

FAIRNESS CONSIDERATIONS FOR PLCA

EXAMPLE MICROPHONE USE CASE



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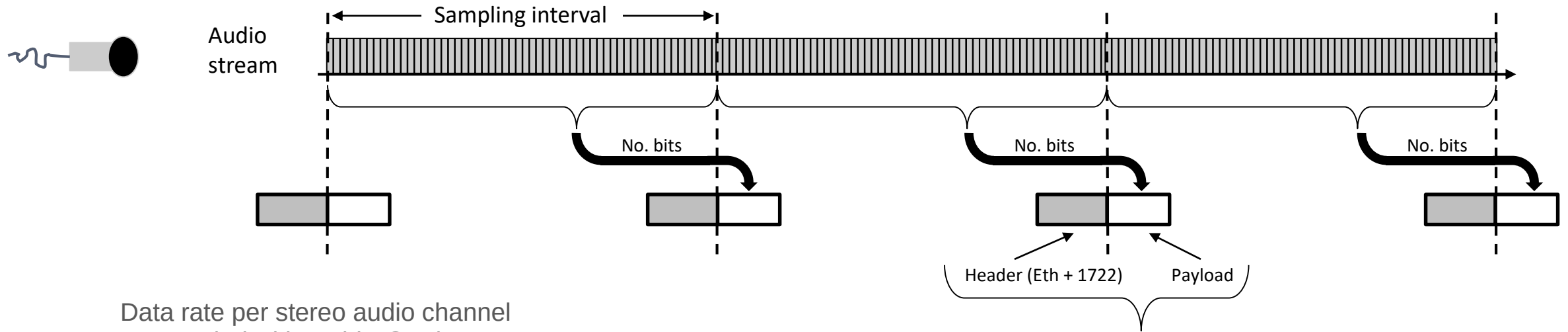
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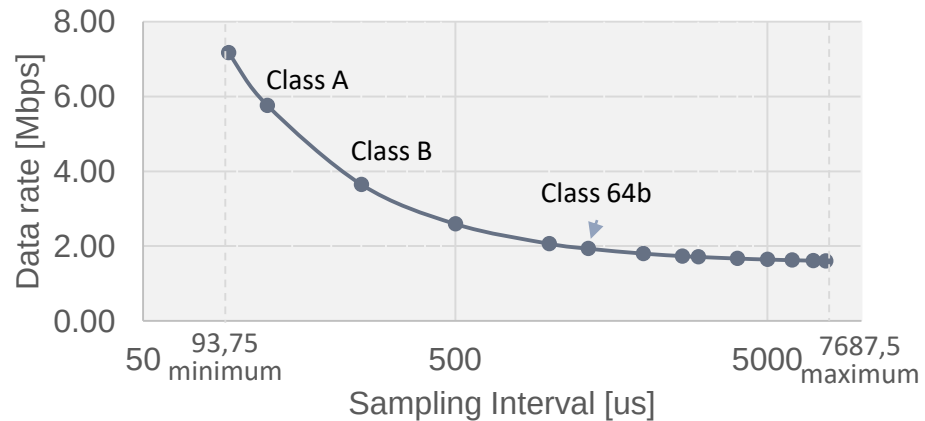
PROBLEM DESCRIPTION

- On the multidrop link segment multiple units share the bandwidth available on the channel.
- The channel access is organized via PLCA, i.e. on a fairness per packet basis.
- If packet sizes on the channel vary, the channel access might lead to unfavourable delays, even if the overall bandwidth required is well under the limit.
- This presentation investigates various possibilities to create better delays without needing to change the existing solution.

MICROPHONE USE CASE SET UP (1).



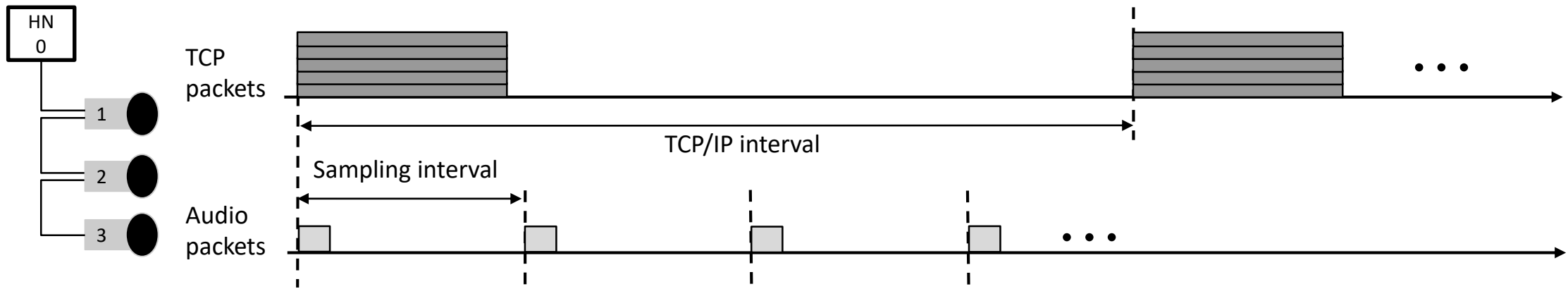
Data rate per stereo audio channel
sampled with 16 bits@48kHz



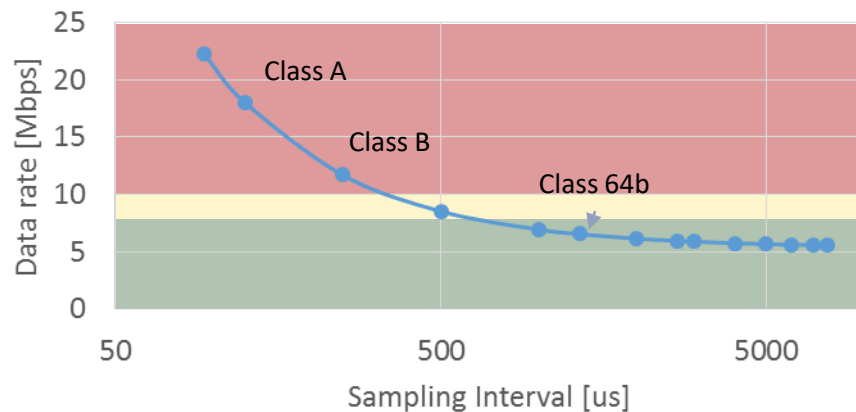
Length of audio packet in bytes is independent of Ethernet speed grade
Data rate needed depends on sampling rate and sampling interval only

$$\begin{aligned}
 \text{Data rate [MHz]} &= \text{payload data rate [MHz]} \\
 &+ \text{header data rate [MHz]} \\
 &= 2 * \text{sample bits} * \text{sample frequency [MHz]} \\
 &+ (42+24) * 8 \text{ bits} / \text{Sampling interval [ms]}
 \end{aligned}$$

MICROPHONE USE CASE SET UP (2).



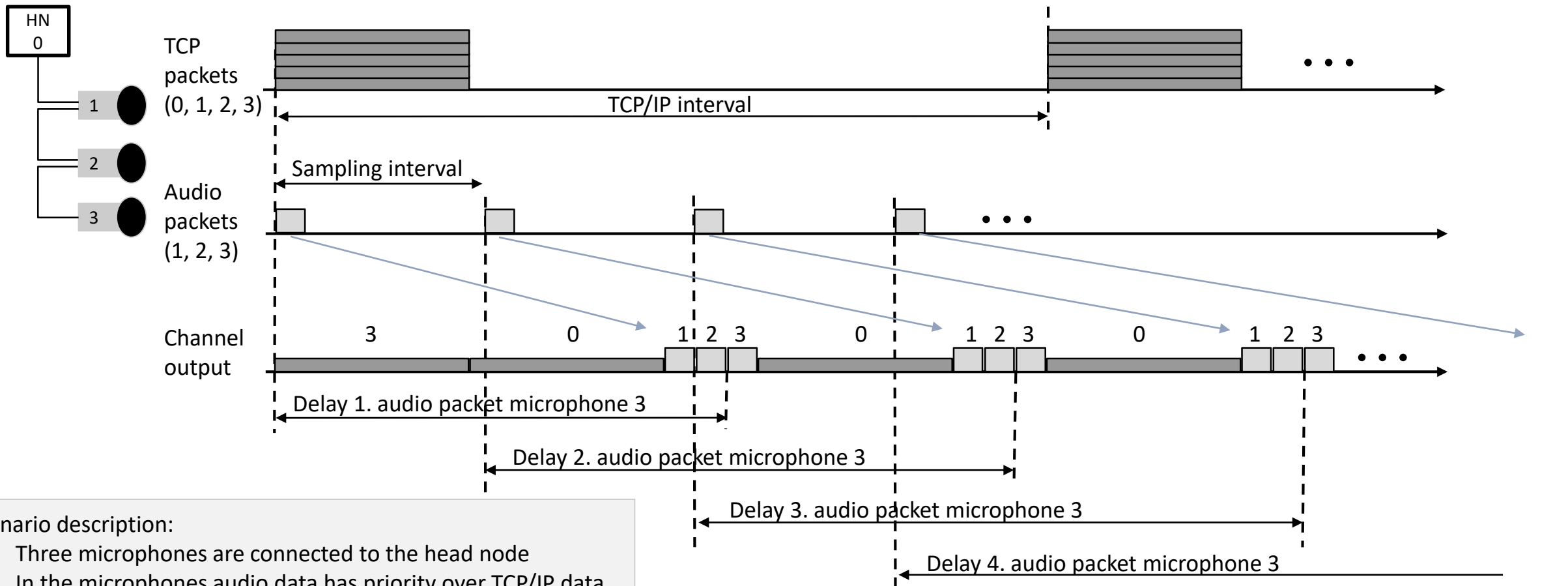
Overall data rate for 3 stereo audio channels
plus 5 TCP/IP packets duplex every 0,5s per
node



The overall data rate needs to fit the channel

$$\text{Data rate [MHz]} = \text{No. microphones} * \text{audio data rate [MHz]} + 2 * \text{No. microphones} * \text{TCP/IP data rate [MHz]}$$

WORST CASE DELAY SCENARIO.

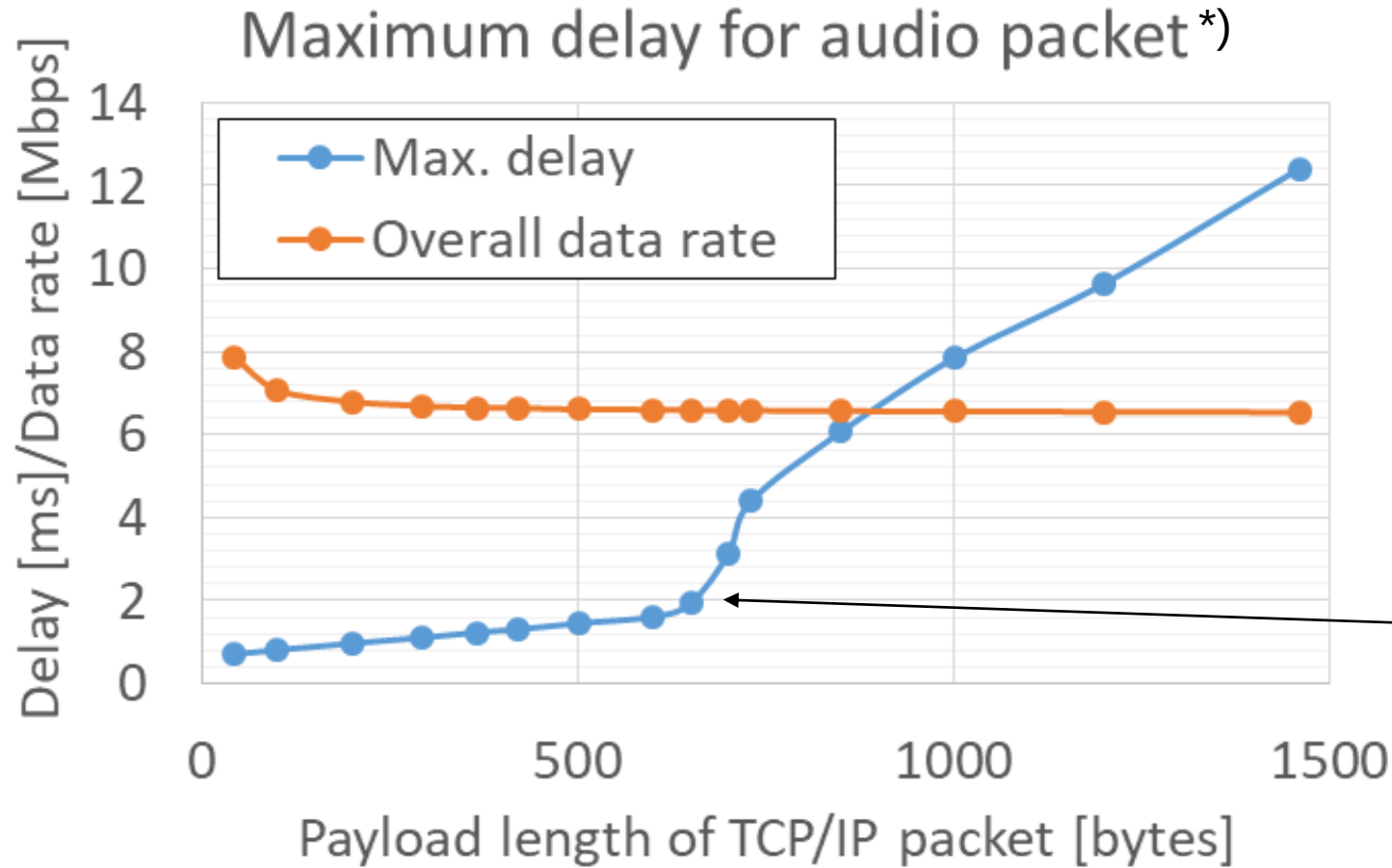


Scenario description:

- Three microphones are connected to the head node
- In the microphones audio data has priority over TCP/IP data
- All units want to transmit their TCP/IP data at the same time
- All units want to transmit their audio packets at the same time
- The first audio packets just miss their slots

- Delay increases until HN has sent all its TCP packets
- Microphones send their first TCP packets once there is no delay of the audio packets

SOLUTION 1: SHORTENED TCP/IP PACKETS.



Results

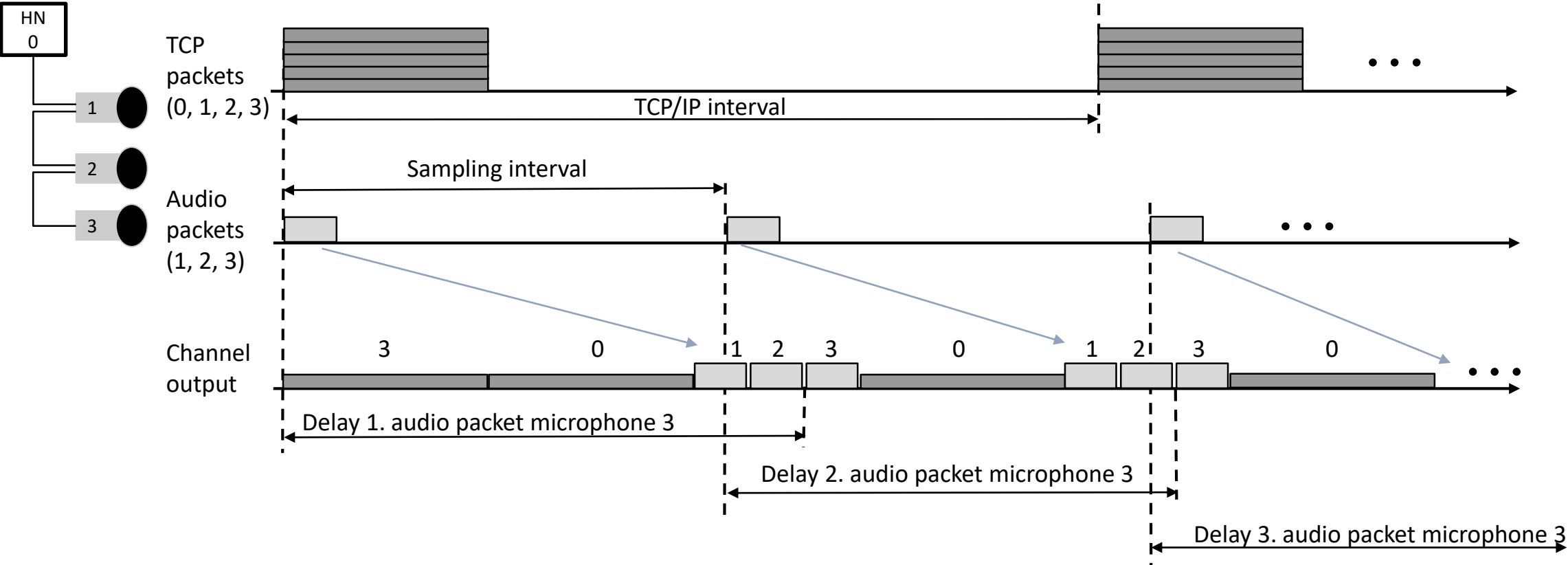
- The delay decreases with decreasing payload size (even if this increases the number of TCP/IP packets)
- Once the length of the TCP/IP packets is such that

$$\text{No. Microphones} * \text{length audio packet} + \text{length TCP packet} < \text{sampling interval}$$

The delay decreases significantly and its maximum delay value converges to

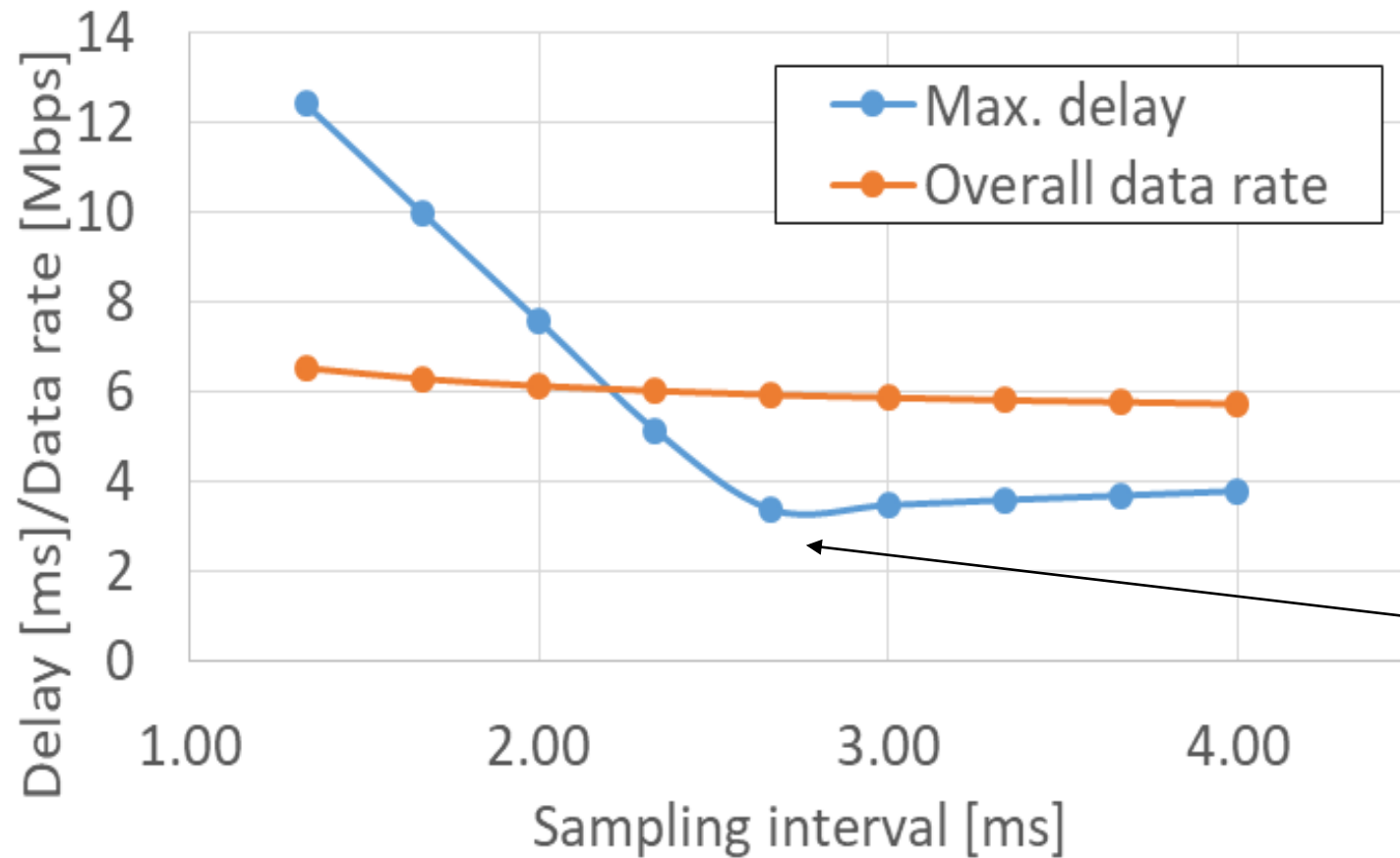
$$\sim 2 * (\text{length TCP packet} + \text{length audio packet})$$

SOLUTION 2: INCREASED AUDIO SAMPLING INTERVAL. (1)



SOLUTION 2: INCREASED AUDIO SAMPLING INTERVAL. (2)

Maximum delay for audio packet *)

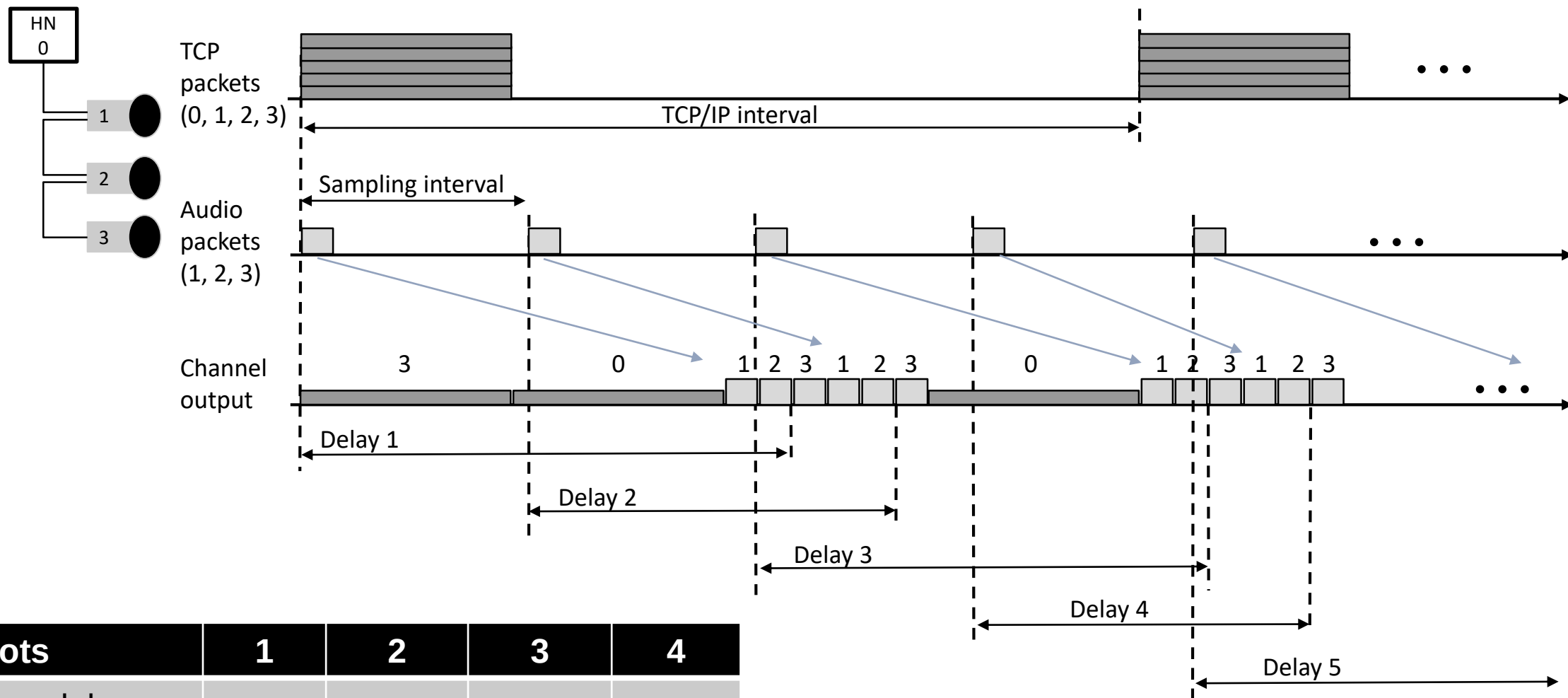


Results

- The delay decreases with increasing sampling interval up to the point where the maximum delay is determined by the first packet
- Then the delay increases and is

$$= (\text{No. Microphones}-1) * \text{length audio packet} + 2 * \text{length TCP packet}$$

SOLUTION 3: ASSIGNING MULTIPLE PLCA SLOTS. (1)



Slots	1	2	3	4
Max. delay [ms]	12,41	4,56	2,98	2,98

Results

- Smallest max. delay is limited by $2 \times \text{length TCP packet} + (\text{No. Microphones} - 1) \times \text{length audio packet}$

SUMMARY

- Especially in set ups, in which units with short and long packets share a multidrop link, unfavourable delays can occur with PLCA that regulates fairness on a per packet basis.
- Without adding any other mechanisms there are three possibilities to reduce that delay
 - Decreasing the size of the (TCP/IP) control packets
 - Increasing the sampling interval
 - Assigning multiple PLCA slots
- With all three mechanisms the maximum delay can be reduced significantly. However, the results achievable are directly linked to the size of the control packets.
- A combination of mechanisms has not been investigated but should achieve good results (e.g. Assigning multiple PLCA slots and limiting the size of packets from the end nodes).
- Tbd: Automated/flexible configuration