

## MEF Carrier Ethernet 2.0 Certification Training

5-day instructor-led course with certification exam taken on afternoon of Day 5.

### At the end of this course, course attendees should be able to:

- Discuss and understand key Carrier Ethernet Concepts,
- Understand tasks related to designing, deploying and maintaining a Carrier Ethernet network,
- Offer effective solutions to implementing a Carrier Ethernet enterprise network given available customer resources and requirements,
- Carry out informed discussions using industry Carrier Ethernet ‘vocabulary,’ and
- Pass the MEF CECP 2.0 professional accreditation exam.

**Course Prerequisites:** The course attendees need to be conversant with data networks, as well as Ethernet and IP technologies.

### Section One: Understanding Carrier Ethernet

At the end of this section, course attendees will have a thorough understanding of what is involved in the setting up of a Carrier Ethernet service, in order to understand subsequent course matter in context. Specific examples of actual equipment, management systems and architectures typically implemented in actual real-life deployments are used to explain these concepts. The animated presentation further helps the attendees identify how various aspects of a Carrier Ethernet service are practically provisioned.

<b>Introduction to Carrier Ethernet</b>	What is Carrier Ethernet?	
	Brief outline of Carrier Ethernet Evolution	
	Advantages of Carrier Ethernet	Why is Carrier Ethernet so successful?
	The MEF	<ul style="list-style-type: none"> <li>• The Work of MEF</li> <li>• Key MEF Specifications</li> </ul>
	High Level Definitions	UNI, EVC, OVC, EPL/EVPL, EP-LAN/EVP-LAN, EP-Tree/EVP-Tree, etc, overview (detail in Section Two)
<b>How Carrier Ethernet Works</b>	Service Frame Handling Overview	C-tagging, S-tagging, MPLS label tagging, etc overview (detail in Section Two)
	Carrier Ethernet classic architecture	<ul style="list-style-type: none"> <li>• Carrier Ethernet at the Customer Premises</li> <li>• Carrier Ethernet in the Metro (metro rings, aggregation and homing nodes, etc)</li> <li>• The Carrier Ethernet Core (regional, national and global architectures and interconnects)</li> </ul>
	Animated overview of how Carrier Ethernet Works	<ul style="list-style-type: none"> <li>• Where UNI attributes are positioned</li> <li>• Where Service Attributes (EVC and EVC per UNI attributes) are positioned</li> <li>• How and where Bandwidth Profiles are applied</li> <li>• Where tagging and service multiplexing is applied</li> <li>• Where L2 protocol processing takes place</li> </ul>
	Examples of Carrier Ethernet equipment	Customer premise equipment, aggregation and homing nodes, core equipment.
	Examples of Carrier Ethernet management systems	
<b>The Setting Up of a Carrier Ethernet Service</b>	Step 1: Choose service type	EPL/EVPL, EP-LAN/EVP-LAN, EP-Tree/EVP-Tree, EVLine, etc
	Step 2: Customer Premise equipment tasks	UNI-C tasks (UNI attributes, service attributes (EVC and EVC per UNI) and bandwidth profiles)
		UNI-N tasks (L2 protocol handling)
	Step 3: Non-CPE tasks	Access, metro and core connections set up

## Section Two: Carrier Ethernet Concepts in depth

In this section, Carrier Ethernet concepts are studied in depth, with the aim of enabling the student to master these ahead of their application to the Attributes section next. A thorough understanding of these concepts will enable the student to carry out complex Carrier Ethernet job tasks with ease, and also to pass the exam without 'cramming' text.

<b>Carrier Ethernet Definitions in Depth</b>	UNI	UNI I & II, UNI-N and UNI-C, etc
	NNI/ENNI	
	EVC	
	OVC	<ul style="list-style-type: none"> <li>• OVC type (P2P, M2M, Rooted MP)</li> <li>• OVC end point (root, leaf, trunk)</li> <li>• OVC end point map</li> <li>• OVC end point bundling</li> </ul>
	Carrier Ethernet Service types in detail	EPL/EVPL, EP-LAN/EVP-LAN, EP-Tree/EVP-Tree, EVLine, Access EPL and Access EVPL
<b>Carrier Ethernet Service Frame Handling</b>	Frame Delivery	<ul style="list-style-type: none"> <li>• Unicast, multicast and broadcast frame delivery (Conditional/unconditional delivery, etc)</li> <li>• Tagged, untagged and priority</li> </ul>
	Tagging	<ul style="list-style-type: none"> <li>• C and S-Tags</li> <li>• 802.3, 802.1d, 802.1q, 802.1ad, 802.1ah evolution</li> <li>• VLAN ID translation/preservation. Also contrast with CoS preservation</li> </ul>
<b>Other Key Carrier Ethernet Concepts</b>	Carrier Ethernet MTU	MTU at UNI, MTU at ENNI
	Physical Layer Attributes	FastEthernet, Gigabit and 10Gigabit Ethernet IEEE Std 802.3 – 2005
	Service Multiplexing and Bundling	Concept and detail, rules and implications
	Hairpin Switching	
<b>Managing Bandwidth in a Carrier Ethernet Network</b>	The Token Bucket Algorithm and the Concept of Frame Colors	Token Bucket Algorithm in the Context of Carrier Ethernet (EIR, CIR, CBS, EBS, Coupling Flag, etc.)
	Color concepts	<ul style="list-style-type: none"> <li>• Color in relation a service frame's status</li> <li>• Frame Handling/Delivery (recoloring)</li> <li>• Color Awareness attribute</li> <li>• Color Forwarding</li> </ul>
	Bandwidth Profiles	<ul style="list-style-type: none"> <li>• Bandwidth Profile rules and concepts (Ingress, Egress, Max no. classes of service, etc)</li> <li>• MEF permissible CoS identifiers, DEI bit value (in S-Tag), PCP bit value (in C-Tag or S-Tag), or DSCP value (in IP header).</li> <li>• Multi-flow bandwidth concepts (Token share, etc)</li> </ul>
	CoS	<ul style="list-style-type: none"> <li>• CoS rules and concepts (CoS Labels, Performance Tiers, Geographical Tiers, etc)</li> <li>• CoS Label and Color Identification Using PCP Bits, DEI Bit, and/or EVC/OVC End Point</li> </ul>

## Section Three: Carrier Ethernet Service Attributes

The 'meat and bones' of Carrier Ethernet. At the end of this section, course attendees will have an in-depth understanding and knowledge of specific attributes of Carrier Ethernet components. This knowledge is absolutely essential for designing, deploying and otherwise implementing Carrier Ethernet network solutions.

<b>Overview</b>	Carrier Ethernet 2.0	
	Blueprint C	
<b>Service Attributes</b>	Per UNI	Physical interfaces, Frame format, Ingress/egress Bandwidth Profiles, CE-VLAN ID/EVC Map, UNI protection, etc
	EVC per UNI	Ingress/egress Bandwidth Profiles, etc
	Per EVC	CE-VLAN ID Preservation, CoS ID Preservation, Relationship between Service Level Agreement and Service Level Specification, Class of Service, etc
	OVC, ENNI, OVC End Point per UNI and OVC End Point per ENNI	Ingress/egress bandwidth profiles, etc

## Section Four: Managing Carrier Ethernet Networks

At the end of this section, course attendees will have the tools and knowledge to manage, monitor and troubleshoot Carrier Ethernet networks.

<b>Overview</b>	MEF Service Lifecycle	
<b>Carrier Ethernet Maintenance Concepts</b>	Port, Link and NE failure, Service Protection Technologies, Fault Identification and Recovery	LAG, Active/Standby EVC, Single EVC with transport protection G.8031, G.8032, MPLS Fast Re-route (FRR)
<b>SOAMs</b>	Connectivity Fault Management	Connectivity Monitoring, Loopback and Linktrace (CCM, AIS, LSK, LBM, LTM, etc)
	Performance Management	Frame Delay (Mean Frame Delay, Frame Delay Range), Inter Frame Delay Variation, Availability, Frame Loss Ratio, Resiliency (High Loss Interval (HLI), Consecutive HLI ), DMM, DMR, SLM, SLR, etc
	Key Concepts	Single vs dual ended, ordered UNI pair calculations, etc
<b>LOAMs</b>	Link discovery, link monitoring, etc	
<b>Terminology and concepts</b>	MEG, MIPs, MEG Levels, etc	

## Section Five: Practical Carrier Ethernet

At the end of this section, course attendees will be able to discuss, understand and offer viable Carrier Ethernet network deployment solutions to varying customer network requirements. These will include wholesale access services, retail commercial/business services, mobile backhaul services, Ethernet access to IP services, and supporting legacy services over Ethernet.

<b>Carrier Ethernet Transport Technologies</b>	Layer 1 transport technologies: Connectivity, capabilities and advantages	SDH/SONET
	Layer 2 transport technologies: Connectivity, capabilities and advantages	Bridging, provider bridging, provider backbone bridging (PBB), provider backbone bridging with traffic engineering extensions (PBB-TE)
	Layer 2.5 transport technologies: Connectivity, capabilities and advantages	<ul style="list-style-type: none"> <li>MPLS VPWS (Virtual Private Wire Service)</li> <li>MPLS Virtual Private LAN Service (VPLS)</li> <li>MPLS-TP (Transport Profile)</li> </ul>
<b>Carrier Ethernet Access Technologies</b>	Ethernet over fiber	Ethernet over SDH/SONET, Ethernet over active fiber, Ethernet over Passive Optical Network (PON, GPON, 10G PON), Carrier Ethernet over OTN, and WDM
	Ethernet over copper	PDH, bonded copper, G-SDSL, 10Pass-TS, etc

	Ethernet over HFC	
	Ethernet over packet radio	
<b>Optimising mobile backhaul with Carrier Ethernet</b>	Key Backhaul Challenges and Mobile Backhaul Solutions: Market pressure, LTE evolution, elements and architecture (RAN BS, NC, GWIF, resilience etc), synchronization, bandwidth management and CoS, etc.	
<b>Circuit Emulation over Ethernet</b>	Overview: Purpose, needs and applications	
	How circuit emulation is used in Mobile Backhaul applications	
	Synchronization: Phased, ToD, External Reference source, SynchE ,NTP (Network Time Protocol) is defined in RFC 1305 (NTPv3) or RFC 5905 (NTPv4 IEEE-1588 v2/ PTP (Precision Time Protocol) ,ACR (Adaptive Clock Recovery)	
	MEF Service Definitions and EVC service attributes used to deliver emulated circuits	
<b>Applying what you know</b>	Wholesale access services, retail commercial/business services, mobile backhaul services, Ethernet access to IP services, and supporting legacy services over Ethernet	
	Carrier Ethernet practical examples and scenarios	<ul style="list-style-type: none"> <li>• Simple Carrier Ethernet solution</li> <li>• Carrier Ethernet with service multiplexing</li> <li>• Carrier Ethernet complex bandwidth profile scenarios</li> <li>• Carrier Ethernet solution for multiple Access Technologies</li> <li>• Carrier Ethernet Enterprise with global reach</li> <li>• Mobile backhaul for Carrier Ethernet</li> </ul>
	Practice Scenarios	Given a scenario, determine appropriate Ethernet services

## Section Six: Going Forward; MEF Certification and Resources

This section equips the student with information regarding getting MEF accreditation. It also includes as well-researched list of study material sourced from various stakeholders that the student should find useful.

<b>MEF Certification</b>	Overview	
	The Certifications	Advantages of certification, prerequisites and procedures: Equipment Certification, Service Certification, Professional Certification
<b>Resources for further study</b>	Slides, whitepapers, presentations and videos	<p><b>Brilliant MPLS-TP presentation</b>  <a href="https://www.youtube.com/watch?v=Hb48e3dPcvk">https://www.youtube.com/watch?v=Hb48e3dPcvk</a></p> <p><b>MPLS-VPLS</b>  <a href="https://www.youtube.com/watch?v=cEf-BxmfbS8">https://www.youtube.com/watch?v=cEf-BxmfbS8</a></p> <p><b>QinQ with Cisco Kit</b>  <a href="https://www.youtube.com/watch?v=re5EI_TM9To">https://www.youtube.com/watch?v=re5EI_TM9To</a></p> <p><b>MEF CE2.0 by industry masters (Bob Metcalf!)</b>  <a href="https://www.youtube.com/watch?v=dt-1wPwWjpc">https://www.youtube.com/watch?v=dt-1wPwWjpc</a></p> <p><b>Carrier Ethernet 2.0 in a nutshell</b>  <a href="https://www.youtube.com/watch?v=AlkFXioVuP0&amp;list=PLF19AB82D75AD2D8D&amp;index=11">https://www.youtube.com/watch?v=AlkFXioVuP0&amp;list=PLF19AB82D75AD2D8D&amp;index=11</a></p> <p><b>Good Carrier Ethernet Overview</b>  <a href="http://www.slideshare.net/rjain51/m-07cee">http://www.slideshare.net/rjain51/m-07cee</a></p> <p><b>Best OAM Presentation (by Accedian)</b>  <a href="https://www.youtube.com/watch?v=Pp9tBp5xVH0">https://www.youtube.com/watch?v=Pp9tBp5xVH0</a></p> <p><b>Brilliant and Hilarious Carrier Ethernet Concepts Overview</b>  <a href="https://www.youtube.com/watch?v=8bzXd7Cch9c">https://www.youtube.com/watch?v=8bzXd7Cch9c</a></p> <p>MEF Wiki  <a href="https://wiki.mef.net/pages/viewpage.action?pageId=25952462">https://wiki.mef.net/pages/viewpage.action?pageId=25952462</a></p> <p><b>Carrier Ethernet Testing Slideshow</b>  <a href="http://slideplayer.com/slide/237636/">http://slideplayer.com/slide/237636/</a></p> <p><b>One-minute Carrier Ethernet for Mobile Backhaul explanation</b></p>

Aragami Tech & Digital