



Testbed for real-time applications and reproducibility of experiments

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Real-time

has to do with timeliness constraints

- Real time network services are needed for the **interaction with external processes** (processes running outside network), if timing of interaction limits quality or even the acceptability of network application.
 - For example, data from sensors should be collected during the availability and deadlines for sending data to actuators should be defined.
- Real-time network service should respond to an event within a predetermined time (i.e. there are "real time constraints" - operational deadlines from event to system response). The timeliness constraints or deadlines are generally a reflection of the physical process being monitored or controlled.
- Contemporary network services are usually non-real-time services, i.e. no timeliness constraints are defined. If we need services with a guaranty of real-time bounds, the "best effort" principle is not acceptable.
- **All-optical e2e lambdas are an enabler for fixed delay of transmission and for reproducibility of experiments.**

Examples of real-time applications with mild constraints

Interactive human collaboration

- Latency jitter limit: 10-50 ms (adaptive play-out delay buffer)
- End-to-end latency: 100-200 ms
- Penalty: mild (user disappointment)

High definition video and Cave-to-Cave

- Latency jitter limit: 20 ms (buffer dependent)
- End-to-end latency: 150 ms
- Penalty: mild (user disappointment).

Examples of hard real-time applications

Remote control of Vehicles or Instruments

- Latency jitter limit: 50 ms
- End-to-end latency: TBD
- Penalty: not acceptable (vehicle crash)

Comparison of atomic clocks

- Latency jitter limits: 50 ps (in short time period, typically over 1000 s) and 1 ns (long time fluctuation, typically over days)
- End-to-end latency: should be minimized to the optical signal propagation delay
- Penalty: not acceptable (outage of comparison)

Examples of experiments

- „**Highly accurate time transfer**“ for comparison of atomic clock scales between Prague and Vienna (distance by fibre about 500 km) asked by Metrological institutes. Authorized Press Release is available on <http://www.ces.net/doc/press/2010/pr100401.html>
- Multivendor 100 Gbps data transmissions have been successfully performed in collaboration with the Alcatel-Lucent company. We demonstrated both single-fiber and long-distance (over 1000 km) transmissions which shared the fibres with regular network traffic, see Authorized Press Release <http://www.ces.net/doc/press/2011/pr110909.html>
- Fibre sharing by various transfer systems also enables formation of virtual networks: **transfer bands are used as virtual fibres so this could be considered to be a new concept in network construction**
- **Thanks for attention. For more questions, please contact me.**