XTran for Metro Lightrail and Mainline Railways
Metro and Railway applications

**Supporting Infrastructure**

**SAFETY and SECURITY**
- Fire detection
- Video Protection
- Emergency Communications
- Access Control

**OPERATIONS**
- Signalling
- Control Room
- Dispatching
- SCADA
- Unified Communications
- ERTMS
- Telephony
- Traction Power

**PASSENGER EXPERIENCE**
- E-Ticketing
- Contact Center
- Public Announcements
- Railway Apps for Smartphones
- Passenger Information Systems
Domains of Communications

- Interlockings and Rail Signalling
- Level Crossings
- Stations
- SCADA Supervisory & Data Acquisition centre
- GSM-R
- Traction Power
Interlockings and Rail Signalling

O&D  
Operation & Display

IIC/OMC  
Interlocking & Interface Component  
Overhead Interlocking Functions

ACC  
Area Control Component

SDH/SONET

PROFIBUS  ➔  Ethernet

IL BUS (Interlocking bus)  ➔  Ethernet

GSM-R  
Voice & Data

Dispatching

CAN BUS  
(to outside equipment)  ➔  Ethernet ...

Ethernet
Level Crossings

O&D
Operation & Display

IIC/OMC
Interlocking & Interface Component
Overhead Interlocking Functions

PROFIBUS → Ethernet

IL BUS (Interlocking bus) → Ethernet

ACC
Area Control Component

CAN BUS (to outside equipment) → Ethernet...
Stations and their surroundings

- SDH/SONET
- Public WLAN
- Private WLAN
- Fixed line Telephony
- Ticket Vending
- Telephony Server
- PIS Passenger Information System
- PA Public Address
- Signalling domain
- Security
- LAN
- Stations and their surroundings

OTN Systems
Committed to getting your information across

© OTN Systems NV - Company confidential
GSM-R Backhaul

1+1 protection

E1/T1 Loop Protection

PDH or SDH/SONET -> ?

Interleaved BTS with Loop Multidrop connection

GPRS for data -> ETCS 2

GSM for Voice
The latest smart-grid technology allows continuous intelligent integration of public power supply networks and traction power grids.
What transmission solution fits best for Networked Communications?

- Increasing Bandwidth needed
- Increasing flexibility needed
- PtP/PtMP
- O&D
- Predictable
- High Availability
- Protected against attacks
- Interlockings
- Controlled Jitter & Delay
- Support for Legacy I/F
- Outside equipment increasingly with Ethernet I/F
- Level Crossings
- SCADA
- IP Based
- SDH is aging technology
- Stations
- Increasing volumes of Packet Data
- Clock distribution & Synchro
- GSM-R
- Increasing Packet Data
- Sub 50ms network restoration time
- Packet data network needed
- Harsh conditions
- Traction Power

OTN Systems
Committed to get your information across
Similar to the Carrier world

Access
- Very High # of sites
- Diversity of connection options
- Harsh environment
- Safety

Metro / Transport
- High number of sites
- Relatively simple traffic flows
- Need for availability and predictability
- Harsh environment
- Safety

Core
- High volumes of data
- Limited # of sites
- Dynamics & flexibility
- Controlled environment
### Access
- **IP/MPLS**
- **MPLS-TP**
- **Industrial Ethernet**
- **NG-SDH**

- IP/MPLS far too complex
- NG-SDH not fit for access – too big and too expensive
- Ethernet is / will be main technology
- “Transport” characteristics mandatory

### Metro / Transport
- **IP/MPLS**
- **MPLS-TP**
- **Carrier Ethernet**
- **NG-SDH**

- IP/MPLS flexibility not needed, even undesirable, too complex
- Smooth interworking with Core IP/MPLS mandatory
- “Carrier Ethernet” is marketing term – no unique definition
- NG-SDH is not future proof, ethernet flexibility forced in rigid containers (GFP and virtual concatenation)
- “Transport” characteristics mandatory

### Core
- **IP/MPLS**

- IP/MPLS done deal
- Benefit for dynamic path selection
- Large bandwidths
- Design for fault tolerance
Our assessment and proposal

<table>
<thead>
<tr>
<th>Access</th>
<th>Metro / Transport</th>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE</td>
<td><strong>Carrier Ethernet Transport (CET)</strong> using MPLS-TP</td>
<td>IP/MPLS</td>
</tr>
</tbody>
</table>

**Carrier-Grade**
- Redundancy & High Availability
- Higher Bandwidth Capacity, higher # of nodes 100’s to 1000’s
- Operations, Administration and Maintenance (OAM) capabilities

**Ethernet**
- Obviously the most popular and flexible Layer 2 protocol

**Transport**
- Uses the “SDH” - like “Transport” way of working
- Easy graphical Management System with E2E service provisioning and performance measurements (SLA management!)
- Deterministic and Static – paths and backup paths are pre-defined
- Transport paths are symmetrical – equal delays in both directions
- Sub 50ms restoration time
What is the problem with IP/MPLS in Transport Networks?

- Operation, Administration and Maintenance (OAM) is not sufficient
  - IP/MPLS does not support Performance Management
  - IP/MPLS lacks some important Fault Management functions
  - OAM packets do not follow the actual data stream

- Data Paths in IP/MPLS are uni-directional and typically have different routes in the forward and reverse directions, no deterministic behaviour

- Path protection to obtain <50ms = Fast ReRoute (FRR) = only a local detour and changes delay etc... to undefined value. Also FRR mechanism causes a lot of internal signalling in the network (lowers performance!)

- Superfluous functionalities in IP/MPLS, with dynamic routing protocols, use up a lot op CPU power -> performance issue!

- Running an IP/MPLS network requires a high level of L2 (Ethernet) and L3 (IP Routing) know-how -> not fit for the traditional Transport department, having typically SDH/SONET experience
That is exactly why MPLS-TP is defined

**MultiProtocol Label Switching – Transport Profile**

- Uses only a subset of IP/MPLS functionality, needed for smooth interoperability and data flow
- Adds missing functionality to make it fit for Transport purposes
- Removes the complexity of IP/MPLS
MPLS-TP advantages

MPLS-TP Characteristics

- Transport Centric Operation Model
  Supports Static (NMS-based) provisioning and management
- Protection Switching
  Triggered by OAM, efficient operation for dense mesh and ring topologies
- Standard MPLS data path
  Guarantees data path interoperability with IP/MPLS
- Connection Oriented
  Bi-directional LSP’s which are co-routed
- Transport optimised OAM
  Fault Management and Performance monitoring support network & services

Customer Benefits

- Simple provisioning similar to SDH/SONET
- <50 ms reconfiguration under all circumstances
- Transparant services and future proof Interoperability with IP/MPLS
- End-to-end Delay and Jitter
  minimal differential delay, suited to transport legacy and protection data
- End-to-End monitoring limits downtime through easy fault localisation
Protection Switching – inband OAM

- No constant data flow in a PSN, so special purpose OAM packets are sent
- OAM must work on Service Level and on Connectivity Level
- OAM must follow same path as data
- Two important components of the OAM mechanism:
  - G-ACh: Generic Associated Channel (for LSP and PW)
  - GAL: G-Ach Label (used in LSP to flag the G-Ach)
Railway Safety relevant norms

- **CENELEC (Comité Européen de Normalisation Electrotechnique)**
  - EN-50126 is the key standard for safety-critical communications
    Railways application – specification and certification of Reliability, Availability, Maintainability and Safety (RAMS)
  - EN-50159 (part 1 and 2) to provide for safe communication in closed networks
    Railways application – safety relevant communication in closed/open transmission networks
  - EN-50128
    Railways application – Software for Railways Control and Supervision Systems
  - EN-50129
    Railways application – Safety relevant electronic systems for Signalling Technology
  - EN-50121-4 on EMC immunity
    Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus

- **IEC International Electrotechnical Commission**
  - IEC 61850
    is a world-wide accepted standard for Ethernet-based communications in Electric Power Substations
  - IEC 61508
    Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
    Describes SIL 1-4 (Safety Integrity Level) as concept to assess the danger related to failure rate of a system

- **IEEE Institute of Electrical and Electronics Engineers**
  - IEEE 1613
    defines the environmental conditions in Electric Power Substations and establishes a common basis for and evaluating Communications Networking Devices in these substations
So, what is our value proposition?

TXCare
Takes Care of XTran Configuration,
Assurance, Resilience and
End-to-end management

XTran
eXellence in Transport
A Rock Solid solution for Mainline Railways

XTran

Ruggedized design
FAN-Less
No moving parts
Operating range
-20°C to +65°C
Demarcation device
-40°C to +70°C
EMC hardened
- IEC61850-3
- IEEE 1613
- EN 50121-4
19” or DIN-rail mountable

Designed for Track Side deployment
Our answer to main Railway Coms trends

- Increased communication needs that demand Packet based Efficiency
  - XTran is a fully packet based solution for meshed networking
  - XTran allows to create a Connection-Oriented network
- High demand for flexible, easy to manage MPLS based communication
  - XTran uses the latest evolutions of the MPLS standard (MPLS-TP) to cope with the demands of next generation Aggregation and Transport networks
  - XTran Integrates the latest views on OAM for performance and network diagnostics
- Industrialisation of Communication equipment
  - XTran is a modular, 19” and DIN Rail mountable solution
  - XTran is a Hardened solution with a very High Availability
Module: CSM310A

- Central Switching Module
- MPLS-TP Compliant
- High performance switching fabric
  - 4x10G + 24x1G
  - Non blocking
  - Hardware support for OAM
- Automatic protection switching <50ms in any topology
- Protection schemes
  - 1:1
  - 1+1 Hitless Switching (E1/T1)
  - Logical rings for multipoint applications
- Auto setup of in band communication channel (DCN)
- Encryption of DCN traffic via IPSec
- Fast replacement feature via flash card
Redundancy Protection Switching with CSM

CSM A

CSM B

IFC

1  2  3  4  5  6  7  8  9  10

4x1G
1x10G/1G
1G
Power options

- Hot pluggable power supplies
- AC/DC variant
  - ACP-A
  - DCP-A
- Wide input
  - 110-264 VAC (ACP-A)
  - 18-60 VDC (DCP-A)
  - 88-300 VDC (DCP-B)
- Compliant with IEC61850-3, IEEE 1613
- Mixed operation possible
- Load sharing (XT2210A, XT2206A)
Module: Node Support Module

- Connection for PoE power supply
  - Dual input for redundancy
- Digital inputs
  - Forwarding of local alarms
- Digital outputs
  - Activating local alarms
- Status LEDs
  - CSM active
  - PoE status
- Common module for all nodes
Modules: Ethernet connectivity

1G Interface card
- Operation per interface as WAN or LAN
- 4 interfaces
  - 3x 10/100/1000 gigabit Ethernet Cu
  - 1x Combo gigabit Ethernet Cu/SFP
- Sync-E and IEEE 1588v2
- PoE according to 802.3at

1G L3 Interface card
- Operation as LAN
- 8 interfaces
  - 3x 10/100/1000 gigabit Ethernet Cu
  - 1x Combo gigabit Ethernet Cu/SFP
- L3 router
  - OSPF, PIM-SM, VRRP, IGMP

10G Interface card
- Operation as WAN or LAN
- 1 interface XFP
- Sync-E, 1588v2
Combination of L2 and L3

- Combination
  - Services can be started or terminated on L2 or L3
  - Services can be combined via L2 or L3
- Integration of access layer
- Make virtual networks scalable
Module: TDM connectivity

- **LAN functionality (4-E1T1-L)**
  - E1 or T1 configurable
  - 4 interfaces
  - 64 kbit cross connect per card
  - Circuit emulation via
    - CESoPSN: Structure aware
    - SAToP: Structure unaware
  - Up to 16 independent circuit emulation streams
  - Hitless switching (zero packet loss switchover)
  - Synchronisation

- **WAN functionality (4-E1T1-W)**
  - Ethernet over TDM
  - Channel bonding
Module: Cu connectivity

- 4x SHDSL interface
- Symmetrical bandwidth over a cu pair (0.4-0.8)
- SHDSL.bis
- Speeds depend on distance, quality of cable
  - 192kbps – 5.6 Mbps
  - up to 12km (0.8mm @ 768kbps)
- Functions
  - Concentrator for demarcation devices spur, chained or dual homed (LAN) – EFM-C support
  - Interconnection of XTran nodes (WAN)
- Channel bonding
Cu Demarcation Device

- XTran demarcation based on EFM-C
- Connectivity
  - 2x DSL
  - 4x 10/100 Fast Ethernet
  - 2x18-72VDC power input
- Port security
  - Access Control Lists
  - Radius Authentication 802.1x
- Ethernet protocols
  - ERP (Ethernet Ring Protection)
  - MSTP (Multiple Spanning Tree)
- OAM
  - Y.1731, 802.3ah, Dying GASP
- Management
  - CLI, SNMP towards TXCare
Module: 2W/4W E&M

- Interface card compliant with G.703
  - 4 ports
  - 4W operation with/without signaling
    - Type I/II/V
  - 2W operation
- Circuit emulation
  - 1x64 kbps
- Possible connections schemes
  - Point to Point
  - Point to point shared
  - Point to point with grooming
- Protection schemes
  - None
  - MPLS-TP (<50ms)
  - Hitless (0 packet loss)
Module: Serial Interface

- Interface card compliant with RS232/422/485
  - 7 ports
  - Split out cable
  - Data rates:
    - 1200bps - 56000 bps,
    - 64kbps - 1920 kbps

- Requirements
  - Support for signaling (RTS, CTS,...)
  - Configurable data bits, stop bits, parity

- Circuit emulation
  - Nx64 kbps

- Possible connections schemes
  - Point to Point
  - Point to point with grooming
  - Point to multipoint (master slave)
  - Port server

- Protection schemes
  - None
  - MPLS-TP (<50ms)
Module: SDH Interface

- **Smart SFP**
  - Use cases
    - SDH/SONET can be transported over XTran via circuit emulation: close the SDH over XTran
    - 1x STM-1
      - Optical
      - Unstructured transport, fully transparent

- **2-CHAN**
  - Use cases
    - Legacy grooming to SDH
    - Interconnect XTran over SDH
    - Reuse of legacy radio equipment
    - 2x STM-1/4
      - Optical
      - Structured
        - VC12 for CES termination
        - GFP/VCAT for Ethernet and MPLS-TP
Node types

Chassis options

- XT2210A: 2 PSU  2 CSM  10 IFC
- XT2206A: 2 PSU  2 CSM  6 IFC
- XT1104A: 1 PSU  1 CSM  4 IFC

- 19” or DIN Rail mountable
- Slot capacity depends on CSM
  - CSM310A

<table>
<thead>
<tr>
<th>Slot</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>XT2210A</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
</tr>
<tr>
<td></td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>4x1G</td>
</tr>
<tr>
<td>XT2206A</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
</tr>
<tr>
<td></td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
</tr>
<tr>
<td>XT1104A</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
<td>1G</td>
</tr>
<tr>
<td></td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>4x1G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
<td>10G</td>
</tr>
</tbody>
</table>

1G = Legacy, DSL 4x1G = Gigabit Ethernet, 10G = 10G IFC
Typical XTran node configuration:

- Redundant CSM and PSU
- Failure rate $\lambda = 0,029446$ Failures/Year
- Reliability after 1 year: 97,1 %
- Availability: 99,997311 % or 4,6 nines (for repair time 8 hrs)

Transport Path availability using MPLS-TP path protection

<table>
<thead>
<tr>
<th>Card</th>
<th>MTBF (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backplane</td>
<td>665</td>
</tr>
<tr>
<td>CSM</td>
<td>54</td>
</tr>
<tr>
<td>1G LAN/WAN</td>
<td>71</td>
</tr>
<tr>
<td>1G LAN L3</td>
<td>65</td>
</tr>
<tr>
<td>10G LAN/WAN</td>
<td>72</td>
</tr>
<tr>
<td>E1/T1</td>
<td>86</td>
</tr>
<tr>
<td>NSM</td>
<td>437</td>
</tr>
<tr>
<td>PSU</td>
<td>34</td>
</tr>
<tr>
<td>SHDSL</td>
<td>76</td>
</tr>
</tbody>
</table>

Availability:
- 99,971366% 3,5 nines
- 99,997173% 4,5 nines
- 99,999296% 5,2 nines
- 99,999984% 6,8 nines
Local Ethernet Distribution Switches

ETS-3GC7F
Industrial Ethernet Switch
7 x 10/100 TX ports plus
3 x 10/100/1000 Combo ports
Operating Temperature
-40°C to +70°C
Power consumption 15 Watts
Managed by TXCare

ETS-4GC24FP
Industrial Ethernet Switch
24 x 10/100 TX ports plus
4 x 10/100/1000 Combo ports
Operating Temperature
-25°C to +65°C
Power consumption 28 Watts
Managed by TXCare
Network Management System (NMS) for XTran

- Fully integrated graphical **Element Management**, **Network Management** and **Service Management**
- Runs on Windows based Server and Client WS
- Designed to support up to 1000 Network Elements on a single platform
- Scalable, modular design, one or more servers
- Redundancy via warm standby
- Communicates with the XTran nodes via an in-band DCN
- Southbound I/F SNMPv3
- Northbound I/F to umbrella Management System
  - Alarm forwarding or monitoring
  - OPC (-> SCADA), SNMP, HTML (Zero Install Client)
Windows 8 “APS”- look Tile Interface
Tablet / Smartphone ready
Info and functions are grouped in Hubs
TXCare  Look and Feel
TXCare Physical View
Fault Management, Assurance
Configuration Management, Deployment, Inventory
Administration
Performance Management
Security Management

End-to-End Service Creation and Service Monitoring (SLA)
Conclusion

→ OTN Systems is a clear **market leader** in Telecoms solutions for Railways and Metro Rail
→ **Flexibility** and **Reliability** of our solutions are our key assets
→ Our Go-to-Market model is mainly with **Partners** and **System Integrators**
→ Our new **XTran** portfolio is designed for **Railway Applications**
→ **MPLS-TP** provides the needed Carrier Ethernet **Transport** functionality
→ **TXCare** provides the **Graphical** Tools for **end-to-end** Service Management

→ **Next Steps ?**