SHDSL and Optical Access Solution for Ethernet and TDM Business Services
SHDSL and Optical Access Solution for Ethernet and TDM Business Services
Universal connectivity

Line equipment family designed for point-to-point connections and fixed lines

- PBX
- Remote Subscriber Stage
- Access Mux
- Mobile base station
- VLAN/WAN
- Ethernet Switch/
- Bridge/Router
- ...

Transmission

- Copper (SHDSL) 1..4 wire pairs
- Optical Fiber

PSTN - ISDN PRA
- SDH / PDH Mux
- Mobile network controller
- VLAN/WAN
- ATM / Frame Relay
- Internet Server
- Cross Connect
- ...

subscriber  line  network
# Objectives

<table>
<thead>
<tr>
<th>1...4 X E1 (transparent, frame structured, ISDN PRA)</th>
<th>E1</th>
<th>E1 + data (add/top)</th>
<th>Data (X.21, V.35, V36, Eth, FE)</th>
<th>1....4 X E1</th>
<th>1..2 X GbE</th>
<th>1 ...4 E1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper or OF</td>
<td>Copper or OF</td>
<td>Copper or OF</td>
<td>Copper or OF</td>
<td>Copper or OF</td>
<td>Copper or OF</td>
<td>Conversion</td>
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</tbody>
</table>
Voice & Data leased line

ULAF+  ULAF+

Interfaces nx64kbit/s and 2Mbps fract. E1

Backbone Network

Service Provider  Business subscr.
e.g. Branch office

PBX

LAN

LAN

ULAF+

ULAF+
ULAF+ - Bridging the Last Mile – Applications
High Speed Business Class Services

- Ethernet Private Line
- VPN Services
- TDM Leased Line
- PBX Interconnection
- ISDN PRA

High Speed Services

Internet Access

Data Service

Voice Service

Metro Network

SDH
Carrier Grade Ethernet
IP or MPLS

Headquarter

Municipality

Office Building

Branch Office

Optical Fiber
Copper Wire-Pair
2 Copper Wire-Pairs
4 Copper Pair-Bonding
ULAF+ - Bridging the Last Mile –Applications
Backhauling Mobile and DSL Services

Metro Network
SDH
Carrier Grade Ethernet
IP or MPLS

Application Server

GSM BTS
UMTS NodeB
PWLAN or WiMAX
DSLAM
Mini DSLAM

Network Components:
- Metro Network
- SDH
- Carrier Grade Ethernet
- IP or MPLS

Physical Connections:
- Optical Fiber
- Copper Wire-Pair
- 2 Copper Wire-Pairs
- 4 Copper Pair-Bonding

Network Elements:
- BSC
- MSC
- BRAS
- Application Server
## System Components

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
</table>
| 19” and ETSI rack suitable | 16+1 slots  
Redundant power feeding  
TDM and packet bus on backplane  
Clock and alarm in-/output |
| **BSRU**     | SHDSL regenerator unit for 1 and 2 wire-pairs.  
Up to 8 BSRU cascadable  
Remote and local power feeding |
| **BSTU**     | SHDSL termination unit for 1 and 2 wire-pairs (up to 11.4 Mbps)  
TDM and Ethernet interfaces.  
Integrated layer 2 switch |
| **QSTU**     | Quad SHDSL termination unit with 4 wire-pairs.  
4 x E1 interface  
1-, 2- and 4- wire-pair mode |
| **BSTU4 / BSTU EFM** | SHDSL termination unit for advanced Ethernet services.  
4 – 16 wire-pair bonding  
4 port Ethernet switch (VLAN, QoS) |
| **GTU / GTU4** | GTU: Interface converter for Ethernet over E1 or fractional E1 plus data over E1; GTU4: Inverse Multiplexer Ethernet over TDM |
| **BSTU4 / BSTU EFM** | SHDSL termination unit for advanced Ethernet services.  
4 – 16 wire-pair bonding  
4 port Ethernet switch (VLAN, QoS) |
| **BOTU**     | Optical transmission unit for advanced Ethernet and TDM services  
Transmission 155 Mbps (SFP) |
| **MCU**      | Card with SNMP V1 and V3  
Options:  
- Integrated carrier grade layer 2 Ethernet switch  
- TDM over IP module (Available 2008) |
19” Subrack V3

- 19” subrack; extension kit for 21” ETSI rack
- 16+1 plug-in slots
- Any plug-in in any slot (all ULAF+ Versions)
- Full front-access
- Redundant power connections (two DC sources); 40 VDC to 72 VDC
- External clock inputs (120 Ω / 75 Ω)
- Management bus on backplane
  - Up to 4 subracks can be cascaded using only one O&M card
  - OMI SNMP
- Packet- and TDM bus on backplane
- W x H x D = 482 x 315 x 242 mm
- Cable tray available

Max. input power: 750W
Max. power dissipation: 350W
equipped with 16x(STU4+RPS)+MCU
BSTU Application – Ethernet Services

One pair SHDSL.bis for up to 5.7 Mbps

Two pairs SHDSL.bis for up to 11.4 Mbps
BSTU Application – Ethernet and TDM Leased Line

- E1 (G.703/704)
- nx64 kbps
- 10/100baseT

SDH Network

- MUX

One E1 per subscriber

Two SHDSL pairs for extended reach
BSTU Application – ISDN PRA

- Two SHDSL pairs for extended reach

- Interface T
  ISDN PRA / S2M

- Interface V
  ISDN PRA

- E1 (ISDN PRA)

- ISDN Switch
BSTU Application – E1 plus Data
Add/Drop – Add/Top

**Add / Drop**
- Unused E1 time slots are filled with data traffic
- Maximum 2 Mbps

**Add / Top**
- Data traffic is transported on top of E1 traffic
- Maximum 11.4 Mbps
**BSTU – SHDSL Transmission Unit**

- **Cost optimized SHDSL transmission unit for Ethernet and TDM services**

- **Transmission:**
  - ETSI/ITU-T compliant SHDSL over one or two copper wire pairs
  - Support of SHDSL.bis (TC-PAM32 line code)
  - Line speed configurable from 192 kbps to 5.7 Mbps in 64 kbps steps per wire-pair

- **Service interfaces**
  - 1x or 2x E1 (G.703/G.704/ISDN PRA)
  - 1x 10/100base-T (L2 switch on board)
  - 1x data module slot (for nx64 kbps services)

- **Integrated power supply (no external power brick)**
  - Desktop: 95 – 260 V<sub>AC</sub> or 40 – 72 V<sub>DC</sub>
  - Plug-in: 40 – 72 V<sub>DC</sub>

- **Remote power supply circuit on board (Option)**

- **Desktop can be powered from remote**

- **LT/NT user-configurable**
- **Plug-in optimized as COT**
- **Desktop optimized as RT**

- **Various clock sources**
  - From E1 interface
  - From DSL line
  - Internal clock source
  - External clock source (module)

- **Local and remote management**
- **LED for alarm indication**

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QSTU Operational Modes

4 subscribers per QSTU (one wire-pair mode)

2 subscribers per QSTU (two wire-pair mode)

1 subscriber per QSTU (four wire-pair mode)

4 BSTU with any kind of subscriber interface (encapsulated in E1)

2 BSTU with any kind of subscriber interface (encapsulated in E1)

1 QSTU for E1 services
1 BSTU4 for Ethernet
QSTU Application – Mobile Backhauling

- GSM BTS
- UMTS NodeB
- QSTU
- Four SHDSL Pairs
- BSC
- MSC

4 x E1 IMA

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QSTU – SHDSL Transmission Unit

- **Transmission unit with four SHDSL systems on board**

- **Transmission:**
  - ETSI/ITU-T compliant SHDSL over 1, 2 or 4 copper wire pairs
  - Line speed configurable from 192 kbps to 2'048 kbps in 64 kbps steps per wire-pair

- **Service interfaces**
  - 4x E1 (G.703/G.704/ISDN PRA)

- **3 operational modes**
  - 4 one-pair systems (connecting 4 BSTU)
  - 2 two-pair systems (connecting 2 BSTU)
  - 1 four-pair system (connecting 1 QSTU or 1 BSTU4)

- **Integrated power supply (no external power brick)**
  - Desktop: 95 – 260 V_AC or 40 – 72 V_DC
  - Plug-in: 40 – 72 V_DC

- **Remote power supply circuit on board (Option)**

- **Desktop can be remotely powered**

- LT/NT user-configurable

- Plug-in optimized as COT
  - Desktop optimized as RT

- Various clock sources
  - From E1 interface
  - From DSL line
  - Internal clock source
  - External clock source (module)

- Local and remote management

- LED for alarm indication
BSTU4 Application –
Ethernet Private Line over SDH Network

Patent pending MCS (Multi Channel Synchronization) algorithm with autonomous detection and correction of wire-pair or channel interchange

MEF9 and MEF14 Certification for EPL Services

Up to 4x E1 per subscriber

Up to 4 SHDSL Pairs (8 Mbps)
BSTU4 Application
Ethernet Private LAN over Metro Ethernet

Provider Bridge
IEEE 802.1ad (Q-in-Q)
C-VLAN = Customer VLAN
P-VLAN = Provider VLAN

Metro Network
Carrier Grade Ethernet
IP or MPLS

C-VLAN = Customer VLAN
P-VLAN = Provider VLAN

Class of Service
BSTU4 Application
DSLAM Backhaul with Link Aggregation

- Link Aggregation (IEEE 802.3ad)
- Ethernet Frames are distributed among different links (based on MAC-Addresses)
- Up to 91,2Mbit/s over up to 16 wire pairs can be aggregated
- Easy to set-up and configure with Ulaf+ LCT or AccessIntegrator
BSTU4 – SHDSL Transmission Unit for Advanced Ethernet Services

- **SHDSL transmission unit for** Ethernet services using copper-bonding

- **Transmission:**
  - ETSI/ITU-T compliant SHDSL over 1, 2, 3 or 4 copper wire pairs
  - Support of SHDSL.bis (TC-PAM32 line code)
  - **Line speed configurable** from 192 kbps to 5.7 Mbps in 64 kbps steps per wire-pair

- **Service interfaces**
  - 4 ports 10/100base-T

- **Advanced Ethernet switch features**
  - Full/half duplex, flow control
  - Flow control, auto negotiation, auto crossover
  - Self-learning bridge (1024 MAC addresses)
  - VLAN IEEE 802.1Q supported
  - Provider VLAN support (Q-in-Q)
  - 4 priority queues (weighted round robin and strict priority queuing)

- **Integrated power supply (no external power brick)**
  - Desktop: 95 – 260 V_{AC} or 40 – 72 V_{DC}
  - Plug-in: 40 – 72 V_{DC}

- **Embedded clock** for Mobile backhauling

- **Remote power supply** circuit on board (Option)

- **Resiliency**
  - Dynamic reconfiguration if one wire-pair fails

- **Local and remote management**

- **LED** for alarm indication
BSRU – SHDSL Regenerator

- SHDSL regenerator for 1 or 2 copper wire-pairs

**Transmission:**
- ETSI/ITU-T compliant SHDSL over 1 or 2 wire-pairs
- Line speed configurable from 192 kbps to 5.7 Mbps in 64 kbps steps per wire-pair
- Support of line codes TC-PAM16/32

- Feeding voltage 60-180 V<sub>DC</sub>
- Remote power feeding from LT or NT side
- Local feeding source or via separate copper pair
- Up to 8 regenerators can be cascaded and are fully manageable
- Underground and pole-mounting housings available
Housing for two Regenerators

Connectors with solder lugs
(4 x DIN 41617 13-pin)
Data traffic is encapsulated in E1 frame towards SDH MUX. In case of add/drop unused timeslots of fractional E1 are used.
GTU Application
SNMP Management Interface over SDH

Connecting O&M interface to Ethernet module of GTU

E1 connection

MUX

SDH Network

GTU
10/100baseT

Network Management System
GTU – Interface Converter Unit

- Interface converter unit for data (Ethernet or nx64 kbps) over E1 connections

- Transmission:
  - ITU-T G.703/704/ISDN PRA

- Service interfaces
  - 1x E1 (G.703/G.704/ISDN PRA)
  - 1x data module slot for Ethernet or nx64 kbps module

- 3 operational modes
  - Ethernet or nx64 kbps over (fractional) E1
  - Fractional E1 + data (Ethernet/nx64 kbps) over E1
  - NT1-Z termination

- Integrated power supply (no external power brick)
  - Desktop: 95 – 260 V<sub>AC</sub> or 40 – 72 V<sub>DC</sub>
  - Plug-in: 40 – 72 V<sub>DC</sub>

- Various clock sources
  - From subscriber E1 interface
  - From E1 line-interface
  - Internal clock source
  - External clock source (module)

- Local management
  - LED for alarm indication
GTU4 Application – Ethernet over multiple E1

- MEF9 and MEF14 Certification for EPL Services
- Patented MCS (Multi Channel Synchronization) algorithm with autonomous detection and correction of wire-pair or channel interchange

Up to 4 SHDSL Pairs (8 Mbps)

Up to 4xE1 per subscriber

10/100base-T

BSTU4 plug-ins

BSTU4

GTU4 plug-ins

10/100base-T
GTU4 – Inverse Multiplexer for Ethernet Services

- Inverse multiplexer for Ethernet services over multiple E1 links

- Transmission:
  - ITU-T G.703/704/ISDN PRA

- Service interface
  - 4 port 10/100base-T

- Ethernet switch features
  - Full/half duplex
  - Flow control
  - Auto negotiation and auto crossover
  - Self-learning bridge (1024 MAC addresses)
  - VLAN transparency

- Integrated power supply (no external power brick)
  - Desktop: 95 – 260 V\textsubscript{AC} or 40 – 72 V\textsubscript{DC}
  - Plug-in: 40 – 72 V\textsubscript{DC}

- Resiliency
  - Dynamic reconfiguration if one E1 link fails
  - Local and remote management
  - LED for alarm indication
MCU – O&M Card

- Central O&M card (one plug-in for up to 4 cascaded subracks)
- 3 x 10/100base interface for NMS (SNMP V1, V3)
- RJ45 Local Craft Terminal interface
- USB interface (for later use)
- Configurable IP and fix MAC address
- Alarm aggregation
  - Urgent Alarms
  - Non Urgent Alarms
  - LEDs for alarm visualization
  - Push button for alarm acknowledgment

For subrack
  - S3105-B628-A210
MCU-S Applications
Carrier Ethernet Services

Services
- Ethernet Private Line
- Ethernet Private LAN
- Provider Backbone Bridge

Metro Ethernet
**MCU-S Application**

**Link Aggregation**

- Link aggregation enables the user to increase the capacity by parallel connection of several links between two end points. The connection remains available in case one of the physical link fails.

- The ULAF+ V5.0 L2 switch supports link aggregation of all uplinks connections.

- Link aggregation is used as a traffic protection mechanism.
To save GbE ports of the backbone equipment, the data traffic of different NGU subracks can be concentrated using the uplink ports of the MCU.

Using a second GbE backbone access (see dotted line) enables traffic protection.

For the current ULAF+ system there are no uplink capacity limitations for a single subrack (both for unprotected and protected uplink).
MCU-S Applications
VLAN Support

E – Line Service

- VLAN A
  - point to point service
  - customer separation by VLAN

- VLAN B
  - local switching, no need for external switching resources

E – LAN Service

- VLAN C
  - Multipoint to Multipoint connectivity

e.g. SDH MSP
(multi service platform)

FE or GbE up-link

VLAN A
VLAN B
VLAN C
VLAN A
VLAN B
VLAN C
VLAN C

FE or GbE up-link
MCU-S - Management & Concentrator Unit with Integrated Switch

- **O&M card with** carrier grade layer 2 Gigabit Ethernet switch

- **Interfaces**
  - 2x SFP bays for GbE modules
  - 1x 100/1000base-T (electrical)
  - 1x RS232 (RJ45) for LCT
  - 3x 10/100base-T for NMS

- **Switch Features**
  - Non blocking 16-port FastEthernet and 2-port 1GbE switch
  - Wire speed switching in store-and-forward mode
  - IEEE 802.3ad Link Aggregation
  - Max. Ethernet frame length of 2'000 bytes
  - Support of STP (802.1d), RSTP (802.1.w) and MSTP (802.1s)
  - VLAN support according to IEEE 802.1Q
  - Support of GARP and GVRP
  - Support of VLAN stacking Q-in-Q (IEEE802.1ad)
  - Various QoS features

- **Switch Features (cont.)**
  - Support of DiffServ
  - Support of IGMP snooping V3
  - Access control features
  - Broadcast Storm Portection
  - Prepared for later PWE3 support (module)
LCT – Local Craft Terminal

- **Manageability**
  Fault, configuration, performance (G.826), SHDSL values, security

- **Efficiency**
  Configuration up- and download;

- **Firmware upgrade** local and remote

- **Mobility**
  Designed for laptop application

- **Ease of Learning**
  Intuitive „Windows“ look & feel

- **Ease of use**
  Link status at a glance

- **„Remote LCT“:** access via Ethernet network at NMS interface on the controller unit OMI
  SNMP and MCU
LCT – Screen Shots
AccessIntegrator
Element Manager ULAF+

- Element Management System for Nokia Siemens Networks Access Products
- Client-Server Application for Windows and/or UNIX environment (cross-platform operation)
- SNMP V1 and V3 support
- CORBA Northbound Interface towards Umbrella Management system (e.g. Cross Domain Manager CDM)
- Sophisticated alarm- and performance lists
- Easy configuration of ULAF+
- Same look-and-feel like the LCT
- Up to 60 characters user information per network element
DCN Configuration

- ACI Client
- ACI Client
- ACI Server
- Proxy Server
- Port Server
- IP DCN
- SNMP
- 10/100base-T
- V.24
SHDSL Transmission

Standard Compliant SHDSL and SHDSL.bis Transmission
ITU-T G.991.2
ETSI TS 101 524

2-Pair and 4-Pair Transmission for Extended Reach
Up to 40% with 2 copper-wire pairs
Up to 90% with 4 copper-wire pairs

TC-PAM16 and TC-PAM32 Line Codes
Up to 5'696 kbps per copper-wire pair

Adjustable Line Speed – 'Trading Speed for Distance'
Spectral Compatibility with other Services in the Same Cable (e.g. POTS, ISDN, ADSL, VDSL…)

Very Low Power Consumption
Optical Transmission

High Speed Optical Interface

- 155 Mbps, SFP Form Factor Modules
- Bidirectional Modules (WDM) or Standard Two Fiber Modules
- 15 to 120km Distance
- Optional 1+1 Line Protection
Value Proposition

Universal Access Platform for Providing Business Class Ethernet and TDM Services

Reliable Symmetrical High Speed Optical and SHDSL Transmission

- Up to 22.8 Mbps using SHDSL.bis copper-pair bonding
- Up to 91.2 Mbps using SHDSL.bis copper-pair bonding and link aggregation
- Up to 155 Mbps using optical fiber (carrying 1x10/100base-T and 4xE1) *)

Carrier Grade Ethernet Applications and TDM Leased Line with one System

Network Interfaces for SDH, Ethernet, MPLS and IP-based Backbone Networks

Easy-to Learn Network Management System

*) available 2Q 2008
LongReach DSL Application
Very Long Distances

Remote power feeding of up to 6 regenerators from LT with ≤ 290VDC/50mA

Remote power feeding of up to 6 regenerators from NT with ≤ 290VDC/50mA

Distances > 325km on Ø1,2 mm cables
LongReach DSL

- **SHDSL transmission units for long reach applications**

- **Transmission:**
  - Patented Simplex SHDSL transmission technology for very long distances
  - Configurable Line Codes TC-PAM16 and TC-PAM32
  - Line speed configurable between 192 and 2112kbps in 64kbps steps

- **Service interfaces**
  - 2xE1 (two independent systems)
  - Data Service V.24 on all regenerators

- **Up to 12 regenerators can be cascaded and are fully manageable**

- **External power bricks**
  - Desktop: 40 - 72 V$_{dc}$
  - Plug-in: 40 – 72 V$_{dc}$

- **Up to 40% longer transmission distances**
  - ≥ 25 km per section over copper-pairs with 1.2 mm diameter
  - ≥ 16 km per section over copper-pairs with 0.9 mm diameter
  - ≥ 325 km between two modems using 12 regenerators
Service Quality Guaranteed

Customers shall get the service they need

- 15 years of **experience** in developing DSL and optical access systems
  *you can rely on our competence*

- Our system offers **best SHDSL transmission performance** (reach, bit rate, and reliability) in the field
  *you can get best transmission performance*

- **Maximized payload bit rate** due to minimized protocol overhead
  *you can get the most out of your bottleneck access network*

- **Very low power consumption** due to best-in-class SHDSL chip-set and intelligent equipment design
  *you can save energy and money*
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>ACI</td>
<td>AccessIntegrator</td>
</tr>
<tr>
<td>ADSL</td>
<td>Asymmetric Digital Subscriber Line</td>
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<tr>
<td>BSC</td>
<td>Base Station Controller</td>
</tr>
<tr>
<td>BTS</td>
<td>Base Transceiver Station</td>
</tr>
<tr>
<td>COT</td>
<td>Central Office Terminal</td>
</tr>
<tr>
<td>DCN</td>
<td>Data Communication Network</td>
</tr>
<tr>
<td>DSL</td>
<td>Digital Subscriber Line</td>
</tr>
<tr>
<td>DSLAM</td>
<td>Digital Subscriber Line Access Multiplexer</td>
</tr>
<tr>
<td>EM</td>
<td>Element Manager</td>
</tr>
<tr>
<td>EPL</td>
<td>Ethernet Private Line</td>
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<tr>
<td>ETSI</td>
<td>European Telecommunications Standards Institute</td>
</tr>
<tr>
<td>GARP</td>
<td>Generic Attribute Registration Protocol</td>
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<tr>
<td>GSM</td>
<td>Global System for Mobile communications</td>
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<tr>
<td>GVRP</td>
<td>GARP VLAN Registration Protocol</td>
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<td>IGMP</td>
<td>Internet Group Management Protocol</td>
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<tr>
<td>IP</td>
<td>Internet Protocol</td>
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<tr>
<td>ISDN PRA Rate Access</td>
<td>Integrated Services Digital Network Primary Rate Access</td>
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<tr>
<td>ISP</td>
<td>Internet Service Provider</td>
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<tr>
<td>ITU</td>
<td>International Telecommunication Union</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
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<tr>
<td>LCT</td>
<td>Local Craft Terminal</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<tr>
<td>MAC</td>
<td>Medium Access Control</td>
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<tr>
<td>MEF</td>
<td>Metro Ethernet Forum</td>
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<tr>
<td>MPLS</td>
<td>Multi-Protocol Label Switching</td>
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<tr>
<td>MSC</td>
<td>Mobile Switching Centre</td>
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<tr>
<td>MSTP</td>
<td>Multiple Spanning Tree Protocol</td>
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<td>MUX</td>
<td>Multiplexer</td>
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<td>NMS</td>
<td>Network Management System</td>
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<td>NRZ</td>
<td>Non Return to Zero</td>
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<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>PBX</td>
<td>Private Branch Exchange</td>
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<td>POP</td>
<td>Point of Presence</td>
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<td>POTS</td>
<td>Plain Old Telephone System</td>
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<td>PWE3</td>
<td>Pseudo Wire Emulation Edge to Edge</td>
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<td>PWLAN</td>
<td>Public Wireless Local Area Network</td>
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<td>QoS</td>
<td>Quality of Service</td>
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<tr>
<td>RSTP</td>
<td>Rapid Spanning Tree Protocol</td>
</tr>
<tr>
<td>RT</td>
<td>Remote Terminal</td>
</tr>
<tr>
<td>SDH</td>
<td>Synchronous Digital Hierarchy</td>
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<tr>
<td>SFP</td>
<td>Small Form-factor Pluggable</td>
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<tr>
<td>SHDSL Line</td>
<td>Single-Pair High-Speed Digital Subscriber Line</td>
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<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol</td>
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<tr>
<td>STP</td>
<td>Spanning Tree Protocol</td>
</tr>
<tr>
<td>TCM</td>
<td>Time Compression Multiplexing</td>
</tr>
<tr>
<td>TC-PAM</td>
<td>Trellis Code Pulse Amplitude Modulation</td>
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<tr>
<td>TDM</td>
<td>Time Division Multiplexer</td>
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<tr>
<td>ULAF</td>
<td>Universal Line Access Family</td>
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<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
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<tr>
<td>VDSL</td>
<td>Very High Speed Digital Subscriber Line</td>
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<tr>
<td>VLAN</td>
<td>Virtual Local Area Network</td>
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<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
</tr>
<tr>
<td>WDM</td>
<td>Wavelength Division Multiplexing</td>
</tr>
</tbody>
</table>
Danke!

Quante Netzwerke GmbH
Ahrensburger Straße 8
D-30659 Hannover

www.quante-netzwerke.de

Tel: (+49) 511 / 74 01 92 - 0
Fax: (+49) 511 / 74 01 92 - 100