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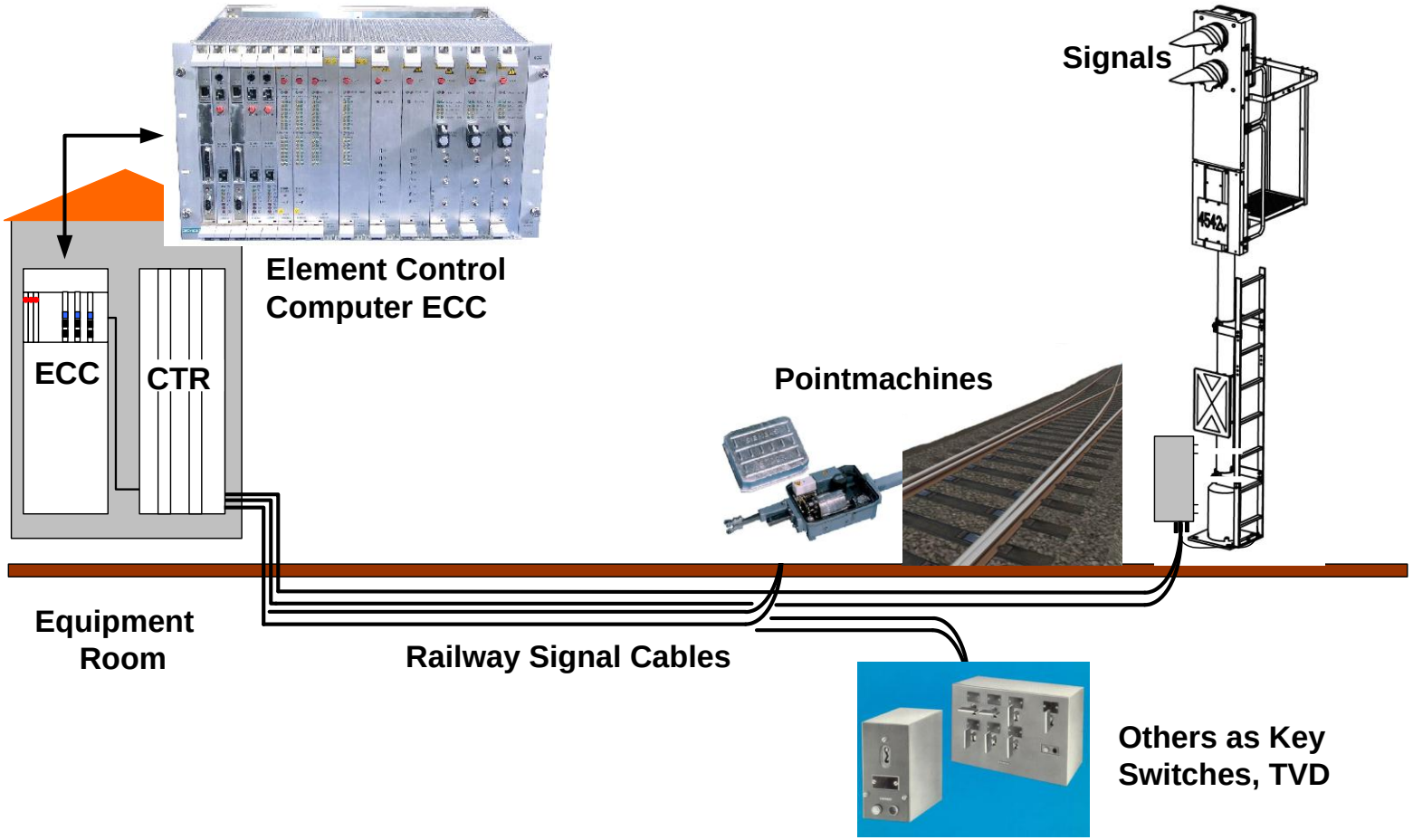
# Siemens Element Control Computer ECC as a Safety related System for Mainline Signalling

1. The Element Control Computer (ECC)
2. Centralised / Decentralised Solutions
3. ETCS Equipment Interfaces
4. Safety Philosophy
5. Railway Signalling Cabling/ EMC
6. Summary: Key Benefits of Electronic Interlocking

# 1. The Element Control Computer (ECC), Overview, typical Interfaces



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## 1. The Element Control Computer (ECC), History

- First Version developed during 1997-2000, Pilot Project Zywiec, Poland
- Worldwide Countries with operational Experience, such as Germany, Switzerland, Austria, Poland, Netherlands, Great Britain, Romania, Greece, Norway, Lithuania, China, India, Saudi- Arabia, Brazil
- Worldwide more than 25000 Element Operation Modules (EOM) in Service
- Used for electronic Interlockings as SIMIS-W, SIMIS-D, SIMIS-IS, SICAS-S7, SICAS- ECC
- Approved as per CENELEC/ EN50129 SIL 4 by EBA (German Board for Railway Safety)

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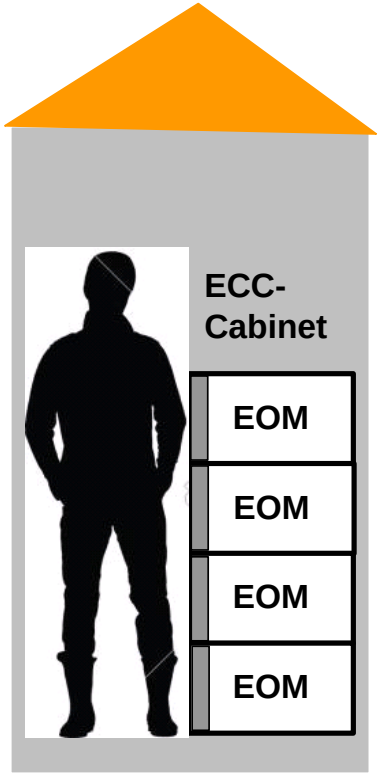
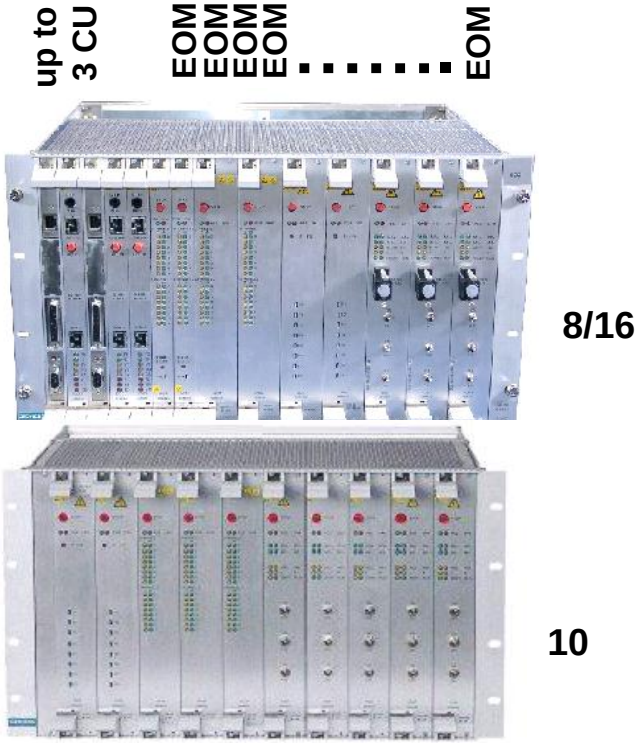
# 1.1 The Element Control Computer (ECC) used for centralised Application




**Equipment Room**

**ECC Indoor Cabinet**




**ECC Base Frame**
**ECC Extension Frame**

3 CPUs (2-out-of-3 Computer-Configuration)

## 1.1.4 Environmental Conditions for ECC Hardware

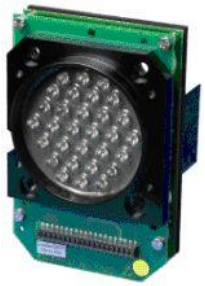
| | | |
|---|---|---|
| Climatic Test | EN 60068-2-1 | Cold in Operation -40°C /16h |
| | EN 60068-2-2 | Dry Heat in Operation +70°C / +85°C 16h |
| | EN 60068-2-14 | Change of Temperature in Operation<br>-40°C / +30°C / 3h / 5 Cycles |
| | EN 60068-2-30 | Damp Heat Cyclic in Operation<br>+55°C / 90-100% / 48h /2 Cycles |
| Mechanical Test | EN 60068-2-27<br>EN 60068-2-64 | Vibration, Shock |
| EMC Test | EN 50121<br>EN 61000 | See 6.2 |

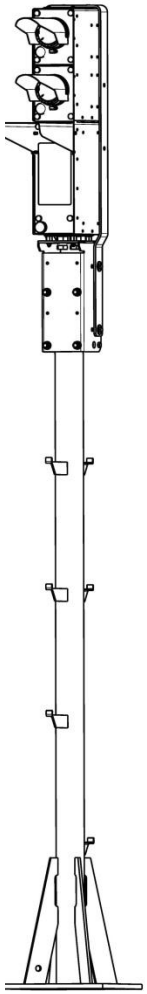
-> In Case of exceeding Limits, the Installation of Air Conditioner is possible

# 1.1.5 The ECC Signal Operation Module (SOM6)


Safety related Function:

- to switch on/off Signal Lamp
- to monitor the Lamp Current
- to monitor the Signal Cable (Loss of Insulation)
- to realise electrical Insulation between Indoor and Outdoor Area



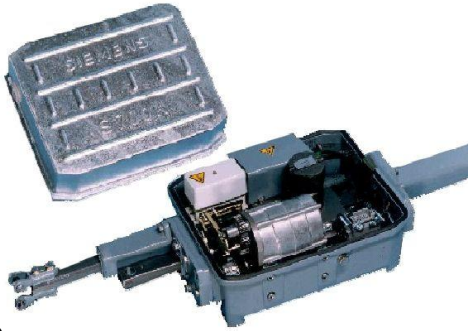


- up to eight Signal Lamps connectable
- up to two Signals per each SOM6 max. two red aspect Lamps (remain switched on in Case of Safety Shutdown)

# 1.1.6 The ECC Point Operation Module (POM4)

Safety related Function:

- to switch the Point Machine
- to monitor the point position
- to monitor the Point Machine Cable (Loss of Insulation)



- to realise electrical Insulation between Indoor and Outdoor Area

- to monitor the running Current

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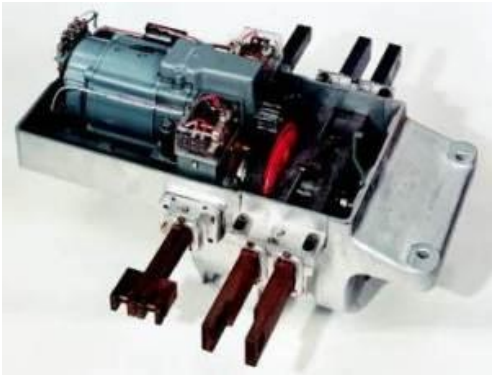
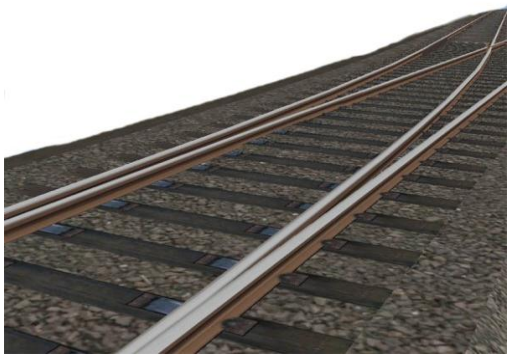
# 1.1.7 The ECC DC Point Operation Module (DC POM)

Safety related Function:

- to switch the Point Machine
- to monitor the point position
- to monitor the Point Machine Cable (Loss of Insulation)



- to realise electrical Insulation between Indoor and Outdoor Area

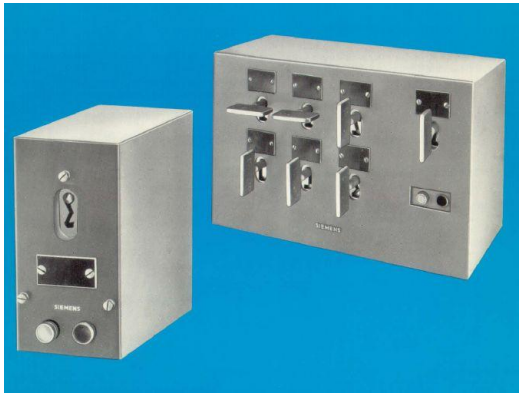


- to monitor the running Current

# 1.1.8 The ECC Universal Operation Module (UNOM2)


Safety related Function:

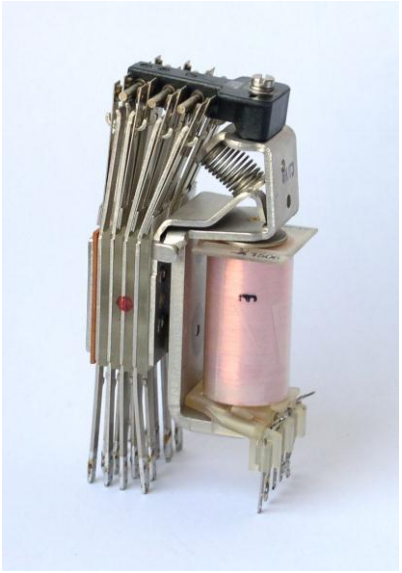
- to read in Key Switch Message, for example
- to monitor the Outdoor Cable (Loss of Insulation)
- to realise electrical Insulation between Indoor and Outdoor Area
- universal In-/Output of Messages and Commands



## 1.1.9 The ECC Input/Output Operation Module (INOM2)

Safety related Function:

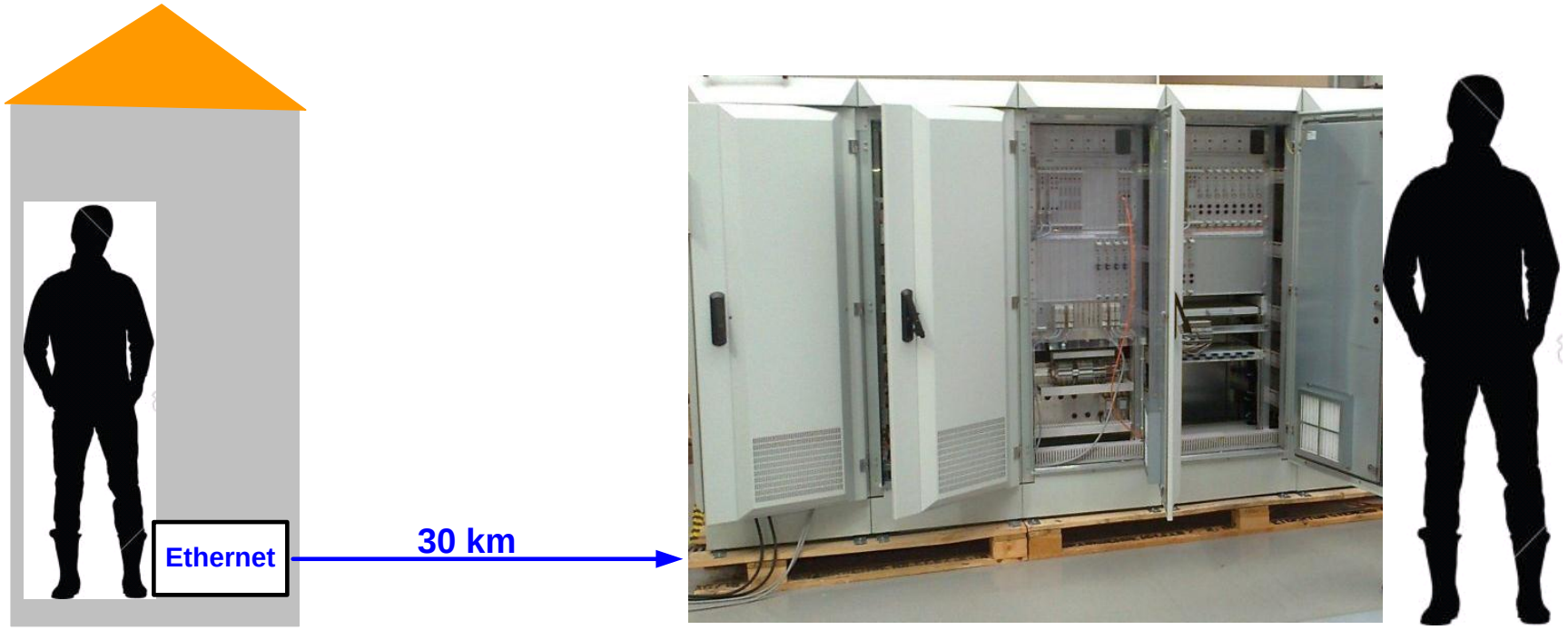
- to read in Track Vacancy Message
- to read in Relay Message
- universal In-/Output of Messages and Commands
- Control of existing Relay Circuits (Interfaces)

In contrast to UNOM2: No electrical Insulation between Indoor and Outdoor Area realised – Indoor Use only!

## 1.2 The Element Control Computer (ECC) used for decentralised Application,

### 1.2.1 - Big decentralised Units, ECC- Outdoor Cabinet



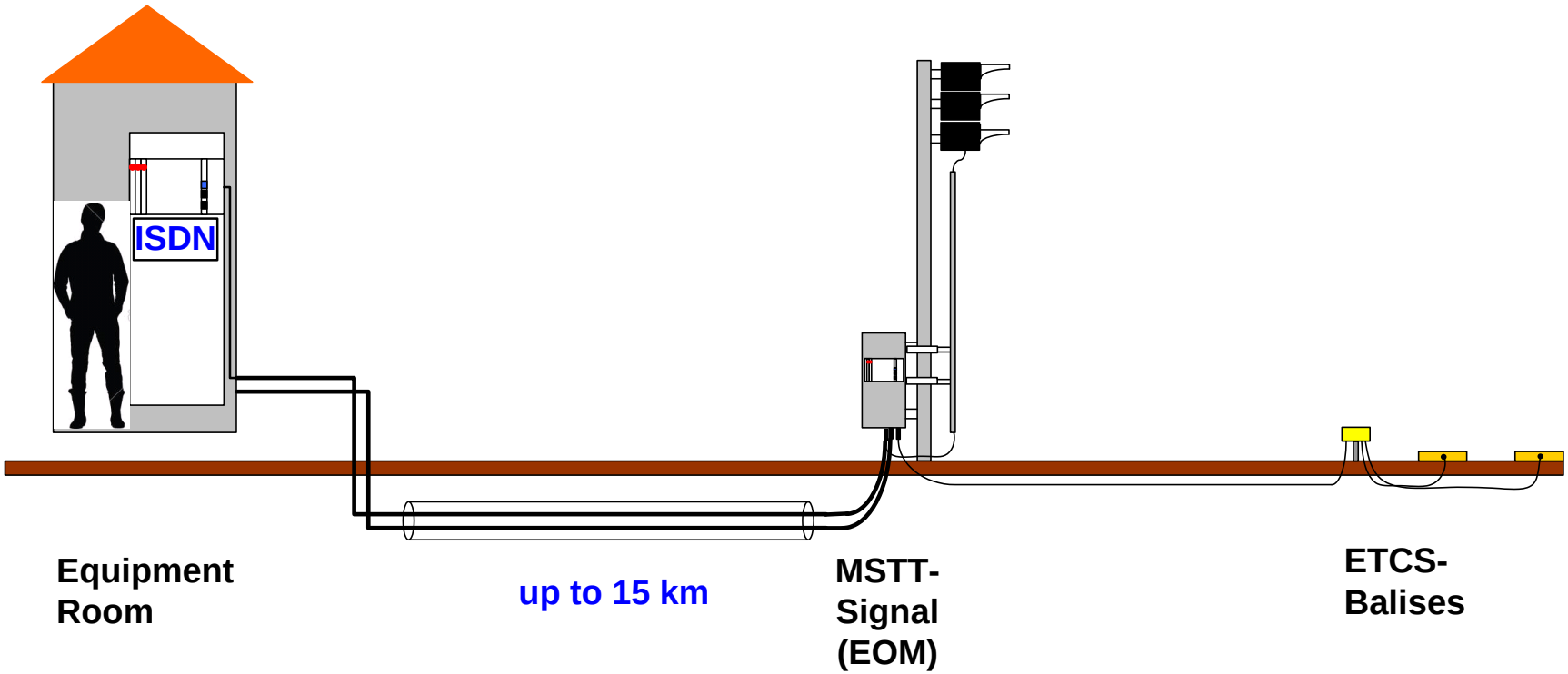

**Equipment Room**

**Optional : IL- Bus, Profibus**

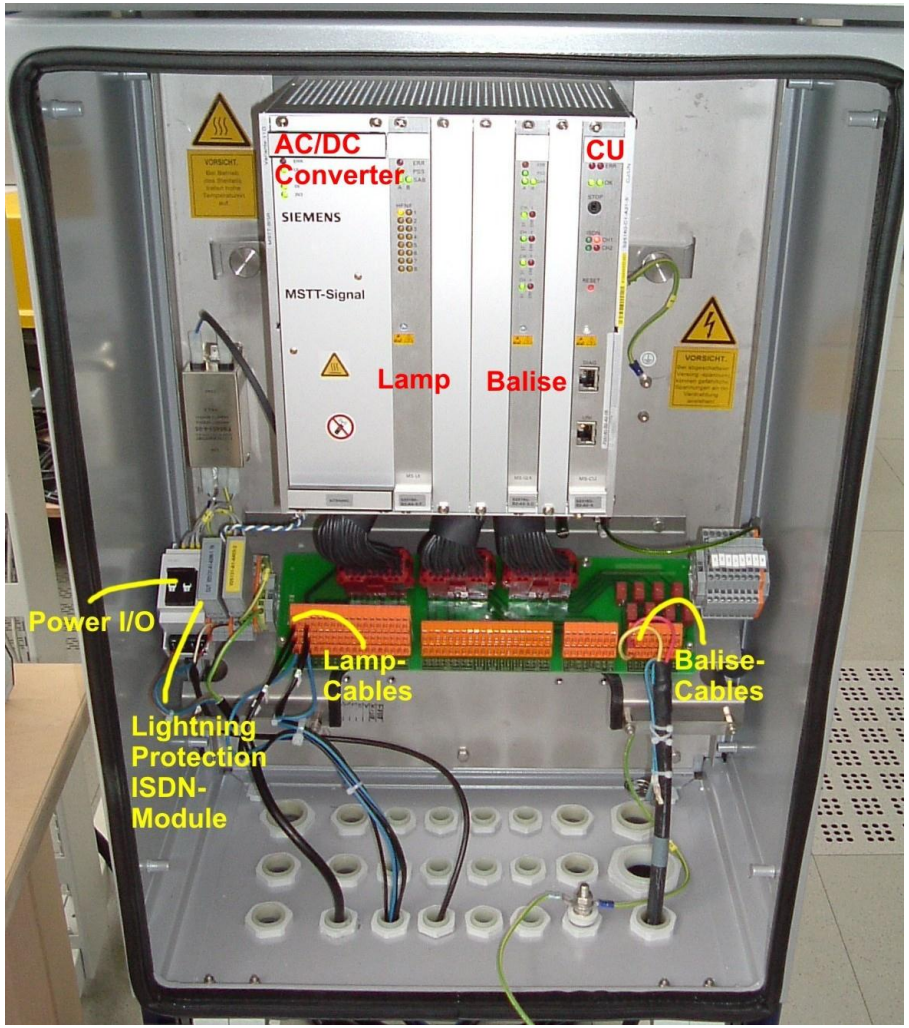
**ECC – Outdoor - Cabinet**

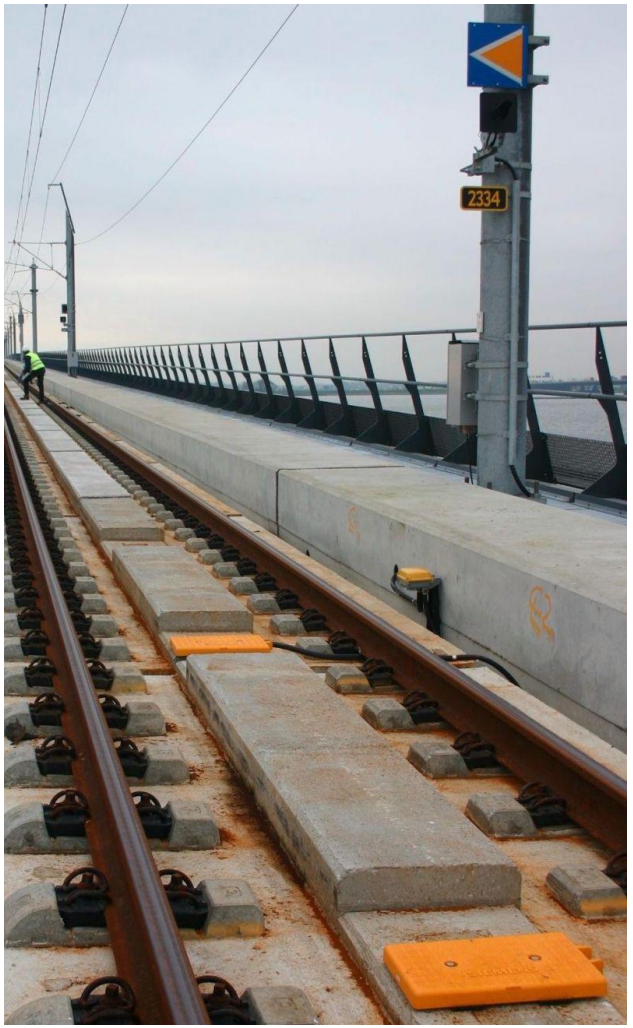
## 1.2 The Element Control Computer (ECC) used for decentralised Application,

### 1.2.2 - Small decentralised Units, MSTT- Signals, DSTT



## 1.2.2.1 Small decentralised Unit, MSTT- Signal, Netherlands, HSL-Zuid



## 2. Centralised / Decentralised Solutions

Old Matter of Dispute:

Interlocking Architecture:

- centralised,
- decentralised

– which one is the best Solution ?

## 2. Centralised / Decentralised Solutions

**Centralised:**

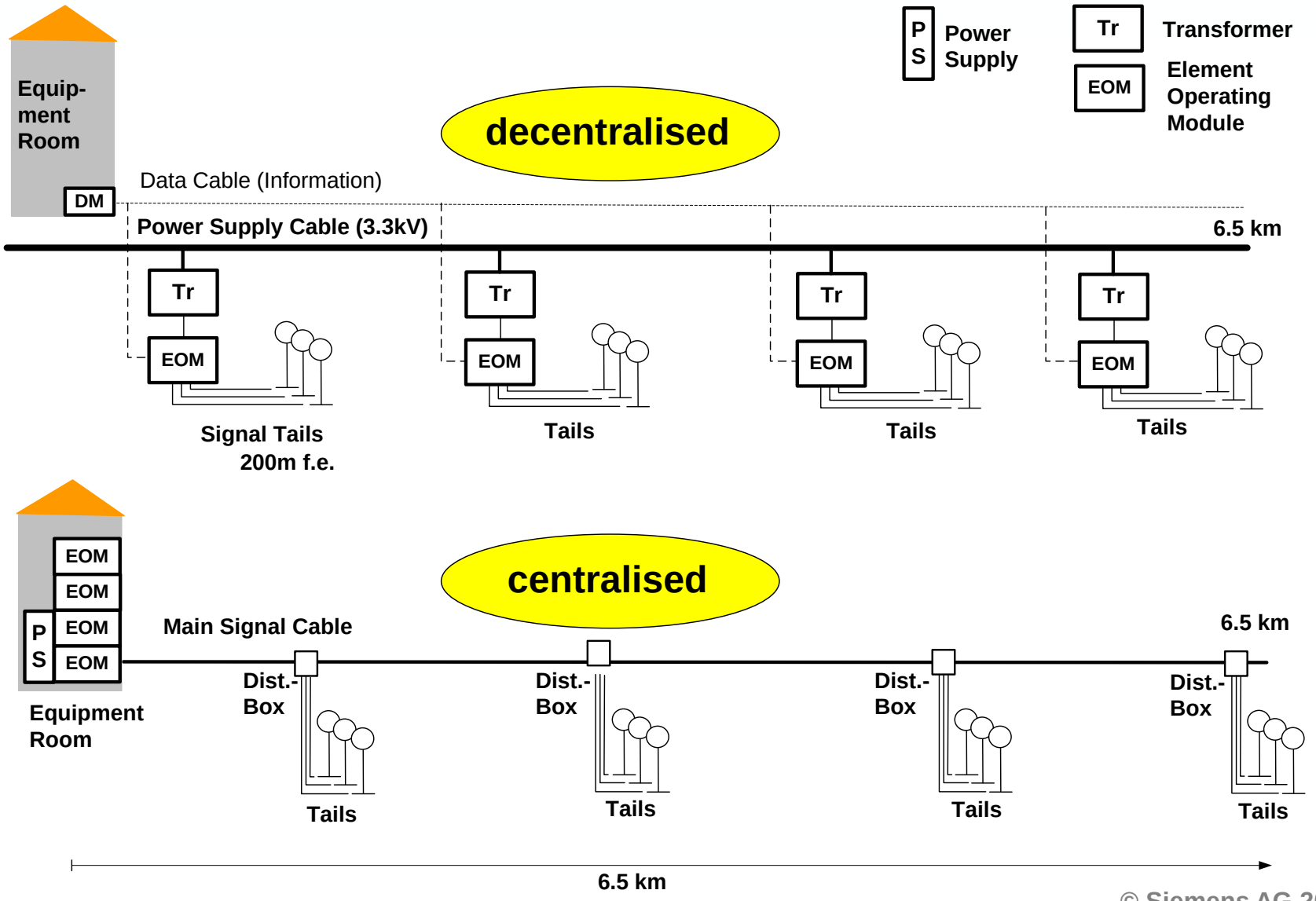
Germany, Austria, Netherlands, Saudi- Arabia

**Decentralised:**

Great Britain, Switzerland, Netherlands

-> Historical Reasons
-> Geographical Reasons
-> Environmental Conditions
-> Countries with sparsely meshed Power Supply

# 2. Centralised / Decentralised Solutions



# 2.1 Centralised / Decentralised Solutions

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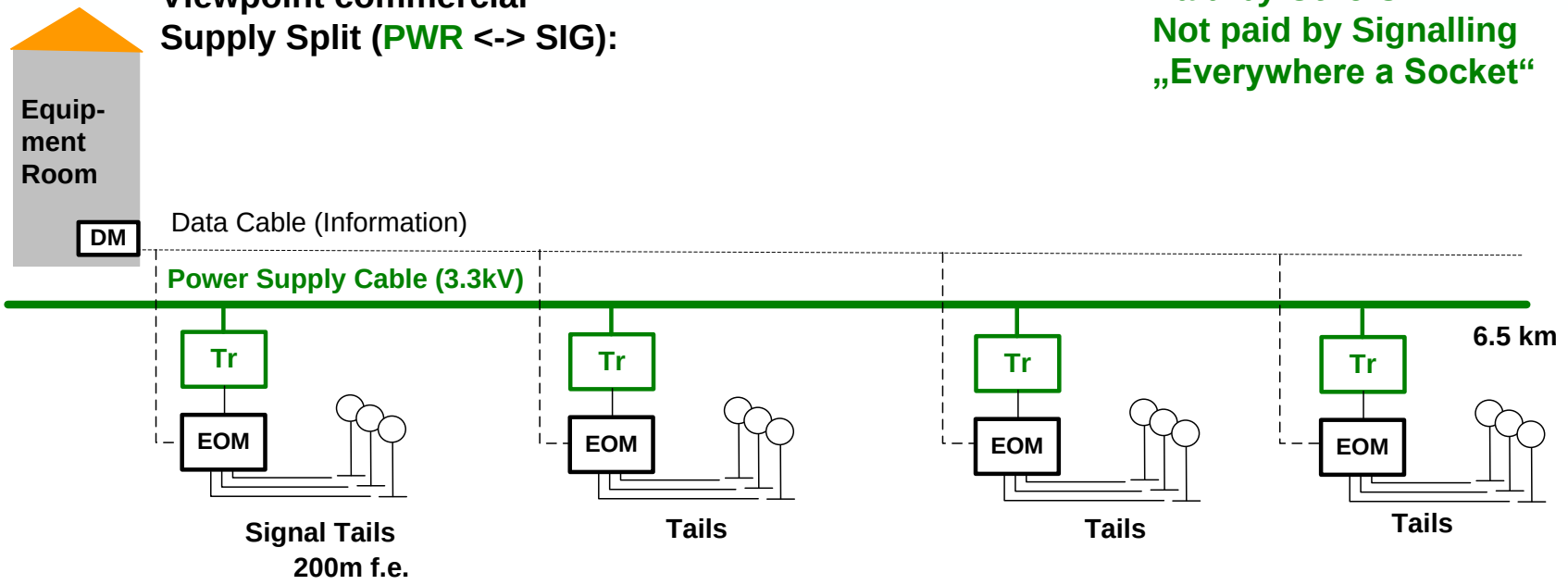
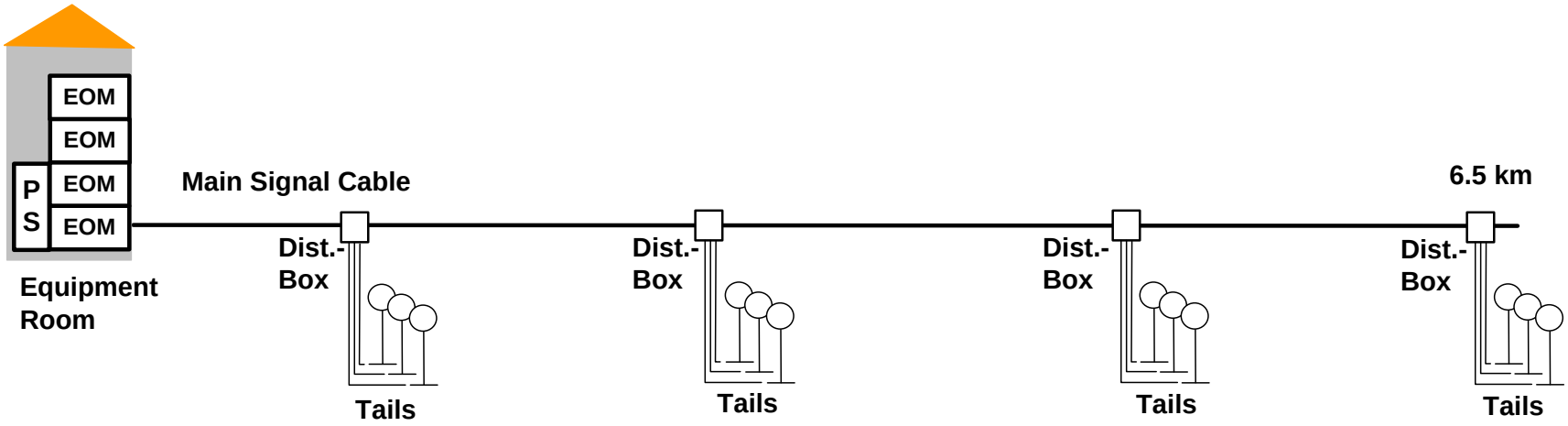
**Viewpoint commercial**
**Supply Split (PWR <-> SIG):**

**Paid by Others <=>**
**Not paid by Signalling**
**„Everywhere a Socket“**



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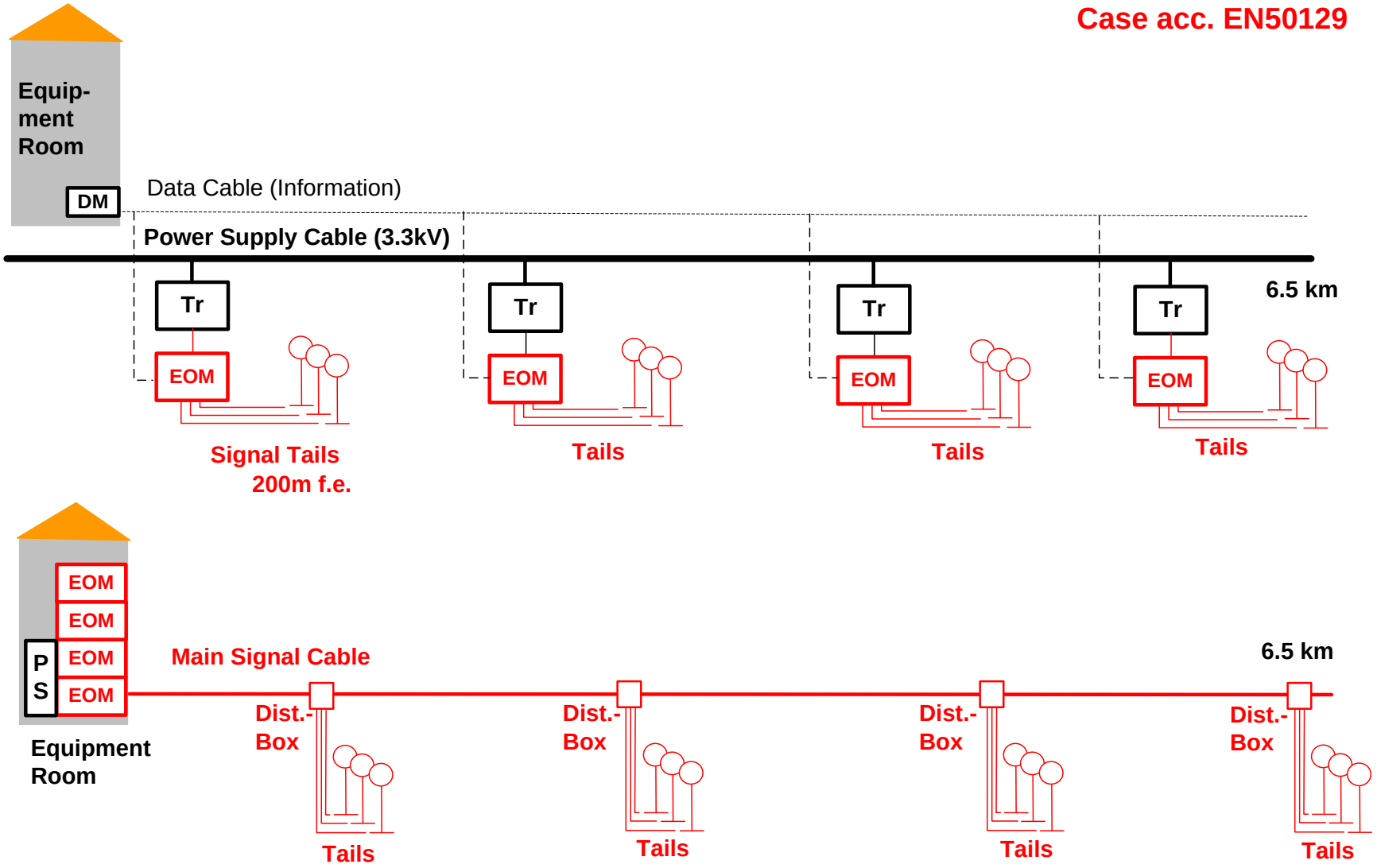
## Viewpoint HW - Safety Case (EN50129)

**To be considered within Safety Case acc. EN50129**



# 2.3 Centralised / Decentralised Solutions

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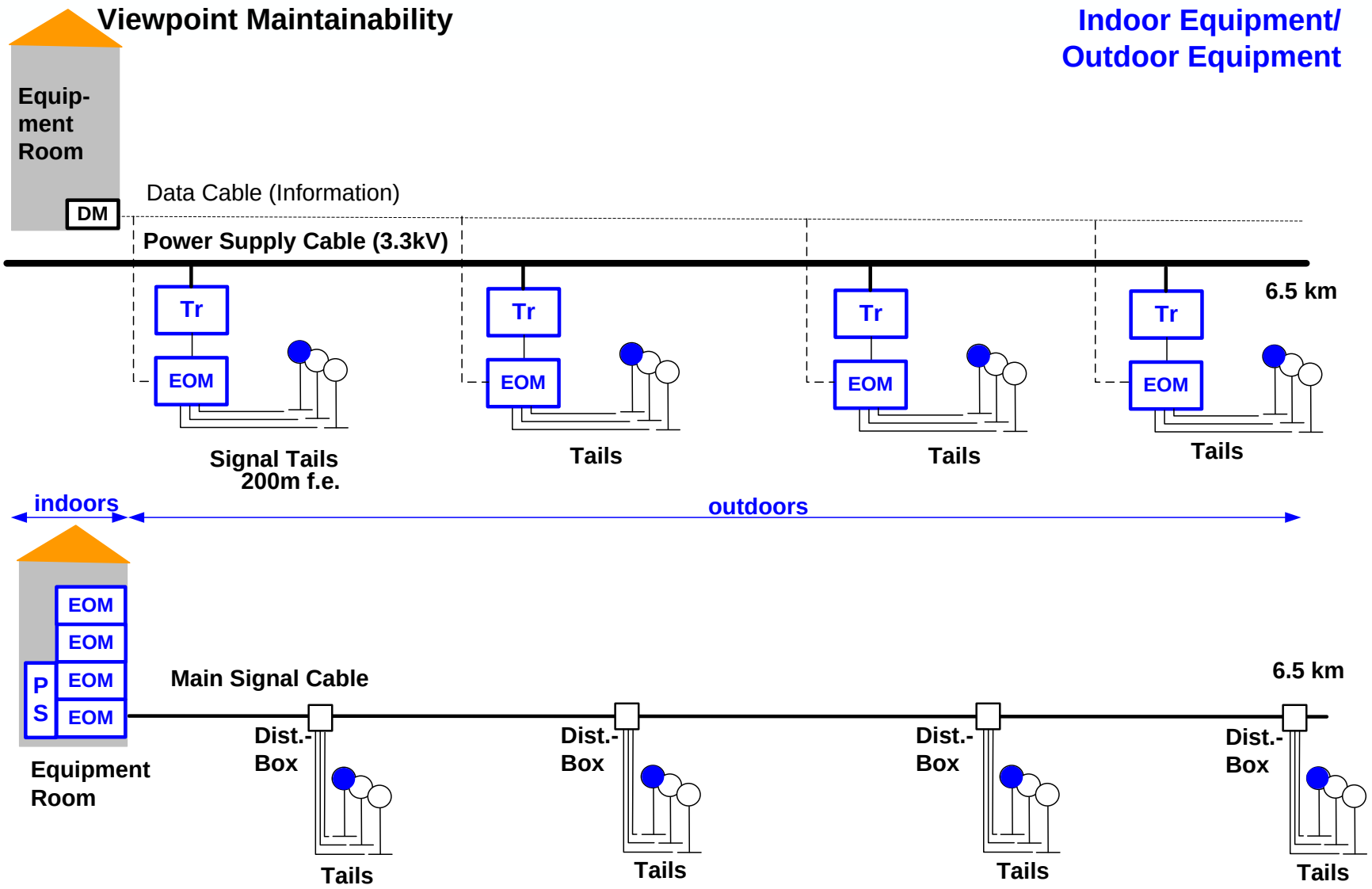

# 2.4 Centralised / Decentralised Solutions

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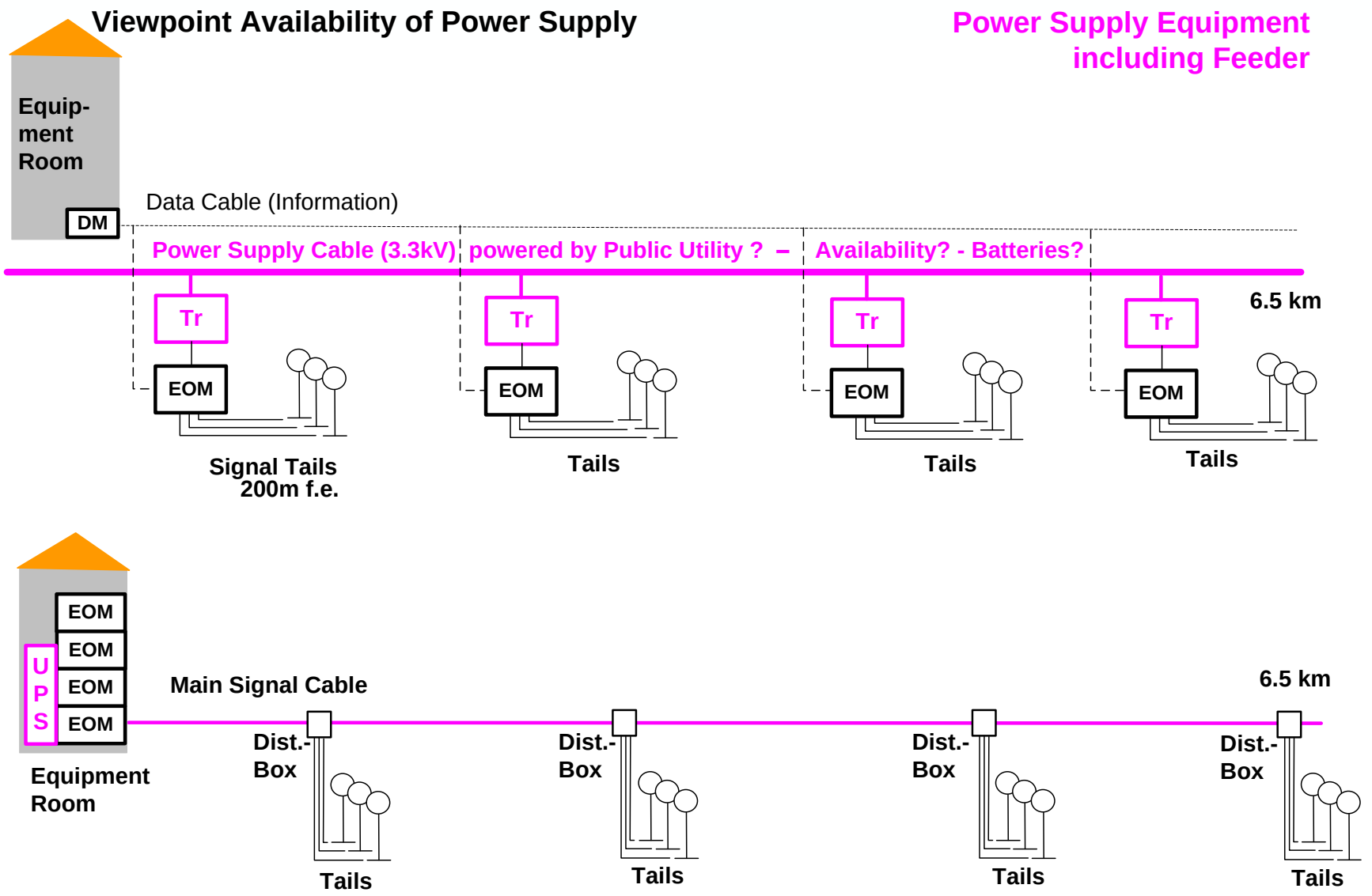

## 2. Centralised / Decentralised Solutions

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Old Matter of Dispute:

Interlocking Architecture:

- centralised,
- decentralised

– which one is the best Solution ?

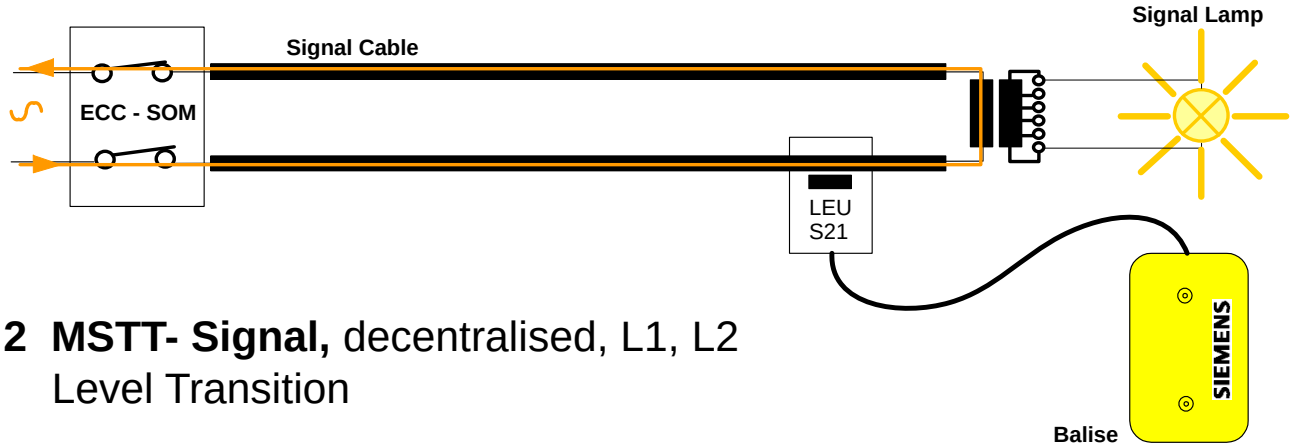
> No general answer possible, Customer and Supplier have to find out the solution which is the best for the relevant application

> Sometimes a combination of both is perfect !

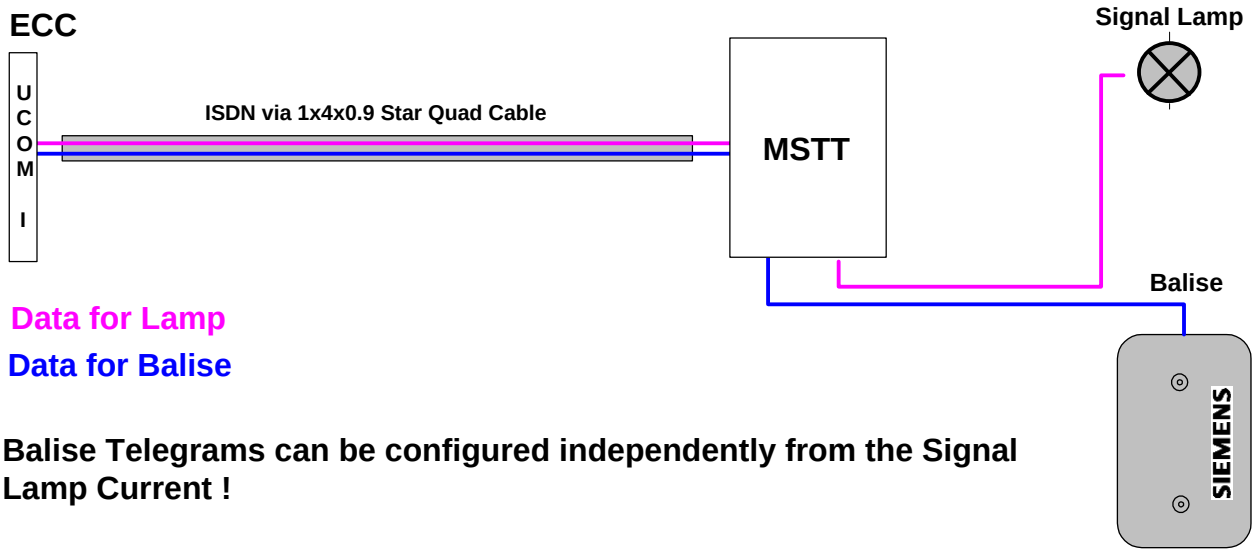
> **Both, centralised & decentralised architecture is possible, using the ECC by SIEMENS**

# 3. ETCS Equipment Interfaces

## 3. 1 LEU – S21, centralised and decentralised, L1




## 3. 2 MSTT- Signal, decentralised, L1, L2 Level Transition





**Balise Telegrams can be configured independently from the Signal Lamp Current !**

# 3. ETCS Equipment Interfaces, L2

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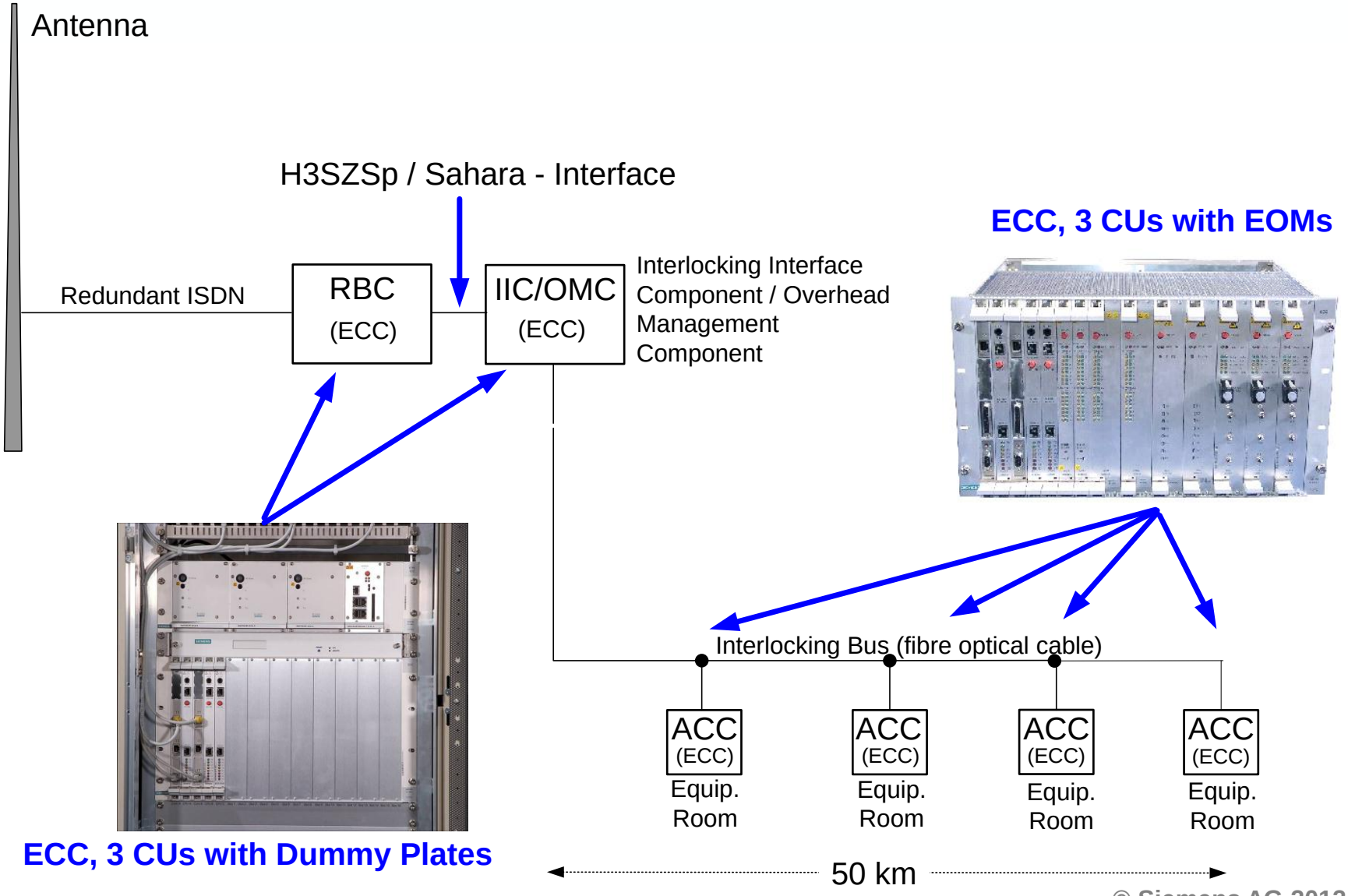

# 4. Safety Philosophy

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EUROPEAN STANDARD **EN 50129**

NORME EUROPÉENNE

EUROPÄISCHE NORM February 2003

ICS 93.100

Supersedes ENV 50129:1998
Incorporates corrigendum May 2010

English version

**Railway applications –**
**Communication, signalling and processing systems –**
**Safety related electronic systems for signalling**

Applications ferroviaires –
Systèmes de signalisation,
de télécommunications et de traitement -
Systèmes électroniques de sécurité
pour la signalisation

Bahnanwendungen -
Telekommunikationstechnik,
Signaltechnik und
Datenverarbeitungssysteme -
Sicherheitsrelevante elektronische
Systeme für Signaltechnik

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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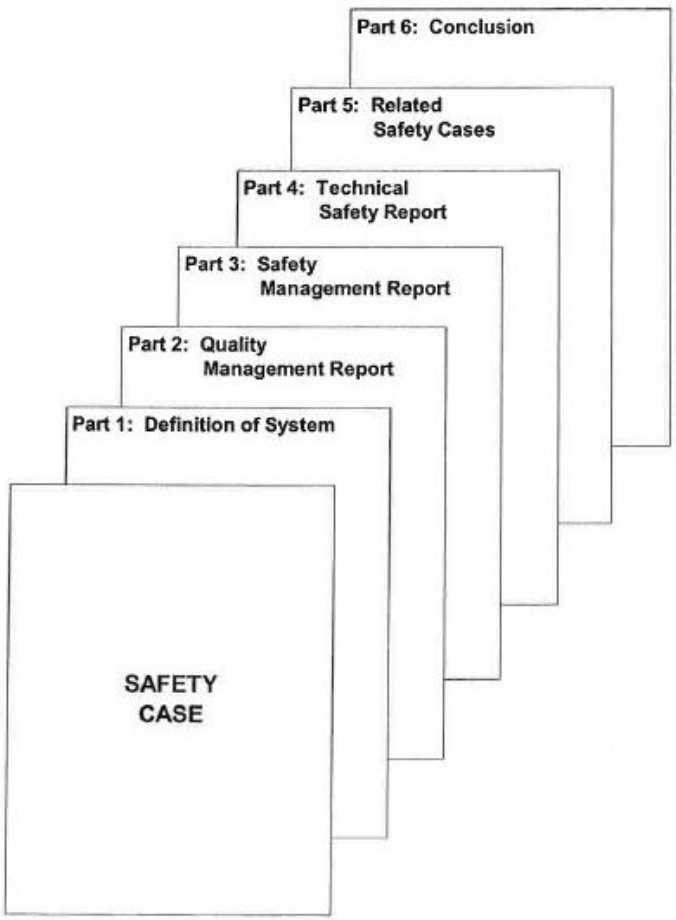
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

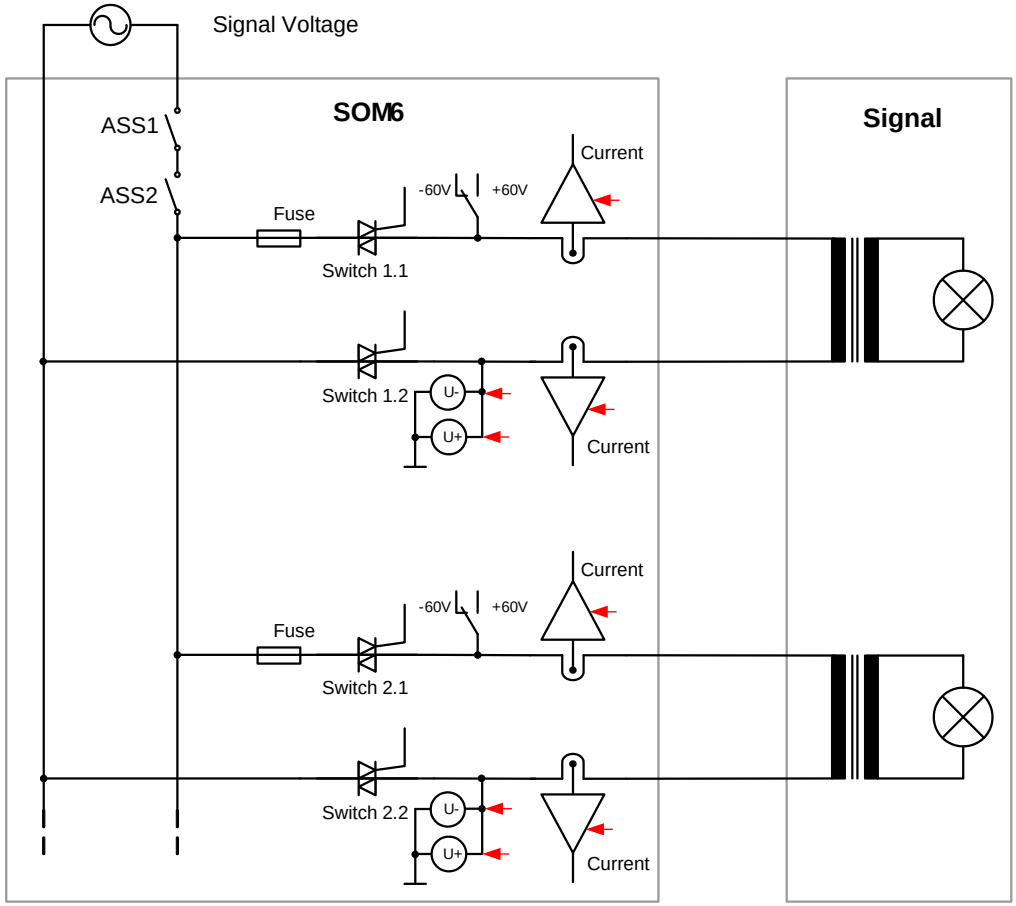
**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**



Ref. No. EN 50129:2003 E



# 4.2 How to obtain the sufficient HW- Safety- Level (SIL2 – SIL4)

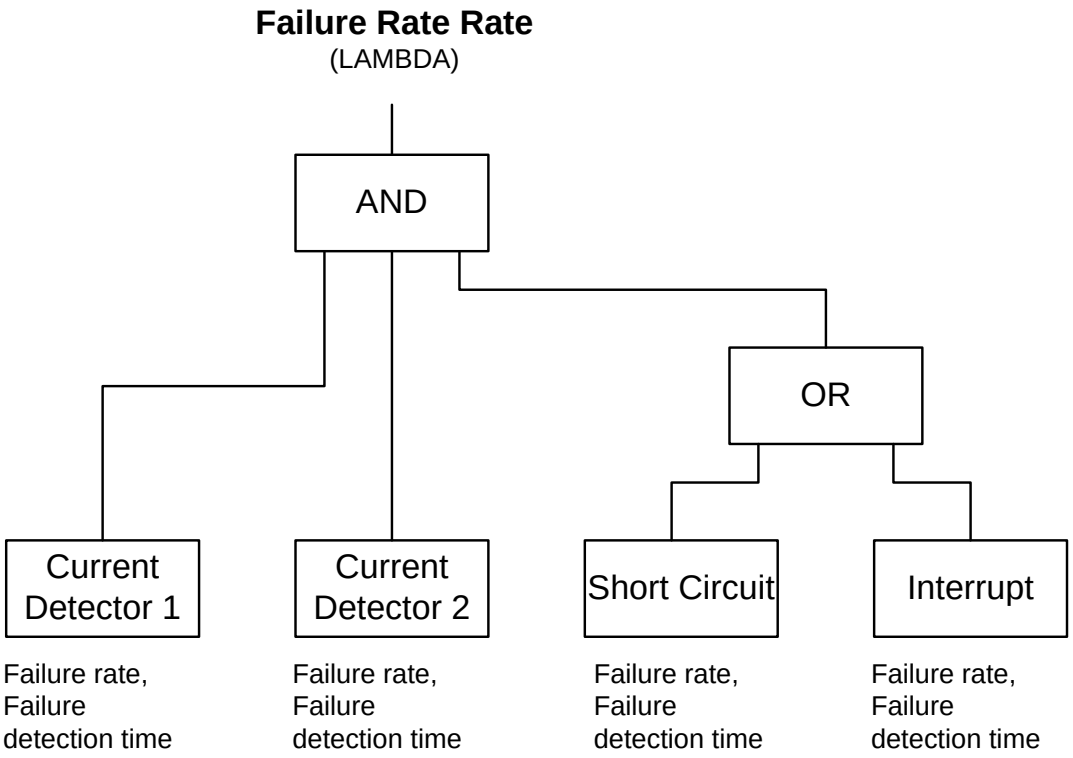



- Short Circuit Detection
  Loss of Insulation
  of the Signal Cable

- Current Detection
- Position Detection (for Points)
- Safety related functions are independently doubled (HW acc. EN50129)

- Safety related functions are checked within sufficient Fault Detection Time ← (SW acc. EN50128)
- Detected Errors may lead to Safety Shutdown (ASS1, ASS2, Red Error LED)
- High Availability, selective Shutdown Concept

# 4.3 Fault Tree Analysis – the Split of Safety Responsibility




- Fault Tree based Calculation
- Safety Case proves that Failure Rate is sufficient
- **Caution:** the resulting Endangering Rate depends not only on the EOM but also on the Outdoor Cabling!
- **Caution:** the resulting Endangering Rate depends not only on the EOM but also on the Adherence of the SAR!

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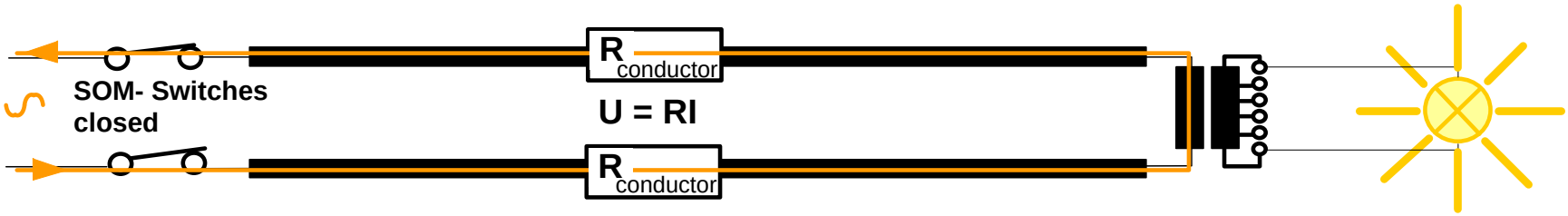
## 5.1 Control Distance limiting Effects, the Ohmic Resistance

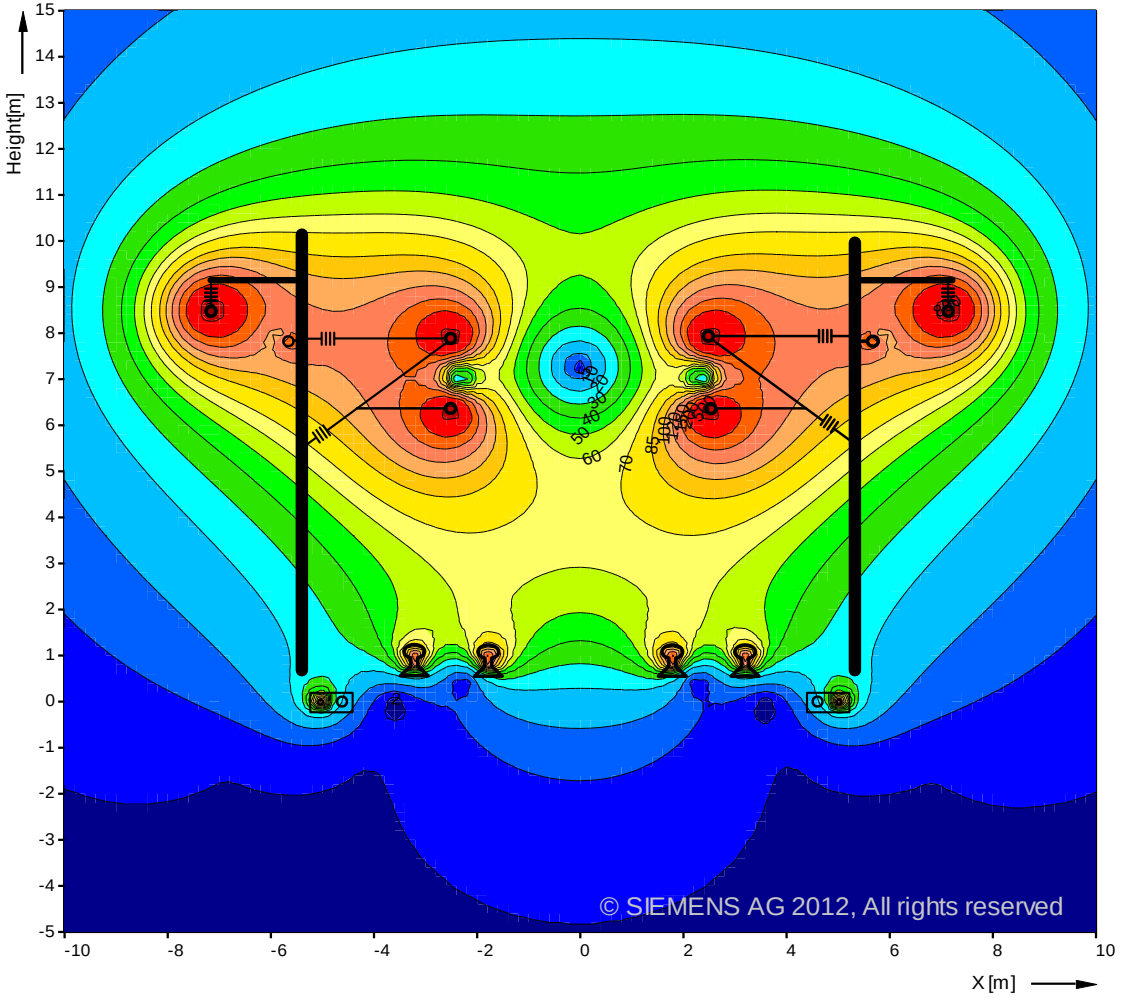



The secondary voltage must be adjustable at the taps of the lamp transformer

Lamp lights with correct brightness

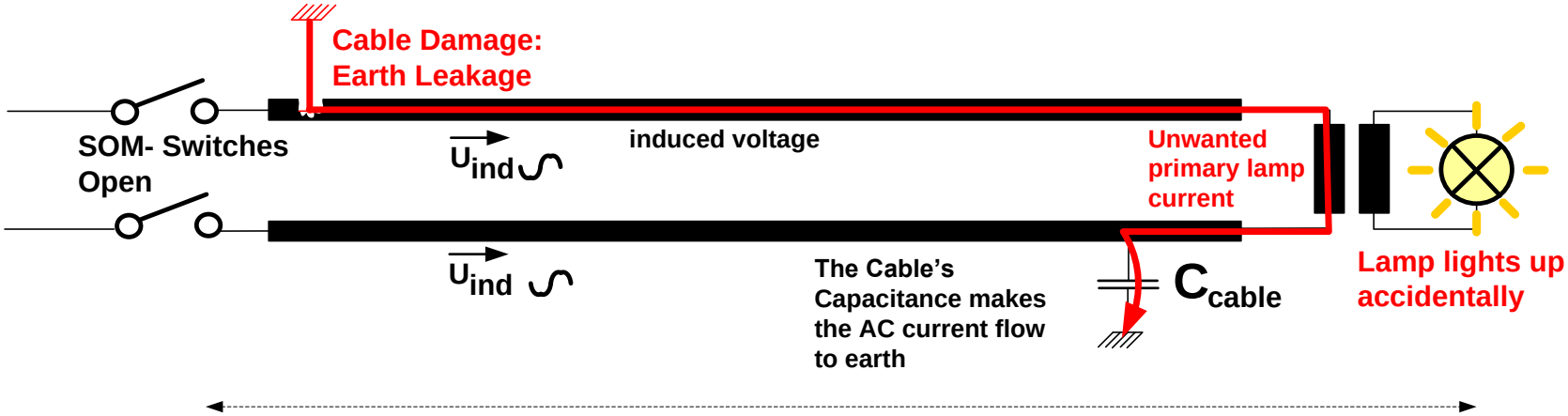
**Maximum control distance depends on the ohmic resistance of conductors up to 6.5km possible or even bigger**

# 5.2 EMC with AC Traction Power Systems (2 x 25 kV Catenary)

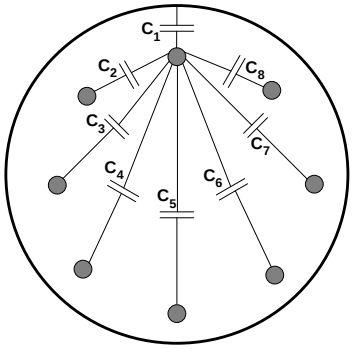


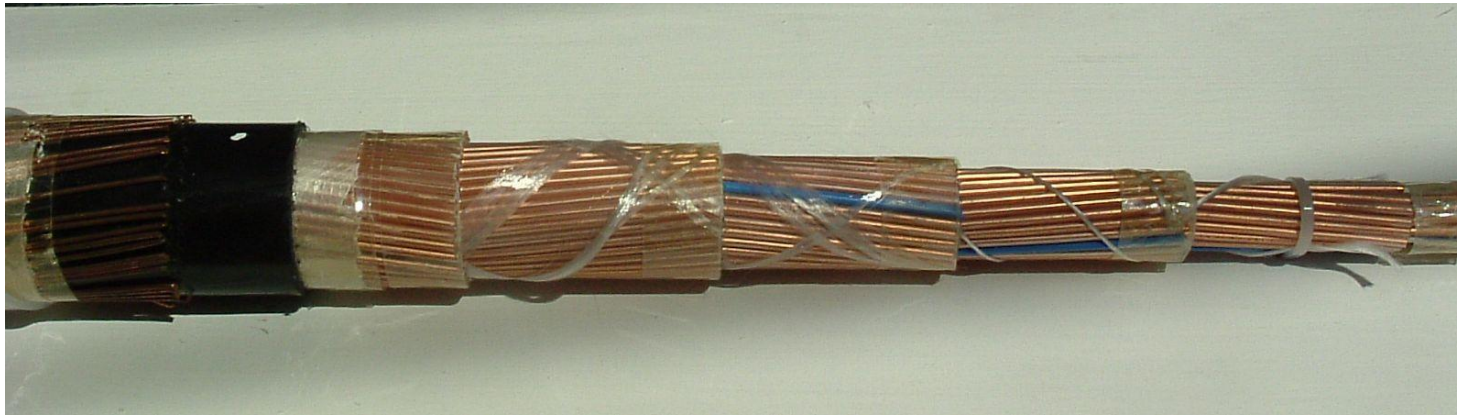

Magnetic Field of a 2 x 25 kV Catenary

## 5.2 Control Distance limiting Effects: The Cable‘s mutual Capacitance,
in Combination with Short Circuit to Earth and induced Voltage from Traction Power




**Maximum control distance depends on the cable’s mutual capacitance**
**up to 6.5km possible or even bigger**



Example of a core- stranded Railway Signal Cable with defined Mutual Capacitance

## 5.3 EMC with AC Traction Power Systems (Catenary)

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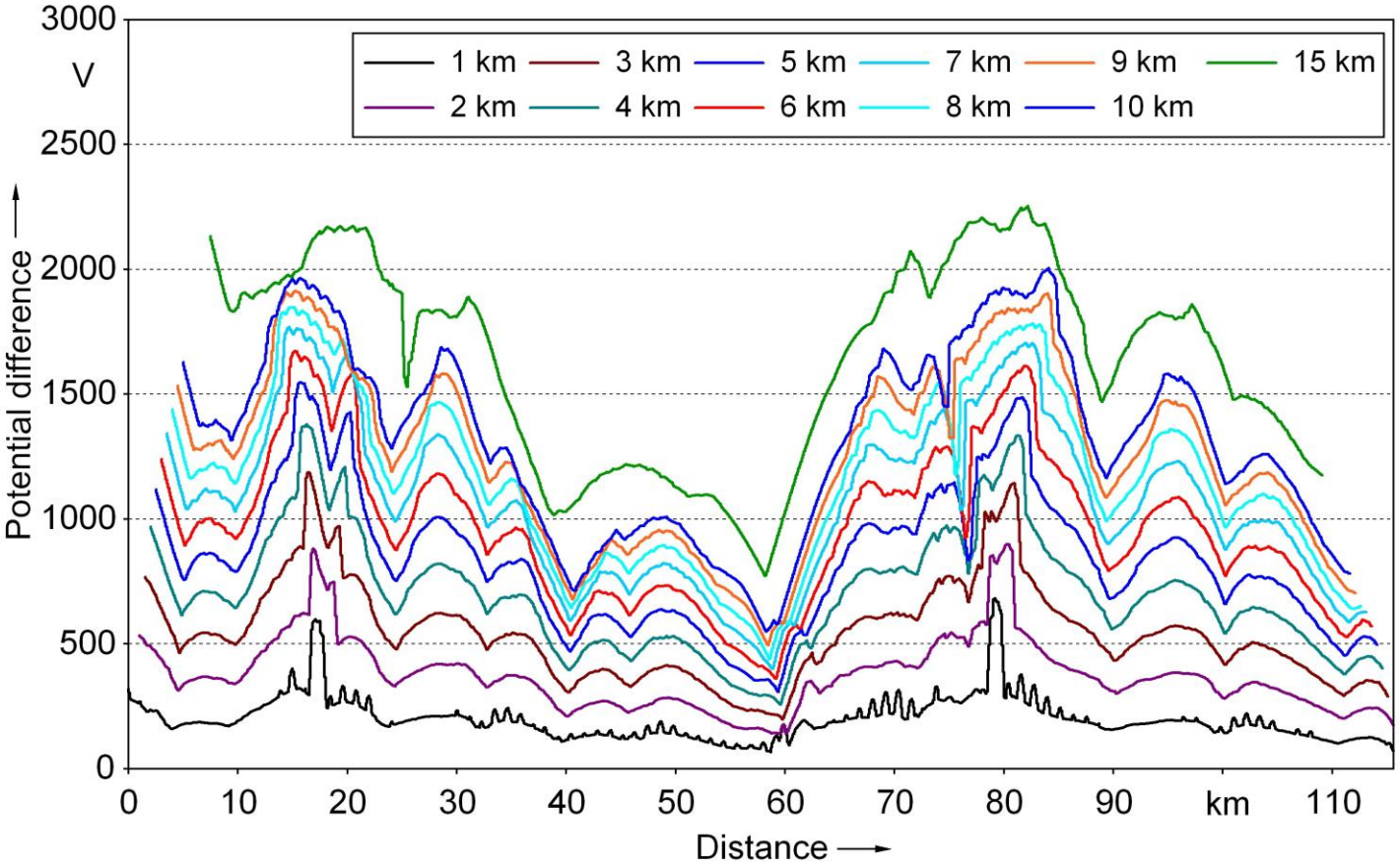
Dimensioning of Induction Protecton for Railway Signalling Cables by Sitras® Sidytrac :




Short term induced Voltage as a Consequence of Catenary Breakdown

# 6. Summary: Key Benefits of Electronic Interlocking

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**Technology**

- Precondition for forward-looking Train Control System as ETCS

**Economy**

- A minimum of space required
- Fast and easy testing with approved functional modules
- Pre-assembled Implementation in containers possible

**Availability**

- Highly reliable hardware design
- Very high availability with redundant hardware

**Maintenance**

- Reduced maintenance due to highly reliable hardware
- Effective maintenance due to diagnostic and maintenance systems for on-line and remote diagnosis

**Safety**

- Conformance to the CENELEC safety requirements
- EN50128/EN50129