Extensions on the traffic specification and status for TSN UNI

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Introduction

- **Deviation** in traffic characteristics sourced by different types of applications has been limitedly considered in traffic specification (**TSpec**) TLVs [1].
- **New streams** arrival circumvents the need for **dynamic** (online) **scheduling** mechanisms.
- **Resource allocation** techniques need to be revised to cover network traffic variability.
- Whether current **Tspec TLVs** meet the needs for static allocation, there is no approach that adds flexibility for **dynamic** network resource management.
- Revisit **TSN Tspec** is urged towards enhancements in flexible traffic engineering.
- In such scenarios, an adaptive **QoS** admission control scheme is required**.**

[1] 802.1Qcc-2018. https://standards.ieee.org/ieee/802.1Qcc/5784/

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Background in IEEE 802.1 TSN

- MSRP is limited to basic traffic parameterization in Talkers **REGISTER_STREAM.request** Tspec [1]:
  - + **MaxFramesPerInterval**
  - + **MaxFrameSize**
- **Optional Tspec:** TimeAware TLV covers the case of Scheduling traffic (ST) based on centralized scheduling in Qcc [1]:
  - + **EarliestTransmitOffset**
  - + **LatestTransmitOffset**
- More advanced [2] compared to MSRP traffic parameterization in Talkers **ANNOUNCE_STREAM.request** Tspec (i.e., Token Bucket Tspec sub-TLV) :
  - + **Minimum Transmitted Frame Size**
  - + **Committed Information Rate**
  - + **Committed Burst Size**

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

Table 46-9—TSpecTimeAware elements

Name	Data type	Reference
EarliestTransmitOffset	uint32	46.2.3.5.5
LatestTransmitOffset	uint32	46.2.3.5.6
Jitter	uint32	46.2.3.5.7

IEEE Std 802.1Qcc-2018

	Octet	Length
MaxTransmittedFrameLength	1	2
MinTransmittedFrameLength	3	2
CommittedInformationRate	5	8
CommittedBurstSize	13	4

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

IEEE Std P802.1Qdd

[2] https://www.ieee802.org/1/files/private/dd-drafts/d0/802-1Qdd-d0-6.pdf

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

Static vs Dynamic resource allocation: Could we further broaden the TSN UNI scope ?

- ✓ **Adaptability** of the network behavior is urged, where new streams are introduced **on the fly**.
- ✓ **Fairness** in resource reservation has to be guaranteed in such **dynamic environment**.
- ✓ **TSN UNI** capabilities needs to cover dynamic resource allocation under network performance variability.
- ✓ 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**.
- ✓ Proposed **traffic parameterization** shall be kept simple and build **on top of the current TSpec** configuration.

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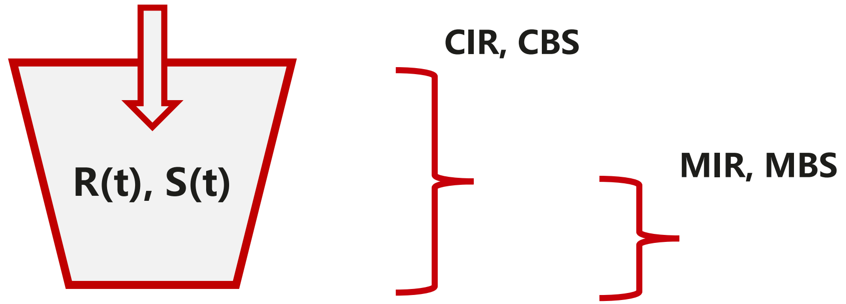
Extensions of the current UNI traffic specification (2/2)

Objective: Flexibility in allocating network resources. More streams to be admitted dynamically!

- Would be useful to add data rates and burst size with ranges in the Tspec of UNI ?
  + **Minimum Information Rate (MIR)**
  + **Minimum Burst Size (MBS)**
- Flexible & agile network management to return a target value of information rate R(t) and burst size S(t) tailored to the talkers announced range of values and the availability of resources:

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



- 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)

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

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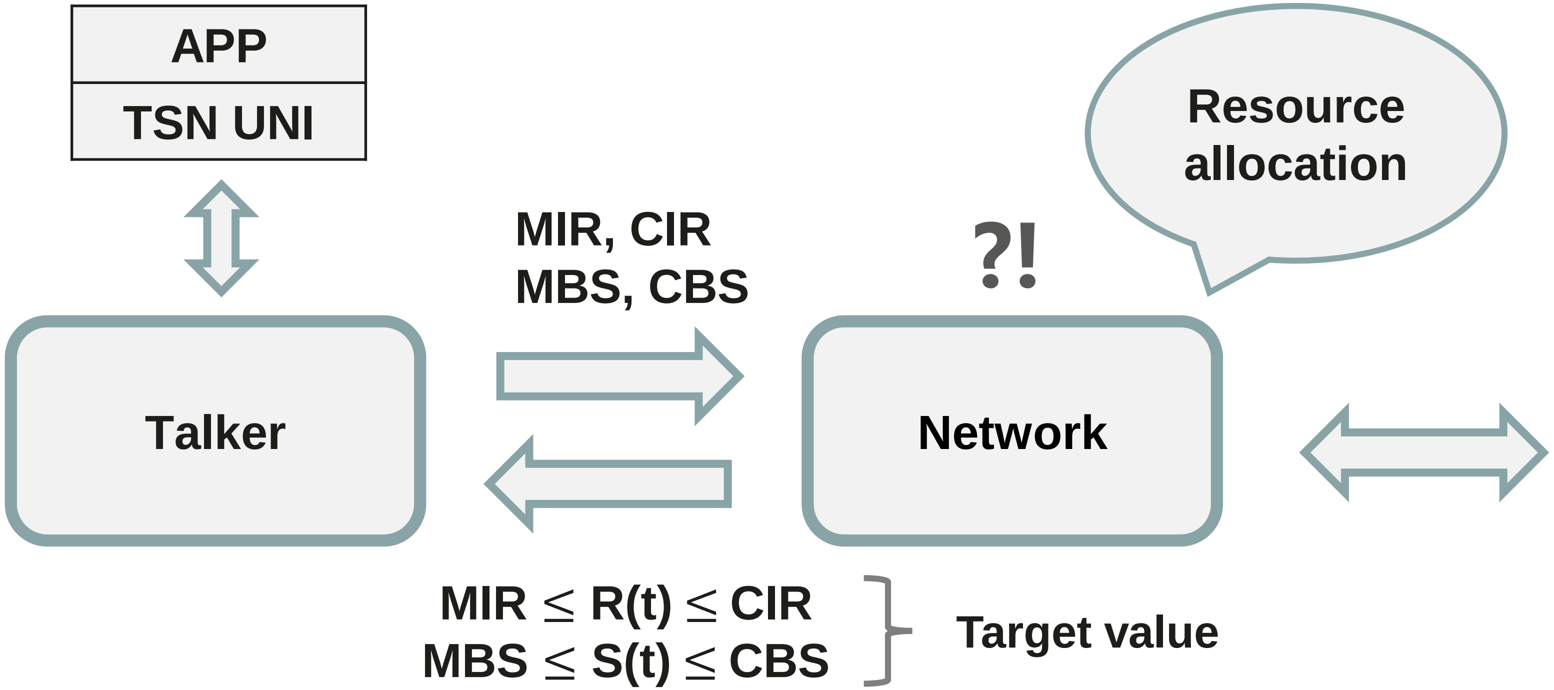
Talker to Network – New stream request (1/2)



Discrete target value set

R(t)	S(t)
R_1	S_1
R_2	S_2
…	…
R_n	S_n

- **Talkers** signal to the network via UNI the stream Tspec **min/max** values, i.e., a pre-defined range.
- **Admission** control and **resource allocation** for the stream request is performed by the network.
- The **target values** to be returned are **discrete** and chosen by a concrete set within the **min/max** values.
- A **withdraw stream** notification shall be sent in case a stream **cannot be admitted** in the network.

Talker to Network – New stream request (2/2)

1. New request:

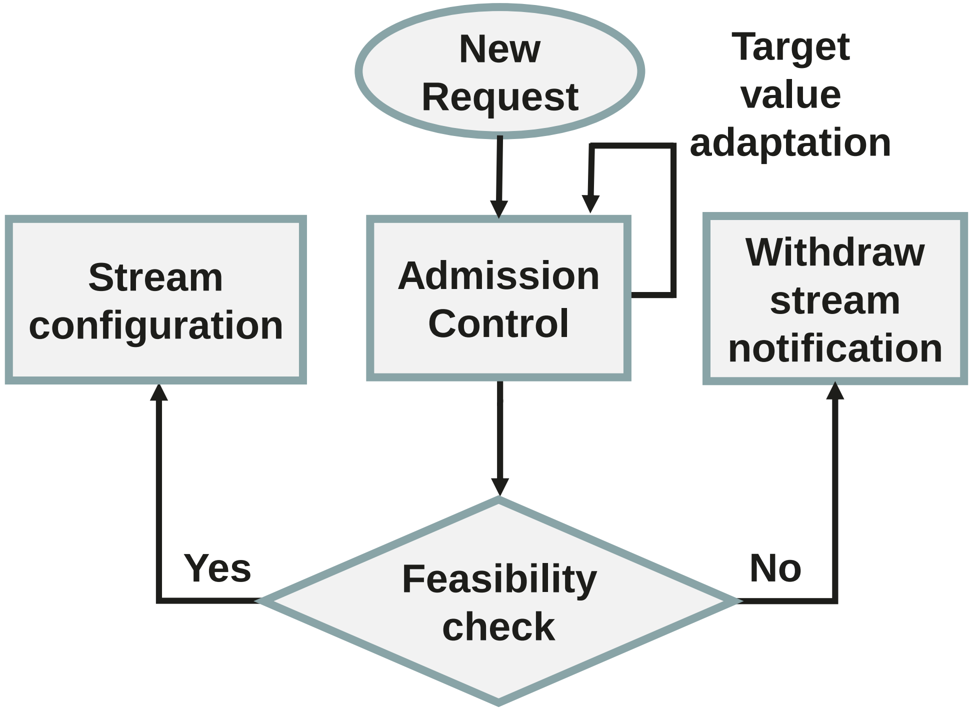
- A new stream reservation request is received by the network carrying the Tspec min/max values.

2. Admission control:

- If the network resources suffice to satisfy the announced Tspec at its max value, then such target value is returned.
- Elsewhere, **adaptation of the target value** within a range is performed for the streams that is sustained starting from the new one.

3. Feasibility check:

- If a feasible solution is reached, the new stream is admitted and configured (**Stream configuration**).
- Elsewhere, the stream is withdrawn and a notification is sent to the talker (**Withdraw stream notification**).



Steps of resource allocation process

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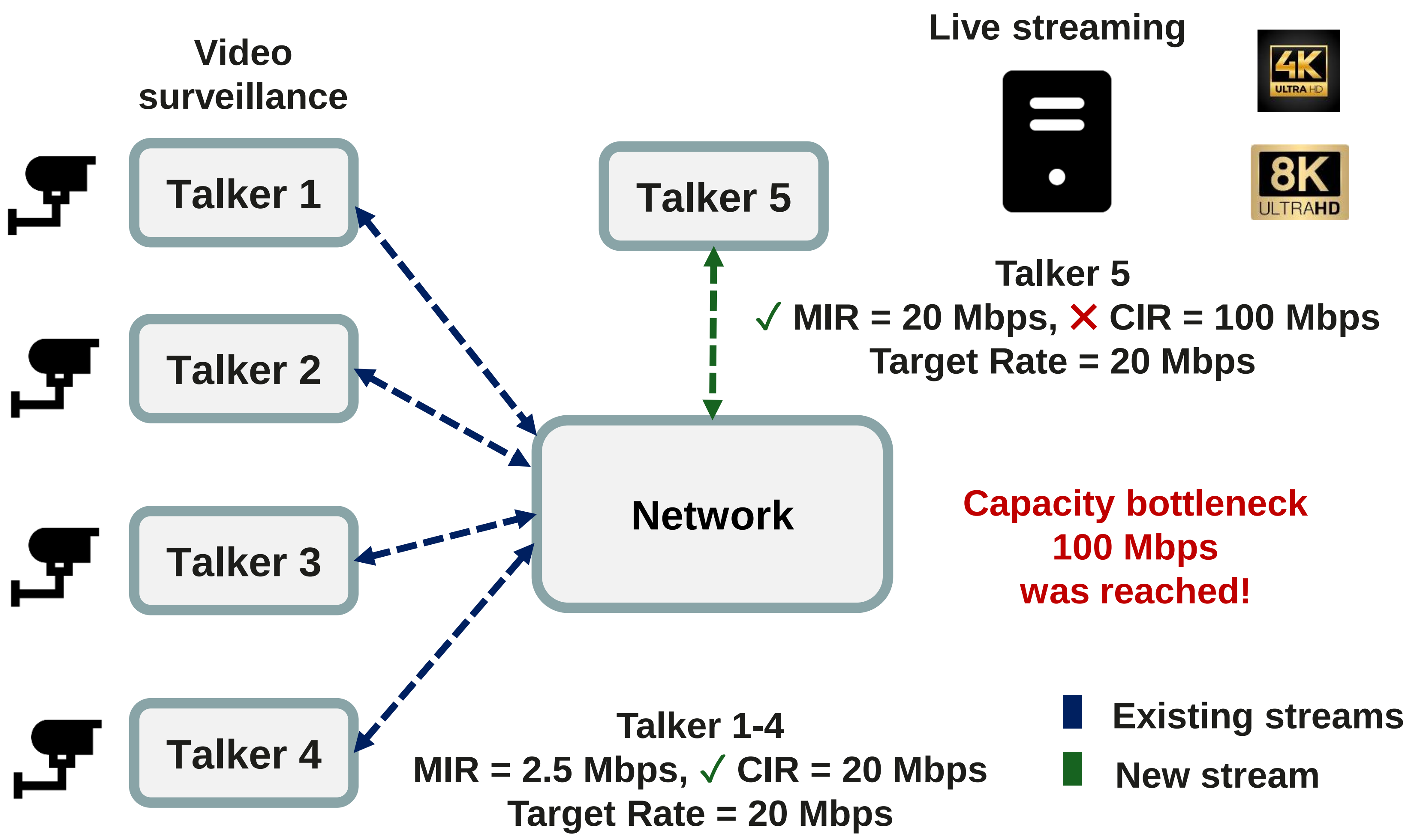
Example - New stream request (1/2)

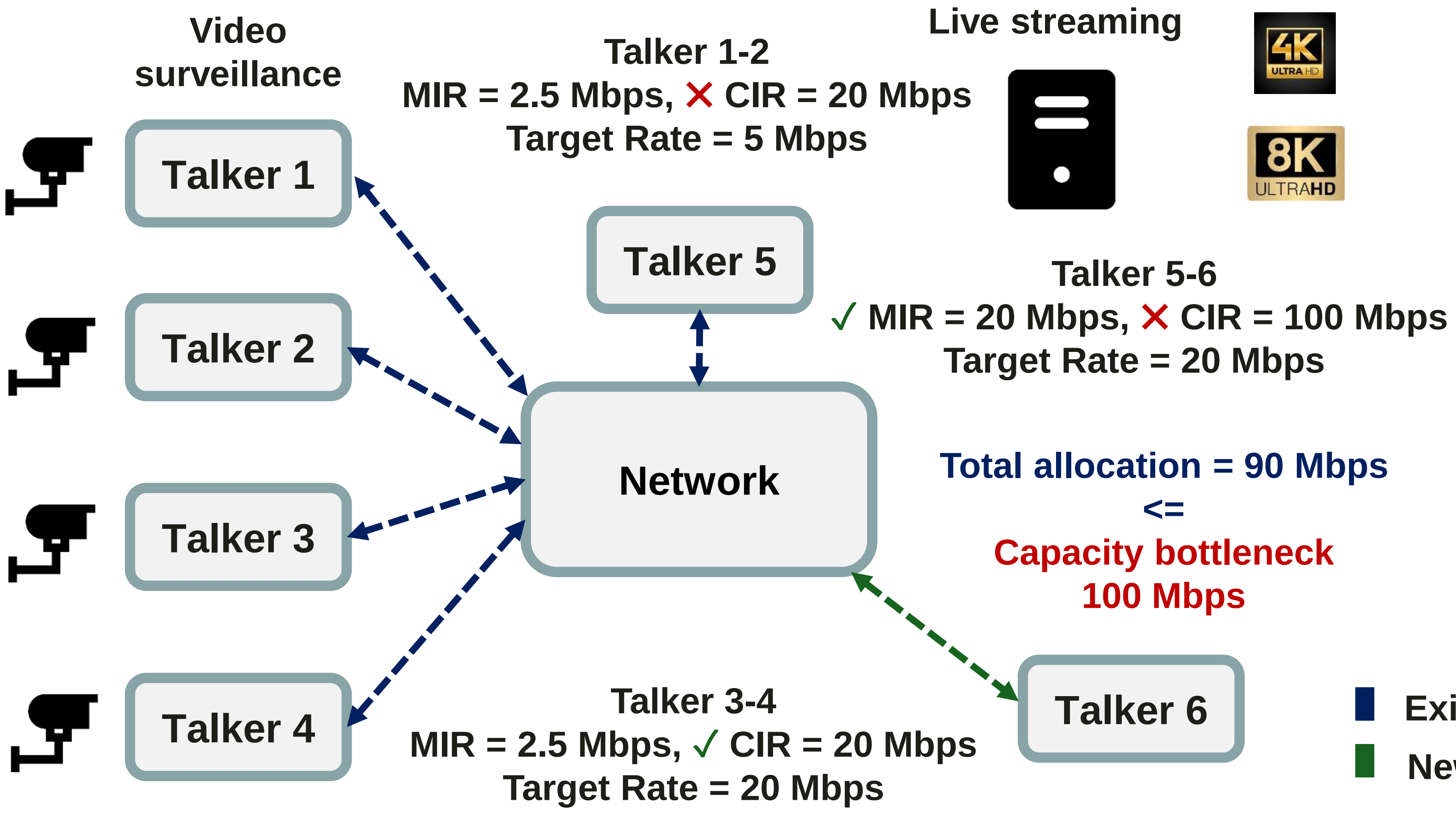


Talker application requirements [3]

Resolution	Target rate
360p	**R_1** = 0.7 Mbps
480p	**R_2** = 1.1 Mbps
720p	**R_3** = 2.5 Mbps
1080p	**R_4** = 5 Mbps
4K (2160p)	**R_5** = 20 Mbps
8K (4320p)	**R_6** = 100 Mbps

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

Example - New stream request (2/2)



Talker application requirements [3]

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Existing streams

New stream

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

Similarities with existing work in 802.1 TSN

Where are we now in YANG modules?

ieee802-dot1dj-tsn-config-uni YANG module (Section 48.5.13 in Qdj/D0.3)

```
+--rw traffic-specification
   +--rw time-aware!
      +--rw earliest-transmit-offset?   uint32
      +--rw latest-transmit-offset?     uint32
      +--rw jitter?                     uint32

+--ro interface-configuration
   +--ro interface-list* [mac-address interface-name]
      +--ro mac-address        string
      +--ro interface-name     string
      +--ro config-list* [index]
         +--ro index                        uint8
         +--ro (config-value)?
            +--:(time-aware-offset)
               +--ro time-aware-offset?       uint32
```

Ref. to Section 46.2.5.3.5 TimeAwareOffset in IEEE Std 802.1Qcc-2018

46.2.5.3.5 TimeAwareOffset

If the TSpecTimeAware group is present in the TrafficSpecification group (46.2.3.5) of the Talker, this configuration value shall be provided by the network to the Talker.

If the TSpecTimeAware group is not present in the TrafficSpecification group (46.2.3.5) of the Talker, this configuration value shall not be provided by the network.

This configuration value shall not be provided to Listeners as it is not applicable.

TimeAwareOffset specifies the offset that the Talker shall use for transmit. The network returns a value between EarliestTransmitOffset and LatestTransmitOffset of the Talker's TrafficSpecification. The value is expressed as nanoseconds after the start of the Talker's Interval. The data type is uint32.

What about extending those YANG modules?

Similar YANG definitions apply to CIR/MIR, CBS/MBS

```
+--rw traffic-specification
...
   +--rw rate-burst!
      +--rw cir        uint16
      +--rw mir        uint16
      +--rw cbs        uint16
      +--rw mbs        uint16
...

+--ro interface-configuration
...
            +--ro cir-chosen   uint16
            +--ro cbs-chosen   uint16
```

Recommended text to be added:

If the rate-burst group is present in the TrafficSpecification group of the Talker, this configuration value shall be provided by the network to the Talker, and the value of "`interval`" and "`max-frames-per-interval`" can be neglected.

This configuration value shall not be provided to Listeners as it is not applicable.

`cir-chosen` and `cbs-chosen` specifies the Committed Information Rate and the Committed Burst Size of the Talker shall use as a limit for transmit. The network returns a value of `cir-chosen` between `cir` and `mir`, and a value of `cbs-chosen` between `cbs` and `mbs`. The value of `cir`, `mir`, and `cir-chosen` is expressed as bit per second. The value of `cbs`, `mbs`, and `cbs-chosen` is expressed as bit/Byte (?).

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Summary – Contribution & Next steps

- **TSN Tspec** has been revisited towards enhancements in network **resource management**.
- A **dynamic scheduling** scheme is proposed based on **adaptive QoS traffic engineering** within a pre-determined range of values.
- Such methodology accelerates **computational convergence** and provides **flexibility** in allocating the network resources.
- The presented **mechanism** can be **applicable** to any of the TSN network configuration models.

How to proceed?

- **Proposal 1:** Current **Tspec** definition is not **complete**: An addition of **CIR/CBS** parameters is urged to cover more use-cases.
  - TSpec can only handle streams reservation for scheduled traffic and not burst one, i.e, time-aware vs rate-burst Talkers.
  - Token Bucket TSpec sub-TLV includes those parameters in IEEE Std P802.1Qdd.
  - Ongoing work in present YANG modules lacks of the aforementioned system characteristics.
- **Proposal 2:** In addition to that, **CIR/MIR & CBS/MBS** parameters inclusion is suggested as an upcoming extension.
  - Flexibility in dynamic (online) scheduling is given by those parameters that define a range within QoS is sustainable.
  - A new stream arrives, do the current resources suffice? Adjustment of new and existing streams resources improves schedulability.

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Thank you.