Proposal for an update of subclause 6.8 Topology discovery

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<< Introductory notes:

This textual contribution is a continuation of the presentation:
https://www.ieee802.org/1/files/public/docs2022/60802-Dorr-LLDP-0322-v01.pdf

It also incorporates some comments, which addressed the Topology discovery subclause.

Comments	
#1019	*delete EPLAN*
#352	*delete the sentence beginning on line 3365*
#601	*delete the text from 3269 to 3272*
#602	*explain engineered topology*
#115	*at least one IPv4 management address*
#116	*save the last received data to the remote systems YANG*
#106	*remove SNMP/MIB from Figure and text*
…	
Contributions	
[1]	*60802-Dorr-LLDP-0322-v01.pdf*

Recap of *60802-Dorr-LLDP-0322-v01.*pdf Summary:
A textual contribution should be provided including:

- Clarification of Topology Verification requirements, -> see 6.8.1
- LLDP Port ID TLV with interface names, -> see 6.8.2.3.3
- New subclause describing Topology Verification principles. -> see 6.8.3

Additional rework:

- Corrected Figure 1 – Usage example of LLDP: -> see Figure 1
  - All IA-stations include an end station component.
- Added subclause 6.8.2.3.4 Time To Live TLV: -> see 6.8.2.3.4
  - Describe all selected TLVs.
- Changed uniqueness of Chassis-ID and Port-ID -> see 6.8.2.3.2, 6.8.2.3.3

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6 Required Functions for an Industrial Network

6.8 Topology discovery and verification

6.8.1 Topology discovery and verification requirements

Electrical engineering of machines with multiple IA-stations includes the definition of the machine internal network topology (i.e., the engineered topology).

The machine internal network topology includes type specific data of IA-stations (for example model name) as well as instance specific data (for example IP addresses or DNS names).

The electrical engineering data of the network topology is used:

– During commissioning to ensure that machine planning and installation are identical.

– By the TDE during operation to verify that the installed machine internal topology matches the engineered topology.

– By maintenance staff during repair to easily identify failed IA-stations, ports, or links to be replaced.

Repair and replacement of an IA-station shall not require an update of the engineered topology for verification. Otherwise, the TDE produces a verification error.

Repair and replacement of an IA-station should not require pre-configuration of the replacement IA-station to avoid a TDE topology verification error.

<<Editor's Note: requires some built-in mechanism to achieve instance data without management interaction, for example DHCP or security bootstrapping; see 60802-Pfaff-et-al-Secure-Device-Identity-Profile-0522-v03.pdf >>

To enable topology discovery and verification in a vendor/organization independent way IA-stations shall support reporting of type and instance data as described in 6.8.2.

6.8.2 Topology discovery overview

LLDP enables the discovery of IA-stations, their external ports, and their external connectivity. A Topology Discovery Entity can query LLDP data by remote management to derive the physical network topology.

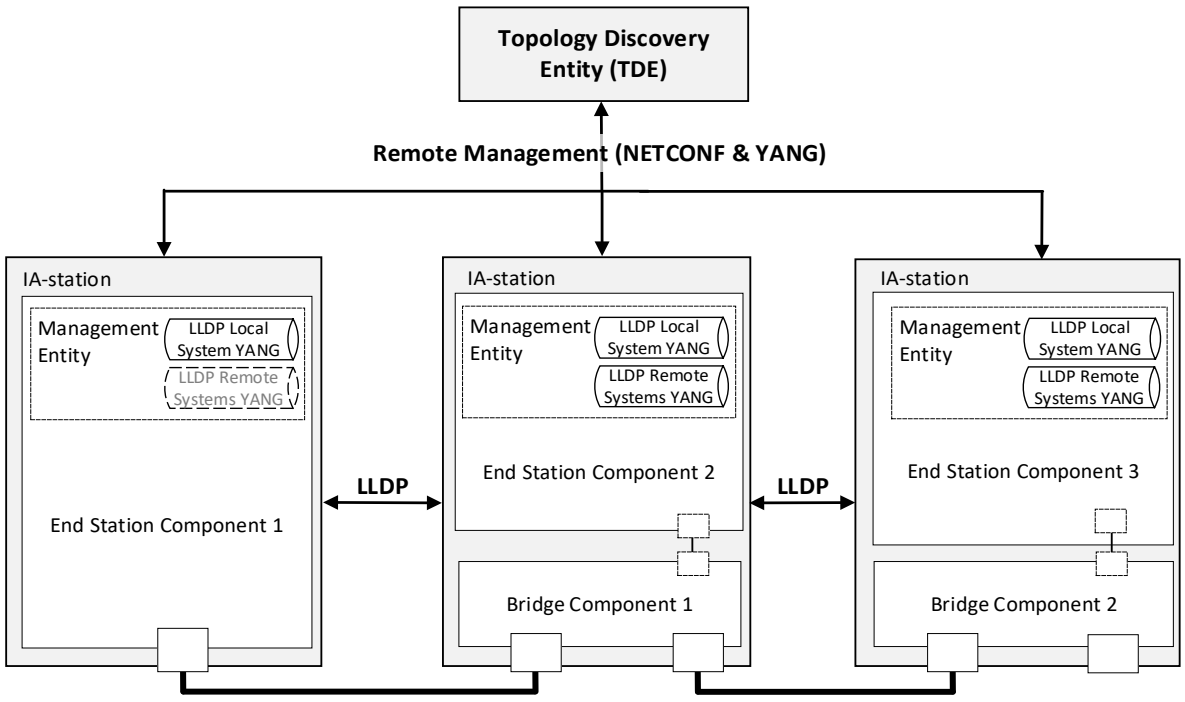

Figure 1 – Usage example of LLDP

Figure 1 illustrates an exemplary network showing the LLDP agent implementations in an IA-station consisting of a single end station component and two IA-stations with end station and Bridge components (see 4.3). The LLDP protocol is used to convey neighborhood information among peers, and NETCONF is used between the TDE and the IA-stations to query this neighborhood information from the IA-stations. This information allows the TDE to discover IA-stations and the physical network topology.

NOTE A Topology Discovery Entity (TDE) can be run from anywhere in the network with reachability to the to-be-discovered devices.

IA-stations announce themselves via LLDP to support discovery by the TDE. Announcements contain the management address and system capabilities (see 6.8.1.4) for the discovery operation. The announced system capabilities information enables the TDE to identify IA-stations with multiple end station and Bridge components. The TDE can use the definitions in 6.7.4 for the discovery of the internal structure of such IA-stations.

To allow for adaptability of the operational behavior and exchanged information, IA-stations support the local system YANG (see <…>). IA-stations that include a Bridge component additionally support the processing of received LLDP messages and support the remote systems YANG (see <…>).

6.8.2.1 LLDP operational control parameters

LLDP defines several operational parameters that control the protocol behavior (see IEEE Std 802.1AB-2016, 10.5.1). These parameter definitions apply to all external ports of an IA-station.

NOTE According to IEEE 802.1AB-2016, 9.1.1 c), changes to the local system that impact information exchanged via LLDP immediately trigger the transmission of an LLDPDU to communicate the local changes as quickly as possible to any neighboring systems.

An IA-station shall support LLDP transmit mode (adminStatus enabledTxOnly) on an external end station component port and may support transmit and receive mode (adminStatus enabledRxTx) on that port (see IEEE Std 802.1AB-2016, 10.5.1).

An IA-station shall support LLDP transmit and receive mode (adminStatus enabledRxTx) on an external Bridge component port (see IEEE Std 802.1AB-2016, 10.5.1).

6.8.2.2 LLDPDU transmission, reception, and addressing

The destination address to be used for LLDPDU transmission (dest-mac-address) shall be the nearest bridge group MAC address, i.e., 01-80-C2-00-00-0E, on all ports to limit the scope of LLDPDU propagation to a single physical link (see IEEE Std 802.1AB-2016, 7.1 item a).

NOTE IEEE 802.1AB-2016 defines LLDPDUs to be transmitted untagged, i.e., frames do not carry priority information for traffic class selection. At the same time, IEEE 802.1AB-2016 neither specifies a well-defined device-internal priority nor management capabilities for the configuration of the traffic class to be used for the transmission of LLDPDUs. It is the user's responsibility to ensure that LLDPDUs do not interfere with the transmission of time-critical control data.

6.8.2.3 LLDP TLV selection

6.8.2.3.1 General

An IA-station transmitting LLDPDUs shall include the LLDP TLVs selected in this sub-clause and may include additional TLVs (tlvs-tx-enable). An IA-station receiving LLDPDUs shall process LLDPDUs.

Each LLDPDU shall contain the following LLDP TLVs specified in IEEE 802.1AB-2016, 8.5:

– Exactly one Chassis ID TLV as specified in 6.8.2.3.2,
– Exactly one Port ID TLV as specified in 6.8.2.3.3,
– Exactly one Time To Live TLV as specified in 6.8.2.3.4,
– Exactly one System Capabilities TLV as specified in 6.8.2.3.5, and
– One or more Management Address TLVs as specified in 6.8.2.3.6.

NOTE The concatenation of the Chassis ID and Port ID fields enables the recipient of an LLDPDU to identify the sending LLDP agent/port.

6.8.2.3.2 Chassis ID TLV

The Chassis ID field shall contain the same value for all transmitted LLDPDUs independent from the transmitting port of the IA-station, i.e., be a non-volatile~~, component-unique~~ identifier which is unique within the context of the administrative domain.

The Chassis ID subtype field (chassis-id-subtype) should contain subtype 4, indicating that the Chassis ID field (chassis-id) contains a MAC address to achieve the Chassis ID's desired uniqueness. For IA-stations with multiple unique MAC addresses, any one of the IA- station's MAC addresses may be used and shall be the same for all external ports of that IA-station.

6.8.2.3.3 Port ID TLV

The Port ID field shall contain the same value for all transmitted LLDPDUs for a given external port, i.e., be a non-volatile, ~~component-unique~~ IA-station-unique identifier of the LLDPDU-transmitting port.

~~For an IA-station with unique MAC addresses per port, t~~The Port ID subtype field (port-id-subtype) should contain subtype ~~3~~5, indicating that the Port ID field contains ~~a MAC address~~ the port interface name (name) according to IETF RFC 8343.

IA-stations should restrict the system-defined port interfaces to read-only access and a maximum name length of 255 characters. The names should match the imprinted port names on the chassis.

6.8.2.3.4 Time To Live TLV

The Time To Live value shall be set as specified in IEEE 802.1AB-2016, 8.5.4 (message-tx-interval * message-tx-hold-multiplier + 1).

<<Editor's Note: The default value is 30*4+1=121s>>

~~6.8.2.3.4~~6.8.2.3.5 System Capabilities TLV

An IA-station consisting of a single end station component shall set the system capabilities and enabled capabilities fields (system-capabilities-supported, system-capabilities-enabled) to Station Only (i.e., bit 8 set to "1") for all transmitted LLDPDUs.

An IA-station with multiple end station and Bridge components shall set the system capabilities and enabled capabilities fields to Station Only (i.e., bit 8 set to "1") and C-VLAN component (i.e., bit 9 set to "1") for all transmitted LLDPDUs.

NOTE The combination of the Station Only and C-VLAN component flags is used as a marker indicating to the TDE that the internal structure of the IA-device consists of multiple components. This is a deliberate deviation from IEEE Std 802.1AB-2016, Table 8-4, which states in a footnote: "The Station Only capability is intended for devices that implement only an end station capability, and for which none of the other capabilities in the table apply. Bit 8 should therefore not be set in conjunction with any other bits."

~~6.8.2.3.5~~6.8.2.3.6 Management Address TLV

An IA-station shall announce at least one IPv4 address by which its Management entity (see 4.3) can be reached (management-address-tx-port).

6.8.2.4 LLDP Remote Systems Data

An IA-station supporting the remote systems YANG shall be able to store information from at least one neighbor per external port.

Receiving LLDPDUs from more neighbors than supported on a given port shall result in the last one received being saved to the remote systems YANG as described in IEEE 802.1AB-2016 9.2.7.7.5.

6.8.3 Topology verification overview

Topology verification checks discovered topologies against engineered topologies. Topology verification data includes for every IA-station:

- model name,
- manufacturer name,
- management address.

Topology verification data includes for every external port of an IA-station:

- port name,
- remote connection (i.e., management address and port name of connected IA-station).

To support topology verification IA-stations shall support LLDP YANG data as defined in <6.7.10…> and Hardware Management YANG data as defined in <6.7.10…>

Note: IA-station hardware instance specific data like MAC addresses or serial numbers are not considered for topology verification. This kind of data changes after a repair and replacement operation and thus, would induce a topology verification error.