



# **NETWORK SYNCHRONIZATION TRAINING COURSE**

2016

## Network Synchronization Training program

<b>Network Synchronization Fundamentals</b>		<b>Ref: NST-1</b>
Target Audience:	Planning managers, network planners, O&M experts, system engineers	
Prerequisites:	Basic understanding of telecommunications transmission principles	
Course Length:	1 day	
Description: This course provides an overview of network synchronization principles for telecom experts		
Content:		
<b>Fundamentals of network synchronization</b>		
Definition		
The need for synchronization		
Relevant synchronization standards and recommendations		
The origin of bit timing frequencies in TDM systems		
<ul style="list-style-type: none"> <li>• Typical speeds in PDH hierarchy for timing transport</li> <li>• Typical speeds in SDH hierarchy for timing transport</li> <li>• The use of non-typical frequencies for network synchronization</li> </ul>		
Timing accuracy and quality of synchronization		
<ul style="list-style-type: none"> <li>• The consequences of synchronization failure</li> <li>• Frequency accuracy</li> <li>• Jitter and wander</li> <li>• Quality masks</li> </ul>		
The topology of synchronization networks		
<ul style="list-style-type: none"> <li>• Plesiochronous</li> <li>• Master-slave</li> <li>• Mutual</li> </ul>		
Distribution of timing signal - Typical synchronization chains		
<ul style="list-style-type: none"> <li>• PSTN</li> <li>• SDH</li> <li>• Distributed PRC</li> </ul>		

<b>Synchronization of Network Elements</b>		<b>Ref: NST-2</b>
Target Audience:	Planning managers, network planners, O&M experts, system engineers	
Prerequisites:	Basic understanding of telecommunications transmission principles, Network Synchronization Fundamentals (NST-1)	
Course Length:	1 day	
Description: This course provides deeper understanding of network synchronization practices for various telecom experts		
Content:		
<b>Synchronization of network elements</b>		
Network Clocks (Frequency references)		
<ul style="list-style-type: none"> <li>• Primary reference clocks</li> <li>• Primary reference quality clocks</li> <li>• Primary reference quality backup sources</li> <li>• Synchronization supply units</li> </ul>		
Synchronization of PDH elements		
<ul style="list-style-type: none"> <li>• Transmission elements</li> <li>• DXC-s</li> <li>• TDM Switches</li> <li>• Soft switches and media gateways</li> </ul>		
Synchronization of SDH elements		
<ul style="list-style-type: none"> <li>• General functionalities</li> <li>• Specialties of SDH elements</li> </ul>		
<b>Synchronization quality testing</b>		
Measured and derived sync quality parameters – TIE, MTIE and TDEV		
<ul style="list-style-type: none"> <li>• Definitions jitter, wander, holdover, source change</li> <li>• Standards and recommendations</li> <li>• Wander parameters and limit curves</li> <li>• Quality Monitoring</li> <li>• Testing and measuring</li> </ul>		

<b>Synchronization over NGN networks</b>		<b>Ref: NST-3</b>
Target Audience:	Planning managers, network planners, O&M experts	
Prerequisites:	Basic understanding of telecommunications transmission principles, Network Synchronization Fundamentals (NST-1), Synchronization of network elements (NST-2)	
Course Length:	1 day	
Description: This course provides deep understanding of network synchronization over IP		
Content:		
<b>Synchronization of NGN networks</b>		
<ul style="list-style-type: none"> <li>• Architecture comparison of 2G, 3G, 4G LTE networks</li> <li>• Requirements for synchronization in 2G, 3G, 4G LTE networks</li> <li>• Synchronization over Pseudowire, SAToP, TDMoIP, CESoPSN</li> <li>• Synchronous Ethernet, ESMC signaling</li> <li>• SyncE and legacy system synchronization</li> <li>• Loop protections and sample configurations</li> <li>• Interworking between TDM and packet synchronization</li> </ul>		
<b>Synchronization with IEEE1588V2 PTP protocol</b>		
<ul style="list-style-type: none"> <li>• IEEE 1588V2 and V1 specifications, overview of standards</li> <li>• Protocol principles, V2 additions</li> <li>• P2P and E2E transparent clocks</li> <li>• G.8265.1 Telecom profile detailed overview, SSM and Clock Classes</li> <li>• G.8275.1 PTP telecom profile for phase/time synchronization</li> <li>• LTE network scenarios with different sample configuration</li> <li>• Evolution</li> </ul>		

<b>Synchronization quality testing – hands-on exercises</b>		<b>Ref: NST-4</b>
Target Audience:	Planning managers, network planners, O&M experts, site engineers	
Prerequisites:	Basic understanding of telecommunications transmission principles, Network Synchronization Fundamentals (NST-1), Synchronization of network elements (NST-2), Synchronization of GSM networks (NST-3)	
Course Length:	1 day	
Description: This course provides theoretical and practical knowledge base on the sync system quality measurements		
Content:		
<p><b>Measured and derived sync quality parameters – TIE, MTIE and TDEV</b></p> <ul style="list-style-type: none"> <li>• Definitions jitter, wander, holdover, source change</li> <li>• Standards and recommendations</li> <li>• Wander parameters and limit curves - TDM</li> <li>• IEEE1588V2 PTP network quality indicators (PDV)</li> <li>• Demonstration of IEEE1588V2 PTP Protocol parameter effects on sync quality</li> <li>• Protocol level analysis methods and troubleshooting</li> </ul>		
<p><b>Sync quality measurement’s methodology</b></p> <ul style="list-style-type: none"> <li>• Principles of a comprehensive (network-wide) Network Synchronization Audit (Network nodes, interfaces and equipment types to be measured)</li> <li>• Measurement practices (Site visit order, length of data collection, parallel measurements in loop configuration, etc.)</li> </ul>		
<b>WORKSHOP</b>		

## Network Synchronization Workshop program - Optional

<b>Network Synchronization Workshop</b>		<b>Ref: NSW-1</b>
Target Audience:	Planning managers, network planners	
Pre-requisites:	Basic understanding of telecommunications transmission principles, Network Synchronization Fundamentals (NST-1), Synchronization of network elements (NST-2), Network Synchronization Planning (NST-3) courses.	
Duration:	2 days	
Description: Sync Network Planning workshop		
<p><b>Day 1: Preparation and analyzes for Sync Network Planning</b></p> <ul style="list-style-type: none"> <li>• Characterizing the services provided by the network and the synchronization demand of the main services</li> <li>• Review of current network structure from network synchronization point of view (Switch stations, main network hubs, transmission network and access link types and topologies, applied network elements and their synchronization requirements)</li> <li>• Overview of synchronization facilities, services and the quality of the installed network elements</li> <li>• Timing distribution connections between network layers (core, edge, access)</li> <li>• Interconnections with partner networks and carrier service providers with respect to timing signal supply and reception</li> </ul> <p><b>Day 2: Draft synchronization network architecture</b></p> <ul style="list-style-type: none"> <li>• Definition of basic synchronization rules applied to the network</li> <li>• Selection of master clock or synchronization gateway station(s) and planning the applied solution</li> <li>• Selection the sites for sync regenerators and planning the applied solution</li> <li>• Outline the sync network topology that best match with the actual network structure</li> <li>• Definition of typical intermediate network stations and their synchronization methods</li> <li>• List of suggested sync network element type with required port type and port capacity</li> </ul>		

# Advanced Network Synchronization Training

## Course details

Advanced Network Synchronization Training		Ref: ANST-1
Target Audience:	Planning managers, network planners, O&M experts, system engineers	
Prerequisites:	Basic understanding of telecommunications transmission principles	
Course Length:	3 days	
Description: This course provides higher level of network synchronization knowledge for telecom experts		
Content:		
<b>Day 1 - Fundamentals of network synchronization</b>		
Definition and backgrounds		
The need for synchronization		
Relevant synchronization standards and recommendations		
Synchronization of legacy (TDM) networks		
Migration paths to IP-based networks and systems		
<b>Day 2 – Sync network planning and operations aspects</b>		
Sync requirements of 2G/3G/4G mobile network elements		
Sync network design rules for TDM and IP-based network segments		
Sync operation in mixed (TDM and IP-based) technology environment		
Sync performance – quality parameters and control procedures to optimal KPIs		
<b>Day 3 – The future of network synchronization</b>		
Sync evolution: potential new synchronization methods and technologies		
Sync-related considerations before selecting new technology vendor		
Future-proof sync solutions		