Capabilities extension for the TSN UNI traffic specification

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Introduction

Why traffic specification (TSpec) is important ?

- Need for a formal definition of traffic characteristics that are being observed in practical applications.
- Enables the extraction of specific traffic parameters and modeling patterns driving forces for standardization.
- Subsequent analysis leads to enhancements in network resource management and specific user QoS requirements guarantee.
- Distinguish various traffic classes contributes to different scheduling and path selection strategies.
- **Not always clear, what is the optimal gamut of traffic parameters to be selected !**

Traffic specification in IEEE 802.1 TSN

- Traffic characteristics sourced by different types of applications have been limitedly considered in traffic specification (TSpec) TLV (see **IEEE Std 802.1Qcc**) [1].

- Reservation of resources urges for **shaping techniques** that have been **standardized** to **ensure deterministic QoS** based on concrete traffic models.

- **Models and shapers** parameterization is not **fully in coherence** with **TSpec TLVs** to support user traffic requirements announce to the network.

- **Resource reservation** relies only on **basic user traffic profiling** and does not cover advanced dynamic network provisioning for user-oriented QoS control methods.

- Current UNI enhancements in **IEEE P802.1Qdj/Qdd** strive to extend the existing user capabilities.

[1] Section **46.2.3.5**: IEEE Std 802.1Qcc.

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Stream reservation – TSpec in MSRP

- MSRP is limited to basic traffic parameterization in Talkers **REGISTER_STREAM.request** Tspec:
  - + **MaxFramesPerInterval**
  - + **MaxFrameSize**
- With the recent advances in IEEE TSN TG, the above parameters do not suffice in configuring network bridges shaping features:
  - ATS concerns the Committed Information Rate, Committed Burst Size and Minimum Frame Size [2].
  - CQF takes into account a specific cycle time.
  - Multi-CQF considers more than one cycle time, i.e., one per traffic class [3].
  - Scheduling traffic (ST) comes with time-aware offsets.

Table 46-8—TrafficSpecification elements

Name	Data type	Reference
Interval	rational	46.2.3.5.1
MaxFramesPerInterval	uint16	46.2.3.5.2
MaxFrameSize	uint16	46.2.3.5.3
TransmissionSelection	uint8	46.2.3.5.4

IEEE Std 802.1Qcc-2018

Could we do something better to adapt specifications to those cases ?

Enhancements in Qdd introduce partially such TSpec TLV in RAP/LRP.

TimeAware TLV covers the case of ST based on centralized scheduling in Qcc [4].

[2] Johannes Specht. On ATS. https://www.ieee802.org/1/files/public/docs2021/new-specht-onats-0921-v01.pdf
[3] Norman Finn. Multiple Cyclic Queuing and Forwarding. https://www.ieee802.org/1/files/public/docs2019/df-finn-multiple-CQF-0919-v01.pdf, September 14, 2019.
[4] 802.1Qcc-2018. https://standards.ieee.org/ieee/802.1Qcc/5784/

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Stream reservation – TSpec in RAP/LRP

- More advanced [4] compared to MSRP traffic parameterization in Talkers **ANNOUNCE_STREAM.request** Tspec:
  - + **Minimum Transmitted Frame Size**
  - + **Committed Information Rate**
  - + **Committed Burst Size**
- It is configurable to choose between Token Bucket or MSRP TSpec (i.e., partially covers standardized shapers attributes)
- Such parameterization is not solidly defined in P802.1Qdj.
- Those parameters fit only to static resource allocation.
- What about dynamic assignment of resources in user to network (UNI) configuration ?
- What are the parameters to be added to achieve that goal?

	Octet	Length
Stream ID	1	8
Stream Rank	9	1
Accumulated Maximum Latency	10	4
Accumulated Minimum Latency	14	4
Data Frame Parameters sub-TLV	18	11
Token Bucket TSpec sub-TLV or MSRP TSpec sub-TLV	29	19 or 7
0 or 1 Redundancy Control sub-TLV	variable	variable
0 or 1 Failure Information sub-TLV	variable	variable
0 or more Organizationally Defined sub-TLVs	variable	variable

Figure 99-12—Value of Talker Announce attribute TLV

	Octet	Length
Maximum Transmitted Frame Size	1	2
Minimum Transmitted Frame Size	3	2
Committed Information Rate	5	8
Committed Burst Size	13	4

Figure 99-14—Value of Token Bucket TSpec sub-TLV

IEEE Std P802.1Qdd

[5] https://www.ieee802.org/1/files/private/dd-drafts/d0/802-1Qdd-d0-5.pdf

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Extensions of the current UNI Traffic specification (1/2)

- TSN UNI needs to be extended to cover dynamic resource allocation under network performance variability.
  - **Adaptability** of the network behavior, where new streams are introduced **on the fly**.
- **Fairness** in resource reservation needs to be guaranteed in such **dynamic environment**.
  - Talkers could ask for a range of resources **up to a maximum value**, but still with less resources **bounded by a minimum value** could sustain the desired QoS.
- **Feasibility in admission** of streams to be guaranteed with **flexible talkers QoS** and fast convergence.
- Does the proposed methodology apply in enhanced configuration models (i.e., **P802.1Qdj**) ?
  - **Dynamic network adjustment** considers a holistic network approach to optimally allocate resources and not to overestimate the user requirements.

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Extensions of the current UNI Traffic specification (2/2)

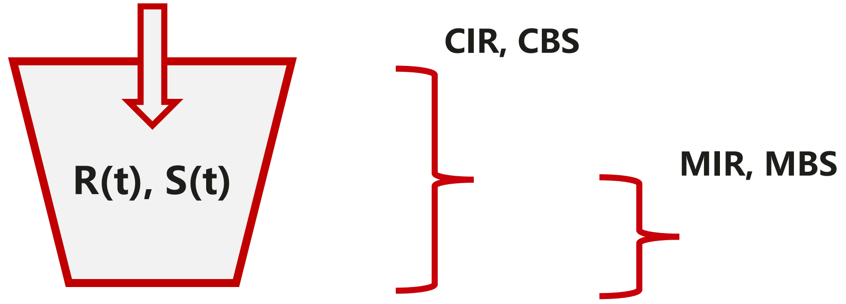
What's new to be added following the previous discussion?

- Would be useful to add data rates and burst size with ranges in the TrafficSpecification of UNI ?

  + **Minimum Information Rate (MIR)**
  + **Minimum Burst Size (MBS)**

- Network management entity to return target value of information rate R(t) and burst size S(t) based on the talkers announced range values:

$MIR \leq R(t) \leq CIR$
$MBS \leq S(t) \leq CBS$



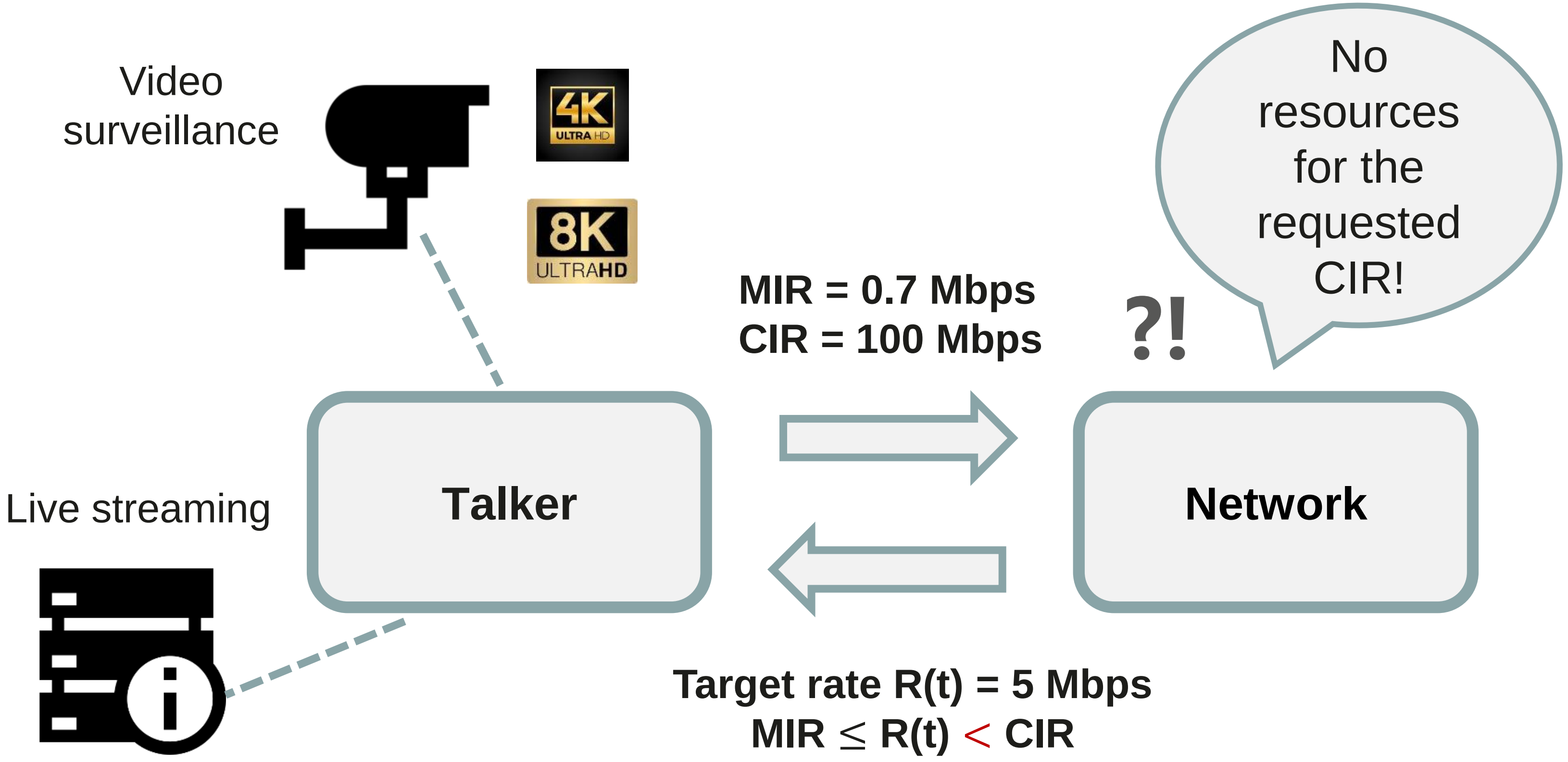
- Either talkers send traffic with the limitation of the target value of R(t) and S(t), or the target value of R(t) and S(t) is used for the traffic shaping of talkers.

Parameters already been proposed
Committed Information Rate (CIR)
Committed Burst Size (CBS)

P802.1 Qdj ?

New parameters to be added
Minimum Information Rate (MIR)
Minimum Burst Size (MBS)

Talker application requirements - Example

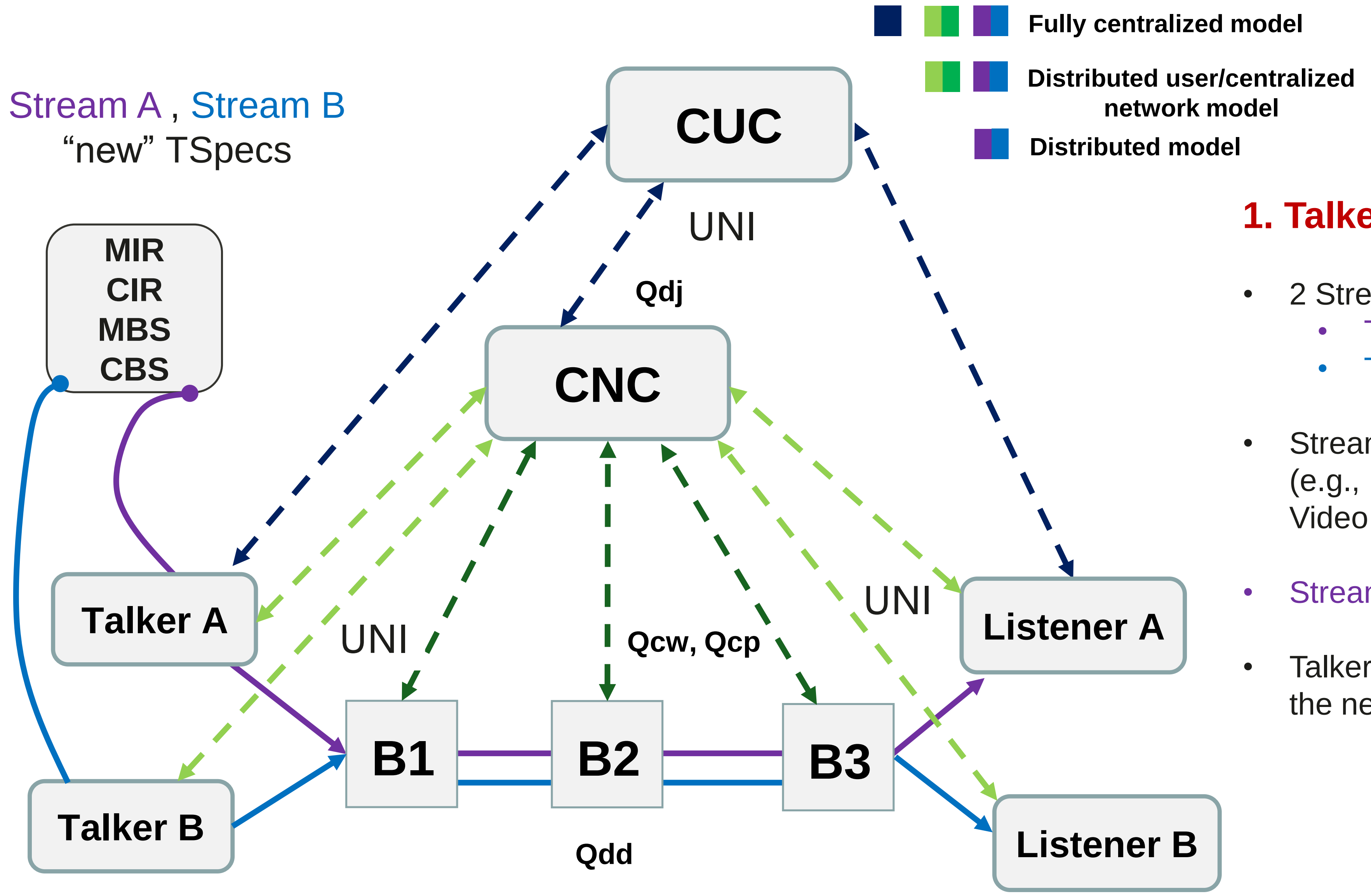


Talker application requirements [6]

Resolution	Rate
360p	0.7 Mbps (MIR)
480p	1.1 Mbps
720p	2.5 Mbps
1080p	5 Mbps
4K (2160p)	20 Mbps
8K (4320p)	100 Mbps (CIR)

[6] https://www.highspeedinternet.com/resources/how-internet-connection-speeds-affect-watching-hd-youtube-videos

Reservation process - Example (1/3)



1. Talkers TSpec → Network

- 2 Streams transmission:
  - Talker A to Listener A.
  - Talker B to Listener B.
- Streams represent different types of traffic (e.g., Video conference, Live streaming, Video surveillance).
- Stream A has higher priority to Stream B.
- Talkers signal the stream specifications to the network via UNI.

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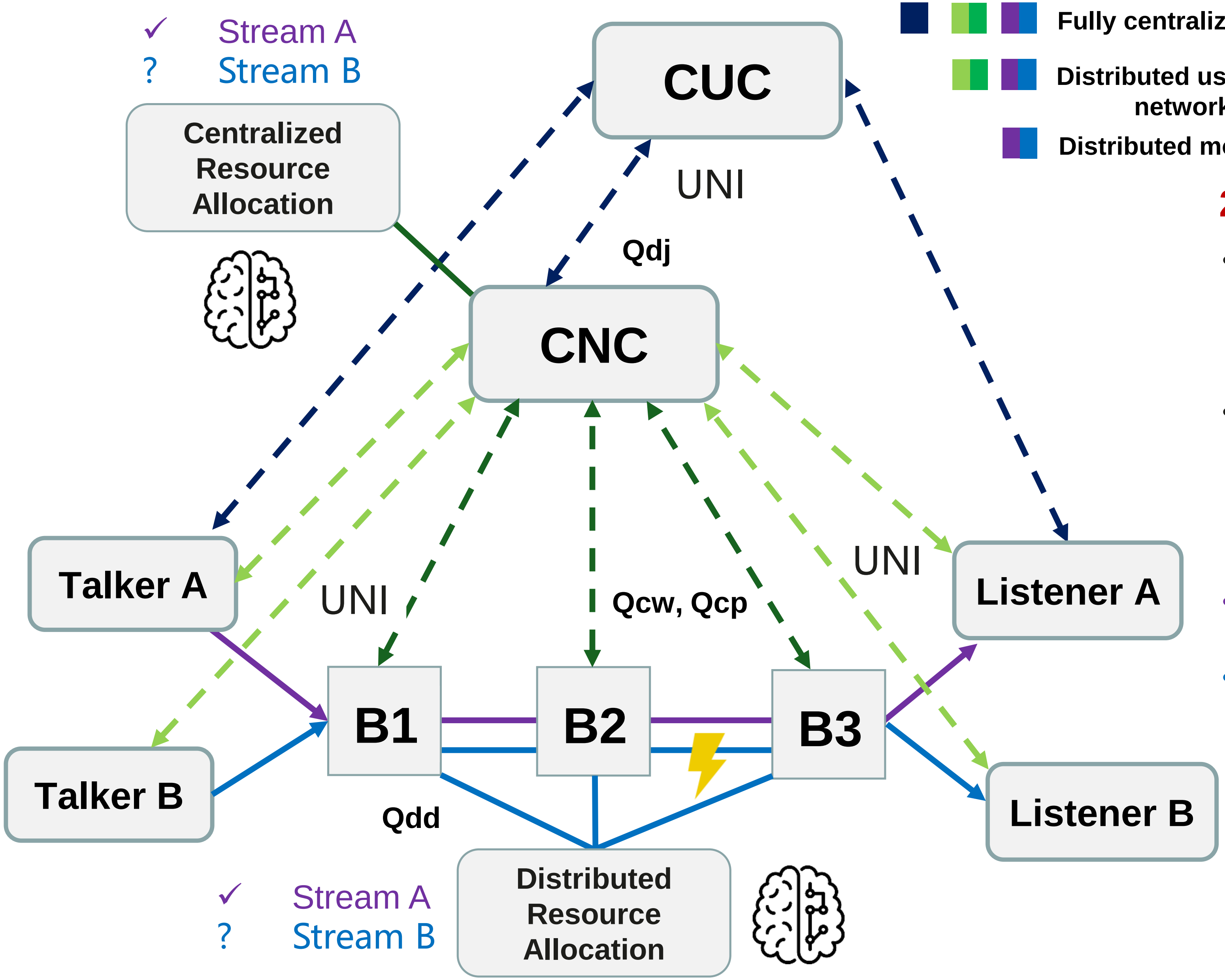
Reservation process - Example (2/3)



Fully centralized model

Distributed user/centralized network model

Distributed model

2. Network Resource Allocation

- Stream reservation can be based on the fully centralized, distributed user/centralized network model and optionally the distributed model.
- Network resources are sufficient to satisfy the announced requirements of the highest priority Stream A, but not the ones of Stream B at requested CIR, CBS.
- Stream A will be admitted with CIR, CBS.
- Adaptation for Stream B shall apply within the requested range:

$$MIR \leq R(t) < CIR$$
$$MBS \leq S(t) < CBS$$

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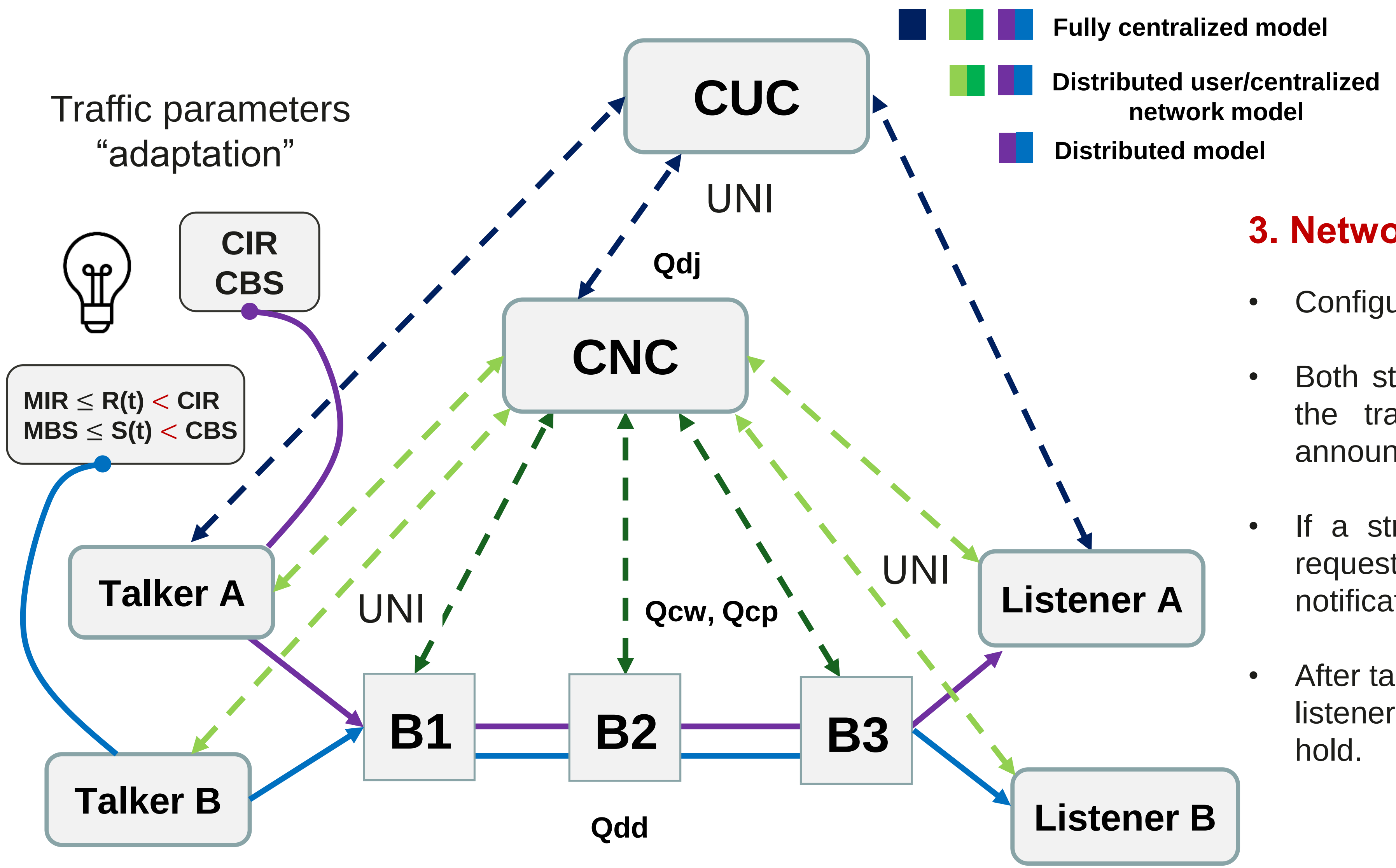
Reservation process - Example (3/3)



3. Network → Talkers

- Configuration to talkers is sent via UNI.
- Both streams can be served if adaptation of the traffic parameters can still fulfill the announced requirements.
- If a stream cannot be admitted within the requested range, then a withdraw stream notification shall be sent.
- After talkers announce and admission control, listeners attach follows, if the above criteria hold.

Summary

- Revisit **TSN traffic specifications** towards enhancements in network **resource management**.
- **New streams** arrival circumvents the need for dynamic **scheduling** mechanisms.
- Such mechanisms shall fulfill the requirements of **adaptive traffic engineering** within a pre-determined range of values on a specific traffic class and priority **QoS guarantees**.
- The above methodology accelerates **computational convergence** and provides **flexibility** in allocating the network resources, especially when interference of streams is present.
- Whether **MSRP TSpec or Token Bucket TSpec** is sufficient for static allocation, the presented approach adds flexibility for **dynamic** reservation of resources.
- Proposed **traffic parameterization** is kept simple and builds **on top of the current TSpec** configuration.
- Such **mechanism** can be **applicable** to fully centralized, distributed user/centralized network model and optionally to distributed model.

Contribution to TSpec Groups – Proposal

Table 46-8—TrafficSpecification elements

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+

Parameters already been proposed
Committed Information Rate (CIR)
Committed Burst Size (CBS)

New parameters to be added
Minimum Information Rate (MIR)
Minimum Burst Size (MBS)

- Suggested work may be led by P802.1Qdj.
- Section **46.1.7.1.2.6** in the next draft of Qdj to be revisited.
- Proposal 1: Add CIR, CBS in Section **46.2.3.5** as an alternative option besides **Table 46-8**.
- Proposal 2: Add MIR and MBS as an optional **TSpecRange** group.

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Thank you.

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