Name

- Name of contributor: Mark Hu
- Title of contribution: Latency & delay definition
- Length of time requested: 30 min
- Brief description of the topic: select the baseline of Latency & delay definition

Presentations considered:

https://www.ieee802.org/3/dm/public/adhoc/080724/turner_dm_01_system_08072024.pdf

Network Latency: The total delay experienced by a frame in the course of its transmission between two points in a network, measured from the time that the first bit in the frame passes the first point (P1) to the time that the last bit in the frame passes the second point (P2). Refer to 3.120 of 802.1Q-2022

- First bit in the frame: The first bit of the MPDU, immediately after the SFD Refer to 3.1.1 Packet format of 802.3-2022, 3.97 of 802.1-2020
- Last bit in the frame: The last bit of the MPDU, which includes the FCS. Refer to 3.1.1 Packet format of 802.3-2022, 3.97 of 802.1-2020
- First point (P1): The MAC service interface on the talker Refer to 6. Support of the MAC Service of 802.1Q-2022
- Second point (P2): The MAC service interface on the listener. Refer to 6. Support of the MAC Service of 802.1Q-2022
- Network: The Bridged Local Area Network Refer to 802.1Q-2022

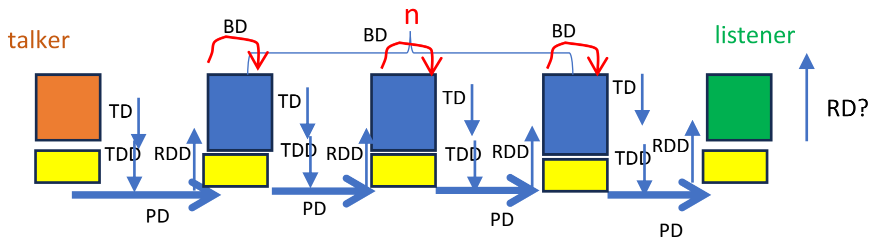
Network Delay: a component of the latency that measures the time for a specific transmission, include:

- propagation delay(PD): delay along the network media (e.g., cable) for a frame transmitted from the specified Port of this station to the neighboring Port on a different station
  =distance(between peer MDIs)/propagation speed refer to 12.32.2 Propagation Delay 802.1Q-2022

- bridge delay(BD): delay of frames as they pass through the Bridge's relay = independentDelay + dependentDelay
  independentDelay= Delay independent of frame length (e.g., MAC address lookup, switching logic).
  dependentDelay = delay for transferring a frame across the MAC Service interfaces from ingress to egress port =frame length/bridge internal transferring rate
  refer to 12.32.1 Bridge Delay, 802.1Q-2022
- transmission delay(TD): queuing delay(time waiting for the frame becomes first in line for transmission on the Port) + access delay(time for transmission of the frame)
  refer to 6.5.9 Priority, 802.1Q-2022

- Transmit data delay(TDD): delay from the input of frame at the XGMII to the presentation of the same frame by the PHY to the MDI.
- Receive data delay(RDD): delay from the input of frame at the MDI to the presentation of the same frame by the PHY to the XGMII.
  refer to 149.10 Delay constraints, 802.3-2022

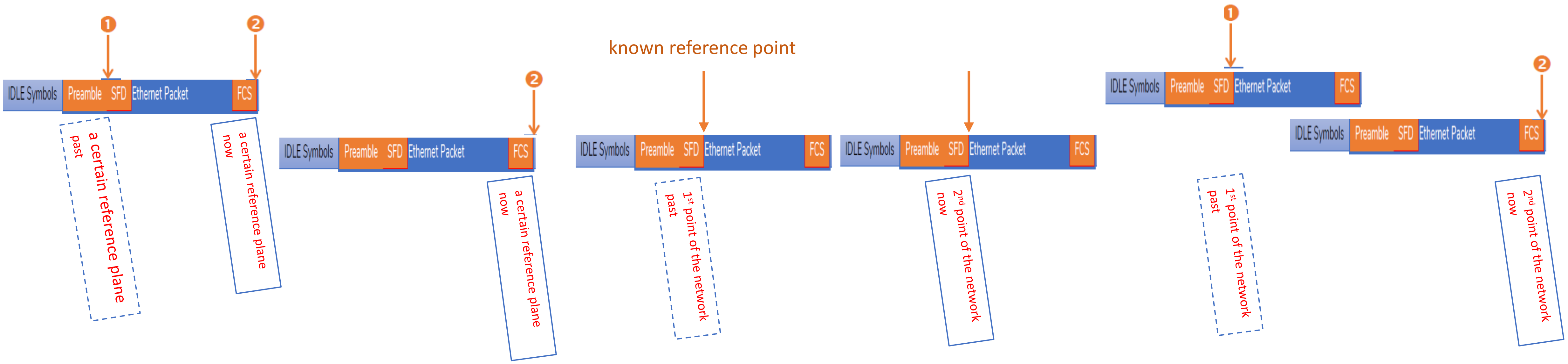
e.x: for an n hop the latency from talker to listener = (n+1)x(PD+TD)+nx(BD+TDD+RDD) = network transit delay refer to 6.5.5 of 802.1Q-2022 and figure 7 of 1722-2016



backup

Alternative definition

definition	MAX's	802.1Q-2022	Suggested
Latency	something'Latency: "first bit to last bit" • Time interval between the (first bit of the) SFD and the (last bit of the) FCS of a certain packet to pass a certain reference plane • Time interval between the (first bit of the) SFD of one packet and the (last bit of the) FCS of a response packet to pass a certain reference plane • Depends on packet length! i.e. dominated by line rate at least for large packets	3.120 latency: The delay experienced by a frame in the course of its propagation between two points in a network, measured from the time that a known reference point in the frame passes the first point to the time that the reference point in the frame passes the second point. NOTE—Latency is sometimes referred to as frame delay.	The delay experienced by a frame in the course of its transmission between two points in a network, measured from the time that the first bit in the frame passes the first point to the time that that the last bit in the frame passes the second point.



a certain reference plane: {MDI, MII, MAC service layer}

1st , 2nd point of the network:{MDI}

1st , 2nd point of the network:{MAC service layer}

- First bit in the frame: The first bit of the MPDU, immediately after the SFD — figure 3-1 Packet format — Refer to 3.1.1 Packet format of 802.3-2022, 3.97 of 802.1-2020
- Last bit in the frame: The last bit of the MPDU, which includes the FCS. — figure 3-1 Packet format — Refer to 3.1.1 Packet format of 802.3-2022, 3.97 of 802.1-2020

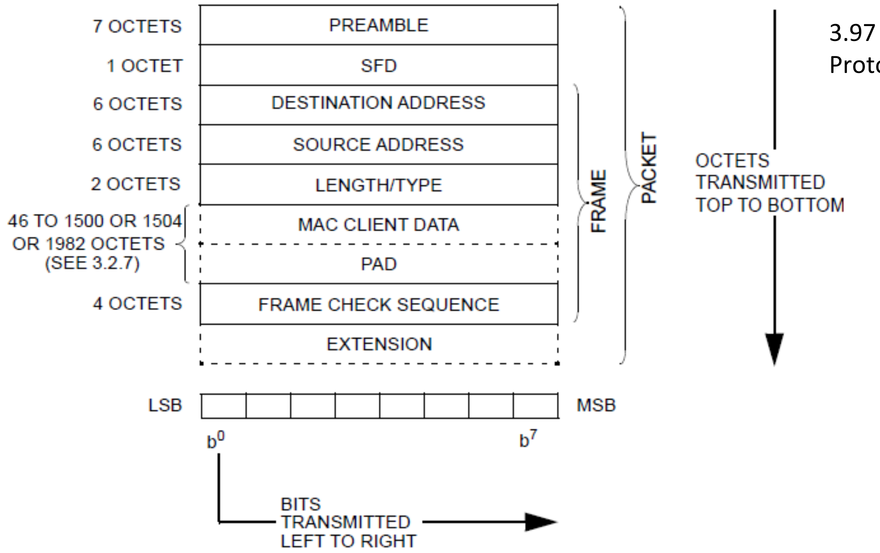


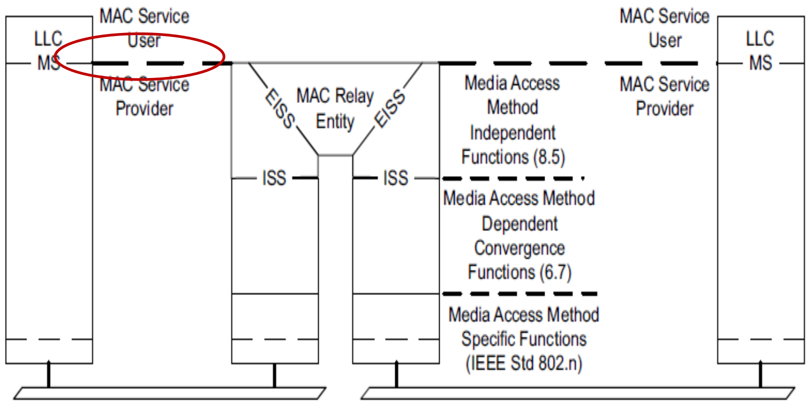
Figure 3–1—Packet format

3.97 Frame: A unit of data transmission on an IEEE 802 Local Area Network (LAN) that conveys a Media Access Control (MAC) Protocol Data Unit (MPDU). Refer to 802.3-2022

Network Latency definition break down

Refer to 802.1-2022

- First point (P1): The MAC service interface on the talker — figure 6-1 Internal organization of the MAC sublayer of 802.1Q-2022, figure 90-1 Relationship of the TimeSync Client, TSSI and gRS sublayer relative to MAC and MAC Client and associated interfaces
- Second point (P2): The MAC service interface on the listener. — figure 6-1 Internal organization of the MAC sublayer of 802.1Q-2022, figure 90-1 Relationship of the TimeSync Client, TSSI and gRS sublayer relative to MAC and MAC Client and associated interfaces



NOTE-The notation IEEE Std 802.n in this figure indicates that the specifications for these functions can be found in the relevant standard for the media access method concerned; for example, n would be 3 (IEEE Std 802.3) in the case of Ethernet.

Figure 6-1—Internal organization of the MAC sublayer

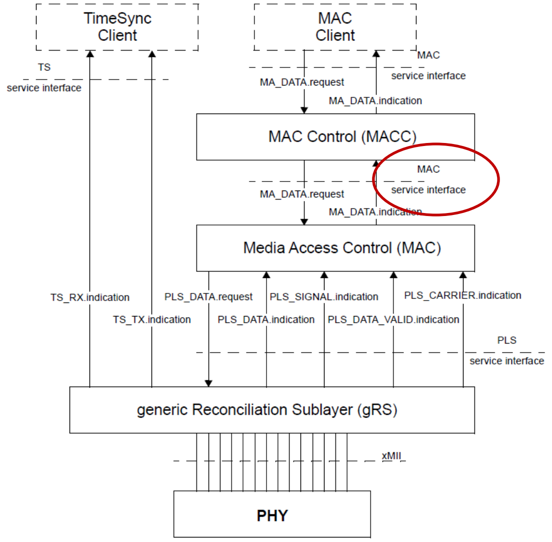


Figure 90–1—Relationship of the TimeSync Client, TSSI and gRS sublayer relative to MAC and MAC Client and associated interfaces

- propagation delay(PD): delay along the network media (e.g., cable) for a frame transmitted from the specified Port of this station to the neighboring Port on a different station
  =distance between peer MDIs/propagation speed refer to 12.32.2 Propagation Delay 802.1Q-2022

- bridge delay(BD): delay of frames as they pass through the Bridge's relay = independentDelay + dependentDelay
  independentDelay= delay independent of frame length (Filters frames using their VID and DMAC addresses
  dependentDelay = delay dependent on frame length, transferring a frame across the MAC Service interfaces from ingress to egress port =frame length/bridge internal transferring rate

er to 12.32.1 Bridge Delay, 802.1Q-2022

12.32.1 Bridge Delay

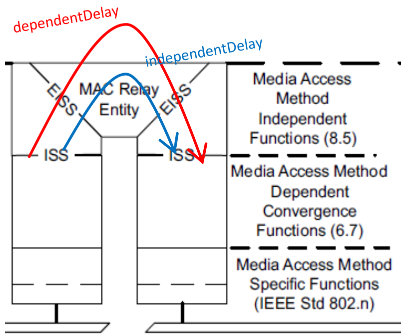
This subclause specifies attributes of a managed object that is used to determine the delay of frames as they pass through the Bridge's relay. There is one Bridge Delay managed object per Port pair per traffic class of a Bridge component. Each set of Bridge Delay attributes is accessed using three indices: ingress Port, egress Port, and traffic class. The set of managed object attributes is shown in Table 12-38.

12.32.1.1 independentDelayMin/Max

These attributes provide the portion of delay that is independent of frame length.

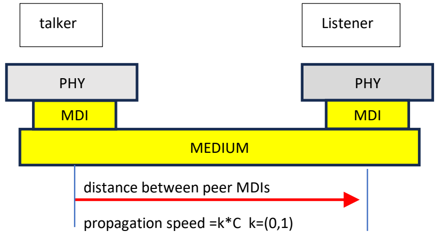
12.32.1.2 dependentDelayMin/Max

These attributes provide the portion of delay that is dependent on frame length, where frame length is the number of octets that transfer across the MAC Service interfaces. Each length-dependent delay attribute specifies the time for a single octet of the frame to transfer from ingress to egress.



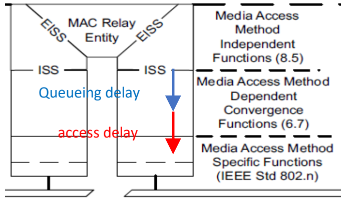
12.32.2 Propagation Delay

This subclause specifies attributes of a managed object used to determine the delay along the network media (e.g., cable) for a frame transmitted from the specified Port of this station to the neighboring Port on a different station. There is one Propagation Delay managed object per Port of a station (i.e., Bridge or end station). The set of managed object attributes is shown in Table 12-39.



List of delay definition

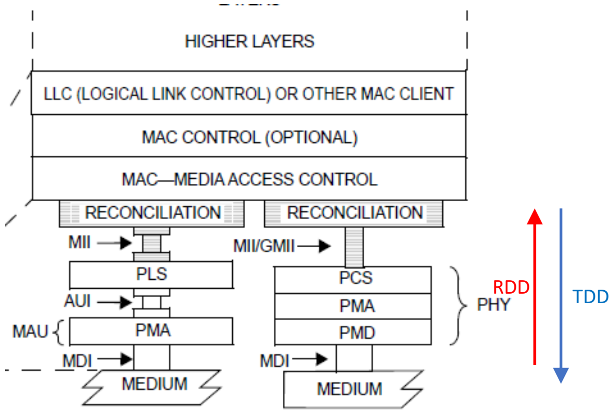
- transmission delay(TD): queuing delay(time waiting for the frame becomes first in line for transmission on the Port) + access delay(time for transmission of the frame) refer to 6.5.9 Priority, 802.1Q-2022



The transmission delay comprises:

a) A queuing delay until the frame becomes first in line for transmission on the Port, in accordance with the procedure for selecting frames for transmission described in 8.6.8.
b) The access delay for transmission of the frame.

- Transmit data delay(TDD): delay from the input of frame at the XGMII to the presentation of the same frame by the PHY to the MDI.
- Receive data delay(RDD): delay from the input of frame at the MDI to the presentation of the same frame by the PHY to the XGMII. refer to 149.10 Delay constraints, 802.3-2022



149.10 Delay constraints

In full duplex mode, predictable operation of the MAC Control PAUSE operation (Clause 31, Annex 31B) also demands that there be an upper bound on the propagation delays through the network. This implies that MAC, MAC Control sublayer, and PHY implementers conform to certain delay maxima, and that network planners and administrators conform to constraints regarding the cable topology and concatenation of devices.

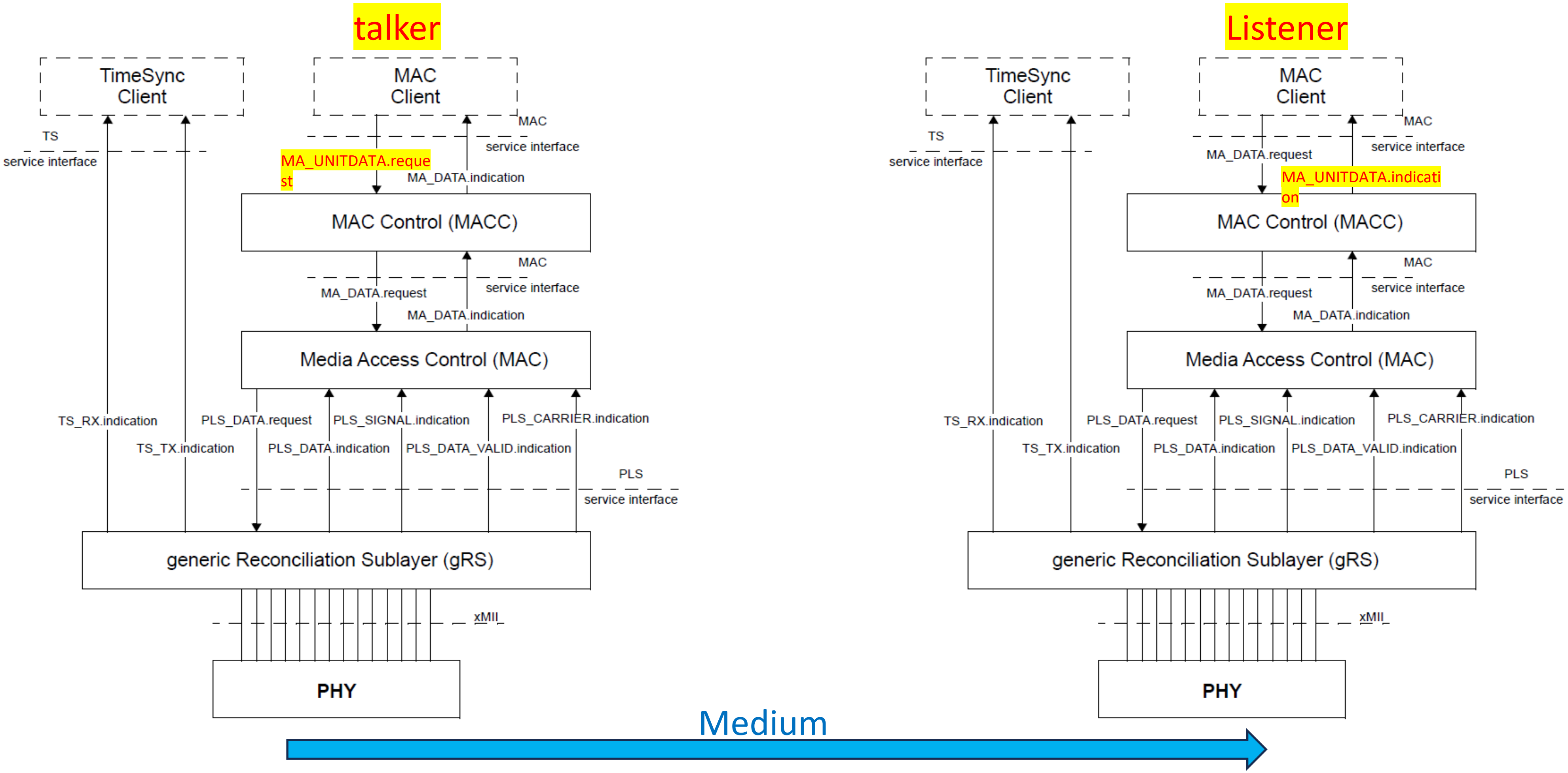
The sum of the transmit and receive data delays for an implementation of the PHY shall not exceed the limits shown in Table 149–20. Transmit data delay is measured from the input of a given unit of data at the XGMII to the presentation of the same unit of data by the PHY to the MDI. Receive data delay is measured from the input of a given unit of data at the MDI to the presentation of the same unit of data by the PHY to the XGMII.

- Network transit delay: the elapsed time between an MA_UNITDATA.request primitive and the corresponding MA_UNITDATA.indication primitive.   Refer to 6.5.5 of 802.1Q-2022

List of delay definition

6.5.5 Transit delay

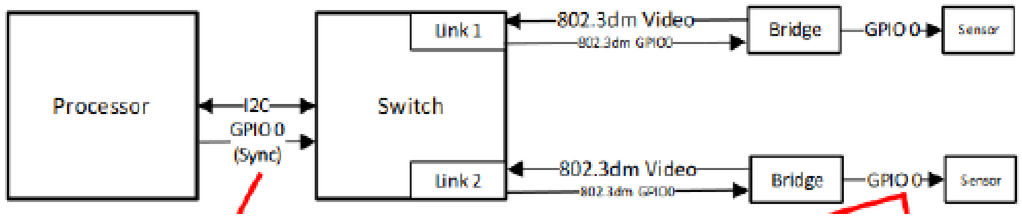
The MAC Service introduces a frame transit delay that is dependent on the particular media and MAC method employed. Frame transit delay is the elapsed time between an MA_UNITDATA.request primitive and the corresponding MA_UNITDATA.indication primitive. Elapsed time values are calculated only on SDUs that are successfully transferred.



Latency Requirements

- Latency and Jitter are important to avoid long initializations of sensors and frame synchronization with other ADAS sensors
- For automotive sensor applications, latency should not exceed
  - There is a 10us hard limit related to functional safety (from switch to camera)
    - This includes a GPIO trigger event or a single I2C command
  - There is a less than 1.0us latency limit from the sensor to switch
  - There is a 1-2us limit on GPIO trigger events from the switch to sensor
  - There is a less than 1.0us latency limit on the video channel from sensor to switch
- Competing SERDES technology can already achieve these latency requirements

IEEE 802.3dm Task Force



page 7

MT questions:

- Can we add a reference for each of those requirements on page 6?
- Can we find terms (Bridge, Switch) which are not already overloaded in the 802.1 realm?

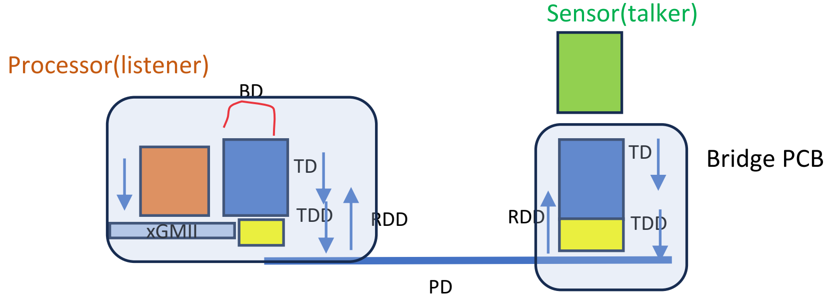
Apply latency delay definition to Marvell example

Using 802.3dm ontology to describe this example:
Bridge=switch
Listener=processor + Ethernet bridge/xGMII
Talker= Sensor + Ethernet PHY/CSI-2

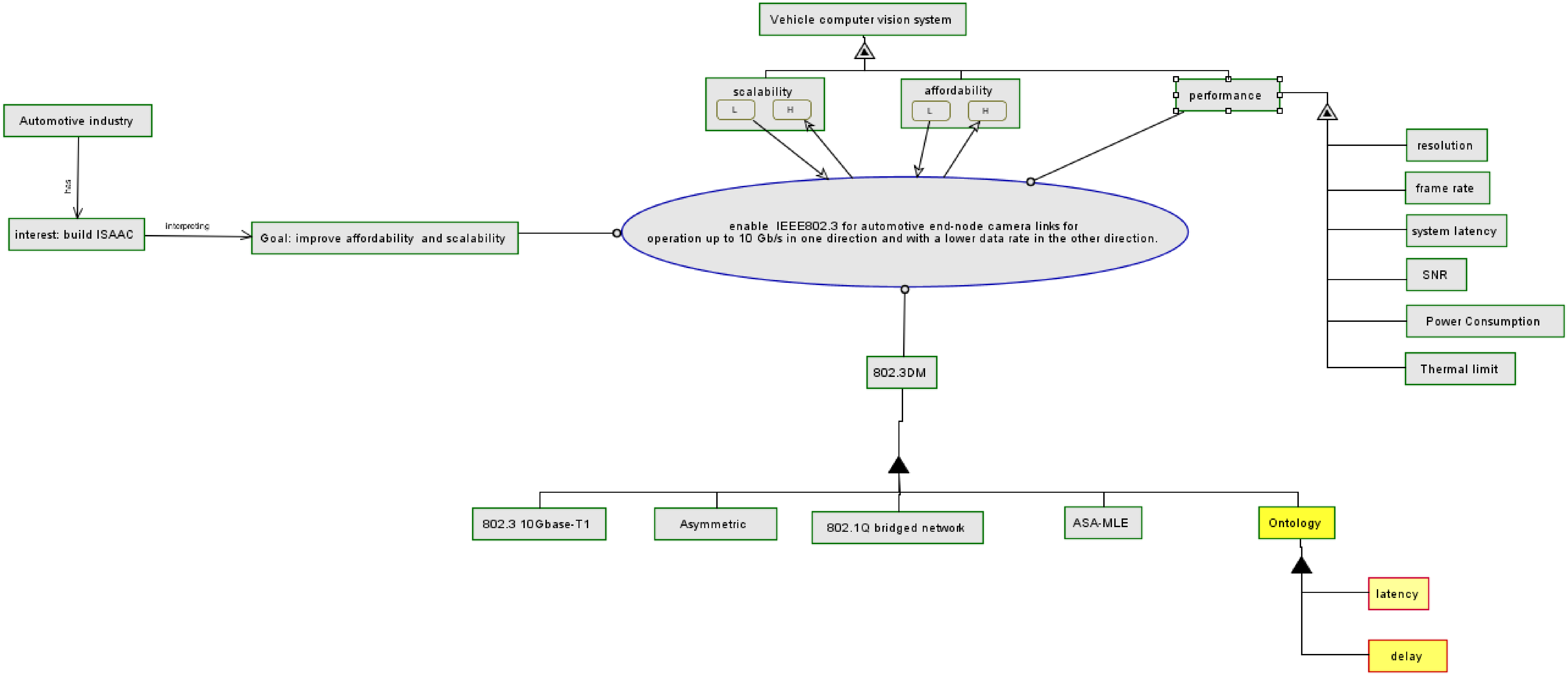
System Latency(startup)= system delay(listener =>talker: wakeup req) + system delay(talker=> listener: wakeup rsp)= 11 us
System delay(listener => talker: wakeup req)=App Latency(wakeup req) + network latency(wakeup req) < 10 us
system delay(talker=> listener: wakeup rsp)=App Latency(wakeup rsp) + network latency(wakeup rsp) <1 us

network latency(wakeup req)=BD(listener)+TD(listener)+TDD(listener)+PD+RDD(talker)
network latency(wakeup rsp)=TD(talker)+TDD(talker)+PD+RDD(listener)+ BD(listener)+ TD(listener) < 1us

System Latency(image frame)= App Latency(image frame)+network latency(image frame)
network latency(image frame)= TD(talker)+TDD(talker)+PD+RDD(listener)+ BD(listener)+ TD(listener)



The ISAAC system modeled in OPD, refer to ISO 19450 Object-Process Methodology



The ISAAC system modeled in OPL, refer to ISO 19450 Object-Process Methodology

Automotive industry has interest: build ISAAC.
interest: build ISAAC interpreting Goal: improve affordability and scalability.
Vehicle computer vision system exhibits scalability, affordability, and performance.
    scalability can be L or H.
    affordability can be L or H.
    performance exhibits resolution, frame rate, system latency, SNR, Power Consumption, and Thermal limit.
802.3DM consists of 802.3 10Gbase-T1, Asymmetric, 802.1Q bridged network, ASA-MLE, and Ontology.
    Ontology consists of latency and delay.
enable IEEE802.3 for automotive end-node camera links for operation up to 10 Gb/s in one direction and with a lower data rate in the other direction. requires Goal: improve affordability and scalability, performance, and 802.3DM.
enable IEEE802.3 for automotive end-node camera links for operation up to 10 Gb/s in one direction and with a lower data rate in the other direction. changes affordability from L to H and scalability from L to H.

enable IEEE802.3 for automotive end-node camera links for operation up to 10 Gb/s in one direction and with a lower data rate in the other direction. consumes performance.