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HS2020: 11072 Advanced Networking and Future Internet

Theoretical Exercises - Week 1

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QoS/QoE (2 points)

Q1. Give an example scenario (incl. appropriate metrics), where using QoS instead of QoE would be appropriate and vice-versa.

- In the case where we are looking to measure application or network performance (e.g. Jitter, Latency, Throughput, Packet Loss), QoS measurements would be more appropriate; QoS metrics are typically **device or transport-oriented** and **quantitative** (Mbps, ms etc).
- If we are looking to measure user-satisfaction (e.g. Mean Opinion Score) based on an application's performance such it's response to an action, then QoE measures would be more appropriate; QoE performance indicators are **user-centric** and can both **quantitative and qualitative** (poor image/video quality, action-response-time, MOE).

TCP vs UDP (2 points)

Q2. Briefly discuss the differences between TCP and UDP protocols. Which protocol would be used in an immersive/real-time communication scenario? Why?

- **TCP** is a **connection-oriented** protocol that is responsible for reliable communication between two end processes. TCP guarantees delivery of data and also guarantees that packets will be delivered in the same order in which they were sent.
- **UDP** is a **connectionless** protocol that, like TCP, runs on top of IP networks. Unlike TCP/IP, UDP/IP provides very few error recovery services, offering instead a direct way to send and receive datagrams over an IP network. It is used primarily for broadcasting messages over a network.
- UDP is preferred to TCP for real-time communication because **recovering from congestion through retransmission usually involves too much latency**. So, QoS mechanisms can avoid undesirable loss of packets by immediately transmitting them ahead of any queued bulk traffic on the same link, even if bulk traffic queue is overflowing.

Multimedia Data Transmission (3 points)

Q3. Explain the meaning of the following data transmission modes, and for each, give an example of it's application:

- Synchronous: Communication with no time restrictions as packets reach the receiver as fast as possible
- Asynchronous: Communication where max end-to-end delay for each packet of a data stream is defined. Packet can reach the receiver at any arbitrary (earlier) time, provided that the upper bound is never violated
- Isochronous: Communication where both max and min end-to-end delay for each packet of a data stream is defined. This means that the delay jitter of individual packets is bounded.

Traffic Engineering (3 points)

Q4. Explain what are the purposes of traffic engineering and software-defined networking. Is it possible to apply the SDN concept for traffic engineering, explain why.

- Traffic engineering is to reduce traffic congestion at certain links by redirecting the traffic to other unloaded network parts.
- SDN is to enable a centralized SDN controller to optimize network operation with the knowledge collected over the all network. The “controller” is separated from “forwarder”.
- SDN is a perfect solution for traffic engineering (traffic engineering is a perfect use-case of SDN), since the controller has the overall view of the network traffic statistics, therefore, it can make the optimized decision about traffic management based on its statistics of the network traffic.

P2P and ICN (2 points)

Q5. What are the differences between the current node-centric Internet architecture and the ICN-based architecture. Subsequently, what are the difference between a P2P and an ICN network?

- Massive amount of mobile video traffic increase exponentially, current Internet architecture (node-centric, an IP address matches to hosting server) can't meet the requests. ICN-based approach enables the content distributed over a scalable network, not on specific hosting servers. Users only care the content, not where it comes from.
- To ensure efficient network utilization and improve data availability, several ICN architectures make heavy usage of data caching. There are two major caching approaches: caching at the network edge and in-network caching. Caching at the network edge includes, e.g., user nodes like in P2P networks, and replicated servers. In-network caching describes the caching of data within the transport network, e.g., on the forwarding path in network routers, or in conjunction with the Name Resolution Service.