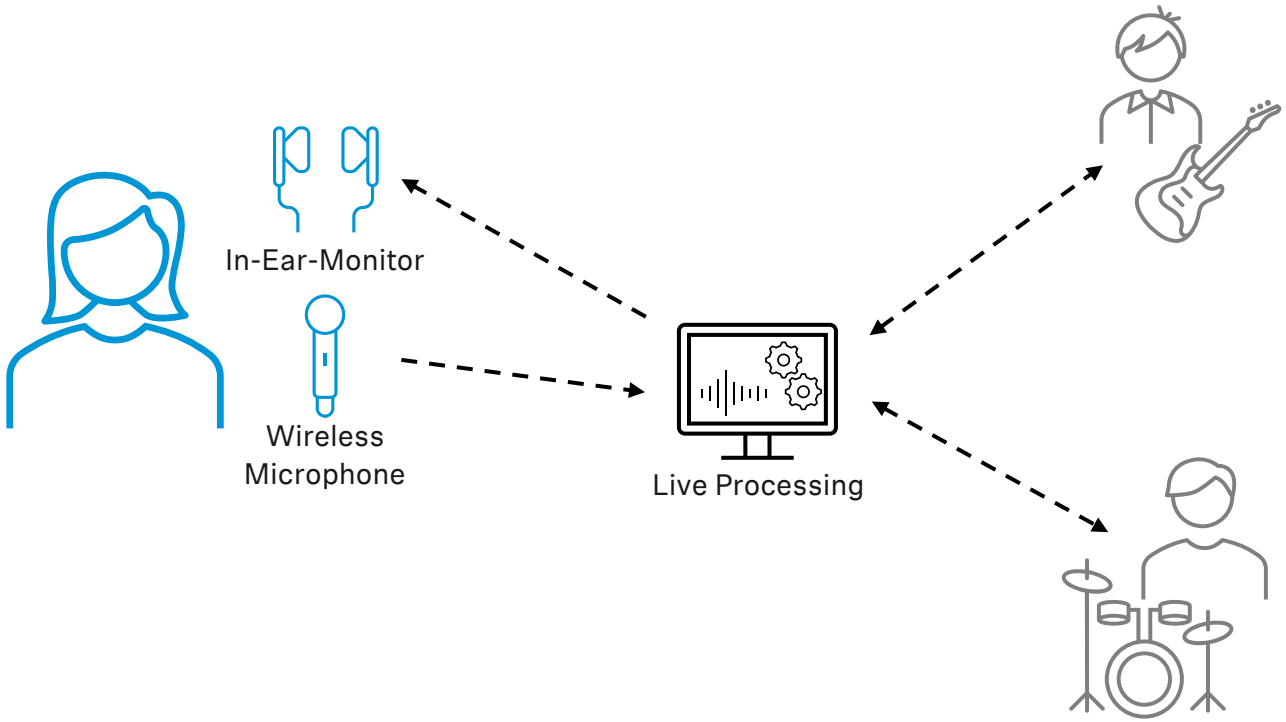
NORBERT WERNER

5G for Wireless Microphones

A Standardized Technology for Professional Audio Productions?

SENNHEISER

Professional Wireless Audio: **Mic & IEM**



Why 5G for Professional Audio?

Live Production / Broadcasting

- Proprietary analog/digital

Business Communication / Education

- DECT
- Wi-Fi

Headphones

- Bluetooth

- Today already using diverse technology portfolio
- Technology selection depends on application, price, business model, ecosystem
- Evaluating further technologies like 5G NR to expand technology portfolio

Key Technology Enablers for Live Productions

Latency

Mouth-to-ear streaming latency
< 4 milliseconds

Spectral Efficiency

Today's solutions: 200 kHz BW / audio channel

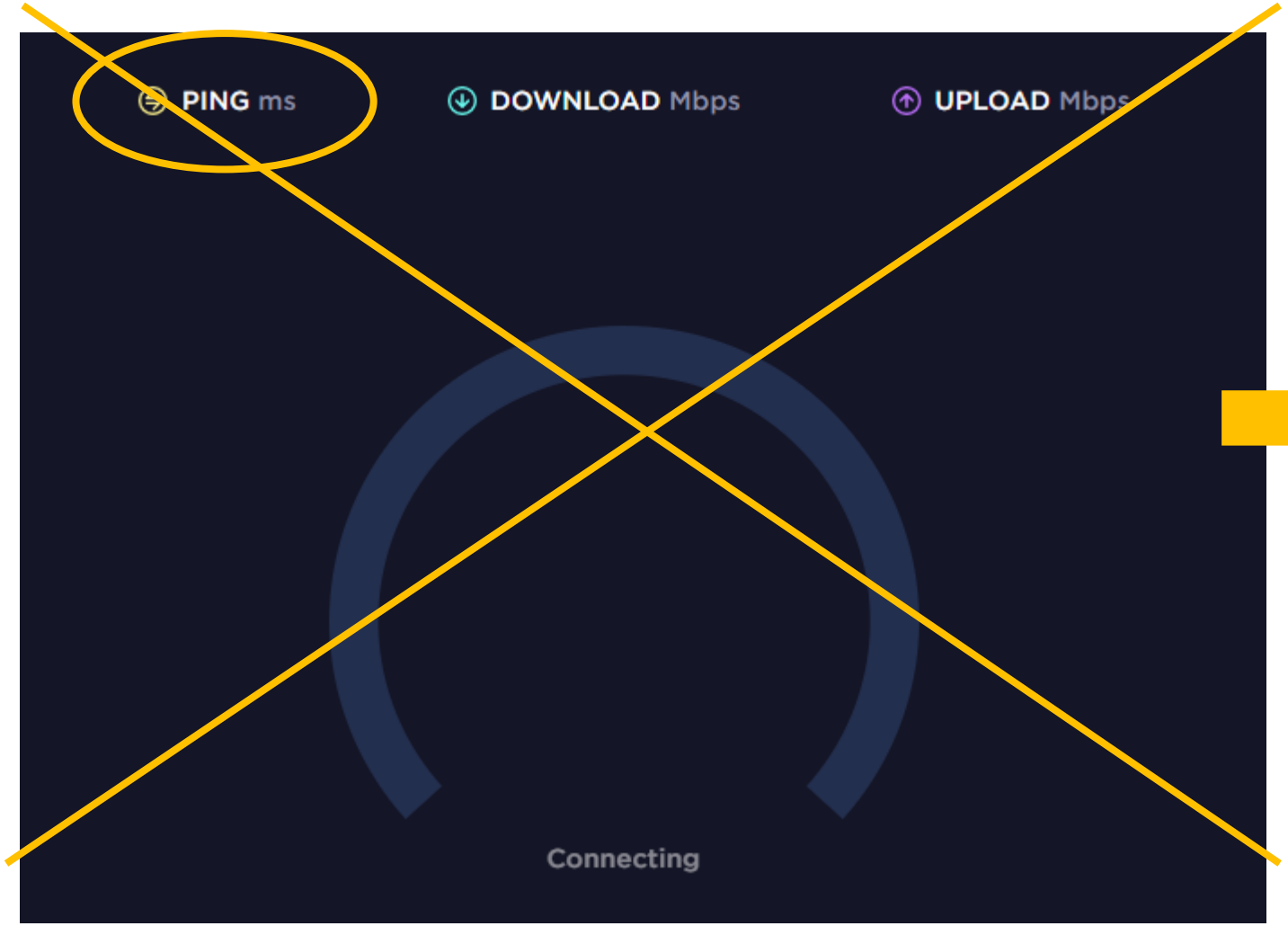
Synchronicity

Time offset between audio devices
< 1 microsecond

Reliability

Reliability > 99.9999 %

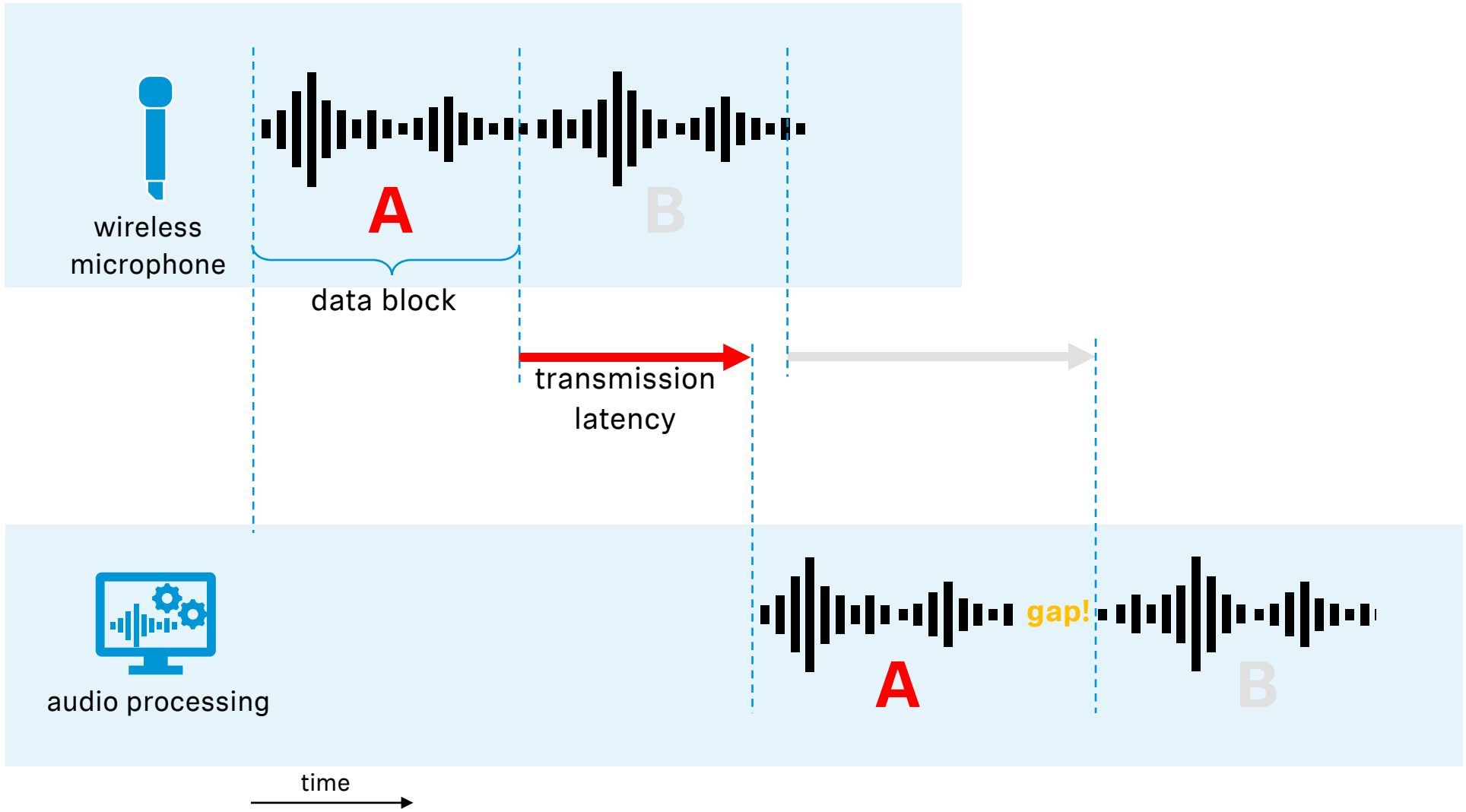
Latency? **Ping!**



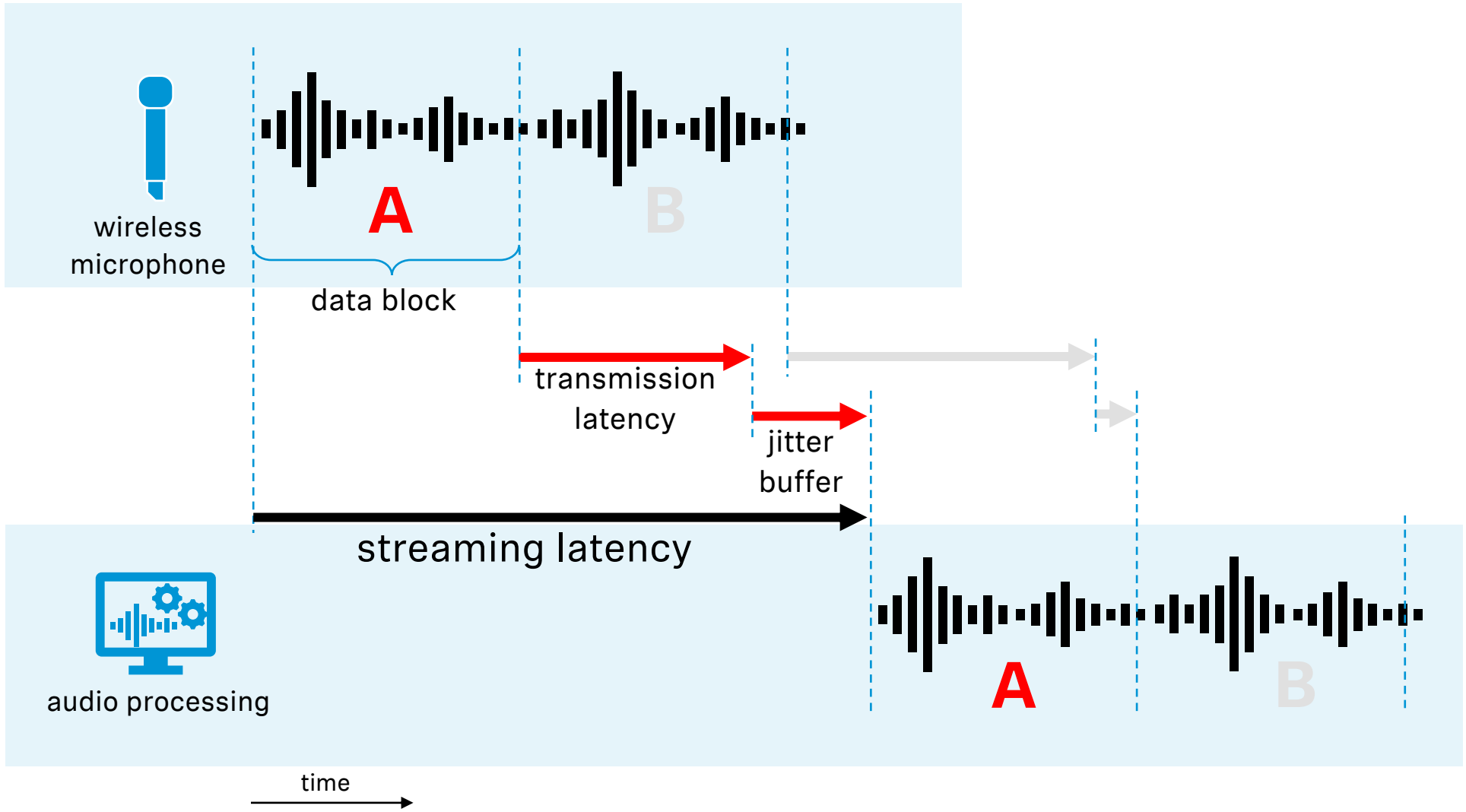
speedtest.net

Streaming latency

What is **Streaming Latency**?

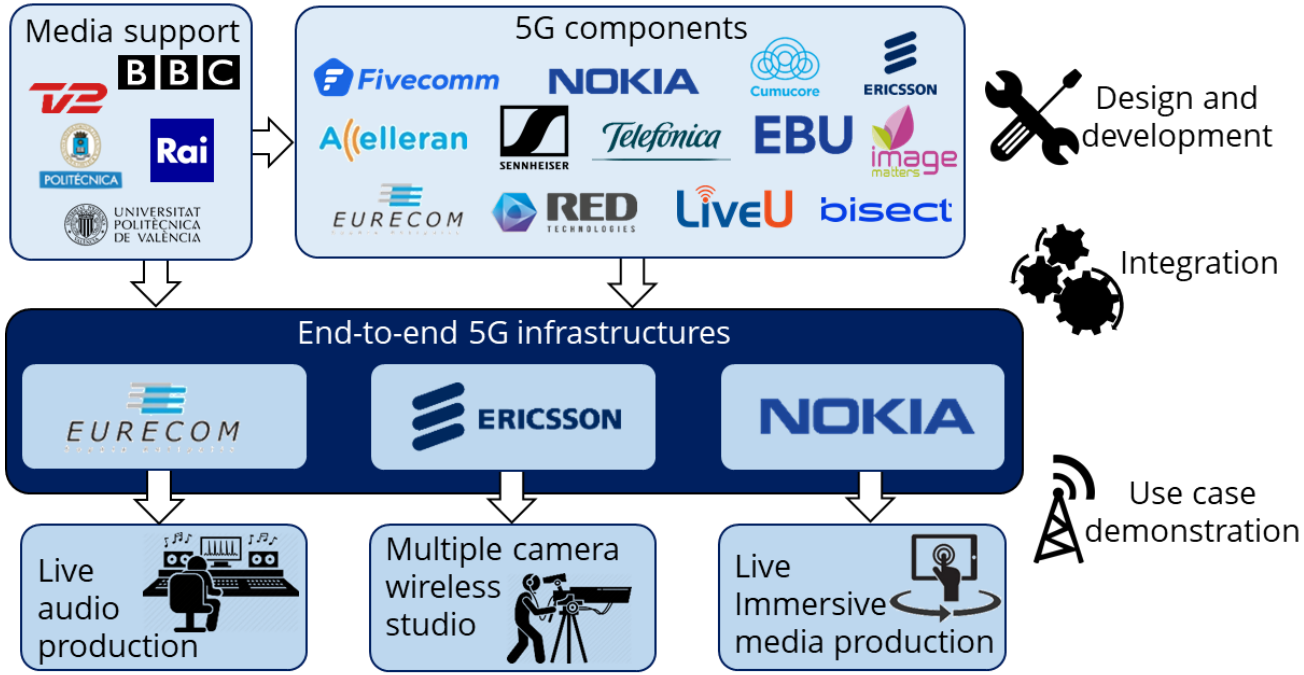


What is **Streaming Latency**?

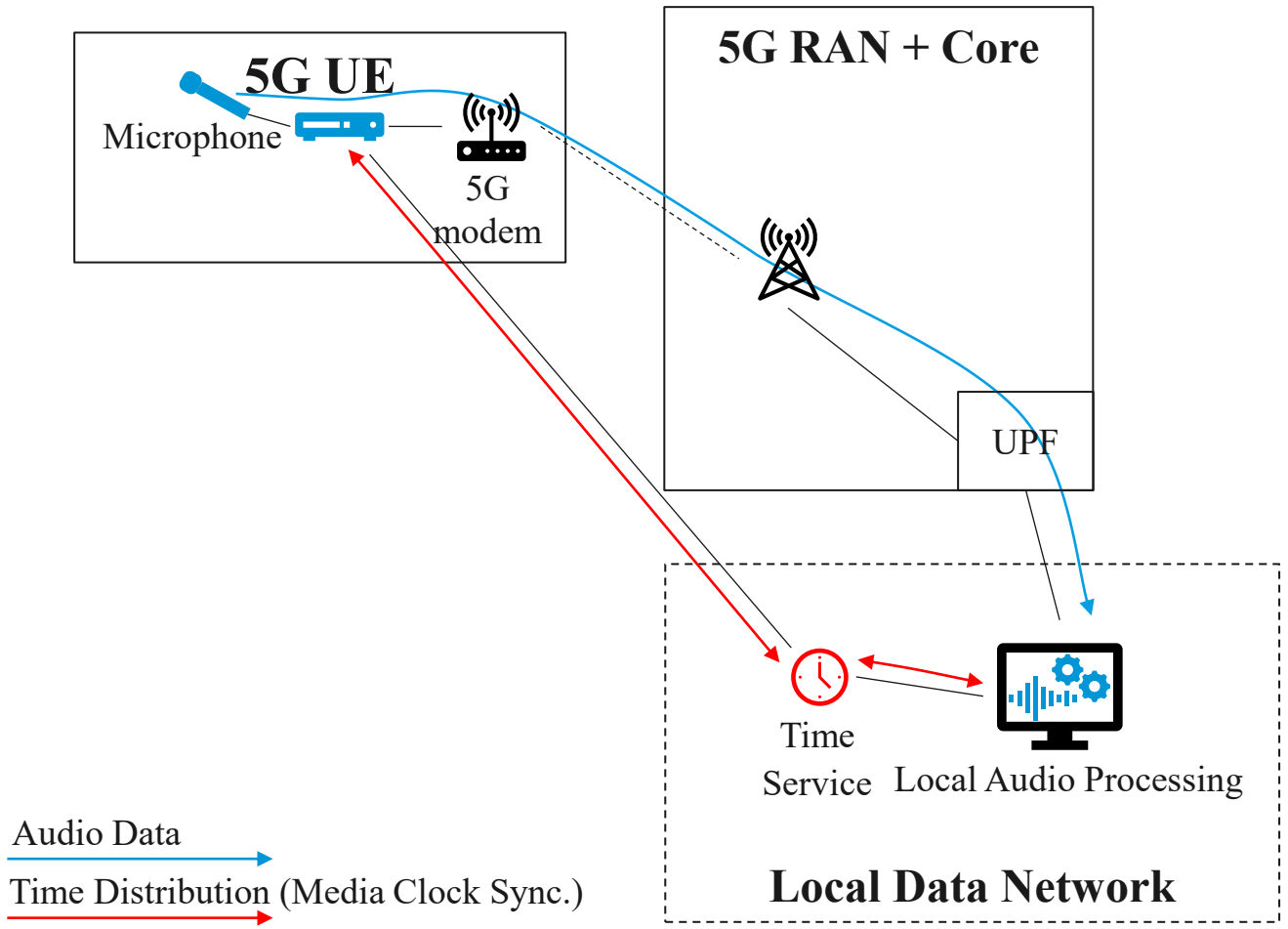


5G RECORDS Project

- EU H2020 Innovation Action (7.4 M€)
- 18 partners with important 5G vendors, broadcasters and high-tech SMEs (11 countries)
- 3 use cases:
  - Live audio production
  - Multiple camera wireless studio
  - Live immersive media production

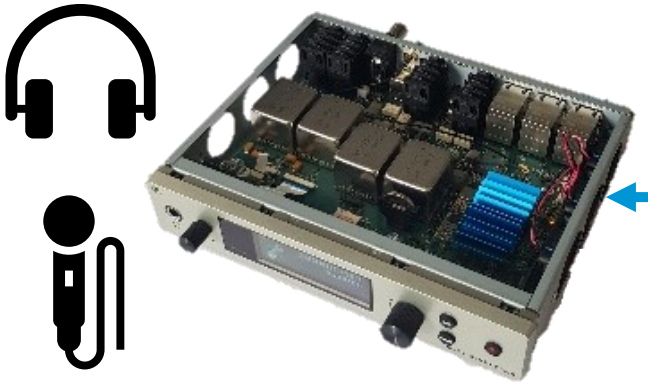


5G Measurement Setup



Testbed	Private 5G network at Eurecom (Sophia-Antipolis, France)
3GPP release	Rel. 15
Mode	SA
Subcarrier spacing	30 kHz
Bandwidth	20 MHz
Frequency	n78, 3.4 GHz

5G Microphone/IEM Demonstrator

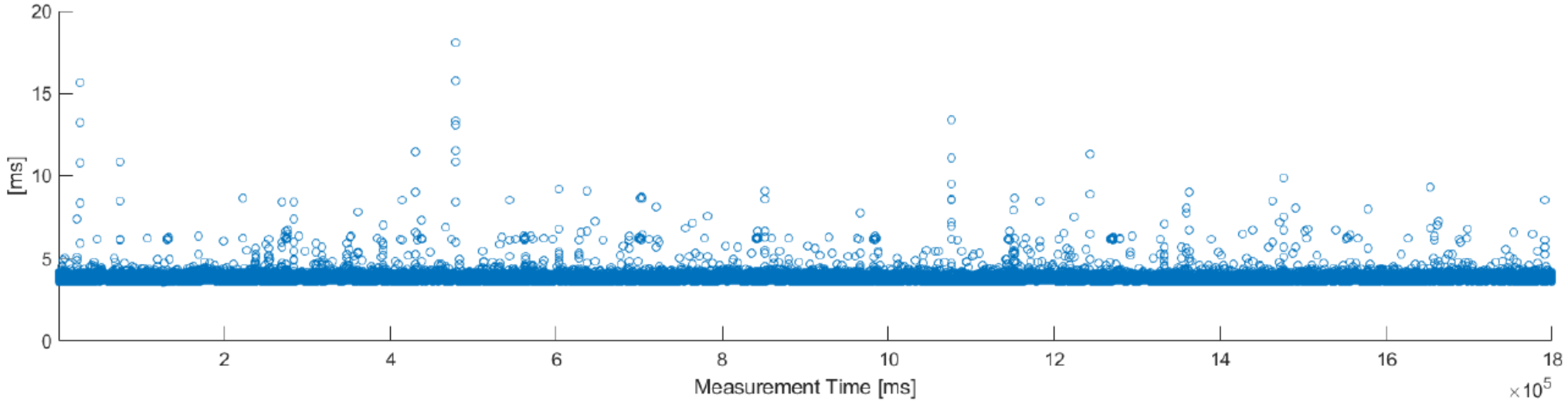


5G

Rapid prototype platform
analog audio <> IP

5G modem (Quectel)
COTS rel. 15

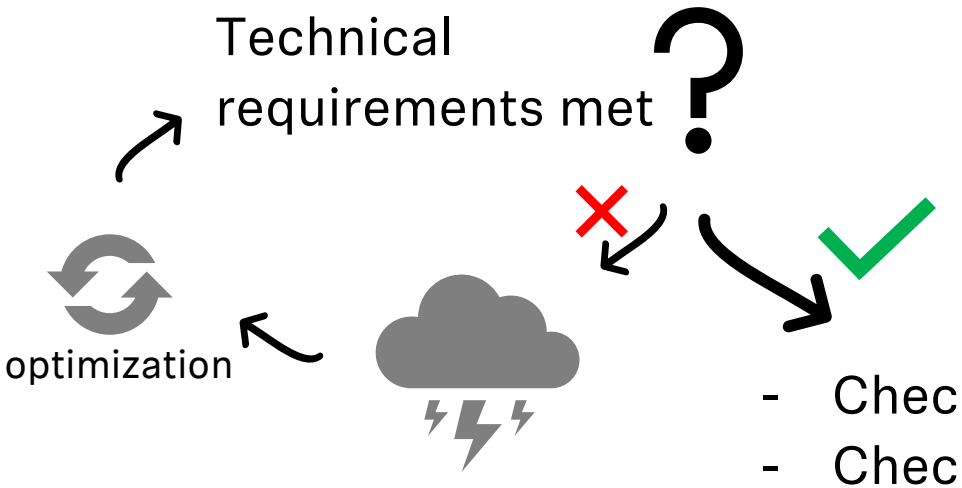
5G Uplink Latency



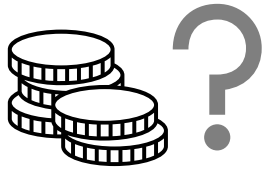
30 minutes

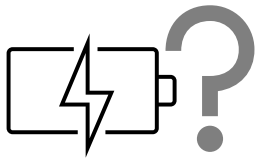
Reliability	Streaming latency (2.5 ms packets)	Theoretical average time between errors - MTBF (2.5 ms packets)
99%	6.47 ms	~0.25 s
99.9%	6.86 ms	~2.5 s
99.99%	9.25 ms	~25 s
99.999%	15.71 ms	~ 4 min
99.9999%	25.54 ms	~ 42 min

Disclaimer: packetloss neglected, only one UE, stationary lab environment

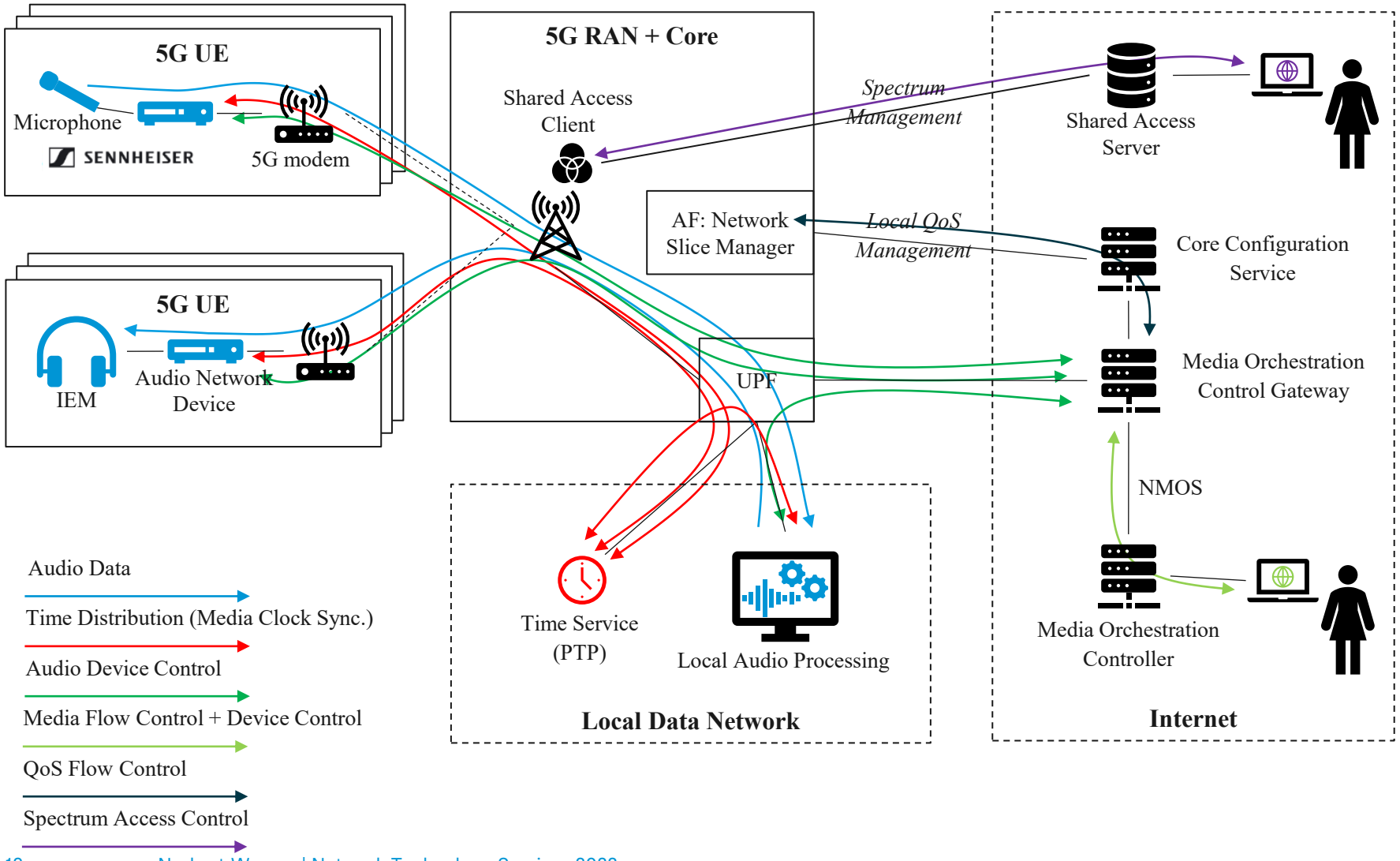


- Check integration topics
- Check business aspects





What else is part of **5G RECORDS**?



Questions or Comments?

- Further information:
  - More details about the presented measurement:

    J. Dürre, N. Werner et. al., “A Disaggregated 5G Testbed for Professional Live Audio Production”, 17th IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Bilbao, 2022

  - More info about the rapid prototyping audio platform:

    R. Hupke, J. Dürre, N. Werner and J. Peissig, "Latency and Quality-of-Experience Analysis of a Networked Music Performance Framework for Realistic Interaction," in *152nd Audio Engineering Society Convention*, Den Haag, 2022

  - Another 5G URLLC audio trial:

    https://www.bell-labs.com/institute/white-papers/low-latency-5g-professional-audio-transmission/

    https://pages.nokia.com/T0066T-Nokia-and-Sennheiser-joint-Webinar-Low-Latency-5G-for-Professional-Audio-Transmission.html