EXTENSIVE 3D MODELLING USE





- MAINTAINABILITY
- ERGONOMICS
- VALIDATION

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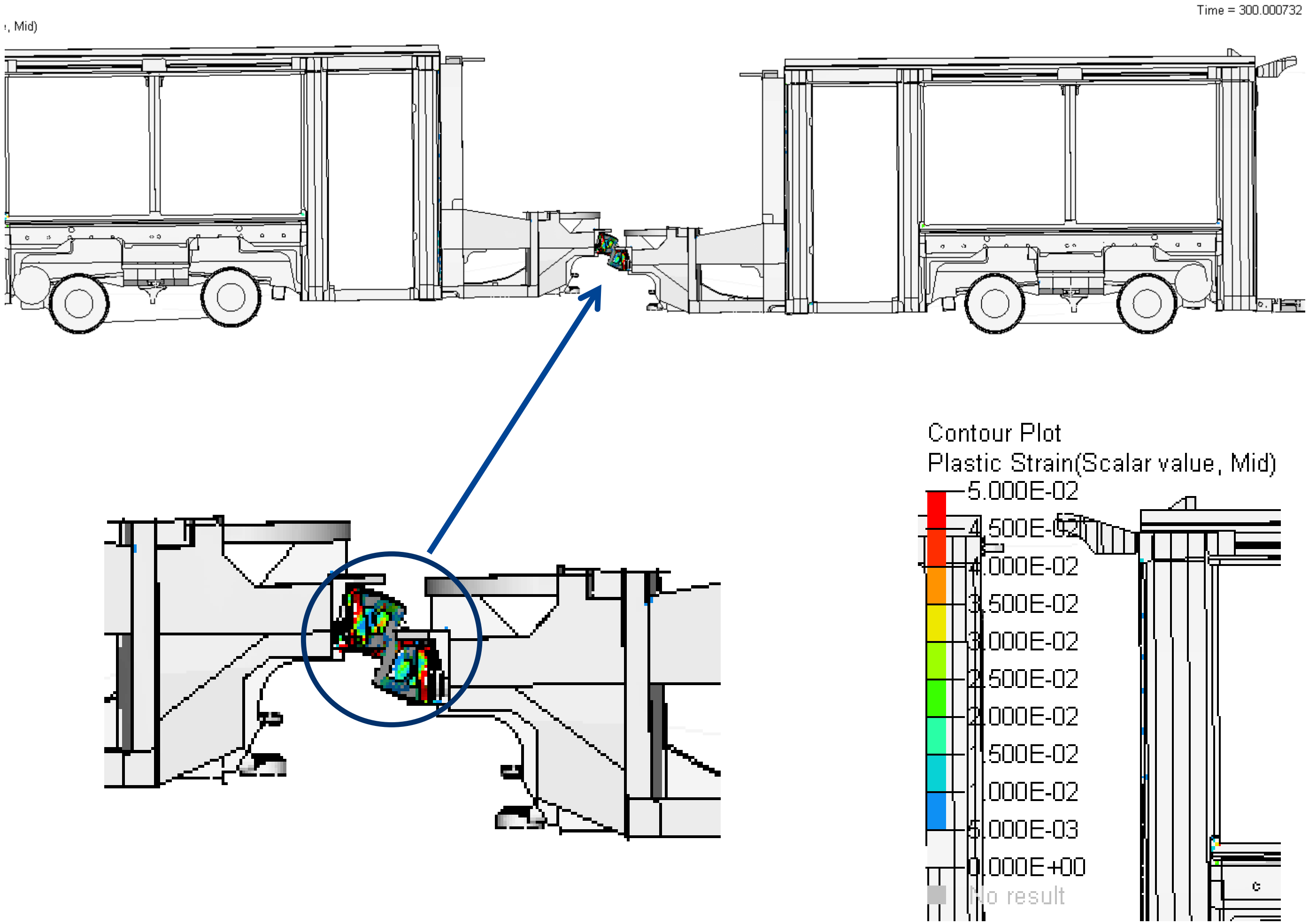
CRASH DYNAMIC MODELLING IN 3D

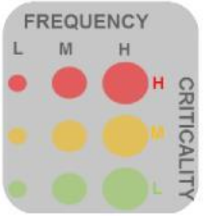


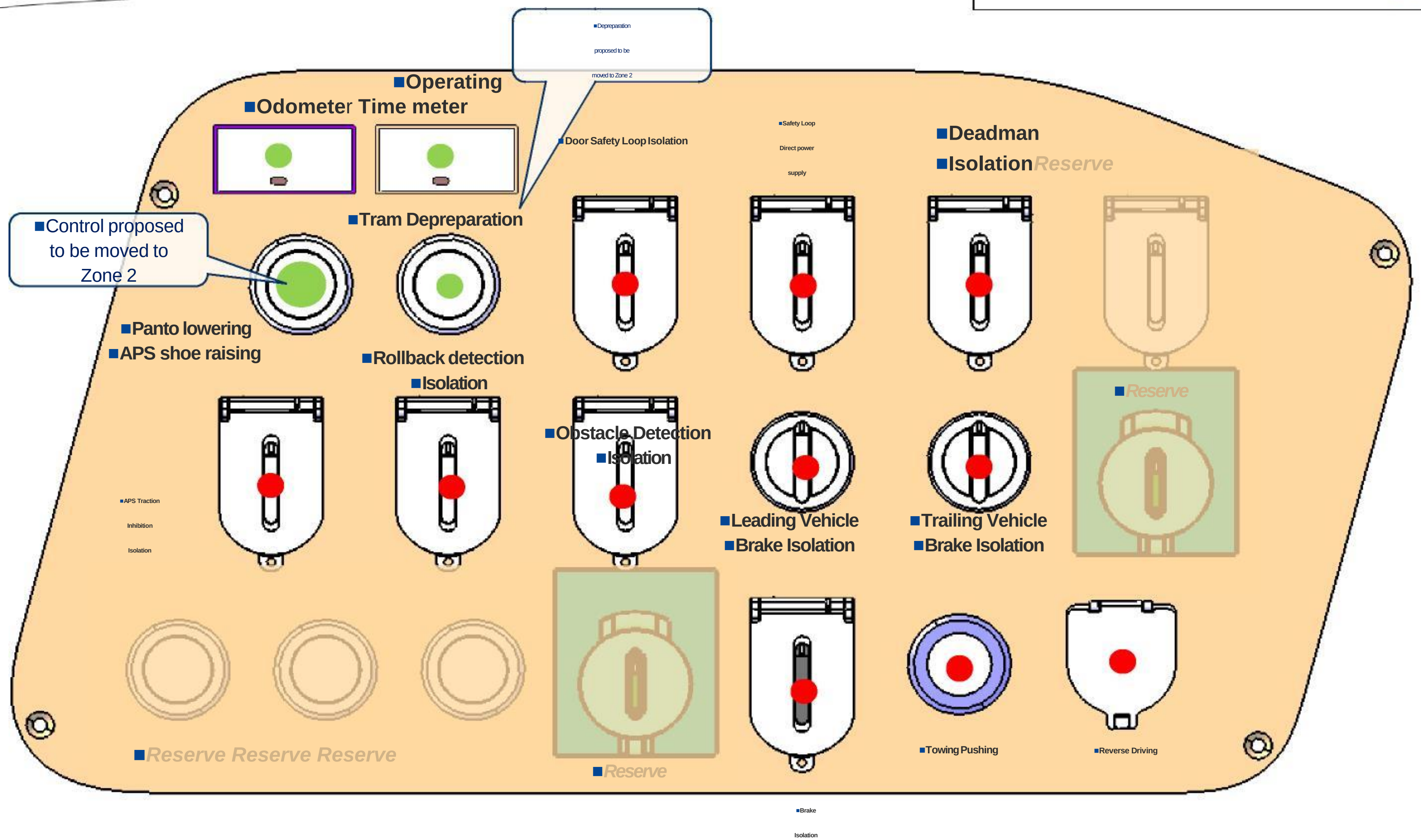
OTHER USE OF NEW TECHNOLOGIES

HIGH-TECH 3D MODEL? NOT EVERYTHING

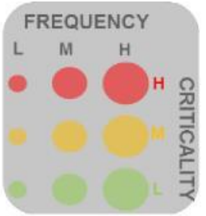
NOTHING REPLACES A LITTLE BIT OF HANDS-ON ACTIVITIES…

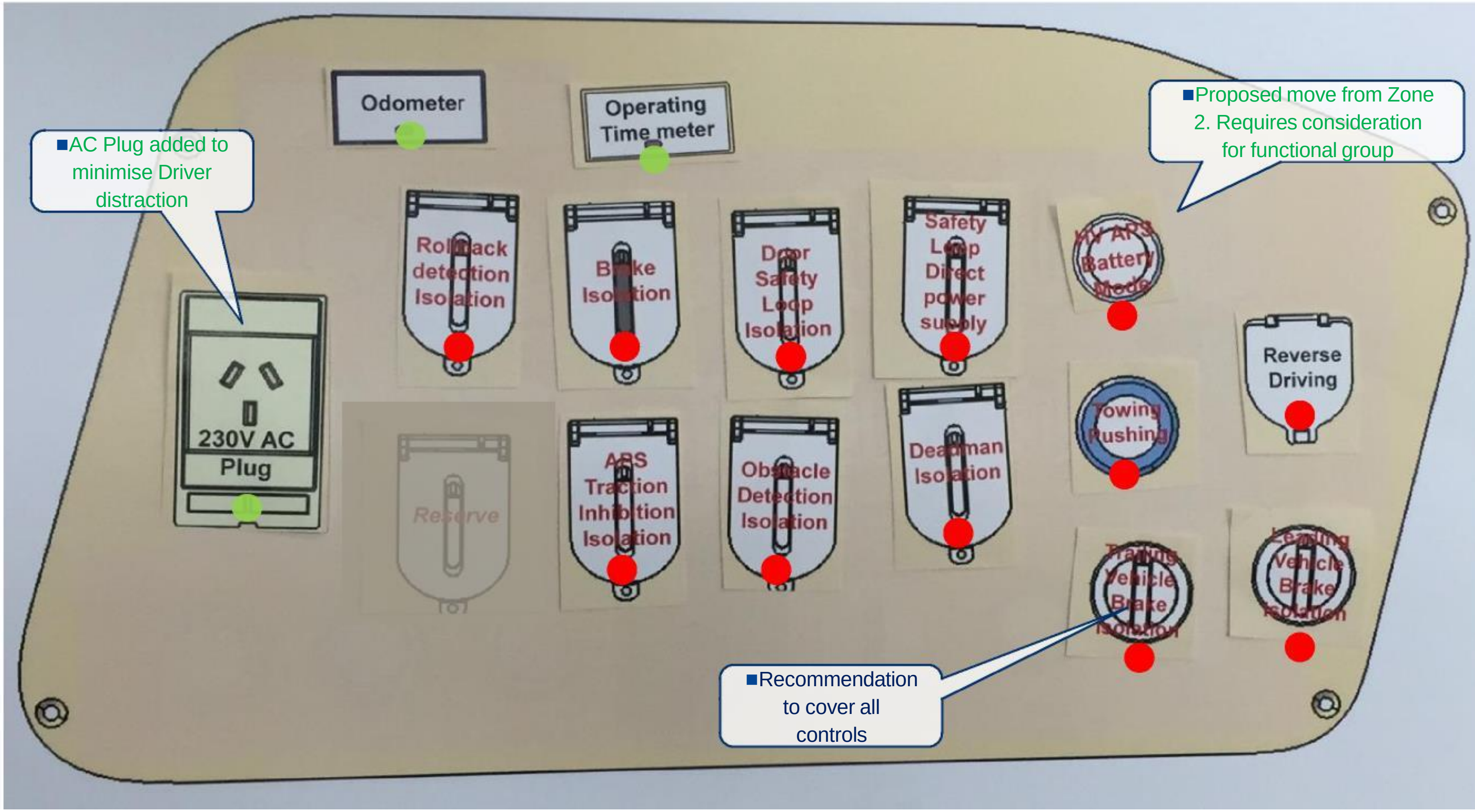
HUMAN FACTORS INTEGRATION





HUMAN FACTORS INTEGRATION

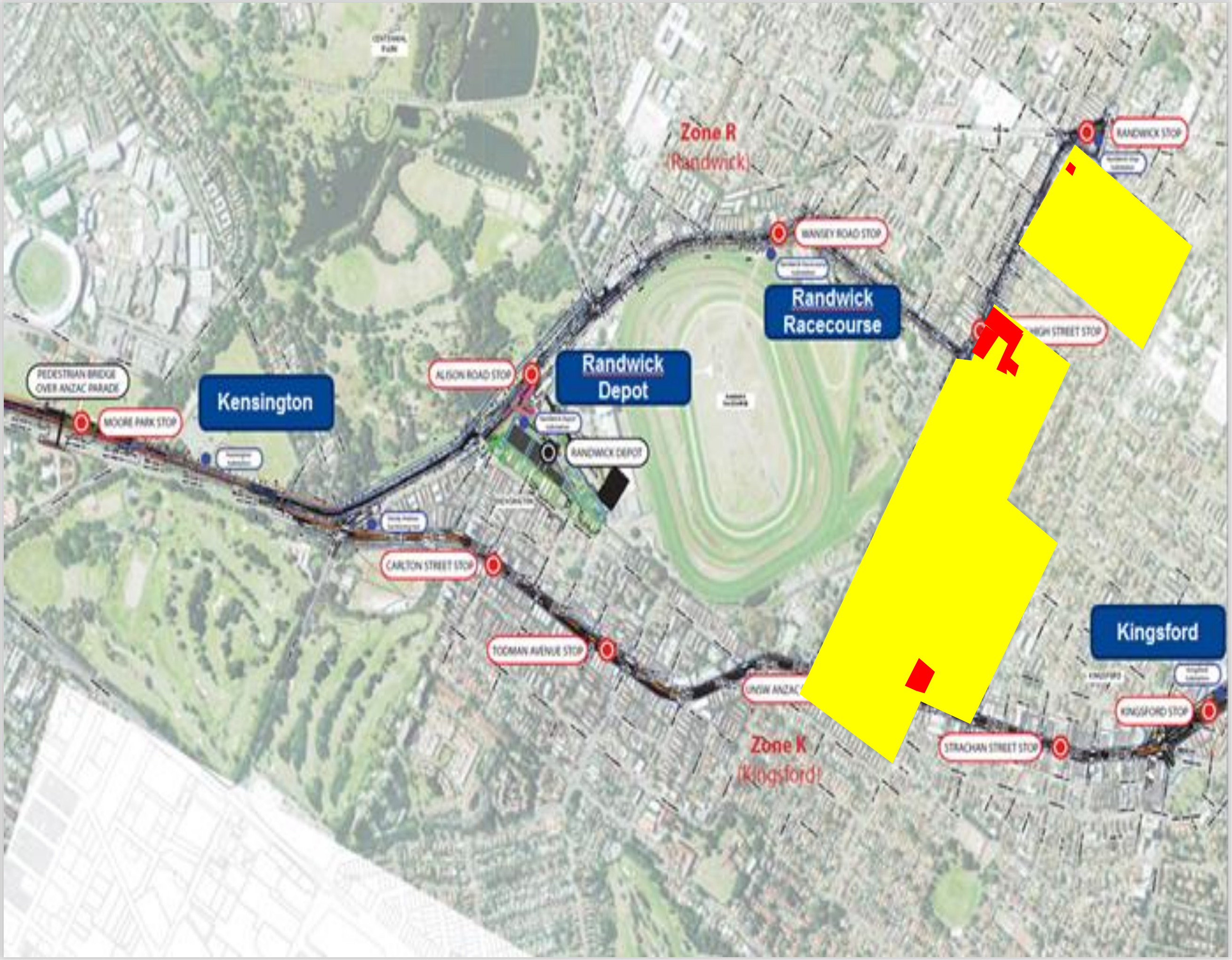




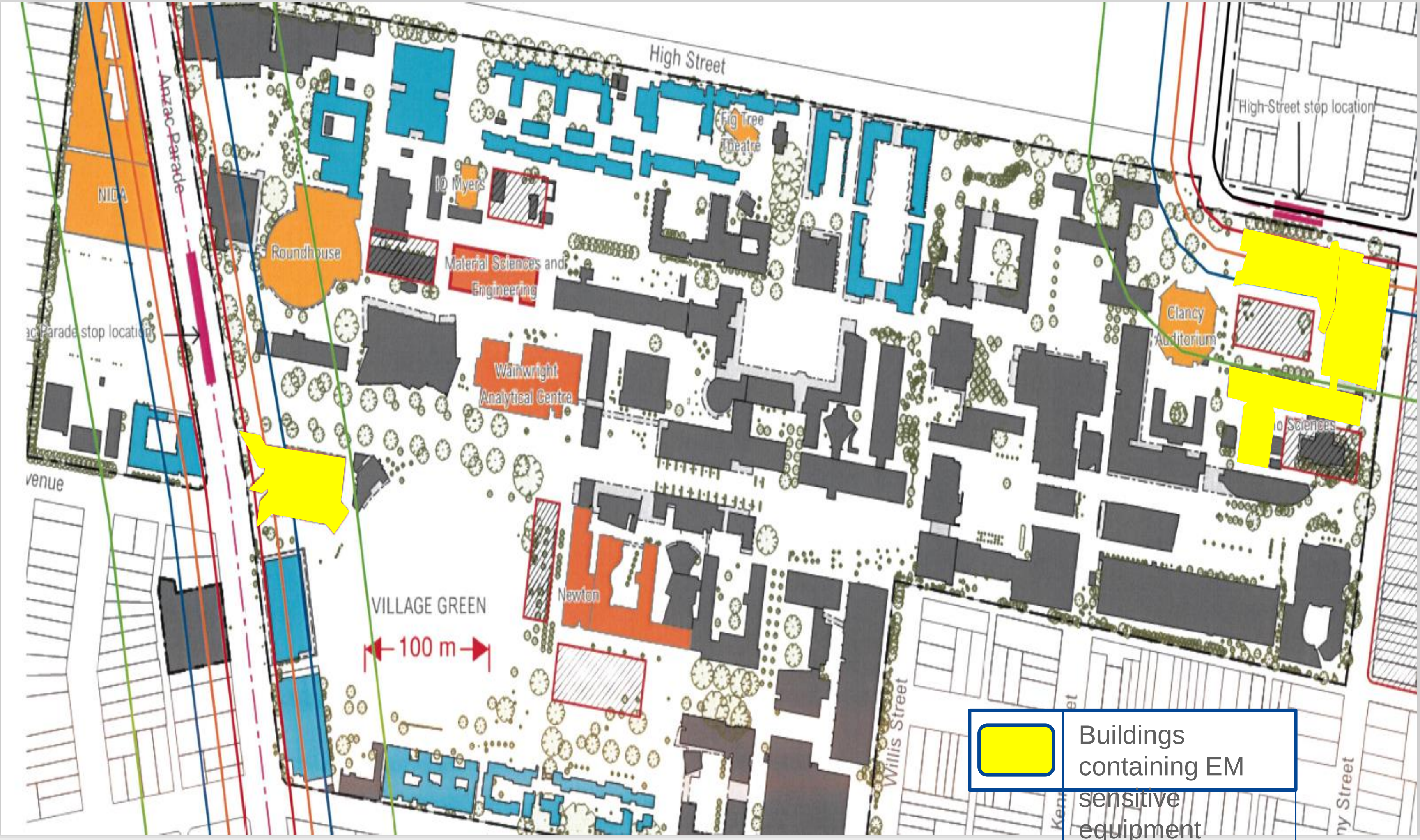
HUMAN FACTORS INTEGRATION- THE RESULT ON THE DRIVER'S DESK

Agenda

ENGINEERING CHALLENGE – PROXIMITY OF UNSW AND PRINCE OF WALES HOSPITAL



CONTEXT: UNSW EM SENSITIVE BUILDINGS



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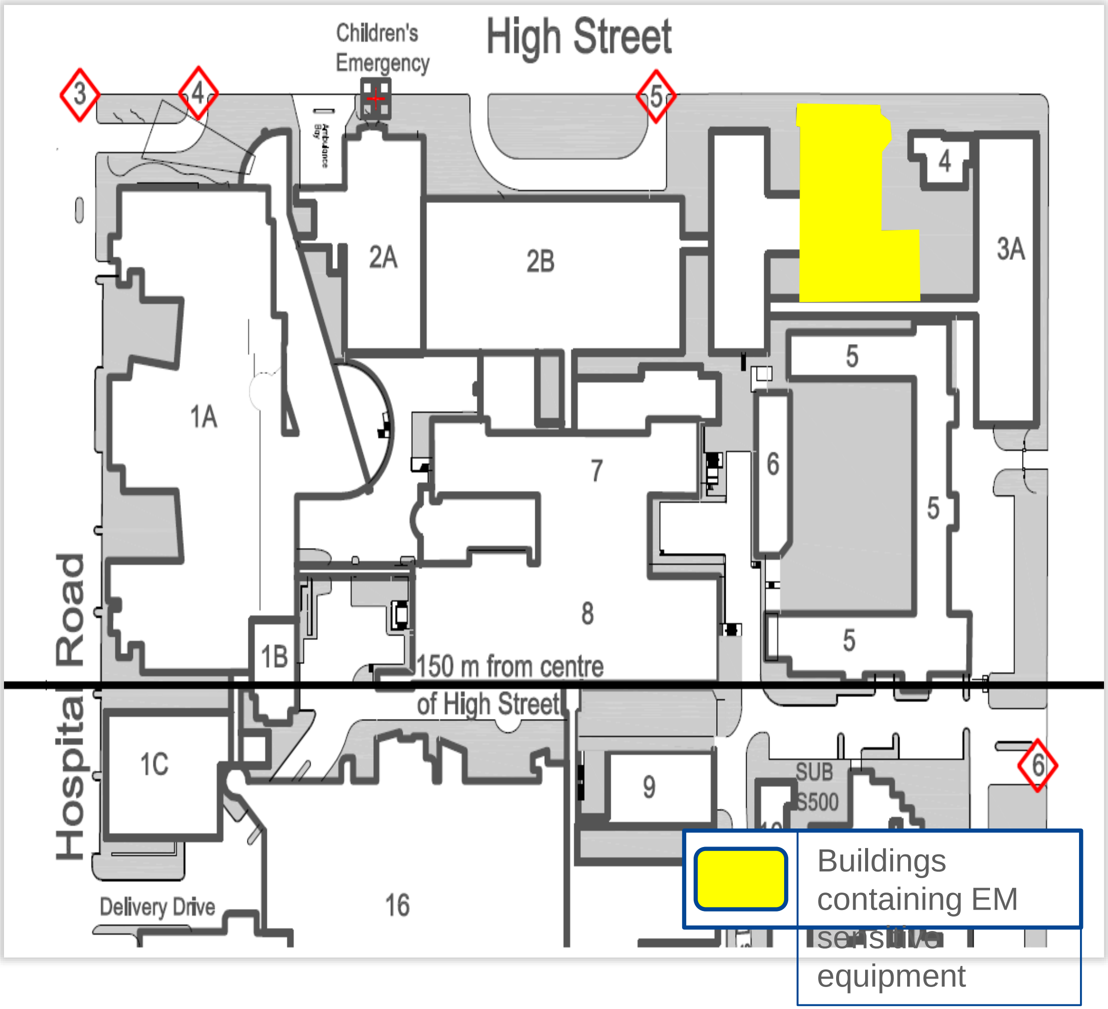
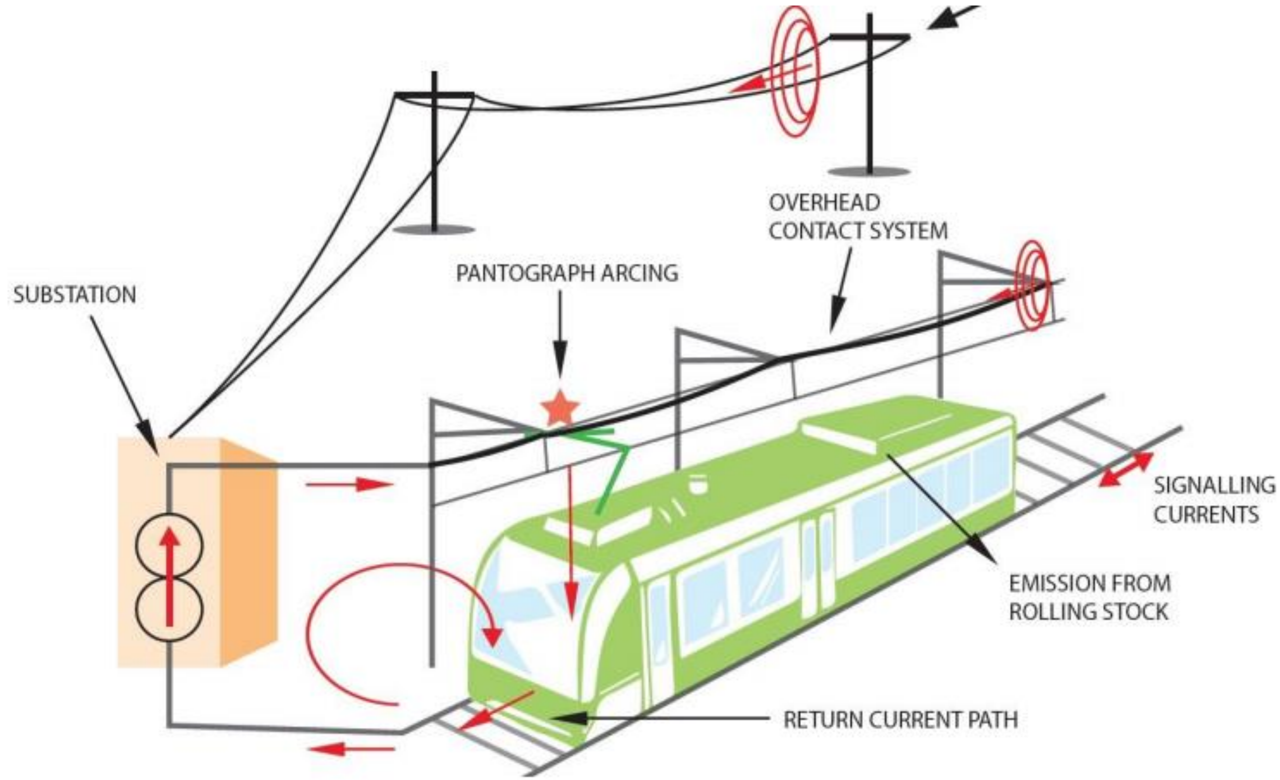
CONTEXT: PRINCE OF WALES HOSPITAL EM SENSITIVE BUILDING



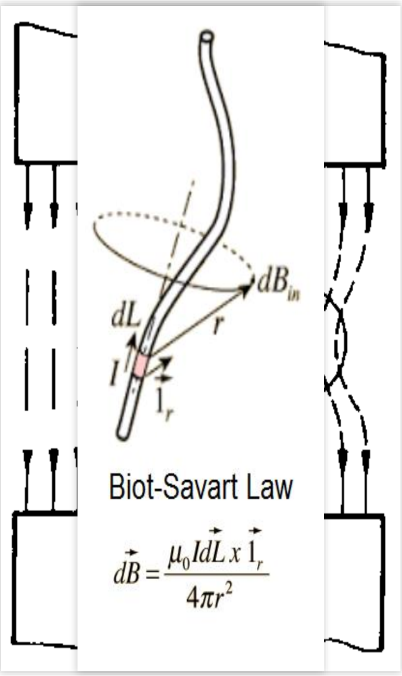
FOREWORD ON THE MAGNETIC PERTURBATION



Radiofrequency (RF) and extremely low frequency (ELF) are the two main forms of EM Fields

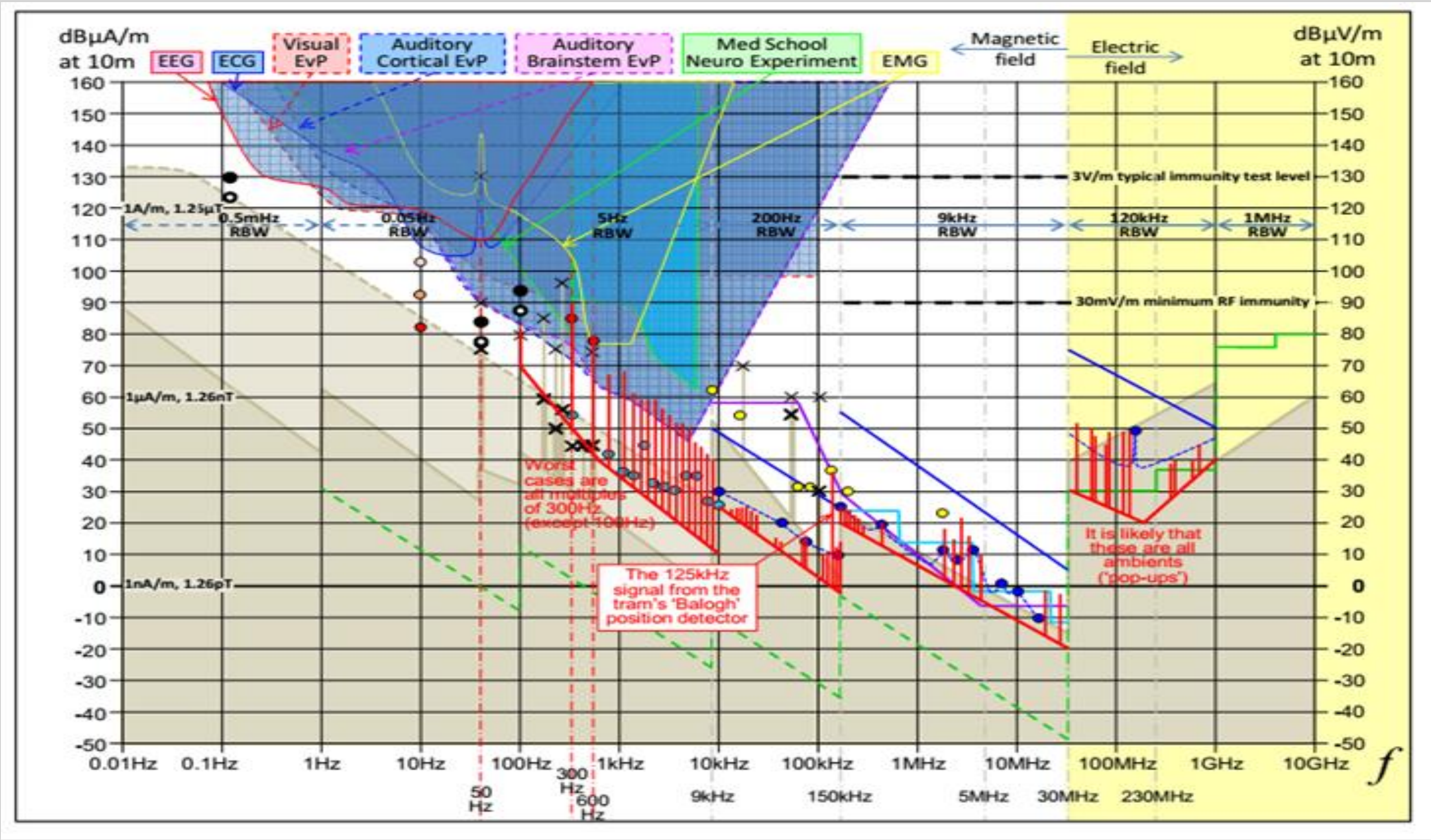
FOREWORD ON THE MAGNETIC PERTURBATION

- The Magnetic perturbation generated by the tram is caused by:
  - The local distorsion of a magnetic field (earth magnetic field) by a ferromagnetic object (Steel parts of the LRV)
  - The generation of a magnetic field by the electric equipment (current through feeder cables, injection cables, OCS, LRV, rails)



$$\vec{dB} = \frac{\mu_0 I \vec{dL} \times \vec{1_r}}{4\pi r^2}$$

PRINCIPLES OF EMC COMPATIBILITY VERIFICATION



Example of a sensitivity graph

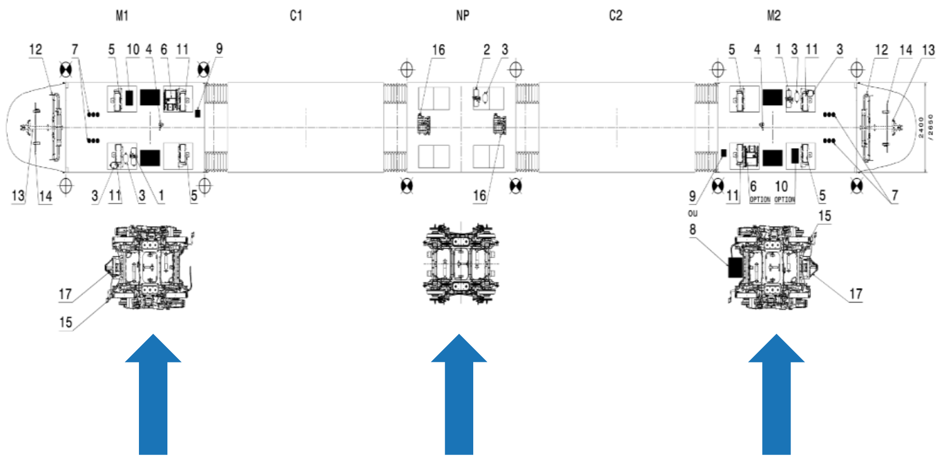
DEALING WITH EARTH FIELD DISTURBANCE

- A moving metallic object is locally disturbing the earth magnetic field
  => metallic parts of a LRV should be reduced to a minimum

In SLR Project, the steel mass of a LRV is about 20t spread along 33,4m.

Most of the frame is made of Aluminium.

Bogies constitute local mass concentration.



4350 Kg

3300 Kg

4350 Kg

More than half of the tram mass is not ferromagnetic

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DEALING WITH EARTH FIELD DISTURBANCE

- The low steel density LRV (compare to road vehicle) significantly reduces the geomagnetic perturbation.

=> confirmed by measurements (November 2015)

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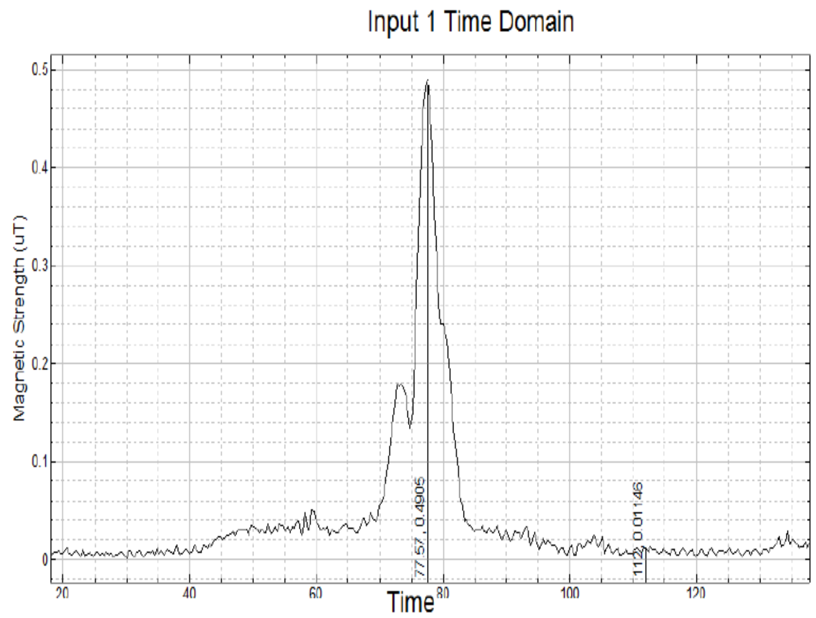
DEALING WITH EARTH FIELD DISTURBANCE

- @7m from the track, the perturbation is similar to that of a bus at 10m.

Total (offset to zero)



Total Magnetic perturbation at 7m from the track centreline due to the moving mass effect of 1 tram towed by a truck

* Measurements performed in Reims at night between the 30/11/2015 & 01/12/2015 on an equivalent LRV.
Convoy moved at 15km/h

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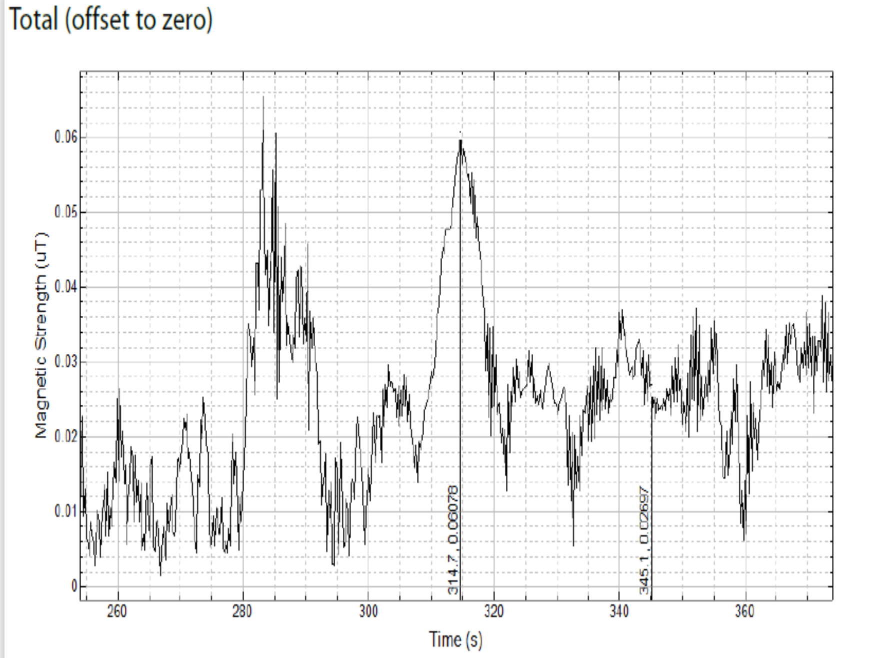
DEALING WITH EARTH FIELD DISTURBANCE

- @21m from the track, the perturbation is negligible*



Total Magnetic perturbation at 21m from the track centreline due to the moving mass effect of 1 tram towed by a truck

* Measurements performed in Reims at night between the 30/11/2015 & 01/12/2015 on an equivalent LRV.
Convoy moved at 15km/h

REDUCING THE DC MAGNETIC FIELD

MAIN PRINCIPLES/IDEAS

- **REDUCTION OF THE OVERALL IMPEDANCE OF THE TRACTION NETWORK:**
  - LESS IMPEDANCE = LESS LOSSES = LESS CURRENT FOR SAME POWER
- **REDUCTION OF THE SIZE OF THE FIELD EMITTING LOOP**
  - GREATER DECAY RATE OF THE FIELD.

REDUCING DC MAGNETIC FIELD

- Normal design : 1 injection every 300m

Summary of the EM Perturbation @10m

EM perturbation on normal section :
100

REDUCING DC MAGNETIC FIELD

- Enhanced design : 1 injection every 30m
  - Feeder Pole every 30m
  - Feeder Box every 30m
  - Injection Cables every 30m
  - Additional Traction fault equipment
  - Additional Surge Arrestor

Summary of the EM Perturbation @10m

- 28%

EM perturbation on normal section : 100

EM perturbation with injection every 30m : 72

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REDUCING DC MAGNETIC FIELD

- Enhanced design : More feeder cables
  - 2 additional 400mm² Cu feeder cables
    => reduction of the resistance

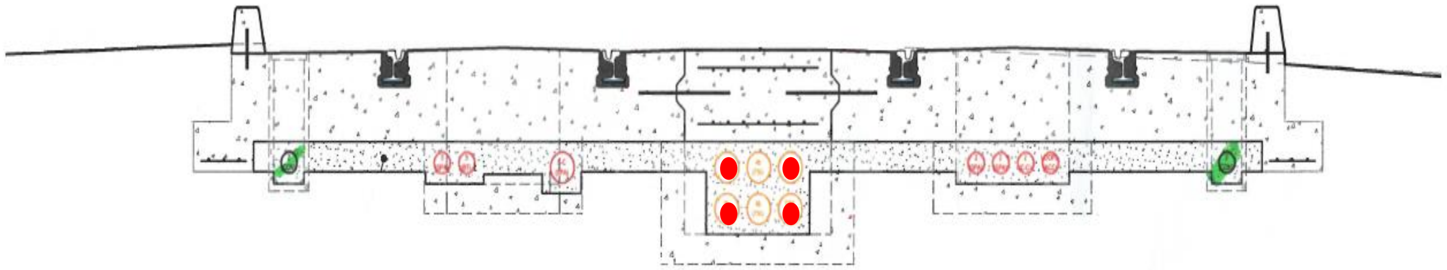
Summary of the EM Perturbation @10m

- 39%

EM perturbation on normal section : 100

EM perturbation with injection every 30m : 72

EM perturbation with added feeder cables : 61



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REDUCING DC MAGNETIC FIELD

- Enhanced design : Crossbonds every 30m
  - Track crossbond every 30m
  - OCS crossbond every 30m

=> Total equipotentiallity of the rails & OCS

Summary of the EM Perturbation @10m

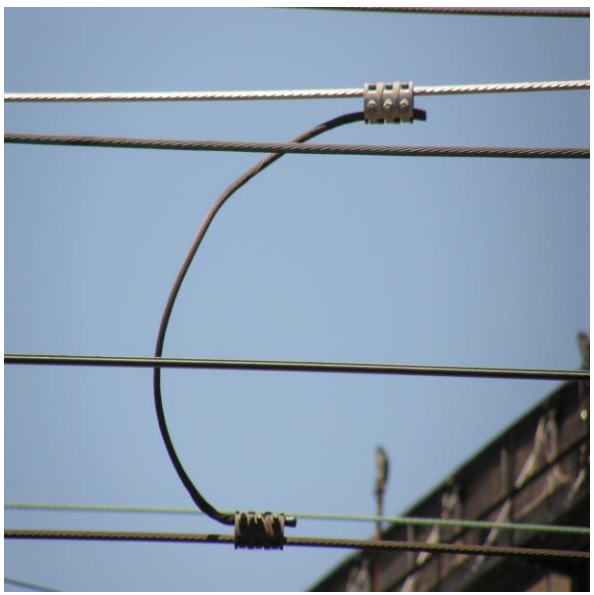
EM perturbation on normal section : 100

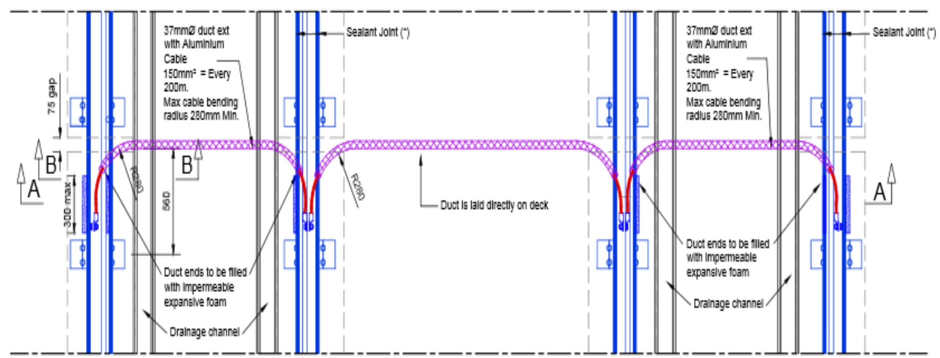
- 47%

EM perturbation with injection every 30m : 72

EM perturbation with added feeder cables : 61

EM Perturbation with crossbonds every 30m : 53





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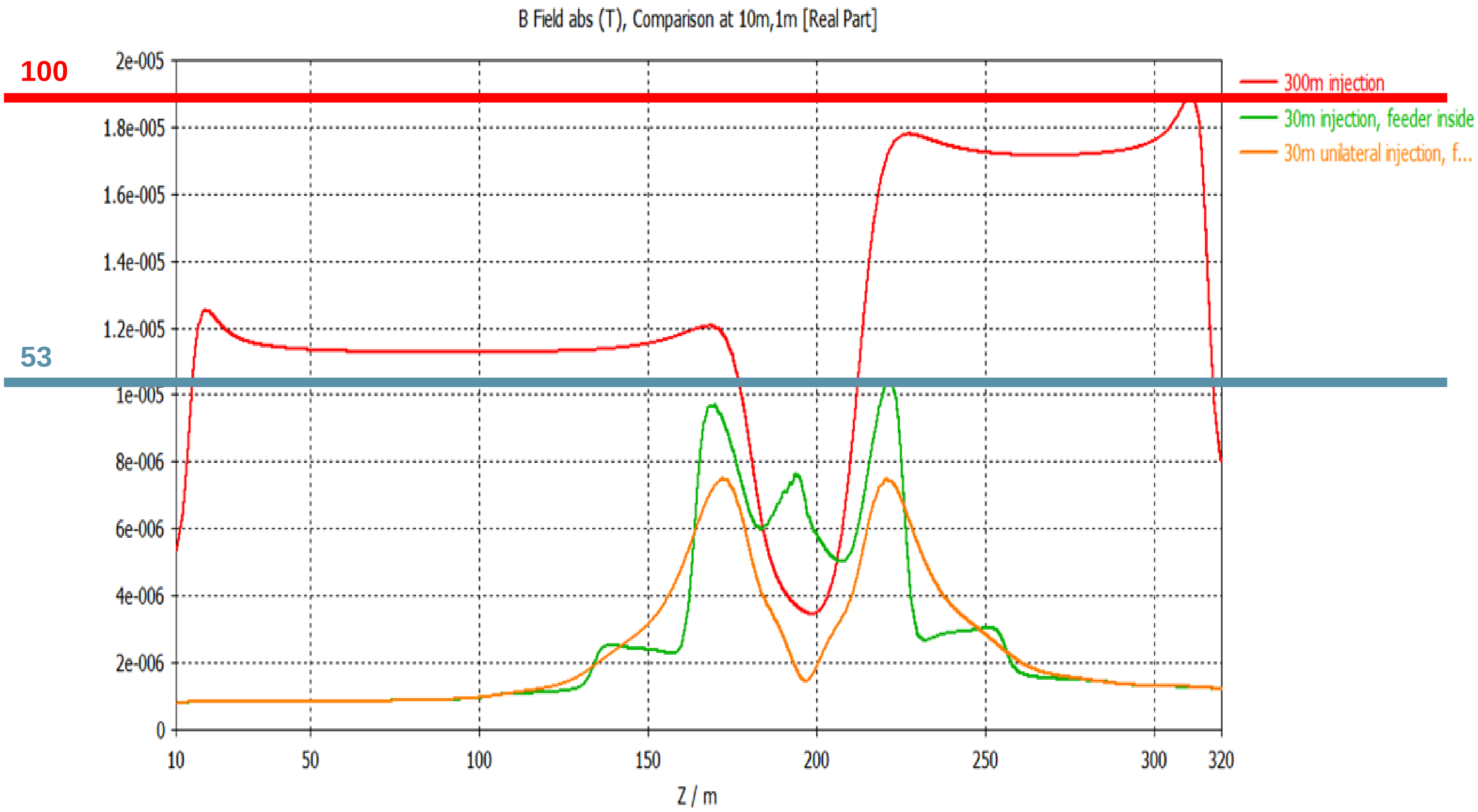
REDUCING DC MAGNETIC FIELD

RESULTS AT 10 M



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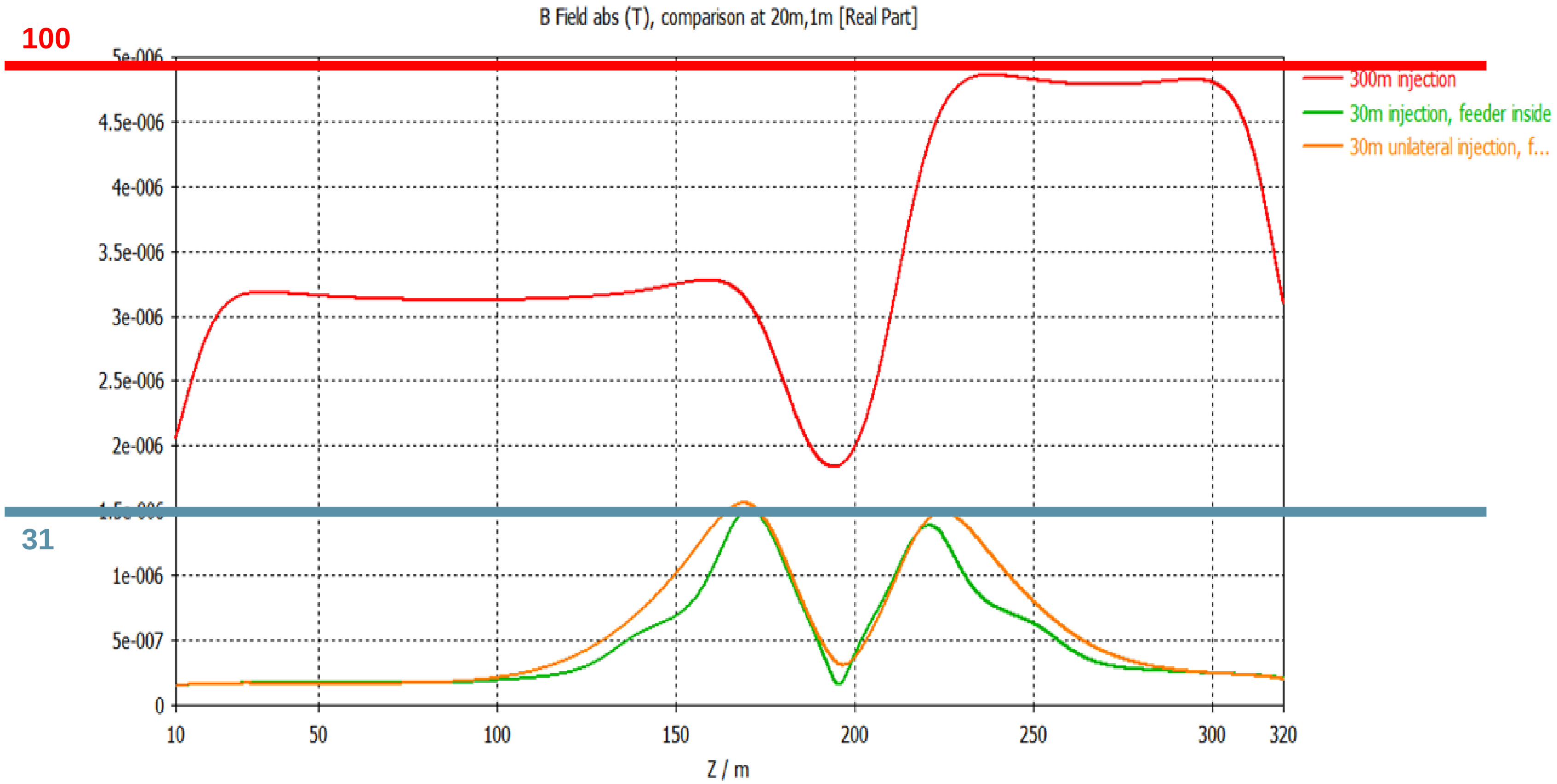
REDUCING DC MAGNETIC FIELD

RESULTS AT 20 M



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9. Other Engineering Challenges

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SLR - Sustainability requirements

Transport for NSW

Sydney Light Rail

Public Private Partnership

Project Deed
Schedule E1 Scope and Performance Requirements
Appendix 7 - Sustainability

- 17 pages document
- Requirements to comply with other standards:
  - ISO 14040, 14064
  - AS 5334-2013
  - BS 8903
  - ISCA
  - SDG

ISCA Infrastructure Sustainability Council of Australia

- 52 credits
- 3 levels for each credit
- Objective: Excellent - 65/100

Management Systems	Man
Procurement and Purchasing	Pro
Climate Change Adaptation	Cli
Energy and Carbon	Ene
Water	Wat
Materials	Mat
Discharges to Air, Land and Water	Dis
Land	Lan
Waste	Was
Ecology	Eco
Community, Health, Wellbeing and Safety	Hea
Heritage	Her
Stakeholder Participation	Sta
Urban and Landscape Design	Urb
Innovation	Inn

Transport for NSW

NSW Sustainable Design Guidelines
Version 3.0

- 23 Compulsory initiatives
- 208 Discretionary initiatives
- Objective: Gold – 80/100

Energy and greenhouse gases

Climate resilience

Materials and waste

Biodiversity and heritage

Water

Pollution control

Community benefit

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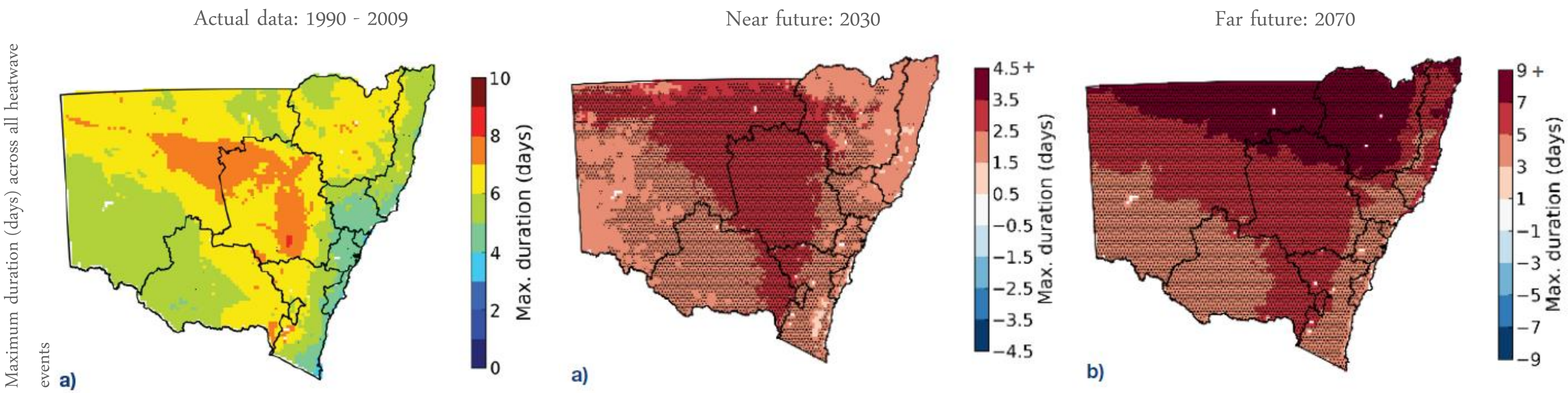
Climate change

- 1st project requesting analysis to demonstrate resilience to climate change of proposed equipment and infrastructure

Heatwave events across NSW actual and projections



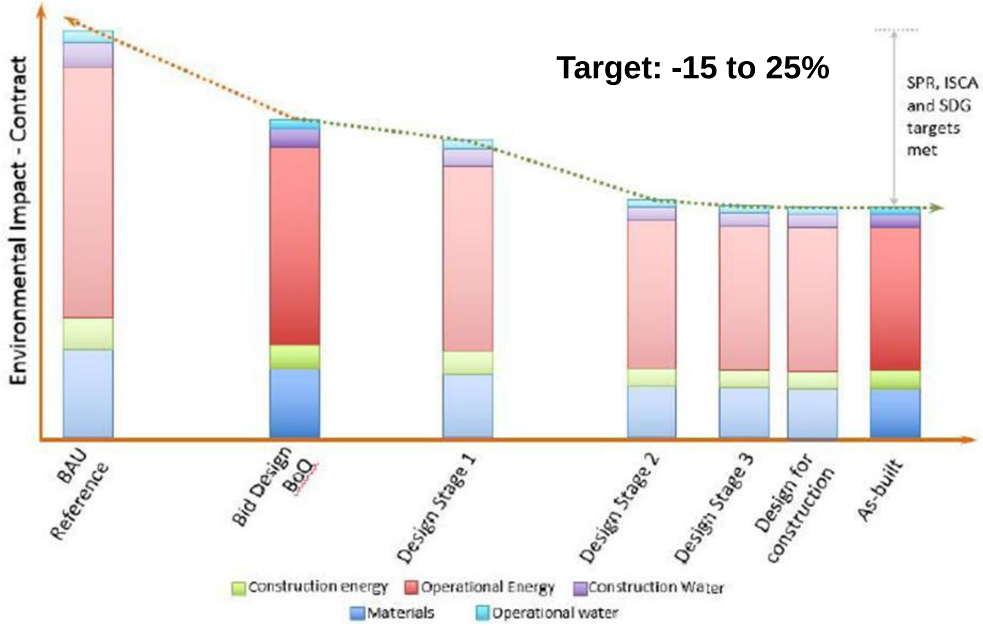
Source: heatwaves climate change impact snapshot

=> Tram system designed to withstand outside T°> 40°C (infrastructure and equipment resistance , HVAC dimensioning) and even >50°C in degraded mode

Reducing project energy & carbon footprint

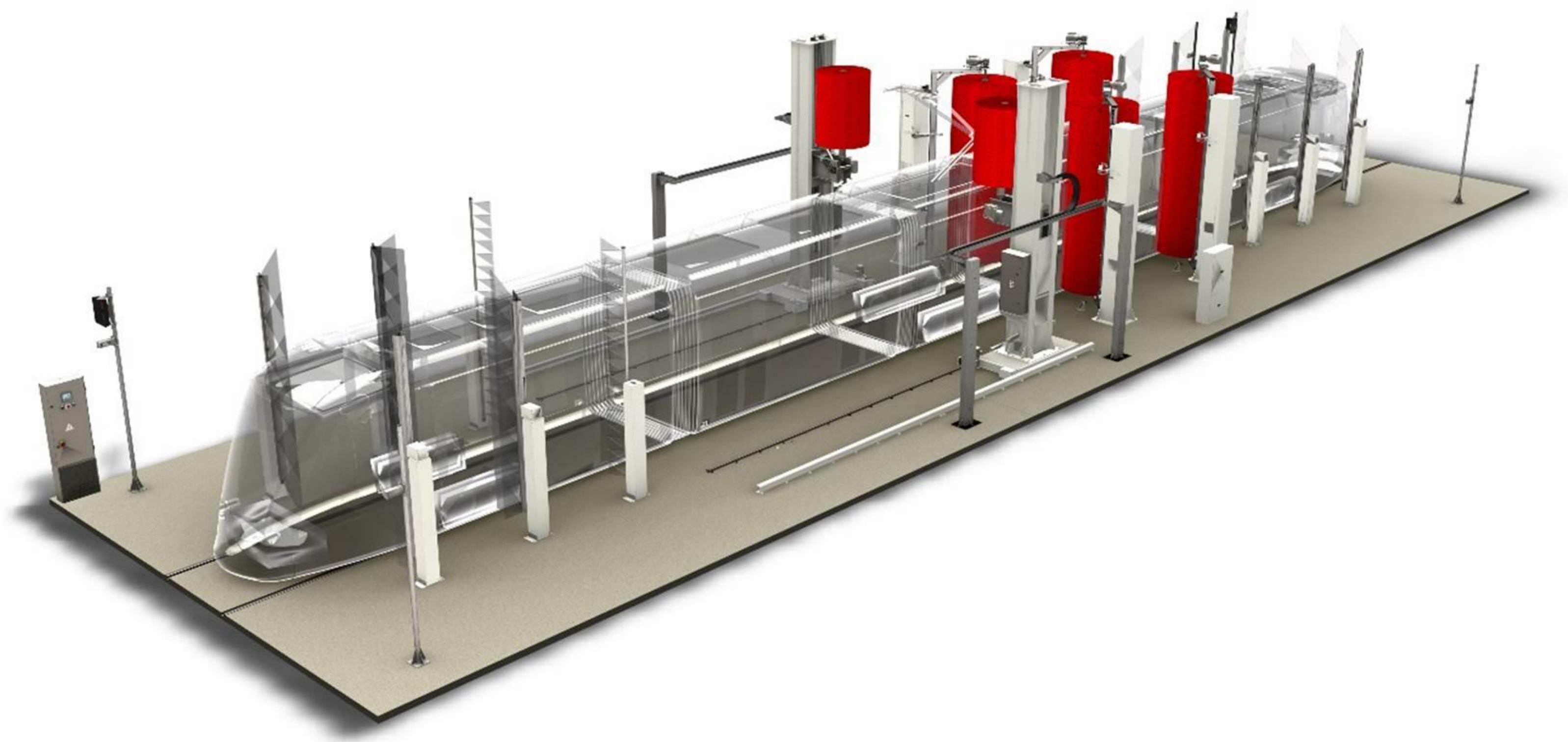
- Monitoring, reduction and use of renewable energy

- SLR target: energy requirements reduced by 15-25% vs. business as usual (level 2 of 3 in ISCA dedicated category)
- Achievable for Systems thanks to:
  - Citadis X05 generation
  - Permanent magnet motor
  - HESOP system
- Civil work footprint reduction:
  - Use of recycled materials:
    - Aggregate
    - Concrete
  - Substitution of 30% of cement
- Other:
  - 150 kW solar panels on depot roof



Limiting water use

- Monitoring, reduction and use of non potable water



- Target: 80% of water for the wash machine to be collected, recycled and reused
- Water will be mostly harvested rainwater

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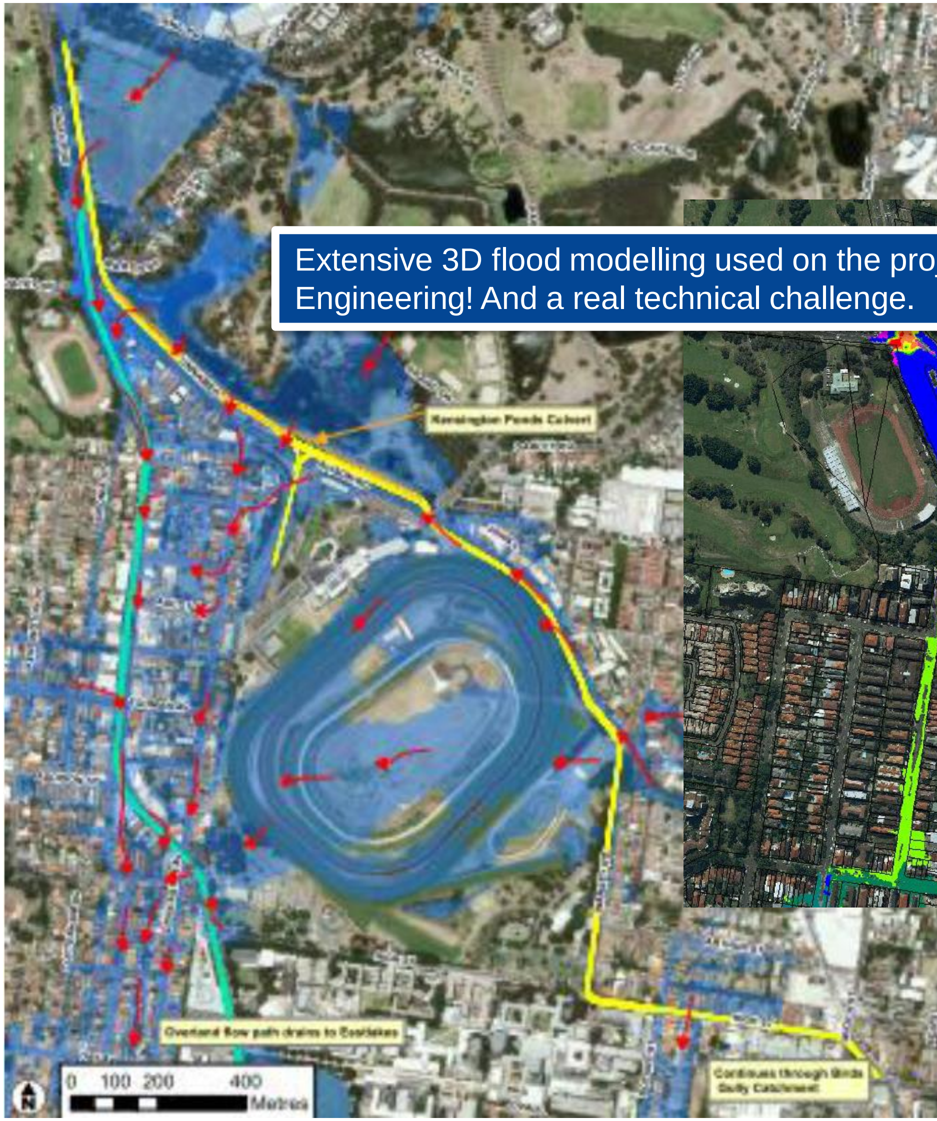
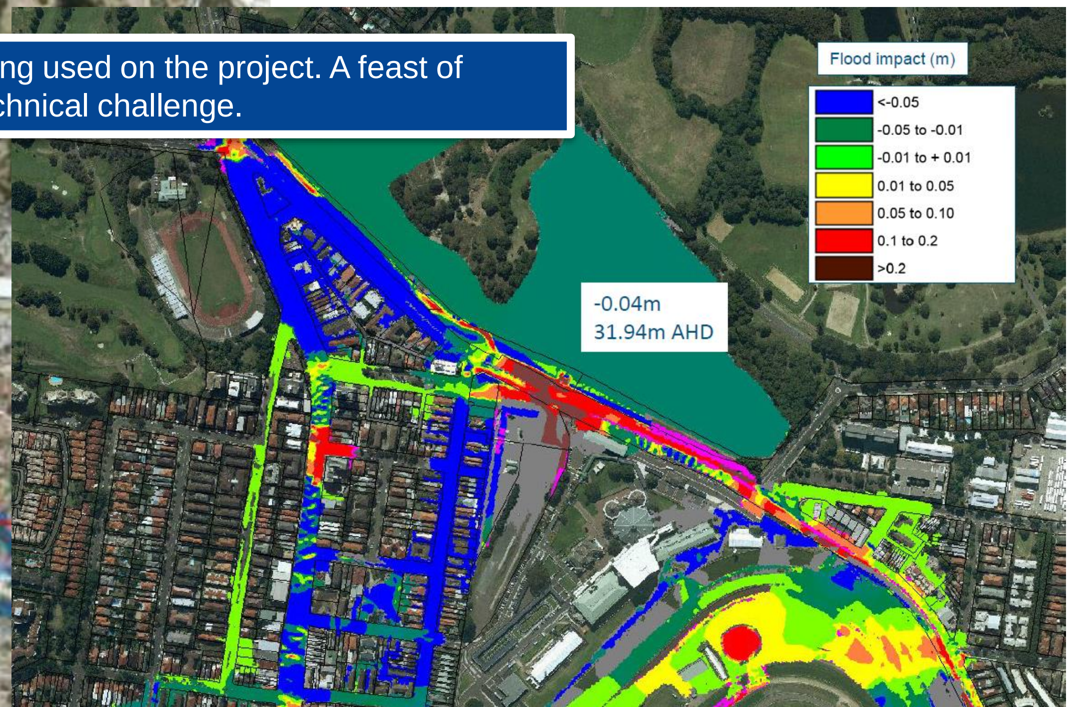
Flooding issues

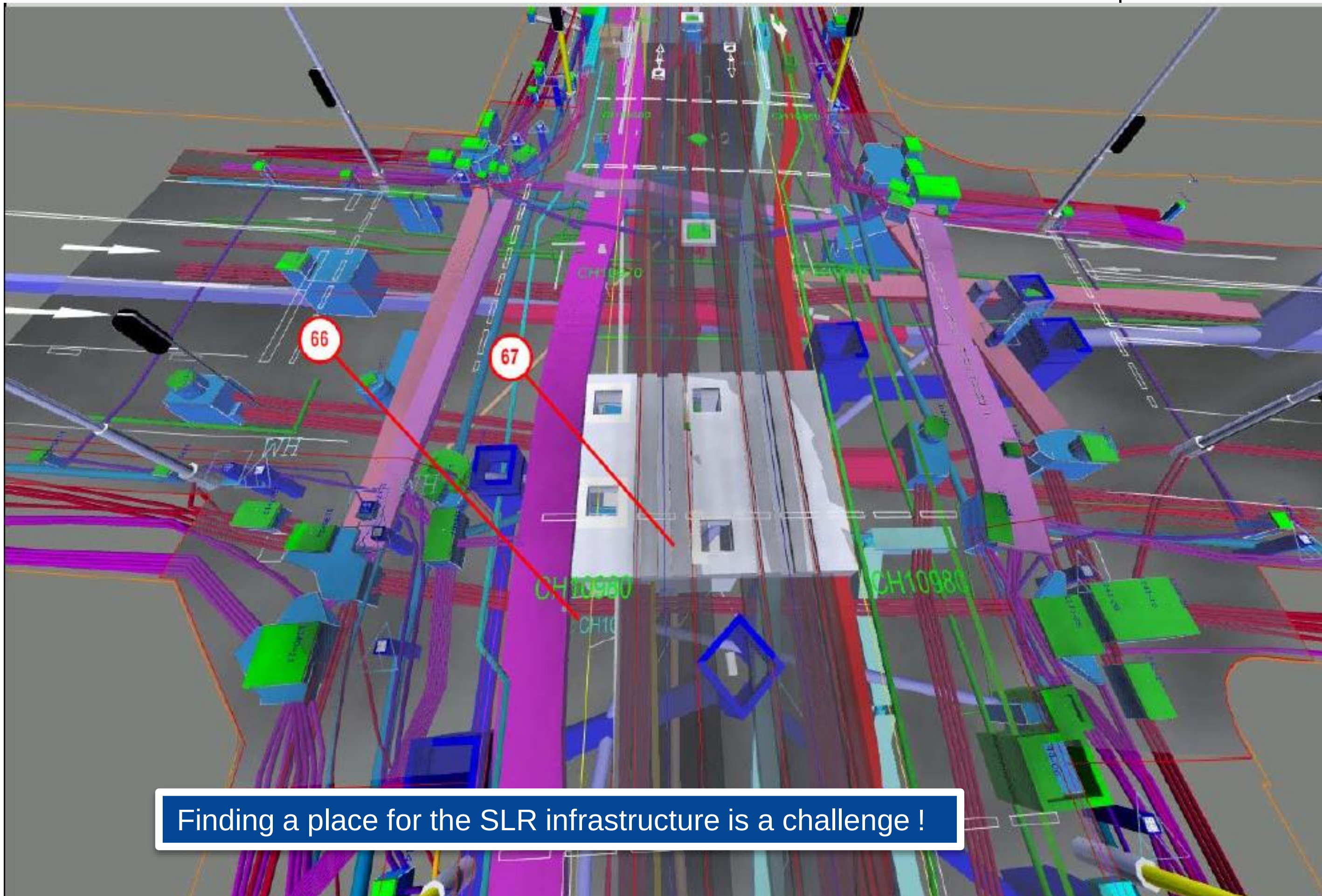


Extensive 3D flood modelling used on the project. A feast of Engineering! And a real technical challenge.



Courtesy of

Utilities



Courtesy of SLR DJV JACOBS GHD

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Take-Away

- SLR project is an Engineering Feast with Innovation at all levels
  - APS system in CBD
  - HESOP traction power system
  - Latest development of Citadis
  - Extensive use of 3D modelling
  - Sustainability engineering to a state-of-the art level
- New disciplines of engineering emerge in our activity (Dynamic modelling, 3D, Virtual reality, etc)
- There is a fantastic opportunity for all sorts of people with different background to bring something in the world of Transport engineering

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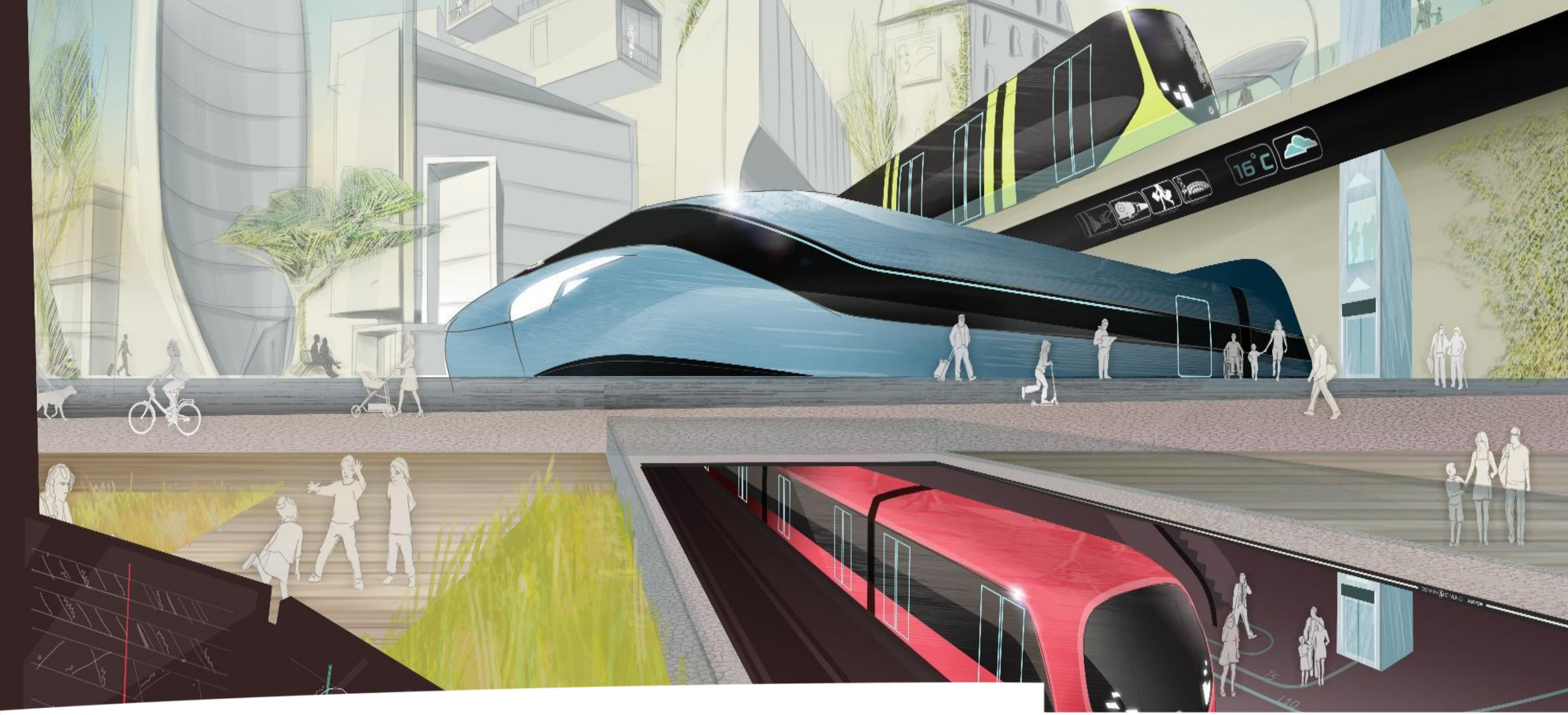

Thank you for your attention

Any Question?

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Designing fluidity