

A woman with curly hair, wearing a yellow trench coat and pink pants, is walking in a modern, brightly lit interior space. She is looking down at a smartphone in her hand. The space features a large, curved glass railing and a ceiling with a grid of white lights. The floor is light-colored with large, abstract geometric shapes in shades of grey and blue.

EthernetConnect EVC - Individual networks of virtual connections

Additional product information



EthernetConnect

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01. General information

The product EthernetConnect EVC (EC EVC) can be used flexibly in customer networks due to the separation of access (As) and connection (Ethernet Virtual Connection, EVC).

This leads to synergies related to the reduction of

- terminating equipment
- space requirement for racks
- energy requirement (power/air conditioning).

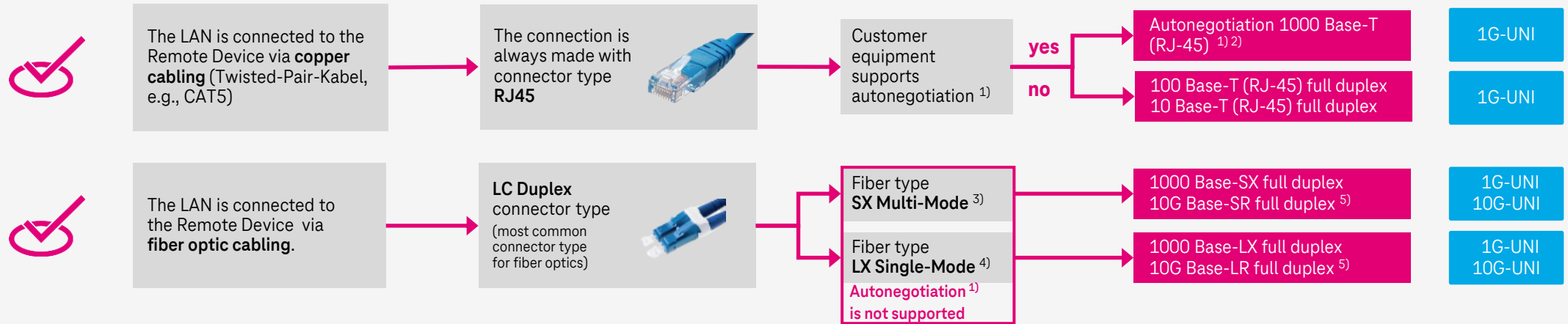
As soon as customer locations have been equipped with EthernetConnect EVC access, the customer can order EVCs linking all locations at short notice. To increase the performance of applications, the customer can choose from of the 4 service profiles (CoS profiles) for each EVC.

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02. Access

Access is delivered at customer locations with remote devices (RD) and offered with rates of 20 MBit/s to 10 GBit/s (effective 9.84 GBit/s).
An RD has several user network interfaces (UNI) on which connections can end.
The customer's UNI (LAN ports) can be configured individually (port-based/VLAN-based) depending on the application.

The customer can choose the following LAN interfaces:



LC: **L**ucent **C**onnector

Information: Adapters to convert from LC to the older SC/PC connector standard are available on the free market (e.g., FO patch cable single mode, duplex, LC/APC-SC/APC; length 0.5 m for < 10 euros)

¹⁾ Autonegotiation = automatic selection of the right port speed

²⁾ The 1000 Base-T interface (copper with RJ-45 socket) is **always** technically implemented with autonegotiation

³⁾ Range of around 500 m with 1000M and around 300-400 m with 10G; most utilized fiber type; less expensive than single mode fibers

⁴⁾ Range of around 5 km with 1000M and around 10 km with 10G; most commonly used on expansive company premises; more expensive than multimode fibers

⁵⁾ For 10G LAN interfaces, a UNI-10G port must be configuratively selected on the RD

Several connections can connect on a RD depending on the type and bandwidth (Access S max. 10 EVCs; Access L max. 80 EVCs and XL max. 200 EVCs).

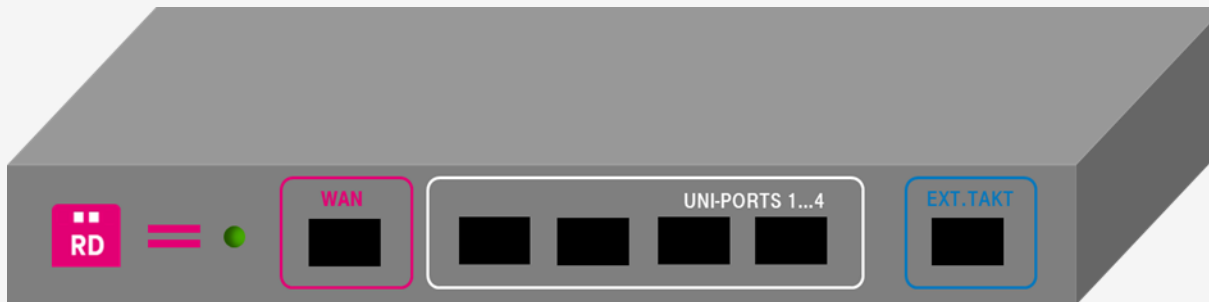
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03. Transfer of connections on the remote device

The EVCs (type EPL or EVPL) are passed to the UNI Ports (port-based / VLAN-based) on the remote device.

For the layer 2 product EthernetConnect EVC,

- Access types 20 MBit/s – 1 GBit/s are up to 4 UNI
- Access types 10 GBit/s are up to 10 UNI 1G and 2 UNI 10G possible
- Access types point-to-multipoint multiplex connection variant "MUX" in the variants 1G or 10G - only one UNI is possible



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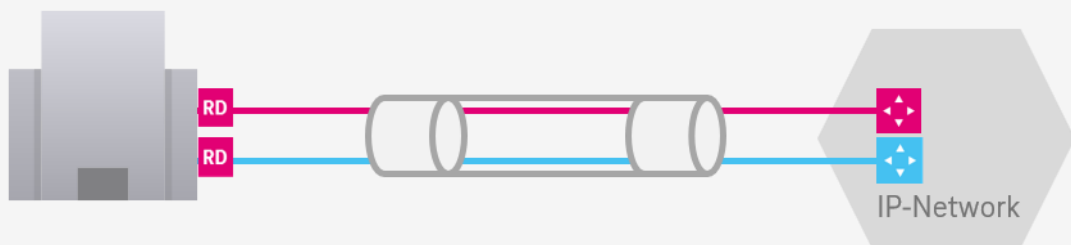
Each UNI allows port-based or VLAN-based configuration,
with the respective possible number of EVCs

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04. Redundancy portfolio

Gold

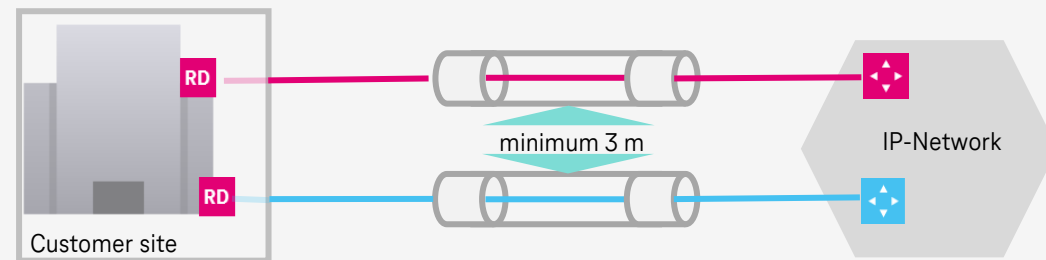
“Gold” Configuration



The **Gold configuration** increases the reliability of a customer connection to 99.8% through two separate connections to different network nodes. The cable paths are not routed separately but are implemented in the same cable or over shared fiber-optic links. The active components - the remote device and the network node - are designed with redundancy.

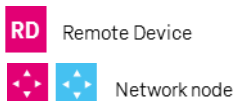
Platin

“Platinum” Configuration



In the **Platinum configuration**, which offers 99.9% availability, redundant connections between the customer site and the network node are routed via two separate paths. The routes have a minimum distance of three meters and there are no crossings or synchronizations in the line route ¹⁾. Compliance with these specifications is ensured and monitored. The network-side redundancy analysis begins and ends at the property line.

¹⁾ A continuous route-disjoint route is only possible for those sections of the cable where there are no technical and geographical barriers. In a few exceptional cases, the two cables may run parallel or there may be isolated crossings. In such cases, the customer will be informed of this as part of the quotation, and the work will only be carried out with the customer's consent.



05. Connections (services)

Ethernet Virtual Connections (EVC) are provided between two accesses:

- 1 MBit/s to 1000 MBit/s (980 MBit/s) as well as 1, 2, 4, 8, 10 GBit/s (9.84 GBit/s) on one access

Design rule

- No EVC may be larger than the access bandwidth.
- The sum of guaranteed traffic may not exceed the access bandwidth.

5.1 EthernetConnect EVCs can be provided in two types

5.1.1 Ethernet Private Line (EPL)

An EPL-EVC is a transparent connection between two UNIs. Only one EVC can end on a UNI. The LAN ports (UNIs) on which an EPL-EVC ends must be configured as “port-based”. Max. 4 EPL-EVCs are possible on a 1G access and max. 12 EPL-EVCs (2x 10G UNI, 10x 1G UNI) on a 10G access.

5.1.2 Ethernet Virtual Private Line (EVPL)

With EVPL-EVCs, several connections can end on one UNI. The EVPL-EVCs must contain a unique identifier known as a C-Tag (customer tag).

Design rule C-Tag:

- EtherType 0x8100
- Usable VLAN IDs 1–4094.
- VLAN IDs may not be assigned twice on one UNI.
- The customer has up to 10 VLAN ranges per EVC.
- The LAN ports (UNI) on which EVPL-EVCs end, must be configured as “VLAN-based”.

VLAN ID	VLAN range
e.g. 10	e.g. 2010–2019

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06. Class of Service (CoS) – Ethernet Private Line (EPL) (1/2)

6.1 Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL)

The following four Classes of Service (CoS) are available:

CoS profile	Profile bandwidth (in %) per CoS of the EVC/application
Premium/voice	100% for small packages with short runtime (language)
Priority/low delay	100% for runtime-critical traffic (SAP applications, video)
Priority/low loss	100% low packet losses, longer runtime (financial transactions)
Standard/best effort	100% applications without special requirements (e-mail); no guaranteed bandwidth

Notes:

- On the network side, all Ethernet frames are transported in the booked class.
- Ethernet frames with the CoS profiles Premium, Priority and Critical are “prioritised traffic”. These are transmitted as a priority.
- The Ethernet frames with the CoS profile Standard are transmitted only if there are sufficient network resources. Otherwise, the Ethernet frames are arbitrarily discarded.
- The customer must ensure that the maximum bandwidth per connection is not exceeded.

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06. Class of Service (CoS) – note on Shaping (2/2)

- The customer interfaces 10BaseT, 100BaseT always have the full bandwidth. This means that it is not possible for customers to overbook.
- In the Wide Area Network (WAN) only the bandwidth, that the customer has ordered as Ethernet Virtual Connection (EVC), is made available.
- A rate limit is set on the remote device. If the customer sends too much data, the frames that violate the traffic contract in exactly this millisecond are discarded.
- Due to the high speeds and associated data volumes, the buffers in the remote devices can no longer cache the packets. For this reason, the customer must limit the bandwidth of his device.

07. Overbooking

EthernetConnect access cannot be overbooked with prioritised traffic (Premium, Priority, Critical). Standard traffic can use the unused bandwidth of other traffic classes.

Example:

- Access L (1G) can be booked with
 - 2 x 400 MBit/s, 1 x 100 MBit/s und 2 x 40 MBit/s EVCs with “Priority” or
 - 3 x 200 MBit/s, 3 x 100 Mbit/s EVCs with “Priority” and 1 x 400 MBit/s “Standard”
- Access XL – up to 200 EVCs with 100 MBit/s each – can be configured using the CoS profile “Standard”

As described in the previous section, a transfer of packets is not guaranteed for the CoS profile “Standard”. “Overbooking” of an access is therefore possible only with standard traffic (best effort).

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08. Technical quality parameters (1/2)

The technical quality parameters (one way) specified in the table on the following page may deviate from the actual values of individual connections. The parameters are dependent on factors such as the actual length of the connection lines and the guide sections in the Telekom network as well as on the type and manner of use (e.g. the services /applications used and the size of the frames).

The primary technical quality parameters for an EVC are:

Frame delay:

The delay of Ethernet frames essentially depends on the access design (fibre glass, copper), the line length and the number of hubs. Frame delay can be specified as one-way delay or round-trip delay. With EthernetConnect 2.0, the delay is specified as one-way delay.

Frame delay variation (jitter)

Frame delay variations are fluctuations arising when transmitting data packets. For real-time applications, e.g., voice over IP (VoIP), delay fluctuations could lead to problems. For this reason, Telekom recommends the CoS profile “Premium” for such applications.

Frame loss ratio

Frame loss ratio is the number of lost or incorrectly received frames divided by the number of frames sent.

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08. Technical quality parameters (2/2)

Table: Quality classes, connections and quality parameters of connection classes

One-way delay values – typical and maximum values:

QoS class	Typical delay ¹⁾	Max. delay	Delay variation	Frame loss ratio
Premium/voice	10 ms	21 ms	< 3 ms	≤ 0.1%
Priority/low delay	10 ms	26 ms	< 5 ms	≤ 0.1%
Critical/low loss	12 ms	41 ms	-	≤ 0.01%
Standard/best effort	-	-	-	-
Surcharge for access type version L ²⁾ (980 MBit/s) by up to	10 ms	14 ms	-	0.1%

1) The typical delay is an expected average value for connections between metro locations and is not a commitment for an individual connection. Metro regions: Berlin, Dortmund, Düsseldorf, Frankfurt, Hanover, Hamburg, Cologne, Leipzig, Munich, Nuremberg, Stuttgart.

2) For accesses < version L (980 MBit/s), the delay per access can increase (surcharge). This surcharge is dependent on the geographical connection length, the number of regenerators and the type of the transmission process.

The actual values depend on the length of the connection and the geographical distance to Telekom hubs at the respective customer locations.

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09. Maximum data throughput

The maximum data throughput (information rate (IR) or frame rate) at an access or connection is defined physically on the one hand and contractually on the other. When Ethernet frames are transmitted, a distance (IFG – inter frame gap) is always maintained between the frames and a start sequence is sent for synchronisation at the beginning of a new frame (preamble). This Ethernet overhead corresponds to 20 bytes per Ethernet frame to be transmitted. Thus, for example, the technically maximum possible usable bandwidth with a full 1 GBit Ethernet is 761.9 MBit/s (with 64 byte frames) and 986.9 MBit/s (with 1518 byte frames). Telekom requires a part of the maximum transferable access bandwidth for network management. This reduces the usable bandwidth, for example, for port L (1G), to 980 MBit/s. With 64 byte frames, 724 MBit/s (approx. 74%) can be transmitted, and for 1518 byte frames it is 980 MBit/s.

Notice for customers who would like to conduct a data throughput measurement: a data throughput measurement is possible by means of HW loops

- For end devices and a 1000 BaseT configuration, an RJ45 cable (at least CAT6, preferably CAT7) is required.
- For ELCON end devices, the customer needs a loop box or a second test device that provides a MAC swap loop.

EthernetConnect 2.0 Access type	Maximum usable Ethernet bandwidth ¹⁾ in MBit/s	Max. throughput in KBit/s for a frame size of 64 bytes on a UNI in KBit/s	Max. throughput for a frame size of 1,518 bytes on a UNI in KBit/s
S (20M)	20	17,000	20,000
L (1G)	980	724,000	980,000
XL (10G)	9,840	7,269,000	9,840,000

1) Max. sum of all prioritised EVC bandwidths

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10. EVC bandwidth (1/2)

Optimal use of the EVC bandwidth without frame losses

Compliance with the EVC bandwidth must be monitored, because only the bandwidth that was ordered can/should be reached. Without monitoring, the maximum possible physical bandwidth may be reached.

This monitoring of compliance with the booked EVC bandwidth is realised on the RD side in the upstream direction by a policer.

This policer works according to the [token bucket principle](#) and is configured with two parameters:

- EVC bandwidth
- Burst size

The policer performs the following two actions:

- Compliant traffic is allowed to pass (pass)
- Non-compliant traffic is discarded (discard -> red-drop)

For optimal usage of the EVC, this RD policer should never be overrun (-> no red-drops).

As a counterpart to each policer, the customer requires a corresponding shaper on their CPE (for their L3 service).

This shaper likewise works according to the token bucket principle and requires the two parameters:

- EVC bandwidth
- Burst size

10. EVC bandwidth (2/2)

Compliance

The following rules apply:

The CPE burst size must be smaller or equal to the RD burst size. For the RD policer burst size, the following generally applies:

CoS	Premium	Priority	Critical	Standard
Access type XS and S	20,000 bytes	20,000 bytes	20,000 bytes	20,000 bytes
Access type L and XL	60,000 bytes	60,000 bytes	60,000 bytes	60,000 bytes

1. Example for access type L:

EVC bandwidth 400 MBit/s, QoS profile 100% Premium

CPE shaper:

- EVC bandwidth (400 MBit/s)
- Burst size (<= 60,000 bytes)

2. Example for access type L:

EVC bandwidth 400 MBit/s, QoS profile 100% Standard

CPE shaper:

- EVC bandwidth (400 MBit/s)
- Burst size (<= 60,000 bytes)

11. Frame-size

12. Flow control

11. Frame size

- The Layer 2 Frame-size of connections can be between 64 bytes and a maximum of 1,590 bytes if the connections end at one or both ends on access 20 MBit/s.
- The Layer 2 frame size is 1,590 bytes. If both Accesses are 1G or greater the Frame size is 9,018 bytes.

12. Flow control

Flow control is not available for EthernetConnect 2.0.

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13. Link loss forwarding – E-LMI (1/2)

Link loss forwarding is not available for EthernetConnect. If several EVCs are connected to a UNI and one EVC fails, the UNI would be turned down, when “link loss forwarding” is activated and thus all EVCs on this UNI would be turned down too. This would lead to a chain reaction.

The status of an EVC can be queried from the UNI via E-LMI (Ethernet Local Management Interface).

EthernetConnect – Ethernet Local Management Interface (E-LMI)

Protocol	EtherType subtype	Destination address	Physical Ethernet link
Ethernet Local Management Interface (E-LMI) MEF 16 based on ITU-T G.933 and X.36	EtherType: 0x8808	01-80-C2-00-00-07	Peered

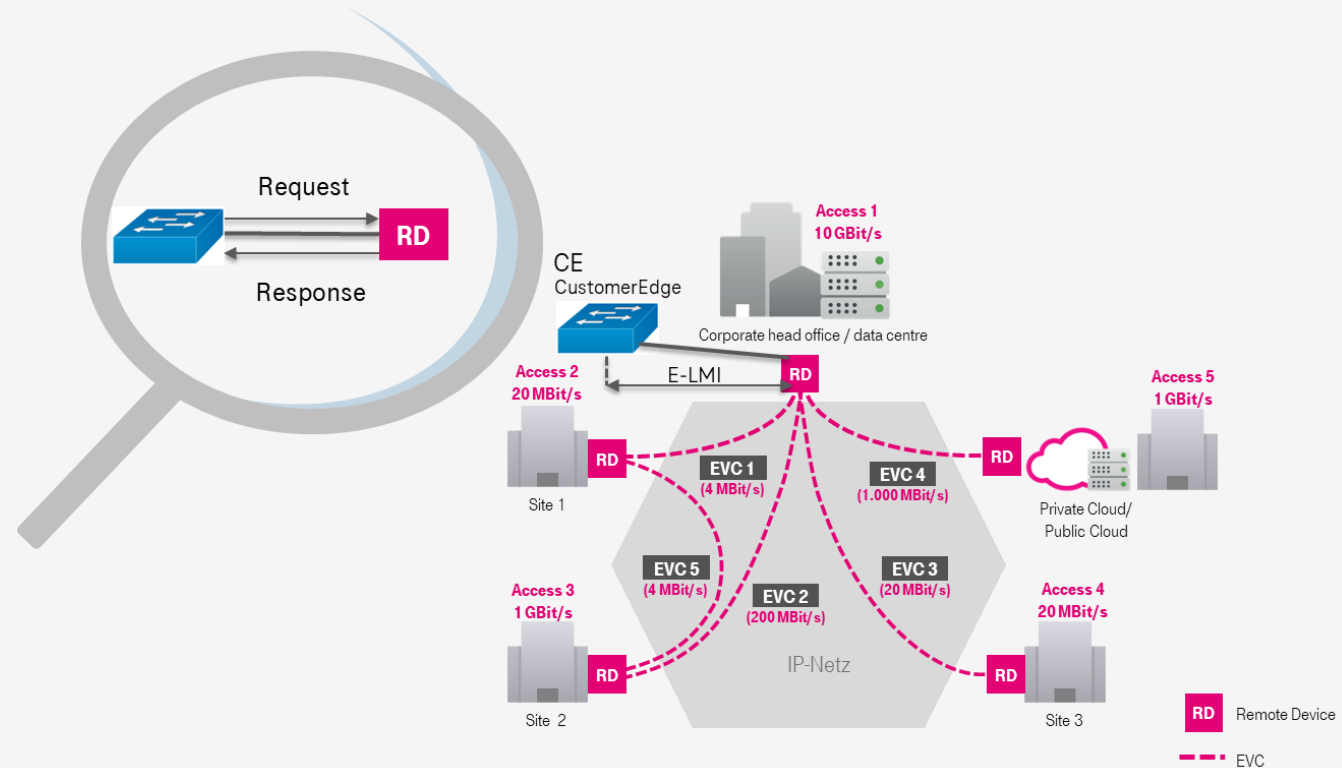
Ethernet Local Management Interface is always enabled.

If an access connected via an EVC is no longer accessible at an EthernetConnect Access (EVC or access failure), a local ETH-OAM-CC alarm is triggered and the customer receives information at the User Network interface via E-LMI. The E-LMI uses the EVC ID to uniquely identify the connection. The ID is communicated to the customer in the order confirmation and final information.

13. Link loss forwarding – E-LMI (2/2)

The following information is shared with the customer via E-LMI:

- EVC is added
- EVC is suspended/deleted
- Status of the EVC:
 - is active → there is no alarm
 - not active → there is an alarm



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14. MACsec

14. MACsec problems

- Customer CPE: The “Replay protection window size” in the MACsecConfig must not be 0.
Extract from Cisco: A replay window is necessary to support use of MACsec over provider networks that reorder frames.
- MACsec cannot be used in combination with LACP.
 - MACsec alone works with EPL
 - alone LACP works with EPL

15. Ethernet control protocol (1/3)

15. EthernetConnect 2.0 – protocol behaviour between the physical interfaces

Protocol	EtherType subtype	Destination address	Link
802.3 Operations, Administration, and Maintenance (OAM link)	EtherType: 0x8809 Subtypes: 0x03	01-80-C2-00-00-02	Discarded ¹⁾
Ethernet Local Management Interface (E-LMI)	EtherType: 0x88EE	01-80-C2-00-00-07	Peered
Ethernet Synchronisation Messaging Channel (ESMC)	EtherType: 0x8809 Subtypes: 0x0A	01-80-C2-00-00-02	Discarded

1) Every remote device type has an active clock output T4. Phase synchronisation (IEEE1588v2) is not configured with EVPL release 1. The SyncE feature is deactivated (discarded) on the UNI in “Standard”. However, it can be activated (peered).
Discarded = packets are not transmitted, they are discarded
Passed = packets are transmitted
Peered = is “protocol partner”, packets are processed

Service-related protocol behaviour

Layer2 control protocols always start with the MAC destination address from room 01-80-C2-00-00-00 through 01-80-C2- 00-00-0F and 01-80-C2-00-00-20 through 01-80-C2-00-00-2F (in accordance with IEEE Std 802.1Q-2011). These are transmitted only in accordance with the MEF-compliant protocol behaviours (see table)! The MAC addresses must only be used in the context of Ethernet control protocols with the matching EtherType.

15. Ethernet control protocol (2/3)

EthernetConnect 2.0 – specific to EPL/EVPL Service-related protocol behaviour

Protocol	Ethernet subtype	Destination address	EPL service	EVPL service
Link Aggregation Control/Marker Protocol (LACP) ¹⁾	EtherType: 0x8809	01-80-C2-00-00-00 01-80-C2-00-00-03	Passed	Discarded
	Subtypes: 0x01, 0x02	01-80-C2-00-00-02	Passed	Discarded
Precision Time Protocol Peer-Delay (PTP)	EtherType: 0x88F7	01-80-C2-00-00-0E	Passed	Discarded
Link Layer Discovery Protocol (LLDP)	EtherType: 0x88CC	01-80-C2-00-00-00 01-80-C2-00-00-03 01-80-C2-00-00-0E	Passed	Discarded
Virtual Station Interface Discovery and Configuration Protocol (VDP)	EtherType: 0x8940, Subtype: 0x0001	01-80-C2-00-00-00	Passed	Discarded
Port-Based Network Access Control	EtherType: 0x888E	01-80-C2-00-00-00 01-80-C2-00-00-03 01-80-C2-00-00-0E	Passed	Discarded
802.3 MAC Control: PAUSE	EtherType: 0x8808 Subtype: 0x0001	01-80-C2-00-00-01	Discarded	Discarded

1) LACP is not available in combination with MACsec

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15. Ethernet control protocol (3/3)

Protocol	Ethernet subtype	Destination address	EPL service	EVPL service
802.3 MAC Control: Priority Flow Control (PFC)	EtherType: 0x8808 Subtype: 0x0101	01-80-C2-00-00-01	Discarded	Discarded
802.3 MAC Control: Multipoint MAC Control	EtherType: 0x8808 Subtype: 0x0002 0x0006	01-80-C2-00-00-01	Discarded	Discarded
802.3 MAC Control: Organisation Specific Extensions	EtherType: 0x8808 Subtype: 0xFFFE	01-80-C2-00-00-01	Discarded	Discarded
Rapid/Multiple Spanning Tree Protocol (RSTP/MSTP)	LLC Address: 0x42	01-80-C2-00-00-00 01-80-C2-00-00-08	Passed	Discarded
Shortest Path Bridging (SPB)	LLC Address: 0xFE	01-80-C2-00-00-2E 01-80-C2-00-00-2F	Passed	Discarded
Multiple MAC Registration Protocol (MMRP)	EtherType: 0x88F6	01-80-C2-00-00-20	Passed	Discarded
Multiple VLAN Registration Protocol (MVRP)	EtherType: 0x88F5	01-80-C2-00-00-21 01-80-C2-00-00-0D	Passed	Discarded
Multiple Stream Registration Protocol (MSRP)	EtherType: 0x22EA	01-80-C2-00-00-0E	Passed	Discarded
Multiple ISID Registration Protocol (MIRP)	EtherType: 0x8929	01-80-C2-00-00-00	Passed	Discarded

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16. Operations administration maintenance (OAM)

17. Fundamental properties of UNI ports on the RD

16. Operations administration maintenance (OAM)

The customer can use OAM levels 6 and 7. OAM levels 4 and 5 can be used by the customer in exceptional cases. However, Telekom reserves the right to discontinue OAM levels 4 and 5 if this is required for regulatory reasons.

17. EthernetConnect 2.0 – fundamental properties of UNI ports on the RD

- The behaviour of the EVC types is described in the table. With EPL, manufacturer-specific protocols are treated transparently in the payload.
- With EVPL, every Ethernet frame on the UNI side must be given the C-Tag agreed there.
- The protocol behaviour for Access-EVCs (A-EPL and A-EVPL) corresponds to that of EPL-EVCs and EVPL-EVCs.
- The frames on the MUX-UNI are only transmitted with the EtherType configured there (0x88A8 or 0x8100) and the registered S-VLANs¹⁾.

EthernetConnect 2.0 – Example of Ethernet protocols specific to EPL/EVPL

Ethernet subtype		Destination address	EPL service	EVPL service
802.1Q			Passed ²⁾	Registered ³⁾ 0x8100 VLAN-IDs
MACsec ⁵⁾ (802.1ae)	EtherType: 0x88E5		Passed	Discarded ⁴⁾

- 2) Passed = packets are transmitted
- 3) Registered 0x8100 VLAN IDs = Only frames with the VLAN IDs ordered by the customer are transmitted
- 4) Discarded = packets are not transmitted, they are discarded
- 5) MACsec is not available in combination with LACP

1) S-VLAN designates the necessary additional tag on the MUX-UNI. This S-Tag is used to assign the Ethernet traffic delivered by the customer to the configured Access-EVCs (regardless of whether A-EPL or A-EVPL). This S-Tag is processed and removed on the MUX-UNI, or processed and added.

18. Hotlines and customer centre enterprise network services (KENS)

18.1 Installation hotline for our customers

In case of any questions about the activation of the telecommunications infrastructure, we are available to our customers for **30 days after provision**. Our **free installation-hotline +49 800 33 07861** is available from Monday to Friday between 8 am and 5 pm.

Important: For quick implementation/support/processing, customers should have the following information ready: transaction number, port or connection ID, customer number.

18.2 EC service hotline

If there are any problems with EthernetConnect, our **AGB customers** can always reach us on **+49 800 5231323**. Our **TDS customers** can reach us on the **personal call number** (part of the TDS contract).

Important: For quick implementation/support/processing, customers should have the following information ready: transaction number, port or connection ID, customer number.

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19. List of abbreviations

- CIR: Committed Information Rate [back to Class of Service](#)
- CBS: Committed Burst Size [back to Class of Service](#)
- CoS Profile (Class of Service): EC with 4 profiles
 - 4 profiles with 100% from one of 4 quality classes each
- EIR: Excess Information Rate [back to Class of Service](#)
- EBS: Excess Burst Size [back to Class of Service](#)
- EPL (Ethernet Private Line): Port-based EVC occupying no more than one user network interface (UNI).
- Ethernet Virtual Connection (EVC): Connection
- EVPL (Ethernet virtual private line): VLAN-based EVC between two user network interfaces (UNIs). Access to UNI is managed via customer-specific VLAN IDs.
- Jitter (Frame Delay Variation): Delay variations in the transmission of data packets
- Remote Device (RD): Telekom end device on the customer's premises
- Shaping: The customer must always take appropriate measures to ensure customer-side traffic does not exceed the maximum bandwidth per CoS class (Premium, Priority, Critical, Standard).
- Token bucket: Certain contingents are regularly assigned to the data flow. These contingents can be used or collected up until a certain limit – see wiki.mef.net
- User network interface (UNI) – customer interface at RD
- Wide Area Network - WAN

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Thank you

