# IEC TC9 WG43
# Train Real Time Data Protocol - TRDP

Dr.-Ing. Uwe Kucharzyk, Armin-Hagen Weiss

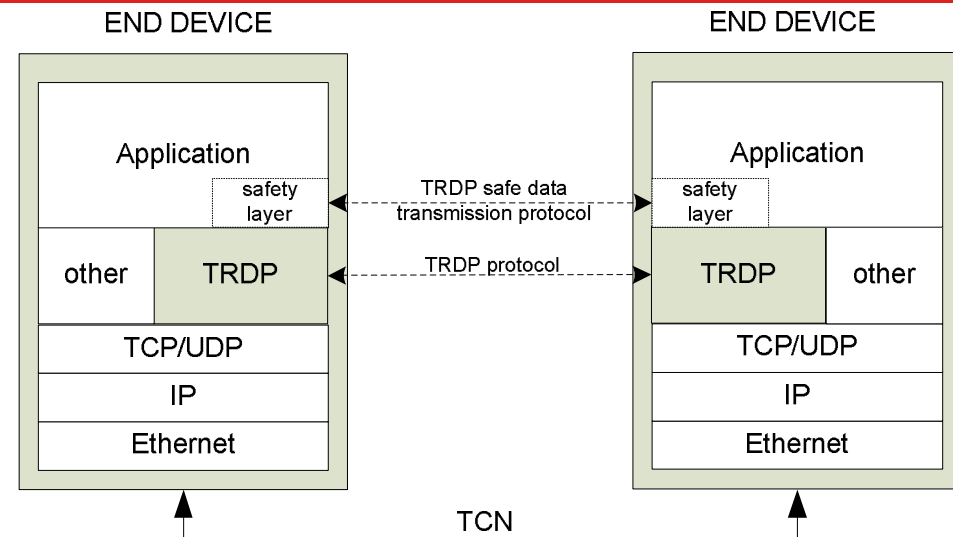CENELEC / ACRI Workshop, Prague, Oct. 20 – 21, 2011

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# Content

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- **Main characteristics**
- **Process Data**
- **Message Data**
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- **Conclusions**

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# Background

- **Increasing amount of requested services on-board for TIS**

- **Need for IP based real-time data protocol for railways supporting dynamic topology changes of train topology**

- **Base standard IP technology to use and connect off the shelf products**

- **TRDP definition fulfils functional requirements of Bombardier, Siemens, FAR Systems, TOSHIBA, MITSUBISHI, HITACHI and West Japan Rail.**

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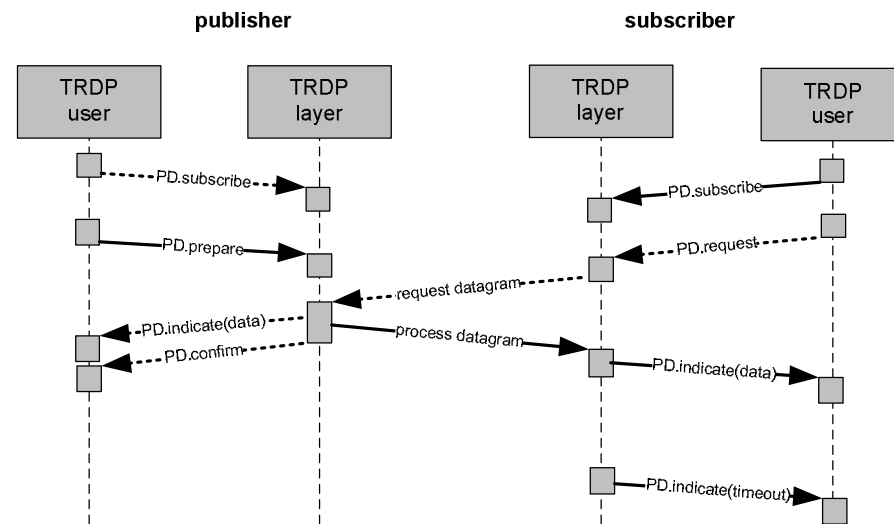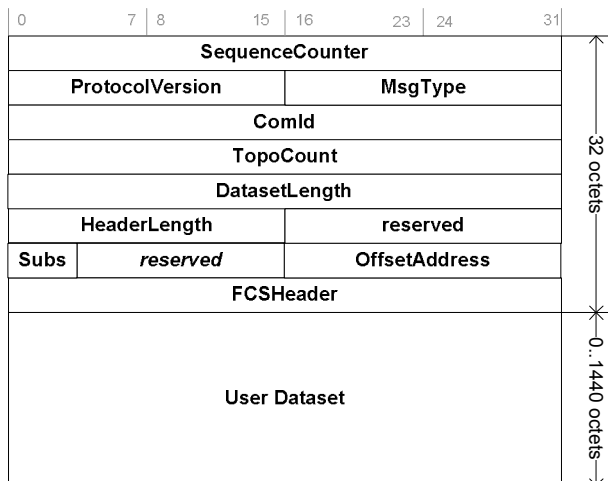
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# TRDP - Main Characteristics

- **Small footprint**

- **UDP based**

- **TCP MD possible**

- **Ladder topology support**

- **Optional SDT support**

- **Transparent redundancy support**

- **Trainwide PD and MD support**

- **Fully defined in IEC61375-2-3**

- **Open source**

- **Easy to implement**

- **Successor of IPTCom**

END DEVICE

END DEVICE

Application

safety layer

TRDP safe data transmission protocol

other TRDP

TRDP protocol

TCP/UDP

IP

Ethernet

Application

safety layer

TRDP other

TCP/UDP

IP

Ethernet

TCN

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# TRDP Process Data – Main Characteristics

- **sent with UDP**

- **restricted to the size of one Ethernet frame**

- **Uses IEC reserved TRDP PD port number**

- **Not acknowledged**

- **Cycle times  >= 1ms**

- **Push (__) and pull (__ , …) pattern support  (pull new)**

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# TRDP Process Data - Patterns

- **Push pattern**
  - point to point (sink known)
  - point to multipoint (sink known - group address)
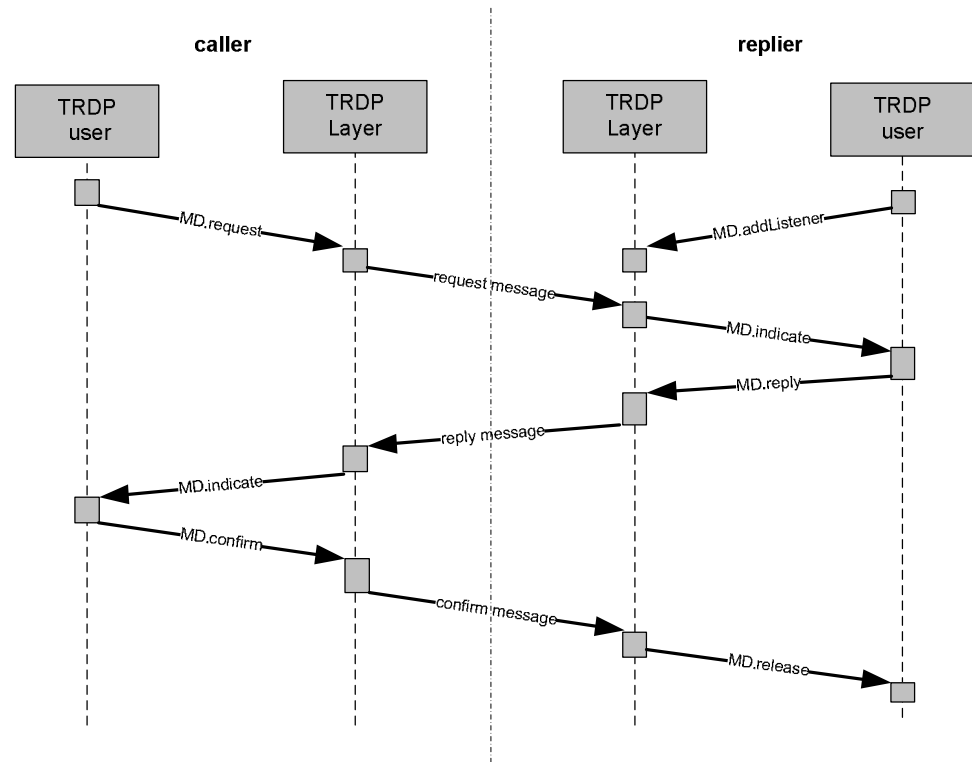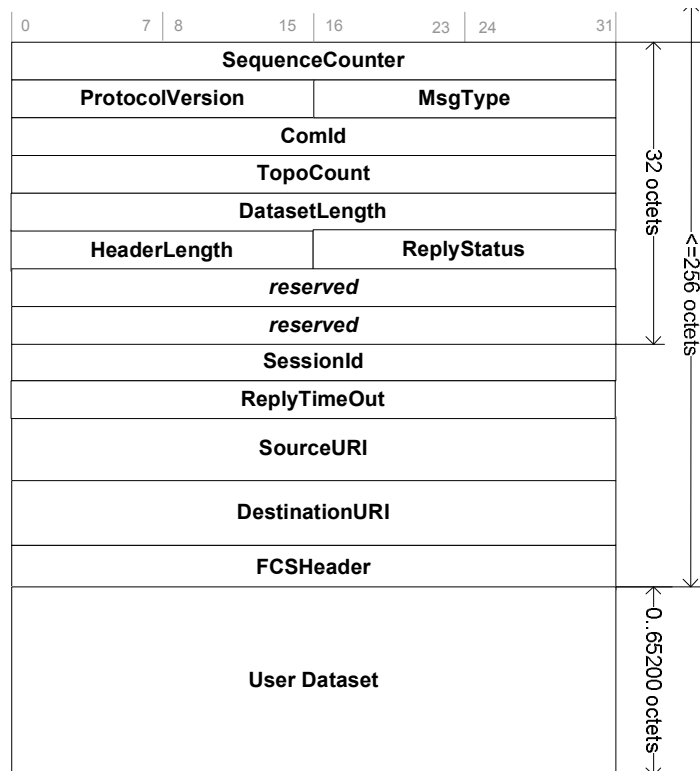  - point to multipoint (sink unknown)
- **Pull pattern**
  - point to point (source known)
  - point to point (source unknown)
  - Point to multipoint (source known)
  - Point to multipoint (source unknown)

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# TRDP Message Data – Main Characteristics

- **may be sent with UDP or with TCP. The choice shall be done by the user when the message data transfer is invoked.**

- **Max user data length**
  - UDP: 65200 bytes
  - TCP: $2^{32}$- (256+TCPOverhead) bytes (new)

- **Uses IEC reserved port number for TRDP MD**

- **No retransmission but confirm (new)**

- **Communication types**
  - Notification (only request)
  - Request – Reply
  - Request – Reply – Confirm (new in comparison to IPTCom) (new)

- **Push and pull pattern support**

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# TRDP Message Data - Protocol

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# TRDP Message Data - Patterns
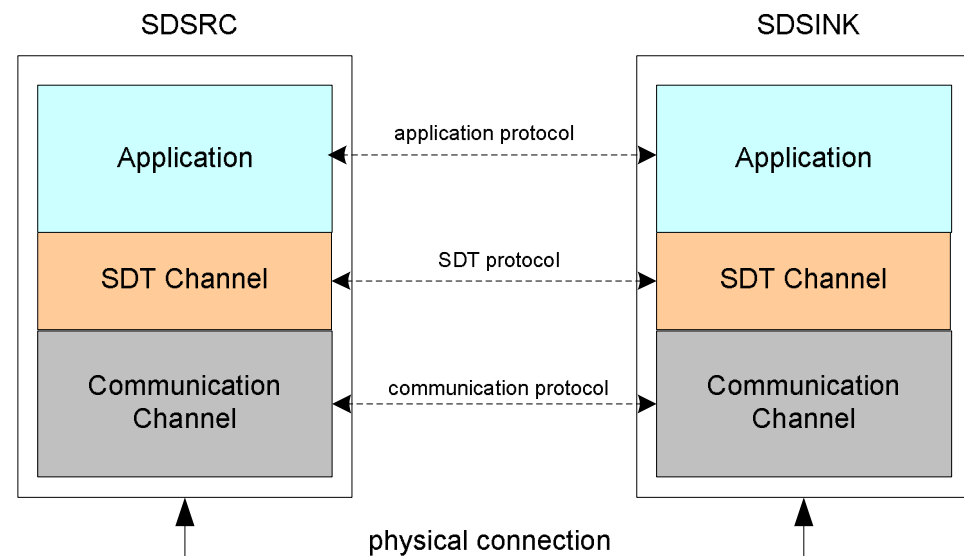
- ## Push pattern
  - point to point , sporadic with acknowledge, source knows the sink
  - point to point , sporadic without acknowledge, source knows the sink
  - point to multipoint, sporadic with acknowledge, source knows the sink
  - point to multipoint, sporadic without acknowledge, source knows the sink
  - point to multipoint, sporadic with acknowledge, source does not know the sink
  - point to multipoint, sporadic without acknowledge, source does not know the sink
- ## Pull pattern
  - point to point , sporadic with acknowledge, sink knows the source
  - point to point , sporadic without acknowledge, sink knows the source
  - point to multipoint, sporadic with acknowledge, sink knows the source
  - point to multipoint, sporadic without acknowledge, sink knows the source
  - point to multipoint, sporadic on first acknowledge, sink does not know the source
  - point to multipoint, sporadic without acknowledge, sink does not know the source

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# TRDP Safe Data Transmission - Basics

- **SDT supports the transmission of safety related data between a safe data source (SDSRC) and one or many safe data sinks (SDSINK)**

- **SDT is an end-to-end protocol over an untrusted communication channel (grey channel)**

- **The SDT layer provides two interfaces**

  – Application interface

  – Protocol interface

| SDSRC | | SDSINK |
|---|---|---|
| Application | ← application protocol → | Application |
| SDT Channel | ← SDT protocol → | SDT Channel |
| Communication Channel | ← communication protocol → | Communication Channel |

physical connection

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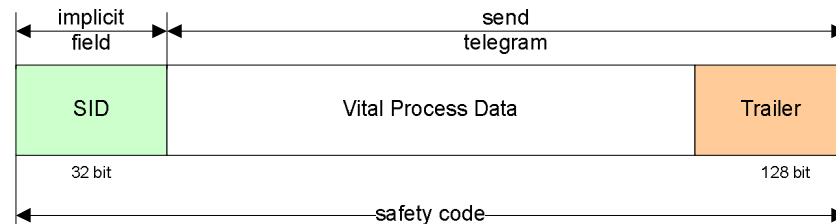
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# TRDP Safe Data Transmission – VPD Telegram

## Safety is proven by

- Safety code check
- Protocol version check
- Sequence check
- Guard time violation check
- Latency monitoring check
- User data version check
- Channel monitoring check

## SID content:
Safety Message Identifier (SMI)
SDT Protocol Version (SDTProtVers)
Unique Consist Identifier (ConsistId)
Safe Topography Counter (STC)

| implicit field | send telegram |
|---|---|
| SID (32 bit) | Vital Process Data | Trailer (128 bit) |

safety code

## Trailer content:
User Data Version
Safe Sequence Counter
Safety Code (32 bit CRC)

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# IP Network use for TCMS in BT projects

- **Start development:** 2006

- **Start project use:** 2008

- **Now more than 20 projects world wide are using ECN/ETB for TCMS**

- **IPTCom open source licenses were granted to 50 companies**

- **Until now in total**
  **~ 5.100 intelligent switches (12- and 8-port ring switches and train switches)**
  **have been used in the TCMS network of BT projects →**
  **~ 30 000 ED connected**

- **yearly about 3300**
  **intelligent switches**
  **to be delivered**
  **to the vehicle projects**
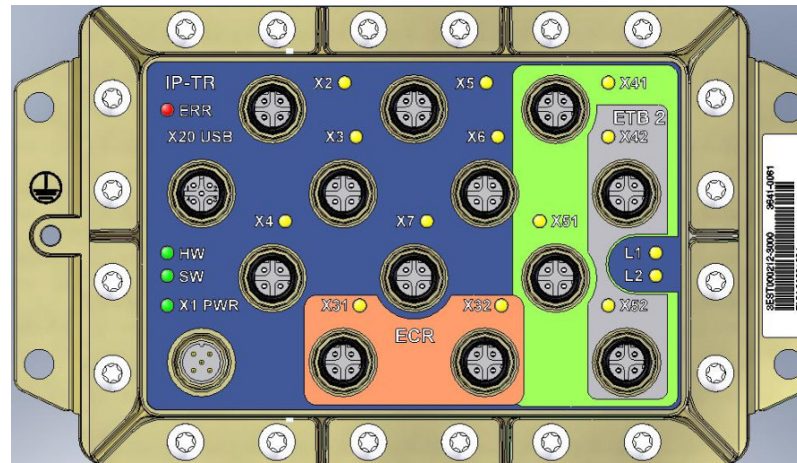


**front view of a train switch**

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# IP Network Operating Experience – Major IPTCom Projects

| In service | ECN | ETB | consists | switches/consist |
|---|---|---|---|---|
| Chicago (CTA)* (1 year 8 cars) | x | x | 4 | 4 |
| Dehli Metro 2 | x | x | 40 | 14 |
| NAT (SNCF) | x | x | 172 | 18 |
| SLT (NS) | x | - | 134 | 6-8 |
| SSL (London Underground) | x | x | 190 | 9-10 |
| BR 422       (DB) | x | - | 84 | 6 |
| Toronto Rocket (TTC) | x | - | 70 | 10 |
| **In commissioning** | | | | |
| Chicago (CTA) (serial delivery) | x | x | 353 | 4 |
| TALENT (DB) | x | (x) | 321 | 4-8 |
| DT5 Hamburg (HH) | x | x | 27 | 6 |
| Singapore (SDTL) | x | - | 219 | 8 |
| **Under development** | | | | |
| ZEFIRO Italy | x | x | 50 | 19 |
| Regio2N (SNCF) | x | x | 129 | 18-22 |
| TWINDEXX (SBB) | x | x | 59 | 12 |
| DO 2010 (DB) | x | x | 27 | 14 |
| BR430 Stuttgart (DB) | x | x | 83 | 6 |
| Metro Montreal | x | - | 60 | 18 |

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# NAT / SNCF

- **Order: 2007**
- **172  7 and 8-car trains**
- **In revenue service**



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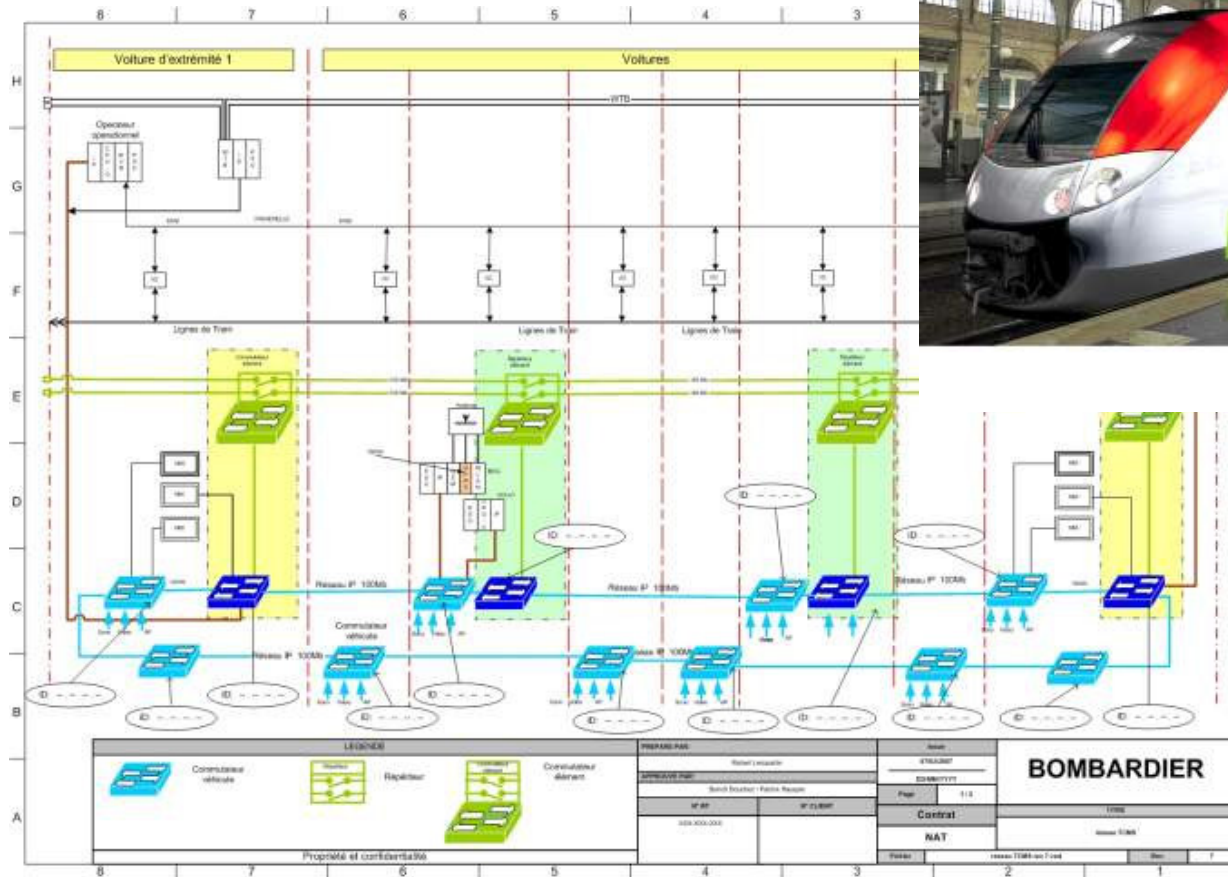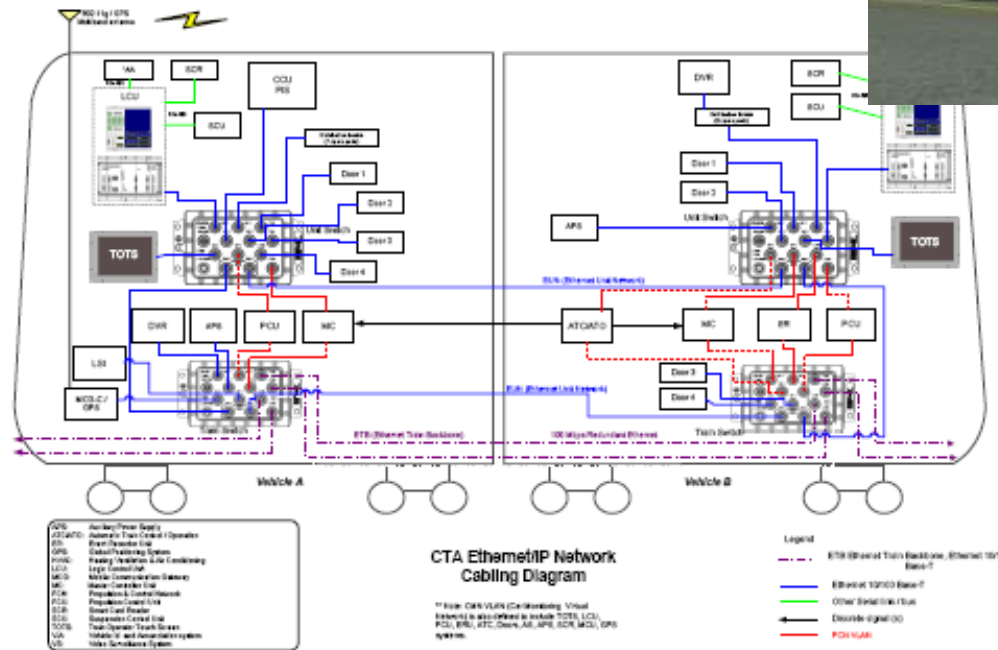
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# Chicago Transit Authorities / U.S.A.

- **Order July 2006**
- **353 * 2-car units**
- **2009-10  8 cars in revenue operation**
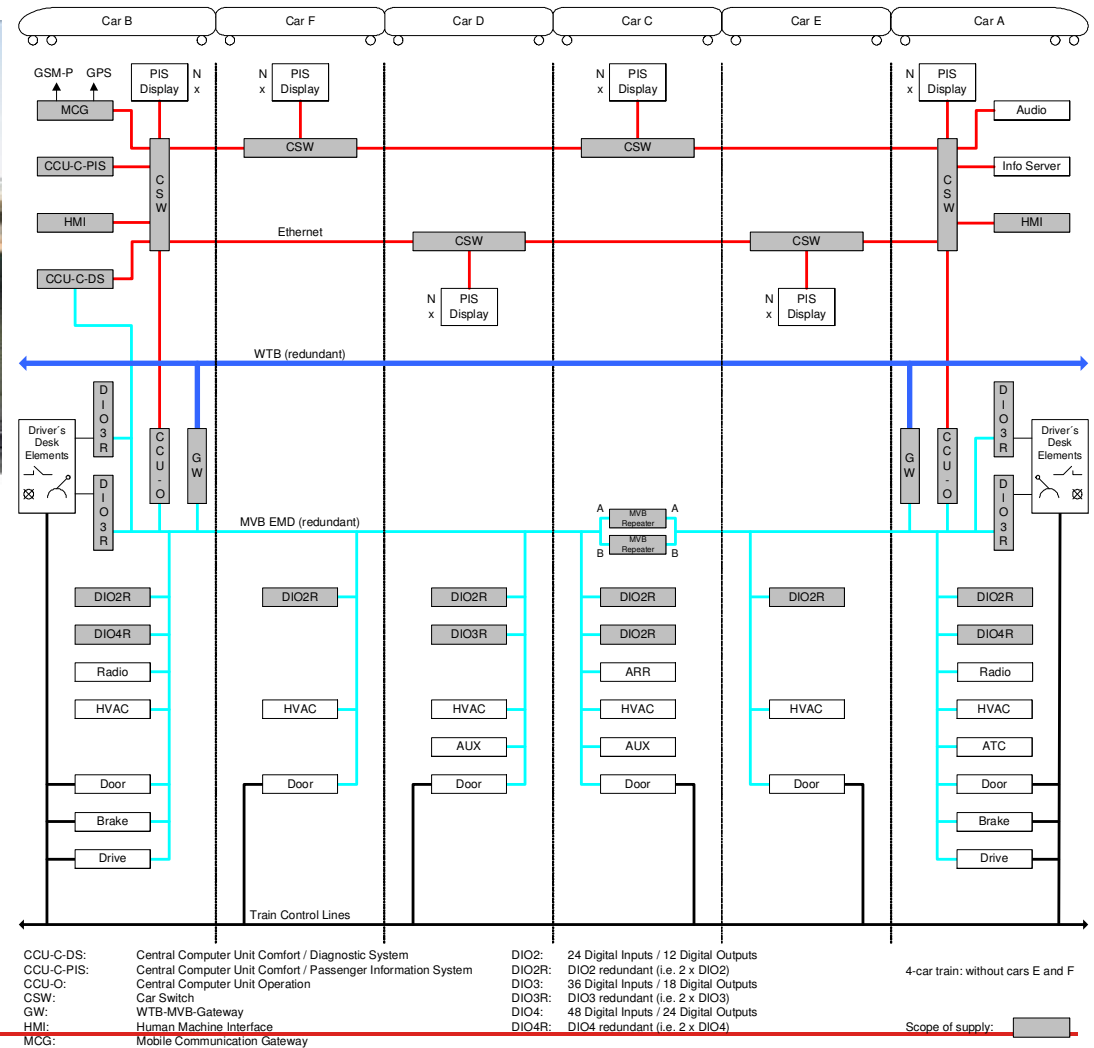- **2011 start of serial delivery**



CTA Ethernet/IP Network Cabling Diagram

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# Sprinter Lighttrain / NS Reizigers



- **Order: 2005 / 2007**
- **134  4 and 6-car units**
- **In revenue service**

| | | | | | |
|---|---|---|---|---|---|
| CCU-C-DS: | Central Computer Unit Comfort / Diagnostic System | | DIO2: | 24 Digital Inputs / 12 Digital Outputs | |
| CCU-C-PIS: | Central Computer Unit Comfort / Passenger Information System | | DIO2R: | DIO2 redundant (i.e. 2 x DIO2) | |
| CCU-O: | Central Computer Unit Operation | | DIO3: | 36 Digital Inputs / 18 Digital Outputs | |
| CSW: | Car Switch | | DIO3R: | DIO3 redundant (i.e. 2 x DIO3) | |
| GW: | WTB-MVB-Gateway | | DIO4: | 48 Digital Inputs / 24 Digital Outputs | |
| HMI: | Human Machine Interface | | DIO4R: | DIO4 redundant (i.e. 2 x DIO4) | |
| MCG: | Mobile Communication Gateway | | | | |

4-car train: without cars E and F

Scope of supply:

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# SSL / London Underground

- **58 * 8-car trains, 133 * 7-car trains**

- **Delivery:**

  - Pre-Series Q1 2009

  - Series Q2 2010

  - 42 trains in revenue service

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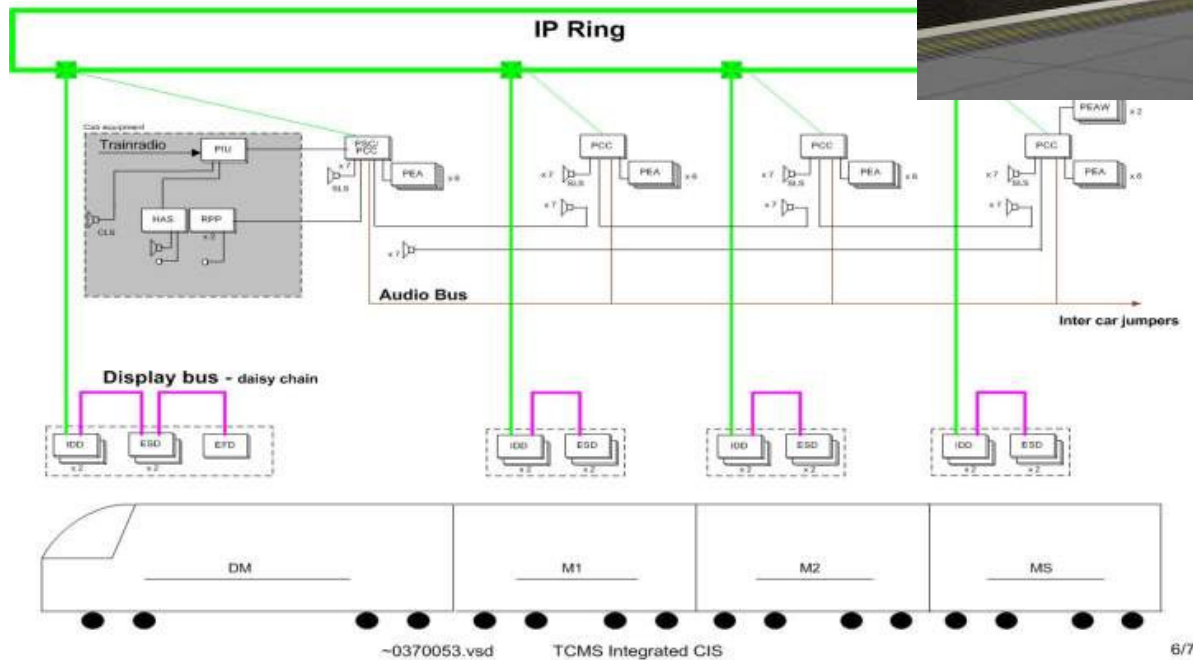
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# Toronto (TTC) Rocket

- **70 Metros, 6-car consist**
- **First trains in service**
- **Along with CTA, first BT project with propulsion commands through IP**
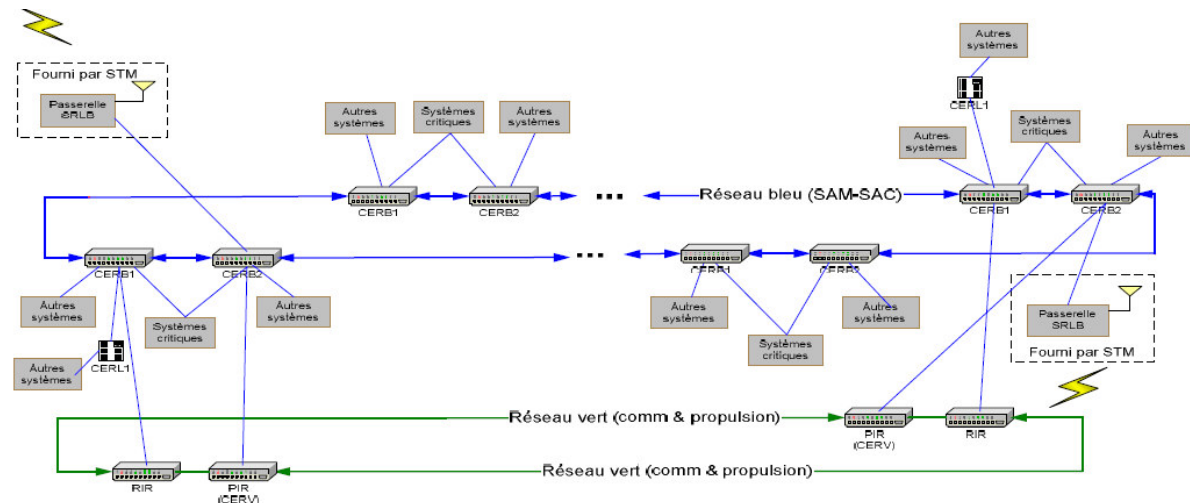- **no WTB or Trainlines for propulsion**

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# Metro Montreal

- **52 Metros, 9-car consist**
- **Consortium Alstom Transport and Bombardier Transportation**
- **Contract: 2010**
- **Prototype: 2013**
- **Serial delivery 2014 - 2018**

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# Conclusions

- **TRDP based on standard IP-technology**

- **Considers railway specific requirements of WG43**

- **Supports dynamic train configuration**

- **Implements safe data transmission**

- **Predecessor implementation is proven in use**

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# Thank you for your attention

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