

EXCENTIS TRAINING PORTFOLIO 2020

- CABLE NETWORK TECHNOLOGIES
- HFC
- (EURO)DOCSIS TECHNOLOGY AND PROTOCOL – LEVEL 1
- (EURO)DOCSIS TECHNOLOGY AND PROTOCOL – LEVEL 2
- (EURO)DOCSIS TECHNOLOGY&PROTOCOL REFRESHER
- eROUTER
- BSOD L2VPN
- DOCSIS 3.1 ESSENTIALS
- DOCSIS 3.1 OPERATIONS
- DOCSIS 3.1
- DISTRIBUTED CCAP ARCHITECTURES – R-PHY
- WI-FI BASICS
- WI-FI TECHNOLOGY & SERVICES
- INTRODUCTION TO EURO-PACKETCABLE
- FUNDAMENTALS OF EUROPACKETCABLE 2.0
- WORKSHOPS
- BYTEBLOWER WORKSHOP
- COMPANY TAILORED TRAINING

Date : July 2020

Excentis
Gildestraat 8, B-9000 Ghent, Belgium
Phone +32 9 269 22 94
training@excentis.com
<https://www.excentis.com>

We share our expertise with about 500 people per year

Strategy Excentis

- » We're not only trainers, we're also engineers tutoring from our **experience**
- » Combining theory with **practical insights**
- » **Independent** partner
- » Different **growth paths** based on job role and prior knowledge
- » **Interactive** training sessions
- » **Tailor-made** workshops using Excentis lab infrastructures
- » **Support** after the training

What to expect?

- » A list of just a few of benefits stated by our attendees:
 - › **Learn a lot** of “difficult specification” stuff **in a short amount of time, explained at the right level by an expert**
 - › **Knowledge clearly sticks**; interaction, quizzes, Q/A ensure that nothing will be forgotten afterwards
 - › **Practical tips** and knowledge, not just specification content, but also current status, trends and so on
 - › **Increasing efficiency**, trainees will thoroughly understand what they configure, monitor, engineer, debug, read and write support tickets about, etc.
 - › Practical situations encountered by attendees can be discussed, **giving** them many **pointers and true confidence**
 - › **Training paths and workshops** allow to dive deeper each time
 - › **A training certificate** from Excentis

Learning Paths

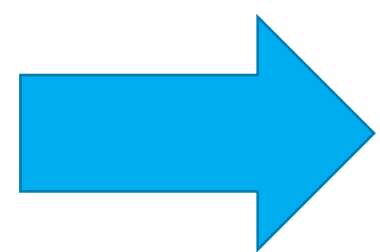
- » Experience has taught us that specific learning paths depend on participants' job roles or perspectives:
 - **Engineering** perspective
 - You really want to understand the technology you're working with; have real involvement for optimizations; fully understand discussions with vendors/operators and get rid of annoying issues to have time for new challenges, improving job satisfaction!
 - **Network operations** perspective (service support and exploitation)
 - You aim to understand what happens within the operational side, you eager to pinpoint any issues you observe and can understand and communicate this to anyone!
 - **Project management** perspective
 - You want to support the team, understand their technical challenges within a project, while creating a high job satisfaction atmosphere for anyone in the team!
 - **Non-technical** perspective
 - You'd like to know what the technical guys are doing but explained using a non-technical approach.

Expertise Level

- » Within a job role, you can reach certain levels of expertise:
 - › New in cable
 - › Professional
 - › Expert

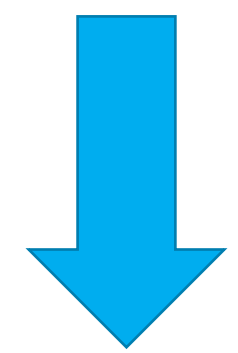
Network Operations and Support Path & Level

New in Cable	Professional	Expert
Cable Technologies ^(1d)	DataCommunications & HFC ^(0.5d)	(Euro)DOCSIS Technology & Protocol Level 1 ^(2d)
		[(Euro)DOCSIS Refresher] ^(0.5d)
		DOCSIS 3.1 for Operations ^(1d)
	<i>DOCSIS Workshop</i>	<i>DOCSIS Workshop</i>
	Wi-Fi Basics ^(1d)	
	<i>Wi-Fi Workshop</i>	<i>Wi-Fi Workshop</i>



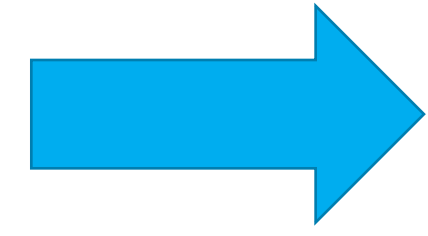
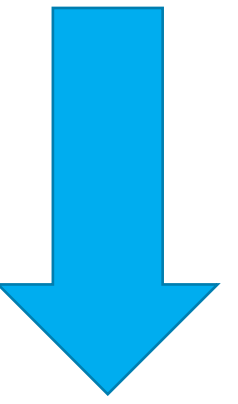
R&D and Engineering Path & Level

New in Cable	Professional	Expert
Cable Technologies (1d)	[(Euro)DOCSIS Refresher] (0.5d)	<i>DOCSIS Workshop</i> <i>Expert Modules</i>
DataCommunications & HFC (0.5d)	(Euro)DOCSIS Technology & Protocol Level 2 (2d)	
(Euro)DOCSIS Technology & Protocol Level 1 (2d)	DOCSIS 3.1 (2d)	
[(Euro)DOCSIS Refresher] (0.5d)	D-CCAP (0.5d)	
DOCSIS 3.1 Essentials (0.5d)	eRouter (0.5d)	
	L2VPN (0.5d)	
<i>DOCSIS Workshop</i>	<i>DOCSIS Workshop</i>	
Intro EuroPacketCable (2d)	EuroPacketCable 2.0 (2d)	
Wi-Fi Basics (1d)	Wi-Fi Technology & Services (2d)	
<i>Wi-Fi Workshop</i>	<i>Wi-Fi Workshop</i>	<i>Wi-Fi Workshop</i>



Project Management Path & Level

New in Cable	Professional	Expert
Cable Technologies ^(1d)	(Euro)DOCSIS Technology & Protocol Level 1 ^(2d)	D-CCAP ^(0.5d)
DataCommunications & HFC ^(0.5d)	[(Euro)DOCSIS Refresher] ^(0.5d)	eRouter ^(0.5d)
	DOCSIS 3.1 Essentials ^(0.5d)	L2VPN ^(0.5d)
<i>DOCSIS Workshop</i>	<i>DOCSIS Workshop</i>	<i>DOCSIS Workshop</i>
	Intro EuroPacketCable ^(2d)	EuroPacketCable 2.0 ^(2d)
	Wi-Fi Basics ^(1d)	Wi-Fi Technology & Services ^(2d)
<i>Wi-Fi Workshop</i>	<i>Wi-Fi Workshop</i>	<i>Wi-Fi Workshop</i>



CABLE NETWORK TECHNOLOGIES

OVERVIEW

HFC networks are able to provide multiple services over a single coaxial cable. This 1-day course provides a basic **overview of the elements in an HFC (Hybrid Fiber Coax) network and the services a cable operator offers.**

The target audience are professionals from the different departments like marketing, finance, operations, project management, ... who require a basic understanding of cable networks without too much technical details. Or people starting in telecom without any background. By attending this course they will have an insight of the technologies used in an HFC network. It will also give them an idea of the different interactions between different services.

WHAT CAN YOU EXPECT?

- Understand basic operation of an HFC network
- Insights in the world of IP and its future
- A view on where and how fiber optics are used in an operator network
- Get an idea on how wireless communication works
- Understand how internet services are provided over an HFC network
- Understand how telephony services are provided over an HFC network
- See how multimedia services can be provided
- Understand how television (analogue/digital) is delivered over an HFC network
- Get a view on some more possible services

COURSE INFORMATION

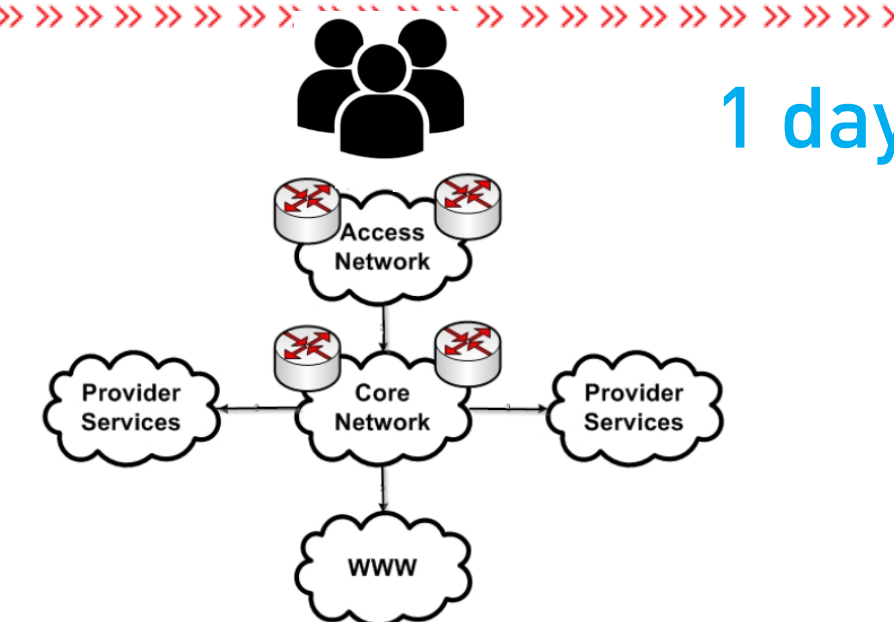
PREREQUISITES: There are no specific prerequisites for this course

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 1-day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com



COURSE CONTENTS

- **PART 1: INTRODUCTION**
Operator's network · Access network · Backbone · Services
- **PART 2: INTERNET PROTOCOL (IP)**
IP network · IPv4 · IPv6 · IP QoS · Multicast · DNS · OTT · Net neutrality
- **PART 3: OPTICAL NETWORKING**
Optical network · WDM/CWDM/DWDM · Fibre in HFC network and backbone · Sonet/SDH · Ethernet
- **PART 4: WIRELESS COMMUNICATION**
Spectrum · Wireless link · Antennas · Duplexing modes · Interference · LTE
- **PART 5: EURODOCSIS**
Goal · Components · EuroDOCSIS 1.0/1.1/2.0/3.0/3.1/4.0 (FDX) · DOCSIS vs. EuroDOCSIS
- **PART 6: VOIP**
POTS · VOIP · Interface with PSTN · Security · Lawful intercept
- **PART 7: (EURO)PACKETCABLE MULTIMEDIA**
Goals · Architecture · Components · Examples
- **PART 8: DIGITAL CABLE TELEVISION**
TV signal · Compression · Digital transport · Conditional Access · Middleware · Services · Switched broadcasting · TV over IP
- **PART 9: SERVICES**
Wi-Fi community · Cloud · FMC · Power-line communication

HFC

OVERVIEW

The Hybrid-Fibre-Coax (HFC) architecture has been adapted by many cable operators for internet, telephony and multimedia services. Understanding the performance of the individual components in an HFC network is important to estimate their impact on the communication signals in the return path (from customer to headend).

The course gives an **introduction to the architecture and the basic components of the return path of an HFC network**. Beside this, the attendee will get insight in the different sources of interference, their influence on the communication signals, and some appropriate mitigation techniques. The audience is typical people starting in cable (engineering, network operations, management, ...)

WHAT CAN YOU EXPECT?

- Understand the architecture of an HFC network
- Knowledge of the performance of basic components in the return path of an HFC network
- Understanding of sources of interference and of techniques to reduce interference

COURSE INFORMATION

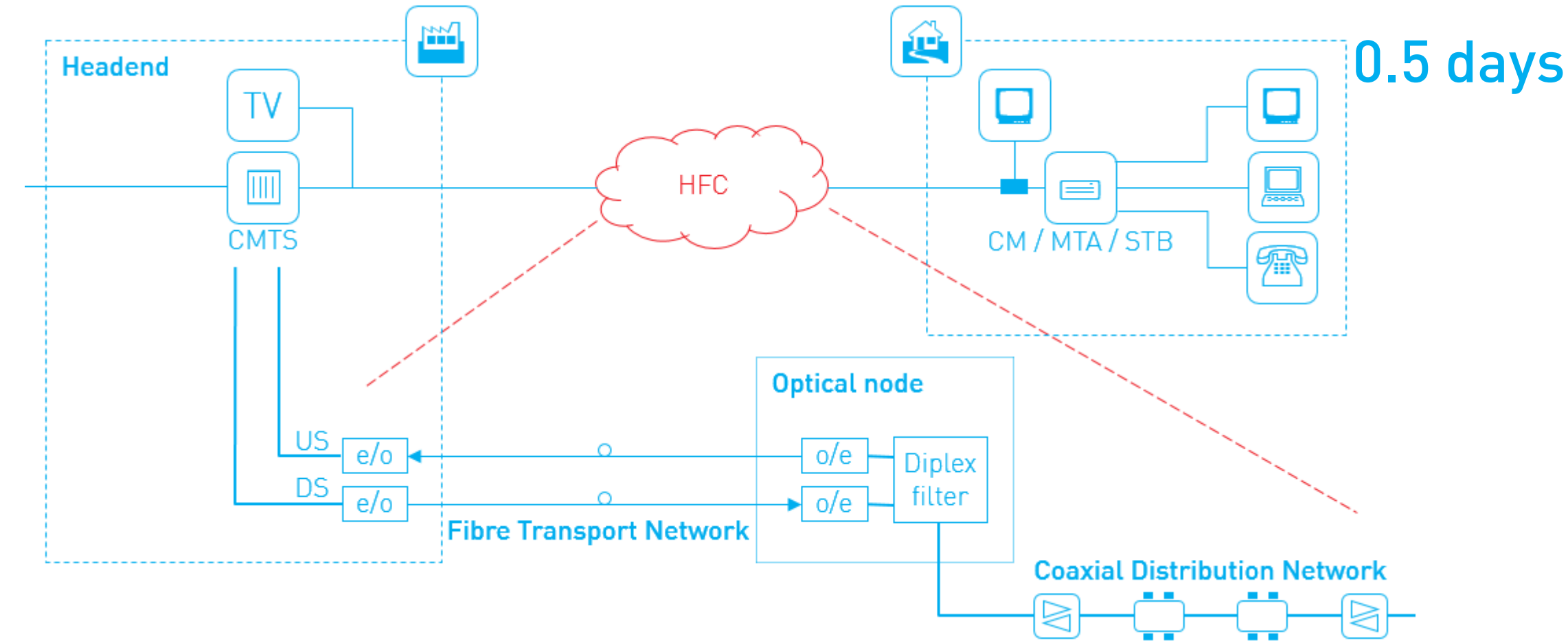
PREREQUISITES: Some experience with RF, basic electronics knowledge

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

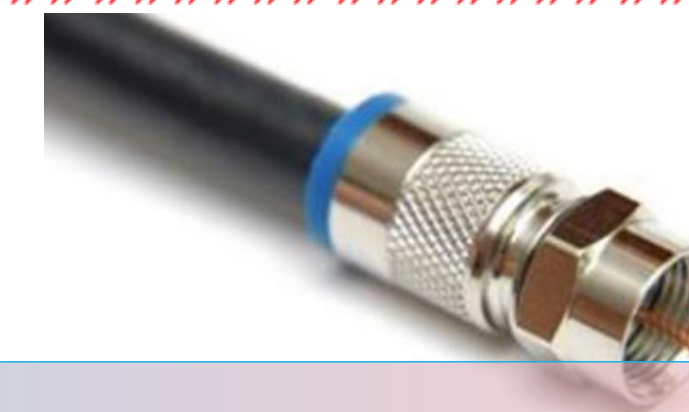
CONTACT: training@excentis.com



COURSE CONTENTS

- **PART 1: INTRODUCTION**
What is an HFC network?
- **PART 2: SIGNALS**
Down- and upstream · Voltage, power and frequencies
- **PART 3: HFC NETWORK ARCHITECTURE**
HFC and backbone · Optical nodes · Coaxial distribution plant
- **PART 4: COMPONENTS**
Passive: coaxial cable, splitter, tap, diplex filter, optical fibre
Active: amplifier, NTU, laser, photo detector, optical node
- **PART 5: NOISE**
Internal interference: intermodulation, thermal noise, group delay, amplitude flatness, micro-reflections, HUM modulation, fibre-optic noise
External interference: ingress, impulse noise and the entry points
- **PART 6: RETURN PATH NOISE MITIGATION**
Hardware techniques: optimal network installation, filtering of upstream components, equalization of attenuation, improved home network
Software techniques: frequency hopping, robust modulation techniques, FEC, interleaving

(EURO)DOCSIS TECHNOLOGY AND PROTOCOL – LEVEL 1



OVERVIEW

The (Euro)DOCSIS technology is the leading technology for broadband IP access in cable networks. The (Euro)DOCSIS cable networks are also the basis for all next generation packet-based services like VoIP, video conferencing and other high-speed multimedia services.

The Level 1 training comprehensively **covers all aspects of the (Euro)DOCSIS technology up to DOCSIS 3.1**. Hereby the fundamentals of the architecture, the cable modem's provisioning process, security issues and their solutions, quality of service, management and much more are explained. This being an excellent starting point for all people new to the real technical subjects and protocol level within (Euro)DOCSIS.

WHAT CAN YOU EXPECT?

- Achieve a comprehensive understanding of the ideas behind the (Euro)DOCSIS specifications up to DOCSIS 3.1
- Understand most important key issues and advantages when using (Euro)DOCSIS in your cable network
- Benefit from hands-on experience of Excentis' EuroDOCSIS certification testing
- After attending this course the attendee will be capable of understanding the (Euro)DOCSIS reference model and concepts

COURSE INFORMATION

PREREQUISITES: Some experience with RF and IP, basic electronics knowledge

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 2-day training / Dates Mutually agreed

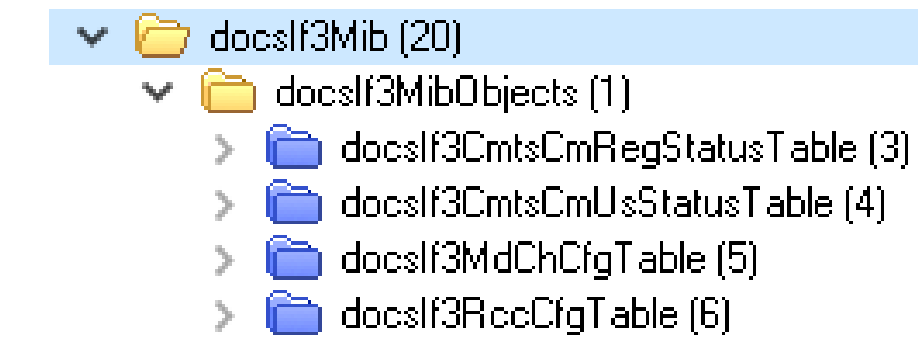
PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

COURSE CONTENTS

- **PART 1: GOALS AND MILESTONES**
EuroDOCSIS Goals and Milestones (1.0, 1.1, 2.0, 3.0, 3.1, 4.0)
- **PART 2: REFERENCE MODEL AND EVOLUTION**
(M-)CMTS, CM and CPE · HFC Network · Packet Forwarding · Evolution (R-PHY, MHA,CCAP,...)
- **PART 3: RANGING, REGISTRATION AND PACKET SCHEDULING**
Big Picture · Initial Problem · Ranging · Registration
- **PART 4: IP LAYOUT, DOCSIS CM AND CPE PROVISIONING**
Routing or Bridging · Assigning IP addresses
- **PART 5: CONFIGURATION FILES**
Usage, format and types
- **PART 6: QOS MECHANISMS**
Service Flows and Classifiers · Relation to VoIP · Management
- **PART 7: CHANNEL BONDING AND LOAD BALANCING**
Channel Bonding · Load Balancing
- **PART 8: SECURITY OVERVIEW**
Security Threats · Beating the threats · BPI(+)
- **PART 9: MULTICAST FORWARDING CONCEPTS**
MDF · Multicast QoS · Multicast Authorization · Multicast Encryption
- **PART 10: CONFIGURATION MANAGEMENT AND MONITORING**
OSSI · CLI · IPDR/SP · SNMP · NETCONF · Notification and Event Handling · (Proactive) Network Monitoring
- **PART 11: CHANNEL DEFINITION AND MODULATION**
SC-QAM Channels · OFDM · OFDMA
- **PART 12: RF ASPECTS**
(Euro) DOCSIS RF Frequencies and D3.1 extensions · CM and CMTS Tx and Rx performance

(EURO)DOCSIS TECHNOLOGY AND PROTOCOL – LEVEL 2



2 days

OVERVIEW

This Level 2 training is the continuation of Level 1, providing **in-depth content** and is **example driven**. This training is specially intended for people wanting to know more than only a view on how the fundamental concepts work. Using examples; configuring and monitoring of modem and CMTS are highlighted. This being very useful for troubleshooting and to be able to elaborate with vendors and operators on more **advanced topics**.

The new technology, DOCSIS 3.1, is only slightly touched here. To get deeper knowledge of specific DOCSIS 3.1 mechanisms, the DOCSIS 3.1 Essentials, DOCSIS 3.1 Operations and DOCSIS 3.1 Engineering trainings are foreseen.

WHAT CAN YOU EXPECT?

- Achieve a comprehensive in-depth understanding of concepts in the (Euro)DOCSIS specifications
- Understand key issues of the technology and protocol with a focus on how to configure a CM and CMTS and get feedback
- Be able to troubleshoot and communicate issues to vendors and operators
- Benefit from hands-on experience of Excentis' EuroDOCSIS certification testing
- After attending this course the attendee will be capable of understanding in-depth (Euro)DOCSIS concepts, configuration and monitoring

COURSE INFORMATION

PREREQUISITES: Attended the Technology & Protocol Level 1 training

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 2-day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

COURSE CONTENTS

- **OVERVIEW OF ALL SPECIFICATIONS AND TECHNOLOGY AREAS**
- **DOCSIS A-TDMA AND MODULATION PROFILES**
UCD fields, IUC, FEC, interleaver, preamble, pre-equalizer, ...
- **DOCSIS CHANNEL BONDING**
topology resolution, RCP, RCC, MDD, DSID, MRCM, TCC, SID-cluster, MTCM, attribute mask, DBC, partial service and CM-STATUS
- **DOCSIS ENERGY MANAGEMENT**
- **DOCSIS QOS CONFIGURATION, CONCEPTS AND FEEDBACK**
Scheduling types, classifiers, 3.x QoS enhancements
- **DOCSIS SECURITY – BPI MECHANISM**
EAE, AK, TEK, KEK, certificates, AES, revocation, BPI+ enforce
- **DOCSIS SECURITY – PACKET FILTERING (LLC, IP, UDC, SAV)**
- **DOCSIS SECURITY - CM SOFTWARE UPGRADE**
CVS, CVC, CSA, signing and co-signing
- **DOCSIS SECURITY – CONFIGURATION FILE SECURITY**
CM and (extended)CMTS-MIC, timestamping and CM IP address, D3.0 EAE, proxy TFTP
- **DOCSIS SECURITY – MANAGEMENT ACCES CONTROL**
- **DOCSIS VERSION COMPATIBILITY**
- **DOCSIS MONITORING AND PNM**
MIBS, RXMER VS. CCR VS. BER VS. CNIR VS. CER VS. ..., PNM
- **DOCSIS IP LAYOUT AND CPE PROVISIONING**
IPv6 layout + Prefix Delegation
- **DOCSIS CONFIGURATION FILES - EXAMPLES**
- **DOCSIS MULTICAST**
DSID forwarding, join authorization, QoS and encryption

(EURO)DOCSIS TECHNOLOGY&PROTOCOL REFRESHER



0.5 days

OVERVIEW

The (Euro)DOCSIS Technology & Protocol Refresher course **refreshes** in a half a day all fundamental aspects of the (Euro)DOCSIS technology up to DOCSIS 3.1. This course is meant for people who can benefit from a quick refresher of the previous attended Level 1 course. Mainly prior to attending the Level 2, DOCSIS 3.1, DCA or L2VPN trainings it is worth considering this quick refresher of the (Euro)DOCSIS fundamentals.

WHAT CAN YOU EXPECT?

- A quick refreshment/recap of the (Euro)DOCSIS Technology & Protocol course Level 1
- After attending this course the attendee will have refreshed its understanding of the (Euro)DOCSIS reference model, concepts, key issues and advantages

COURSE CONTENTS

- DOCSIS Reference Model and its evolution
- RF aspects
- Modem initialization: Ranging, Topology Resolution, Provisioning, Registration, Best Effort packet forwarding and QoS, Security and Monitoring

COURSE INFORMATION

PREREQUISITES: Attended the (Euro)DOCSIS Technology & Protocol Level 1 training or have equal knowledge of the technology and protocol

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

eROUTER

OVERVIEW

Today, most operators deploy cable modems with embedded router and NAT functionality, a basic set of requirements for this type of devices is defined by eRouter. This course describes the **different features** that need to be **supported by eRouter devices**, this includes NAT, IPv6, DS-lite and others. Additionally provisioning aspects of eRouter devices are also discussed.

WHAT CAN YOU EXPECT?

- Get insight into DOCSIS eRouter requirements
- Benefit from hands-on experience of Excentis' EuroDOCSIS certification testing

COURSE INFORMATION

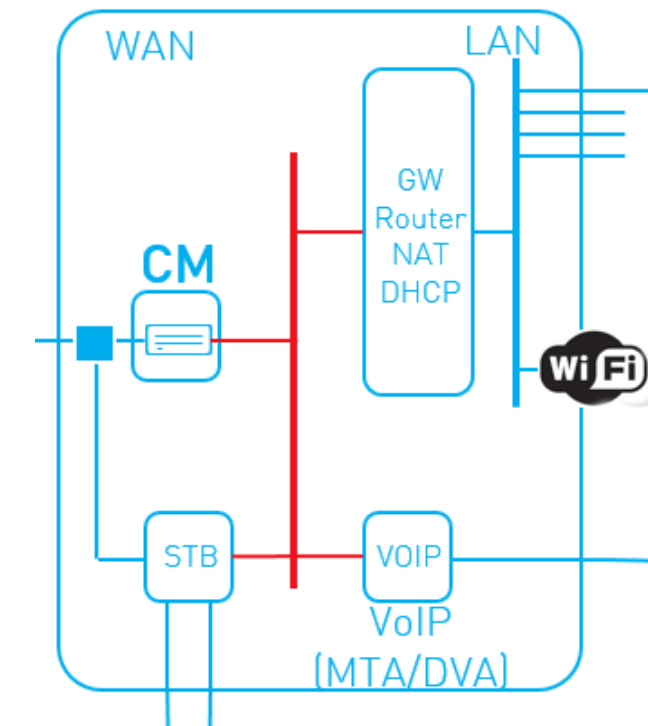
PREREQUISITES: Basic understanding of DOCSIS

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com



0.5 days

COURSE CONTENTS

- **PART 1: INTRODUCTION**
Specification overview (eRouter, RFC6204, RFC6204bis, HIPnet, CMrouter, eRouter, eDevice, eSAFE)
- **PART 2: THEORY OF OPERATION**
Protocol stack · Operational modes · Data forwarding in IPv4 (NAPT, ALG) and IPv6 · RA, SLAAC/DHCPv6/stateless DHCPv6 · DNS RDNSS · Prefix Delegation and division · DS-lite · Multicast · QoS · Security
- **PART 3: PROVISIONING AND MANAGEMENT**
Encapsulated configuration · TR-069 configuration · SNMP configuration · eRouter soft reset
- **APPENDIX**
MIBS and configurations objects

BSOD L2VPN

OVERVIEW

L2VPN is an optional part of the DOCSIS set of specifications. It provides possibilities for operators to deliver new **services to business customers**. This course provides an insight into the operation and configuration of the L2VPN technology. It is perfectly suited for engineers and operational people who need to have a thorough understanding of the issues and possibilities offered by the L2VPN DOCSIS technology.

WHAT CAN YOU EXPECT?

- Understand benefits and possibilities of DOCSIS L2VPN technology
- Understand operation and configuration of L2VPN DOCSIS operation

COURSE INFORMATION

PREREQUISITES: Basic understanding of DOCSIS

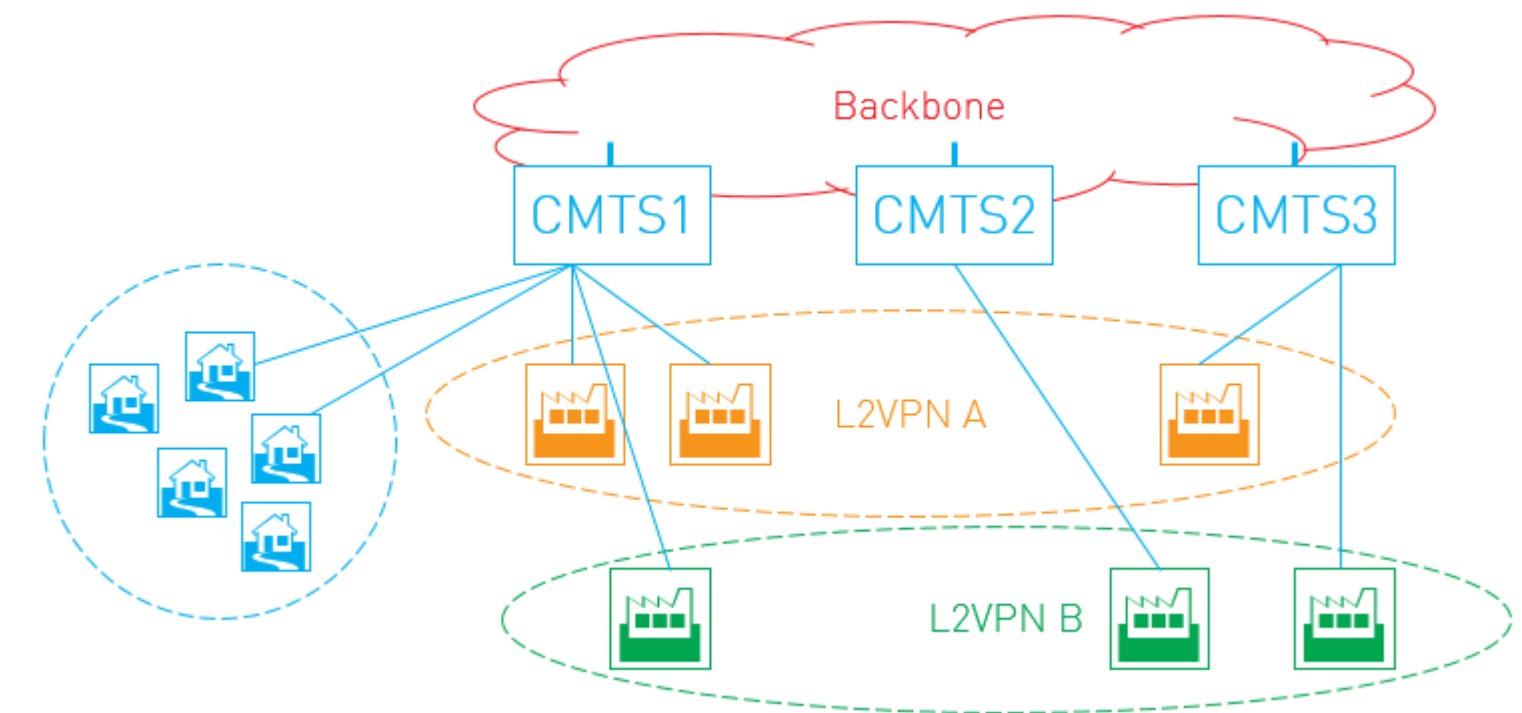
METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

0.5 days



COURSE CONTENTS

- **PART 1: COURSE OVERVIEW AND INTRODUCTION**
Operator network overview · DOCSIS reference model
- **PART 2: L2VPN TECHNOLOGY OVERVIEW**
VLAN (802.1q) · Stacked VLANs · MPLS · VPLS · L2TPv3
- **PART 3: BUSINESS SERVICES OVER DOCSIS: L2VPN**
Reference model · Point-to-point · Point-to-multipoint · Isolation and privacy · Multicast · QoS embedded host exclusion · Config file overview
- **PART 4: CONFIGURATION FILE EXAMPLES**

DOCSIS 3.1 ESSENTIALS

OVERVIEW

DOCSIS 3.1 is the latest version of the DOCSIS set of specifications, promising download speeds of up to 10 Gbps. It defines a totally new physical layer for achieving those speeds.

After attending this course the attendee will be capable of understanding the essential DOCSIS 3.1 concepts.

WHAT CAN YOU EXPECT?

- A quick and dense overview of the technological evolution and its advantages along with basic concepts introduced in DOCSIS 3.1
- An overview of the different features and characteristics without providing the exact mechanisms
- Understanding of the speeds that can be offered by 3.1 based on network parameters

COURSE INFORMATION

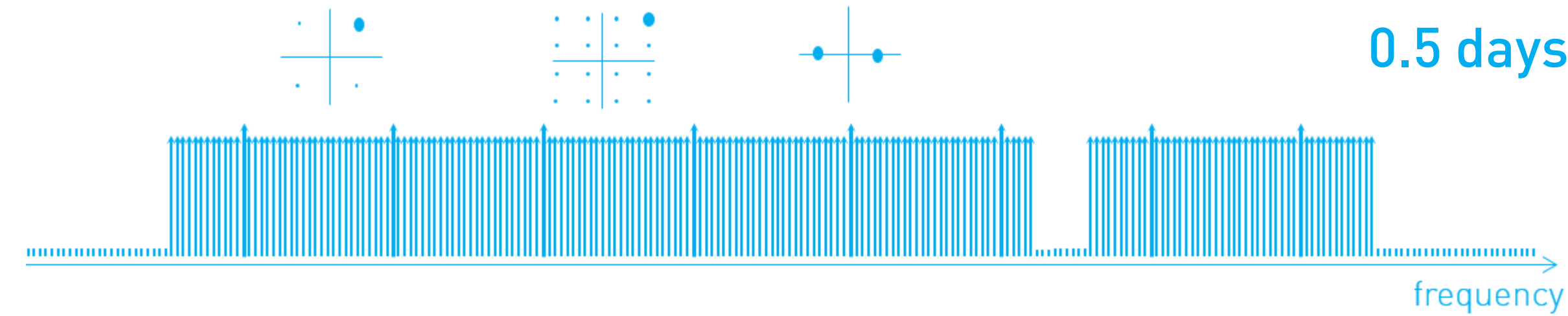
PREREQUISITES: Attended the (Euro)DOCSIS Technology & Protocol Level 1 training or have basic DOCSIS knowledge

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com



COURSE CONTENTS

- Introduction
- Evolved Telecommunication Systems
- Understanding OFDM + DOCSIS 3.1 OFDM Numerology
- LDPC/BCH
- Profiles (+profile promotion)
- Downstream Transmission
- Upstream Transmission
- CM Initialization
- Features and Other Changes
- Preparing for the Transition

DOCSIS 3.1 OPERATIONS

OVERVIEW

DOCSIS 3.1 is the latest version of the DOCSIS set of specifications, promising download speeds of up to 10 Gbps. It defines a totally new physical layer for achieving those speeds. However, to fully utilize its features, major HFC network upgrades are required and the operational side shows quite some differences. This DOCSIS 3.1 training is targeted for people who need a view on DOCSIS 3.1 from the **operations point of view**. The fundamentals of DOCSIS 3.1 are explained and enriched with 3.1 operational monitoring subjects. This training is especially suited for people having to look at the network performance and help to support technical challenges.

WHAT CAN YOU EXPECT?

- Achieve an understanding of technological evolution and its advantages along with basic new concepts introduced in DOCSIS 3.1
- A look at network performance expectations and how efficiency is increased
- Be able to understand operational monitoring of DOCSIS 3.1
- After attending this course the attendee will be capable of understanding DOCSIS 3.1 concepts and perform operational monitoring of DOCSIS 3.1

COURSE INFORMATION

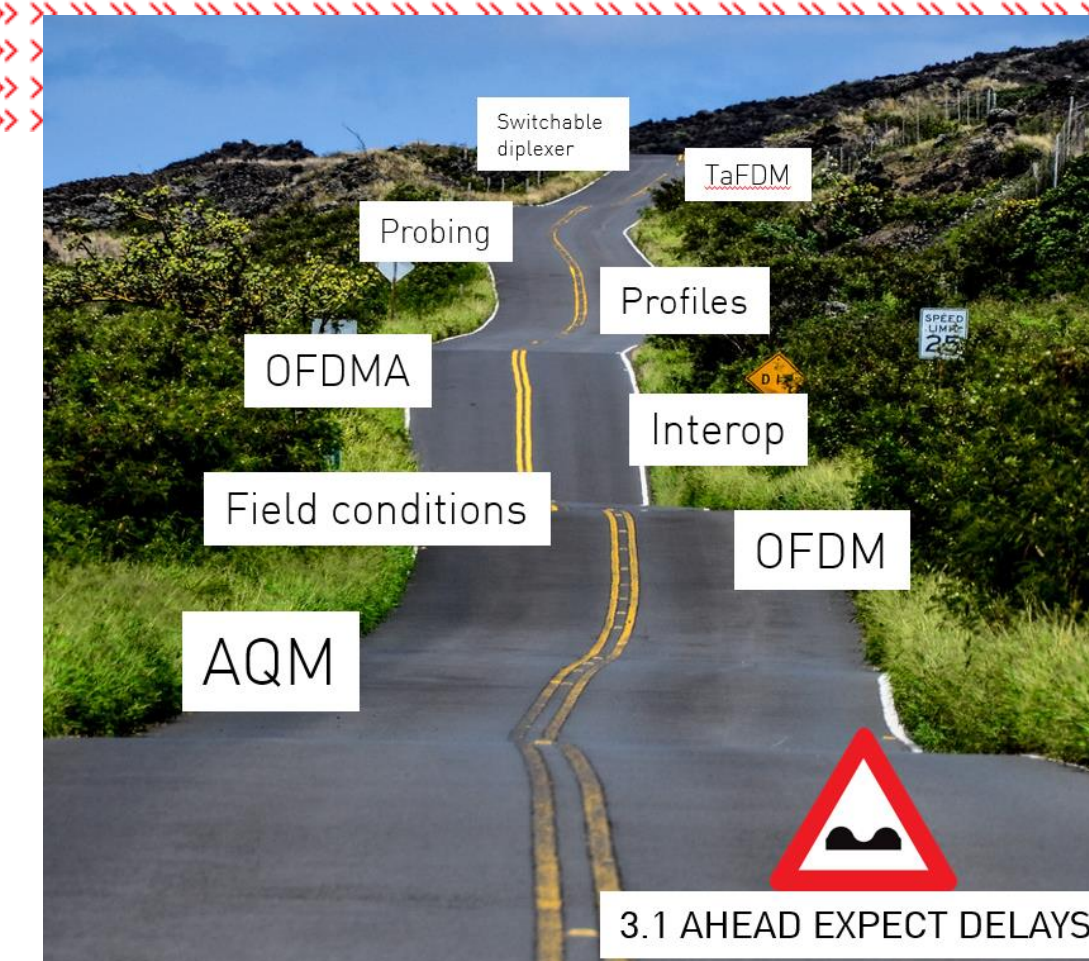
PREREQUISITES: Attended (Euro)DOCSIS Technology & Protocol Level 1 training

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 1-day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

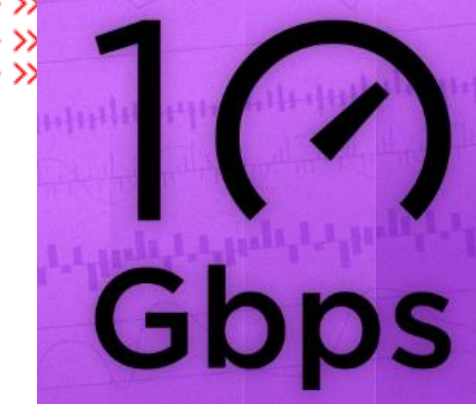


1 day

COURSE CONTENTS

- **PART 1: INTRODUCTION**
Historical perspective Capacity potential
- **PART 2: EVOLVED TELECOMMUNICATION SYSTEMS**
Understanding OFDM · DOCSIS 3.1 OFDM numerology · Benefits of LDPC error correction
- **PART 3: PROFILES**
Profile definition · Concepts and consequences
- **PART 4: CABLE MODEM INITIALIZATION**
Ranging and registration · New 3.1 Initialization Features
- **PART 5: DOWNSTREAM DATA TRANSMISSION**
PHY Link Channel (PLC) · OFDM Channel Descriptor (OCD) · Downstream Profile Descriptors (DPD)
- **PART 6: UPSTREAM DATA TRANSMISSION**
OFDMA scheduler · TaFDM
- **PART 7: FEATURES AND OTHER CHANGES**
DTP · Active Queue Management (AQM) · Hierarchical QoS (HCoS) · Energy Management · DOCSIS Light Sleep (DLS) · PKI certificate signing changes · Software upgrade
- **PART 8: NEW OPERATIONAL CONCEPTS**
Expected timelines and scenario's · 3.1 Network Architecture Evolution · OFDM Parameter Feedback · Profile Management · PNM Concepts

DOCSIS 3.1



2 days

OVERVIEW

DOCSIS 3.1 is the latest version of the DOCSIS set of specifications, promising download speeds of up to 10 Gbps. It defines a totally new physical layer for achieving those speeds. However, to fully utilize its features, major HFC network upgrades are required.

The goal of this **engineering course** is to provide insight into how the new physical layer operates, the impact on the network and how the HFC network needs to be modified. The course also provides a good understanding of the speeds that can be offered by 3.1 based on network parameters.

It is recommended that the attendee already has a good knowledge of DOCSIS to fully benefit of attending this course.

WHAT CAN YOU EXPECT?

- Achieve an in-depth understanding of the technological evolution and its advantages along with the new concepts introduced in DOCSIS 3.1
- An overview of different features and characteristics
- Calculation of speeds that can be offered by 3.1 based on network parameters
- After attending this course the attendee will be capable of understanding DOCSIS 3.1 concepts, numerology, configuration and monitoring

COURSE INFORMATION

PREREQUISITES: Attended Technology & Protocol Level 1 training

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 2-day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

COURSE CONTENTS

- **PART 1: INTRODUCTION**
Historical perspective
- **PART 2: TECHNOLOGY OVERVIEW**
Expanded spectrum, New channel definition · Increased bandwidth · Overview of 3.1 technology and functionality
- **PART 3: NEW TOOLS IN THE BOX**
Modern data communication systems · Understanding OFDM, subcarriers, pilots, cyclic prefix, windowing roll-off and equalization · DOCSIS 3.1 OFDM numerology · LDPC
- **PART 4: DOWNSTREAM DATA TRANSMISSION**
3.1 downstream and its transmitter/receiver · PHY Link Channel (PLC) · OFDM Channel Descriptor (OCD) · Downstream Profile Descriptors (DPD) · Next Codeword Pointer (NCP) · Profiles
- **PART 5: UPSTREAM DATA TRANSMISSION**
3.1 upstream and its transmitter/receiver · Minislot definition · OFDMA Upstream Data Profiles · CCF · Minislot mapping · Unused and excluded subcarriers · TaFDM
- **PART 6: CABLE MODEM INITIALIZATION AND PROFILE PROMOTION**
Ranging and registration · Downstream profile management · OFDM Profile Test (OPT) · CM-STATUS · Upstream profile testing
- **PART 7: FEATURES**
DTP · Advanced Queue Management (AQM) · Hierarchical QoS (HQoS) · DOCSIS Light Sleep (DLS) · PKI signing changes & software upgrade · DOCSIS Low Latency
- **PART 8: PREPARING FOR THE 3.1 TRANSITION**
Expected scenario's · Capacity calculation · HFC network readiness · Power levels and physical layer implications · PNM

DISTRIBUTED CCAP ARCHITECTURES – R-PHY

OVERVIEW

As bandwidth capacity needs grow rapidly, there is increasing pressure on headend and HFC infrastructure. New modular distributed headend architectures are hot topics to address the need for smaller scale and more flexible options. The basic idea around Distributed Access Architectures (DAA) is to **distribute** some or all of the **functionality** of **CMTS/CCAP from headend down to a remote location**.

If you want to know why distributed architectures are a hot topic, what Remote PHY is all about, what the difference with a Remote CCAP architecture is... then this course is for you. We will take a look at the specs, not the marketing.

WHAT CAN YOU EXPECT?

- Gain key insights in current and future remote cable architectures
- R-PHY & R-MAC-PHY advantages and challenges
- Get to know the protocols (GCP, R-DEPI/R-UEPI, R-DTI) R-PHY is using to make this (more complex) distributed system work
- Synchronize time using PTP
- How to provision and monitor all the RPDs, and upgrade them,...
- How to add analog services over the new digital optics using Out Of Band (OOB)
- How to compare R-PHY with R-MAC-PHY solutions

COURSE INFORMATION

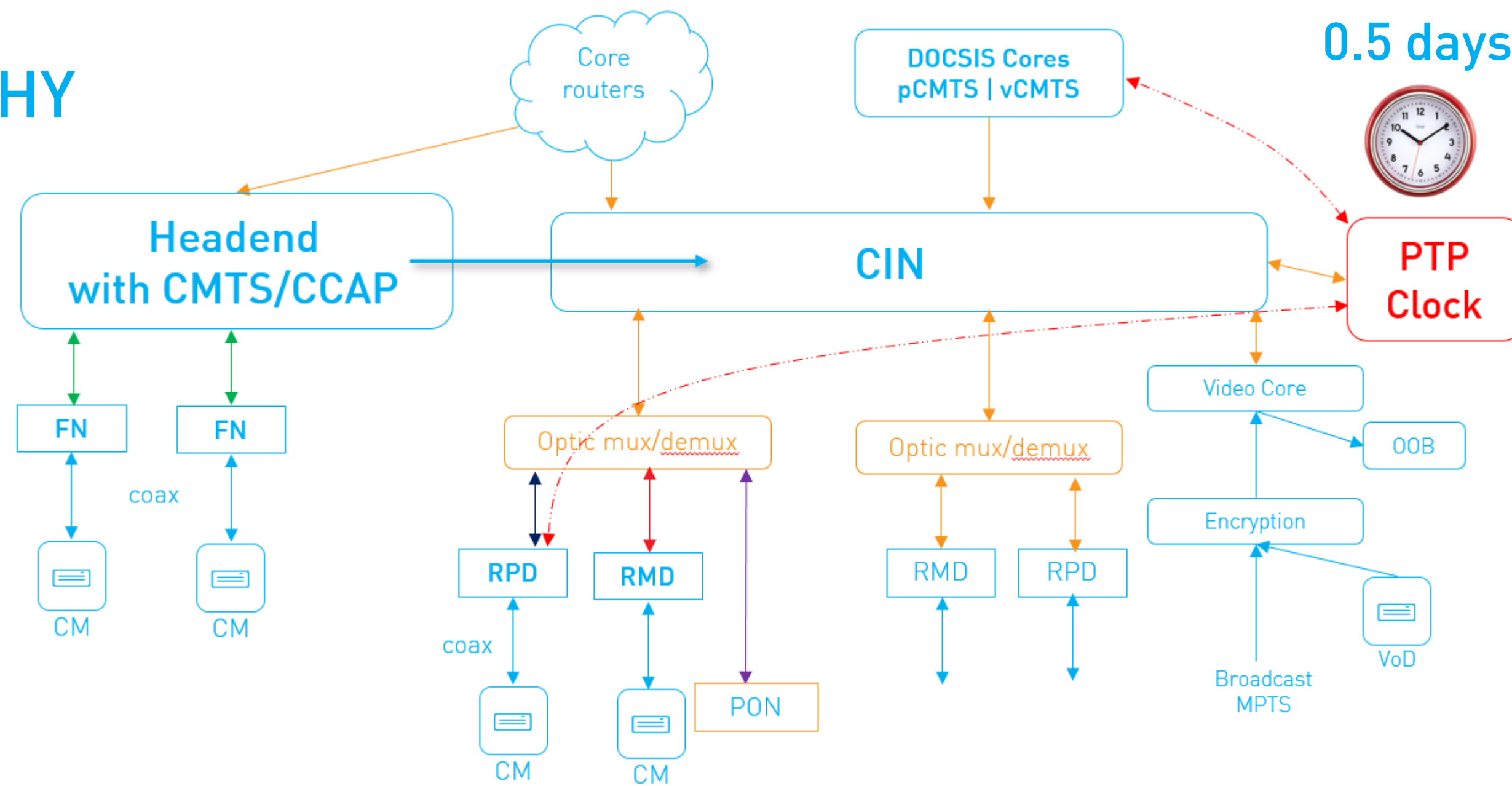
PREREQUISITES: Understand the architecture of an HFC network and basic understanding of (Euro)DOCSIS technology

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com



COURSE CONTENTS

- **PART 1: HEADEND EVOLUTION**
Driving forces · Challenges · Evolution of CMTS and HFC architectures
- **PART 2: DISTRIBUTED CCAP ARCHITECTURES: AN OVERVIEW**
Remote PHY · Remote MAC + PHY · C-DOCSIS I, II, III · SPLIT-MAC, ...
- **PART 3: MHA V2 – REMOTE PHY**
MHA review and MHA v2 architecture · GCP Control plane · R-DEPI and R-UEPI data plane · R-DTI and PTP timing and synchronization · Provisioning and configuration of R-PHY device · RPD software upgrade
- **PART 4: REMOTE MACPHY**
R-MAC-PHY system examples

Wi-Fi



OVERVIEW

Wi-Fi has become almost as essential as food, water and shelter. Wi-Fi issues have become the demon for both customers and ISPs and among the biggest problems are common misunderstandings about Wi-Fi.

This course provides a **thorough understanding of Wi-Fi networks and the issues that surround them**. It explains current standards, including Wi-Fi 6, and technology aspects, as well as new market developments.

The course also provides the basics on how to plan, deploy and troubleshoot Wi-Fi networks.

WHAT CAN YOU EXPECT?

- Understand current Wi-Fi standards, their options, their performance and limiting factors
- Wi-Fi 6 promises interesting improvements in latency, throughput, range, power consumption, but how do they work and achieve what is promised?
- Learn how to successfully plan and deploy a residential Wi-Fi network
- Learn the basics of Wi-Fi troubleshooting

COURSE INFORMATION

PREREQUISITES: Understanding of Ethernet

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: 1-day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

COURSE CONTENTS

- **PART 1: THE Wi-Fi PHYSICAL LAYER**
Technology overview · Wi-Fi 6 (802.11ax) · Modulation techniques · OFDMA · Channels · DFS · Wi-Fi 6E · Antennas · EIRP · (MU-)MIMO · Link adaptation algorithm
- **PART 2: THE Wi-Fi MAC LAYER**
Packet transmission · BSS color · QoS (WMM) · Beacon · Making a connection · Security · WPA3 · Roaming · Power efficiency (TWT)
- **PART 3: Wi-Fi NETWORK PLANNING**
Coverage definition · Attenuation · Interference · Network components · Mesh · Transmit power · Troubleshooting and tools
- **PART 4: CASE STUDIES**

Wi-Fi 6



OVERVIEW

Wi-Fi has become almost as essential as food, water and shelter. As many other technologies, also Wi-Fi gets improved all the time.

This course covers all concepts of the latest Wi-Fi technology, called Wi-Fi 6 or 802.11ax. It is ideally suited for everyone who previously followed a Wi-Fi training when Wi-Fi 6 wasn't out yet. Want to know what Wi-Fi 6 promises and how it will achieve that: register for this Wi-Fi 6 training.

WHAT CAN YOU EXPECT?

- We debunk all the myths that surround the buzzwords such as OFDMA, MU-MIMO, BSS coloring, TWT and much more.
- These new technology features promise interesting improvements in latency, throughput, range, power consumption, but how do they work and achieve what is promised?
- What about Wi-Fi 6E? How will this play a role in the future of Wi-Fi: Europe vs US?

COURSE INFORMATION

PREREQUISITES: Understanding of previous Wi-Fi technologies

METHODOLOGY: Instructor-led course, slides and notes on a digital platform, interactive quizzes, support afterwards

COURSE DURATION: half a day training / Dates Mutually agreed

PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)

CONTACT: training@excentis.com

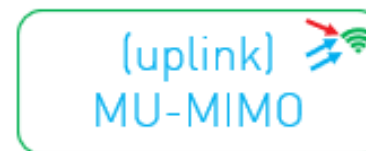
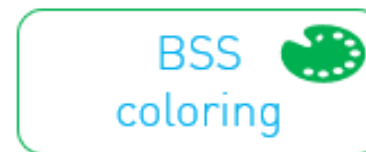
COURSE CONTENTS

- **Wi-Fi 6 - 802.11ax**
 - Introduction
 - Technology evolution
 - Wi-Fi 6E
 - OFDMA
 - Increased guard interval
 - Uplink MU-MIMO
 - BSS coloring
 - Target wake time
 - WPA3

Lower latency



High-density environments



IoT



Wi-Fi HANDS-ON



OVERVIEW

Wi-Fi has become almost as essential as food, water and shelter. As many other technologies, also Wi-Fi gets improved all the time. This hands-on workshop allows to have exclusive insights in Wi-Fi testing (stability, performance benchmarking, features) at Excentis Wi-Fi testing facilities. This is a highly valued approach of learning everything that was discussed in theory in practice. It is ideally suited for everyone who previously followed a Wi-Fi training.

COURSE CONTENTS

- **Analysis of Wi-Fi connections**
- **Wi-Fi technology testing**
 - Airtime fairness
 - Throughput
 - Roaming
 - Security
 - Other feature support

WHAT CAN YOU EXPECT?

- Take captures and analyze the Wi-Fi communication between AP's and clients
- Execute expert-led exercises such as validating airtime fairness, throughput, roaming, security, and other feature support.

COURSE INFORMATION

PREREQUISITES: Understanding of Wi-Fi
METHODOLOGY Instructor-led interactive hands-on exercise session
COURSE DURATION: 1-day / Dates Mutually agreed
PUBLIC + IN-COMPANY COURSES: At Excentis or on-site in different languages (English, German, French or Dutch)
CONTACT: training@excentis.com

WORKSHOPS

OVERVIEW

The workshops are based on a **mutual predefined scope and time**. The purpose is to have a custom workshop **session** with a group of people of the same company **led by a subject expert**. That way specific content can be discussed, or a more **practical approach is possible**. The workshops are still trainings but can be guided by the trainees, the workshops are however not intended as consultancy to solve individual problems.

Example workshops that we currently offer are the ByteBlower, (Euro)DOCSIS, Wi-Fi and XRA-31 workshop. Workshops are always tailored on a specific demand and the content need to be agreed on prior to getting an individual offer.

WHAT CAN YOU EXPECT?

- A subject expert leading an interactive training session
- Be able to ask all your questions within a predefined scope
- Ability to have hands-on using Excentis lab or your own lab setups

COURSE INFORMATION

PREREQUISITES: Depends on the topics of the workshop

METHODOLOGY: Instructor-led interactive training session

COURSE DURATION: Depends on the topics to cover / dates mutually agreed

PRIVATE TRAINING: At Excentis or on-site

For availability in different languages (English, German, French or Dutch) please

contact training@excentis.com

CONTACT: training@excentis.com



x days

COURSE CONTENTS

To be defined

Example topics (Euro)DOCSIS:

- CMTS CLI configuration and feedback
- Monitoring using SNMP MIBs
- Creating a (Euro)DOCSIS HFC or lab network
- Analysis of spectrum and modulation
- Simulating customer traffic using the ByteBlower traffic generator/analyser
- Creating a modem config file and testing the applied settings
- Setting up voice calls
- Taking RF captures and analysis

BYTEBLOWER WORKSHOP



OVERVIEW

ByteBlower is a TCP/IP traffic generator/analyzer tool to perform exhaustive tests on IP networks and networking equipment, either in a lab environment or in real-life networks.

This 1-day workshop provides a detailed overview of ByteBlower. It covers the ByteBlower components, the flexibility of the GUI and the power of the API.

The ByteBlower server, including the installation and update process, is also covered in detail.

Target audience for this workshop are all users of the Excentis ByteBlower traffic generator.

This workshop is only available when a company contracts to host it for a group of participants.

WHAT CAN YOU EXPECT?

- Achieve a comprehensive understanding of ByteBlower, its components and software
- Get a grasp of the possibilities of ByteBlower
- An interactive workshop with examples, questions and answers

COURSE INFORMATION

PREREQUISITES: Ethernet, TCP/IP

METHODOLOGY: Instructor-led interactive training session

COURSE DURATION: 1 day / dates mutually agreed

PRIVATE TRAINING: At Excentis or on-site

For availability in different languages (English, German, French or Dutch) please

contact training@excentis.com

CONTACT: training@excentis.com

COURSE CONTENTS

- **PART 1: INTRODUCTION TO BYTEBLOWER**
Main concepts of ByteBlower and traffic testing
- **PART 2: THE BYTEBLOWER SERVER**
ByteBlower server, installation and update process
- **PART 3: THE BASICS OF THE BYTEBLOWER GUI**
First steps with the GUI: wizards, views, ...
- **PART 4: IPv4 TESTING USING THE BYTEBLOWER GUI**
Full possibilities of ByteBlower GUI for testing IPv4 networks (unicast, multicast, ...)
- **PART 5: IPv6 TESTING USING THE BYTEBLOWER GUI**
Full possibilities of ByteBlower GUI for testing IPv6 networks (unicast, multicast, ...)
- **PART 6: THE BYTEBLOWER COMMAND LINE INTERFACE**
Running tests without a graphical environment
- **PART 7: INTRODUCTION TO THE BYTEBLOWER TCL INTERFACE**
An initiation to automation and scripting using ByteBlower API

COMPANY TAILORED TRAINING

OVERVIEW

Excentis also has experience in offering a company specific tailored training on topics related to cable network technologies and services, (Euro)DOCSIS, Wi-Fi. With such a **customized training** the content can be **adapted to the specific network conditions, services, operations, monitoring, ... of the cable operator.**

WHAT CAN YOU EXPECT?

- Customized training content made together with the client
- Professional slide material

COURSE INFORMATION

PREREQUISITES: Depends on the topics of the workshop

METHODOLOGY: Instructor-led interactive training session

COURSE DURATION: Depends on the topics to cover / dates mutually agreed

PRIVATE TRAINING: At Excentis or on-site

For availability in different languages (English, German, French or Dutch) please

contact training@excentis.com

CONTACT: training@excentis.com



T
R
A
I
N
I
N
G

x days

COURSE CONTENTS

- To be defined

Example topic

- Cable Technologies and services overview for a specific operator
 - For administrative people
 - For technicians
 - For engineers
 - For managers

Practicalities

» LOCATION

- › Trainings can take place on-site at the client's facilities or at Excentis' offices
- › When travelling is not an option, contact us regarding options for live online sessions

» TIME SCHEDULE

- › Public sessions:
 - Full day classes: 09:30h - 17:00h
 - Half day morning classes: 09:30h - 13:00h
 - Half day afternoon classes: 14:00h - 17:00h
- › On-demand sessions:
 - Dates and time mutually agreed

Practicalities

» REGISTRATION

- › For individual people, please use the online registration forms on the Excentis website
- › For groups a quote can be requested or a training campaign can be offered
- › Excentis needs a minimum of four participants to have a session take place

» LANGUAGES

- › For availability in different languages (English, German, French or Dutch) please contact training@excentis.com

If our attendees say it ... a few quotes

- » It was a great training course, as always! The trainers are skilled and know what they are talking about, thumbs up.
- » I like that we were a smaller group, which made it more interaction with the instructor possible. Being able to relate what we are learning to what we are doing in our own network is very valuable.
- » The training course has given me the confidence I need to work further on this topic myself.
- » This was one of the best training courses I've had so far. I was especially impressed by the level of knowledge of the trainer, no question was left unanswered. Looking forward to my next session from Excentis!
- » Very good tempo, not boring, very interactive and inspiring with plenty of possibilities to ask for clarifications if needed.
- » Come as a novice, leave as an expert!
- » Good meaningful content, highly knowledgeable trainers & very well presented.
- » You guys really know how to teach those complex techniques in an interesting manner in detail while the topics are still clearly described!

“The trainer was a true expert in the technology and has excellent communication skills. All course attendees were highly impressed.”