

# IP-BACKHAUL FOR MOBILE NETWORKS

“The outline suited us perfectly and it was obvious that Widermind's instructor really understood our working environment and spoke from his own experience.”

- Anders Lagerström, Manager Transmission Planning, 3GIS (RAN Sharing company for Telenor and 3), Sweden

## Course Description

Mobile networks offering LTE/4G services, require high capacity/high QoS transport networks. LTE/4G relies on IP connectivity only. Combined with Ethernet as the preferred layer 2 link technology, many transport networks require re-designs and capacity upgrades.

The majority of mobile operators have migrated from ATM/SDH to IP/Ethernet based transport. In these networks, the signalling and user traffic utilise the common transport technology based on the Internet Protocol standards.

The main driver for the choice of IP/Ethernet as transport technology is its ability to combine low cost, simplicity and high capacity. In order to offer high service quality, a number of QoS related requirements are set on the new infrastructure. Applicable transport network architectures, together with correct mapping of existing traffic and signalling priorities into IP and Ethernet handled service classes are paramount in order to meet those requirements.

The course “IP-backhaul for Mobile Networks” describes the architecture, network topology, components, performance and solutions necessary to provide a modern, resilient and secure transport Network with top level capacity and QoS.



## Content

### ORGANIZATIONS AND STANDARDIZATIONS

- 3GPP & IETF
- Internet standard and standardization bodies

### MOBILE BACKHAUL BACKGROUND

- Backhaul Network Costs Distribution
- Basic Backhaul Technologies and Developments
- Topology

- Drivers for the MBH Network Change
- Traffic Growth, Dense Networks
- Revenue Per Bit Decreasing and Lowered Operational Costs

### **MOBILE SERVICE DEVELOPMENTS AND TRAFFIC GROWTH**

- Traffic Forecasts for Proper MBH Design
- Traffic Peak Rates
- Average Service Bit Rate
- Traffic Distribution Into Classes
- Mobile Network Developments
- More Native Packet Traffic
- Flat Mobile Network Architecture
- Redundancy
- Direct Links Between New Base Stations
- Urban (Hot Spot) Cell Sites
- Connecting Temporary Cells
- Backhaul Cost-Efficiency Improvements
- Improved Ability to Handle Bursty Traffic
- Optimized Backhaul Dimensioning
- Lower Operational Costs
- Network Simplification
- New Equipment and Automation

### **DEVELOPMENTS IN GENERAL TRANSPORT**

- Packet-Based Backhaul Networks
- Physical Network and Topology
- Logical Network and Protocol Layers
- Making Transition to Packet Technology Networks
- Transition Strategies for Packet-Based Backhaul

#### **Widermind**

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- Target MBH Network
- Serving Existing and New Mobile Systems
- Different Types of Areas
- Overlay or Replacement
- Leased Lines and Out-Sourced Transport Services
- Implementing Transition and Network Evolution
- Planning the Changes
- Addition of New Equipment and Links
- Parallel Working of Old and New

### **2G & 3G MOBILE SYSTEMS**

- Radio Technologies and Backhaul
- 3GPP Releases
- Network Evolution – 2G
- Circuit Switched and Packet Switched Traffic
- Abis
- Network Evolution – 3G
- Protocol Stacks for Circuit Switched and Packet Switched Traffic
- Air Interface Channels
- FP, MAC and RLC Protocols
- HSDPA
- Iub, Iur, Iu-cs, Iu-ps and GTP-U

### **LTE**

- 3GPP Releases. LTE
- Architecture
- Packet Switched Traffic, Protocol Stack
- Air Interface
- S1 and X2

- Bearers and Connections
- Mobility Management
- Interworking with 2G and 3G
- Voice Support
- Self Configuration and Self-Optimization

## PACKET NETWORKS

- Network Overview
- TCP/IP and Comparison CS/PS
- Backhaul and Transport Services
- Access, Aggregation and Core
- 3GPP Guidance for the Backhaul
- Networking and Backhaul
- Physical Interfaces, High Data Rates
- Ethernet Ports
- E1/T1/JT1
- Ethernet, Medium & Devices
- SDH/Sonet, PPP and ML-PPP
- PPP over Sonet/SDH
- Carrier Ethernet
- Ethernet Bridging and Link Aggregation
- VLANs & Class of Service
- Ethernet O&M
- Provider Bridging
- MPLS Based Carrier Ethernet

## INTERNET PROTOCOL

- Network Protocols
- Layered communication

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- OSI Reference Model, functions and advantages
- TCP/IP Model and Protocol stack
- Data and TCP/IP Encapsulation / Decapsulation
- Layer 2, Internet Protocol Function, IP
- IP Packet and IP Fragmentation
- IHL & TTL
- Type of Service (TOS)
- Comparison IPv4 and IPv6
- Data link Layer Standards
- Ethernet, Token Ring, LAN
- Principle of Shared Ethernet: CSMA/CD
- MAC and Spanning Tree
- WMMap-2, IPv4 Routing
- HUBs vs. Switches vs. Routers
- Routing, Routing Table, Static and Dynamic routing
- Popular routing protocols
- Border Gateway Protocol (BGP)
- Layer 4, Transport Layer, TCP/UDP
- Port addressing & Port Assignment
- SCTP

## APPLICATIONS & INTERNET

- ICMP and PING
- Traceroute or Tracert
- ARP
- DNS
- Multimedia over IP (Both TCP & UDP)
- Integration of Switching and Routing

- PAN, LAN, WAN, MAN, GAN

### **BACKHAUL TRANSPORT TECHNOLOGIES**

- Overview of Backbone Network
- Network Architecture of Backbone Network
- MPLS/ IP Applications
- Label Distribution Protocol
- MPLS L3 VPN and MP-BGP
- Pseudowire Emulation Edge to Edge
- MPLS L2 VPN-VPLS and MPLS-TE/TP
- Access Schemes
- PDH, SDH and OTH
- Next Generation SDH
- ATM and Hybrid TDM/Packet

### **WIRELESS/WIRELINE BACKHAUL TECHNOLOGY**

- Wireless Backhaul Technology
- Radio Wave Propagation, Frequencies and Capacities
- Network Topologies
- Availability, Resiliency and Performance
- DSL Technologies
- Optical Technology
- Wavelength Division Multiplexing (WDM)
- Passive Optical Network (PON)
- Ethernet Interfaces
- DOCSIS
- Aggregation and Backbone Tiers
- Leased Line Services for Mobile Backhaul
- Ethernet Services and SLA's (MEF)

- UNI and EVC
- Ethernet Service Definitions
- Ethernet Private/Virtual Private Line/LAN Service
- Service Level Agreement and Service Attributes
- Bandwidth Profiles (BWP)
- Service Performance
- Leased Ethernet Service Offering
- IP as a Backhaul Service

### **SYNCHRONIZATION**

- Requirements for Frequency Accuracy
- CDMA and TDD Systems
- Single-frequency Network
- E911 Phase II OTDOA
- Frequency Synchronization in TDM Networks
- Synchronization Architecture in TDM Networks
- Freq. Synchronization in Packet Networks
- ACR (Adaptive Clock Recovery)
- NTP & PTP Protocol, ITU PTP Telecom Profile
- Synchronous Ethernet
- Optical Transport Network
- One-way Synchronous Ethernet Links
- TICTOC
- Synchronization Metrics for TDM and Synchronous Ethernet
- Stability Metric MTIE
- Packet Synchronization Fundamentals and Metrics
- The Principles of Packet Timing
- MATIE and MAFE

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- Pktfiltered MTIE
- Floor Delay Packet Population
- Two-way Messaging
- Delay Jumps
- Testing Packet Timing Slaves
- Rules of Thumb for Packet Timing Network Implementation
- GNSS Systems and PTP for Time Synchronization

## RESILIENCE

- Restoration, Protection, Recovery & Availability
- MTBF and MTTR
- Increased Availability, Network Failures and Human Errors
- Native Ethernet and Resilience
- Ethernet Bridging
- Spanning Tree Operation
- Carrier Grade Ethernet
- MEF Services
- Ethernet OAM, IP Layer, VRRP
- Load Sharing, Routing Protocols, OSPF & BFD
- Loop Free Alternates
- MPLS Resilience, Label Allocation
- LDP Sessions
- IP MPLS VPN & VPLS
- MPLS TE, MPLS OAM & MPLS-TP
- GMPLS Control Plane
- Resilience in BTS Access
- IP Addressing & Active-Passive Ports
- IP Load Sharing

- Ethernet Link Aggregation
- OSPF in the Access
- Static Routes
- First Hop Gateway Redundancy
- Microwave Access Links
- Attachment to a MEF Service
- BSC and RNC and Their Site Solutions
- VRRP Example
- SCTP Multihoming
- Use of Multiple Core Network Nodes

## QoS

- WMMMap 3: QoS
- Table Value ranges
- End User and Transport Layer Service
- End-to-End QoS
- QoS Alignment with Radio and Backhaul
- Per-Hop behaviour
- MPLS Traffic Class
- Priority Bits
- VLANS
- QoS with MEF Services
- Ingress & Egress
- Egress Scheduling, Queue Management
- Schedulers, Buffering, Tail Drop
- Active Queue Management and Shaping
- 2G, Native PCM-Based Abis and Abis over Pseudowire
- 3G/HSPA, Bearers and Their Attributes

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- Iub, User Plane and O&M
- Synchronization (by Packet)
- Congestion Control, Admission Control
- Co-existence of Radio Networks

## SECURITY

- Security in 3GPP Mobile Networks, 2G, 3G and LTE
- Network Domain Security
- Management Traffic
- Protection of the Backhaul
- Leased Service, Ethernet Services and Traffic Separation
- IEEE 802, MEF, IPsec and IKE Protocol
- Anti-Replay Protection
- Network Element Authentication
- Firewalls and Access Control Lists
- Network Control Protocols Protection
- IP Sec VPN Deployment and Profiles
- VPN Resilience and Fragmentation
- LTE S1 and X2 Study Case

## PACKET BACKHAUL SOLUTIONS

- Creating a Packet Based MBH Solution
- MBH Solution Starting Points
- MBH Optimization Considerations
- Optimization for Operator, Region for Flexibility and Implementation
- MBH Solution Alternatives
- Enhancing SDH/Sonet with NG-SDH/MSPP or with a Pkt. Overlay
- Fully Packet Based Networks for MBH Access
- Green-Field-, Overlay- and “Fill-in” Case

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- Outsourcing the MBH Network or Parts of it
- Economic, Technical, Strategic and Organizational Considerations
- MBH Solution for 3G/LTE in Dense Urban-/Suburban Area
- MBH Solution in Rural Area for New 3G Network
- From the Selected MBH Solution to Detailed Network Plans

## Target audience

The target audience is Transmission planner, Transmission Network Engineers, NOC engineers etc.

## Pre-requisites

The participants should be familiar with both TCP-IP and mobile networks basics.

## Course length

3-5 days

*Widermind* communicates the knowledge you need to develop and implement new technologies for current and future network operations. Our clients are telecom operators, system integrators, system suppliers and consultancy firms.

Based in Stockholm, Sweden, we develop courses backed by a comprehensive network of associates. Our instructors employ technical and pedagogical skills that have made Widermind training well known and appreciated as one of the best services in the field.

You are warm welcome to contact our representatives at:

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