

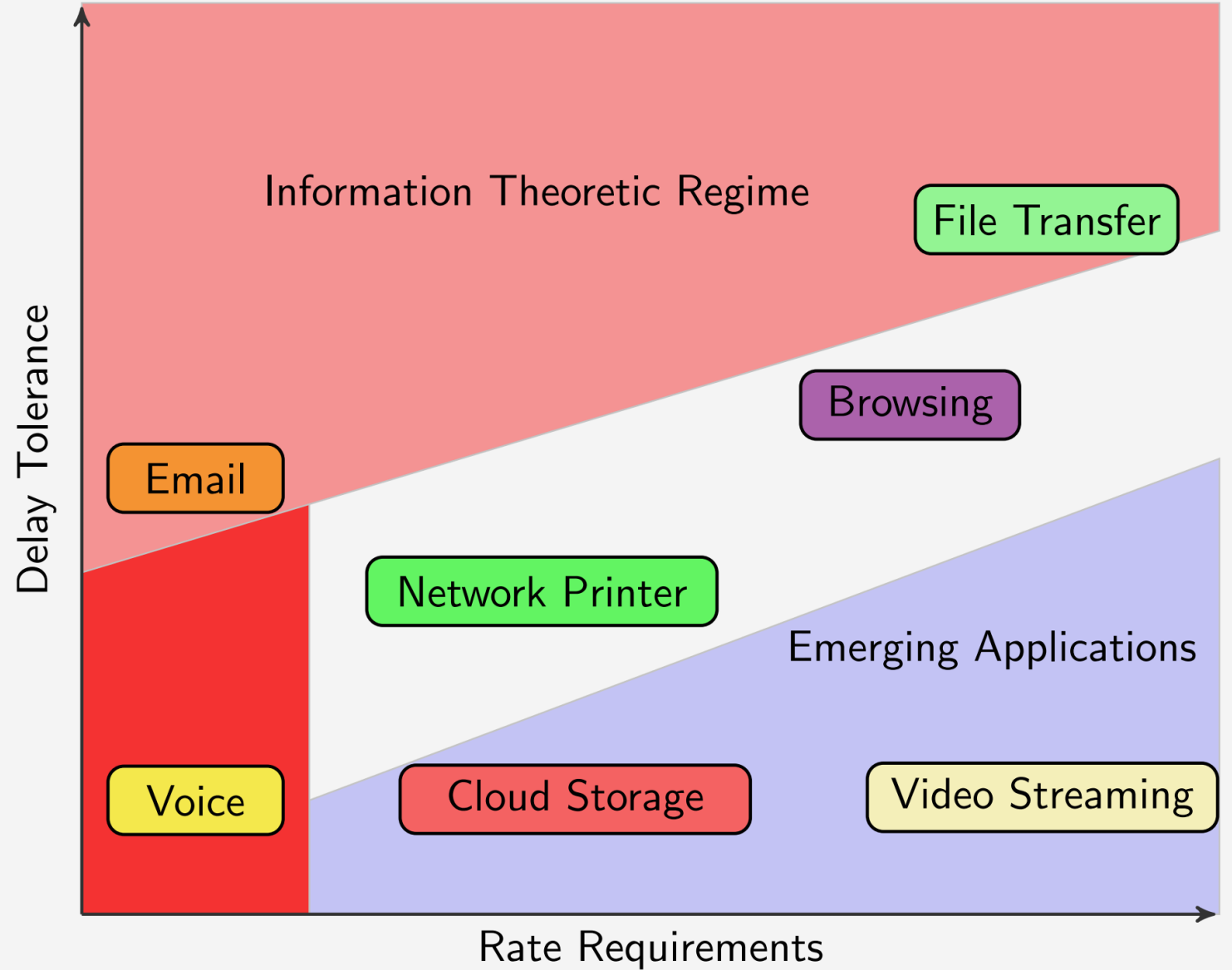
Next-Generation Communications & Networking

Parimal Parag

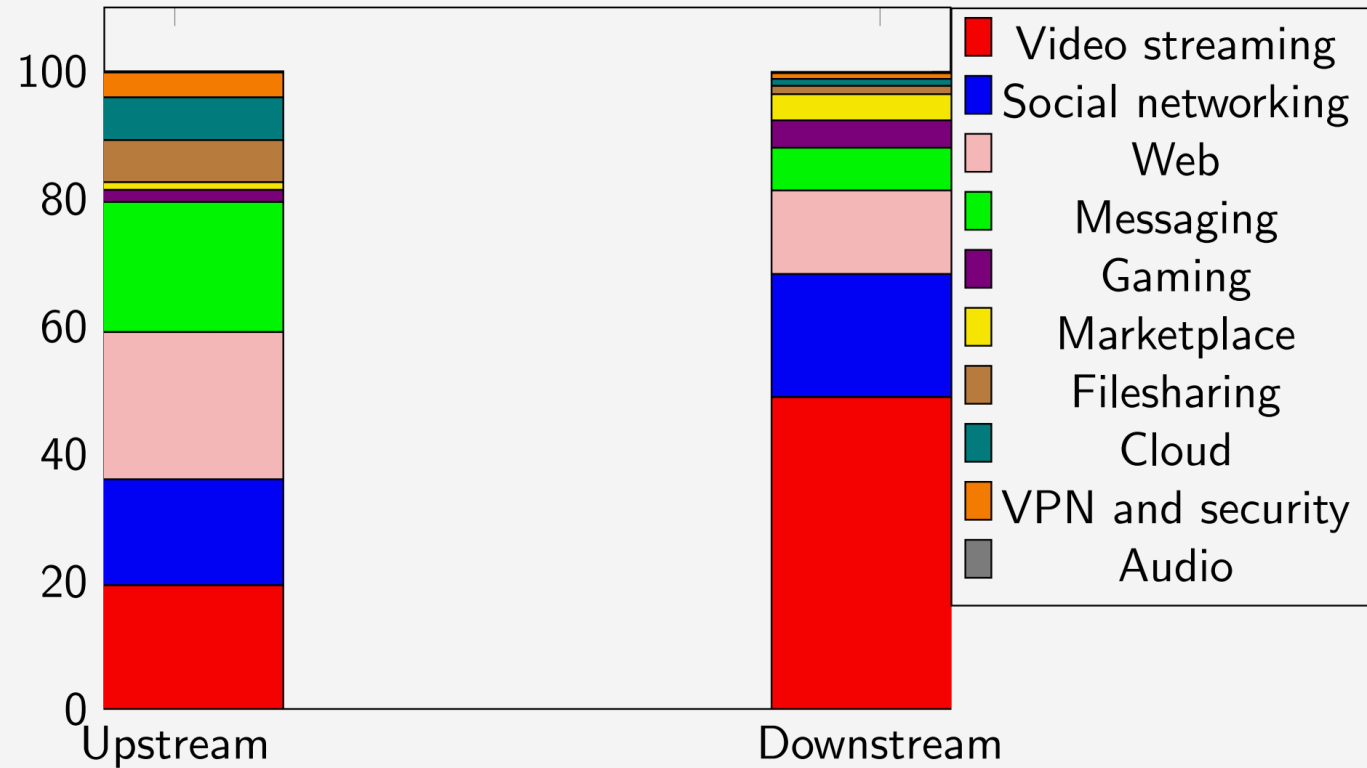
Electrical Communication Engineering Department

Indian Institute of Science

Evolving digital landscape

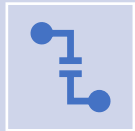


Global application traffic share (2021)



¹ https://www.sandvine.com/hubfs/Sandvine_Redesign_2019/Downloads/2021/Phenomena/MIPR%20Q1%202021%20Q4

AR/VR/XR/Metaverse



Low-latency, high-throughput network



Support multiple users and co-exist with other applications: slicing

Image source: <https://www.purdue.edu/newsroom/releases/2020/Q4/augmented-reality-to-provide-new-skills-for-manufacturing-workforce-education.html>



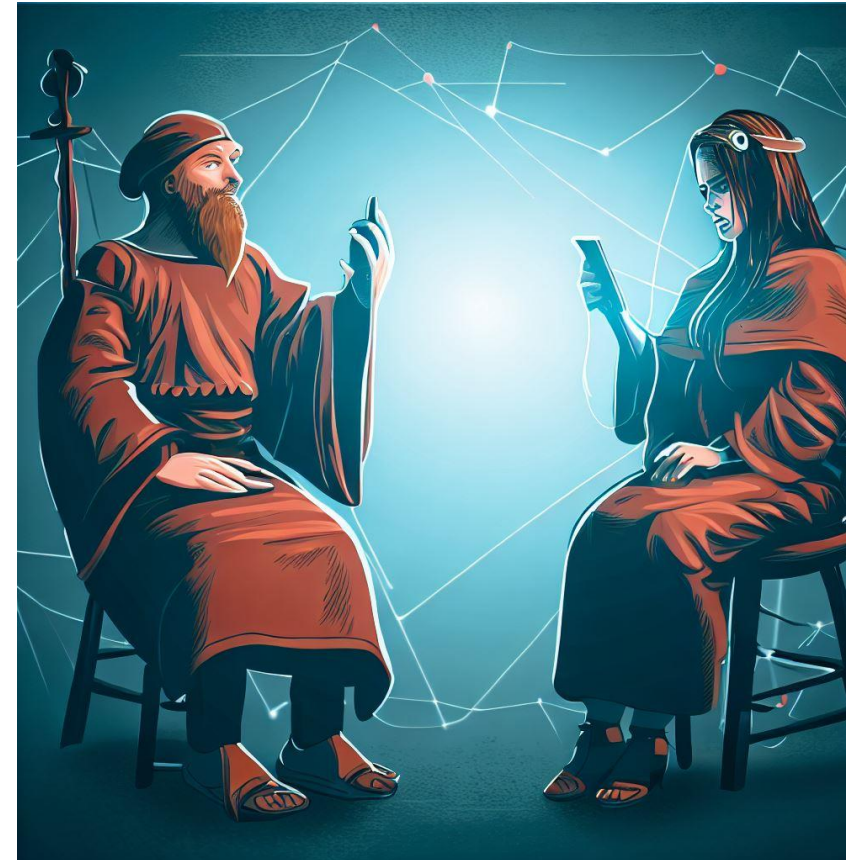


Configuration-free, secure, ubiquitous communication

- Handoff-free multimodal wireless connectivity
 - Non-Terrestrial (low-orbit satellites)
 - Cellular connections through mobile base stations
 - Wi-Fi
- Remote perception building and real-time control through a combination of cameras, radars, sensors

Semantic communication

- Feature-based high-fidelity, low bandwidth audio-video communication
 - run-time feature extraction
 - Only the features and parameters transmitted over the network
 - AI-based reconstruction (avatars?) at the end-device



Extending cloud to the edge devices

- Ultra-low latency buffering-free transport over unreliable links
 - Messages as first-class primitives
 - Priorities associated with individual messages
 - Exploiting multi-path redundant messages



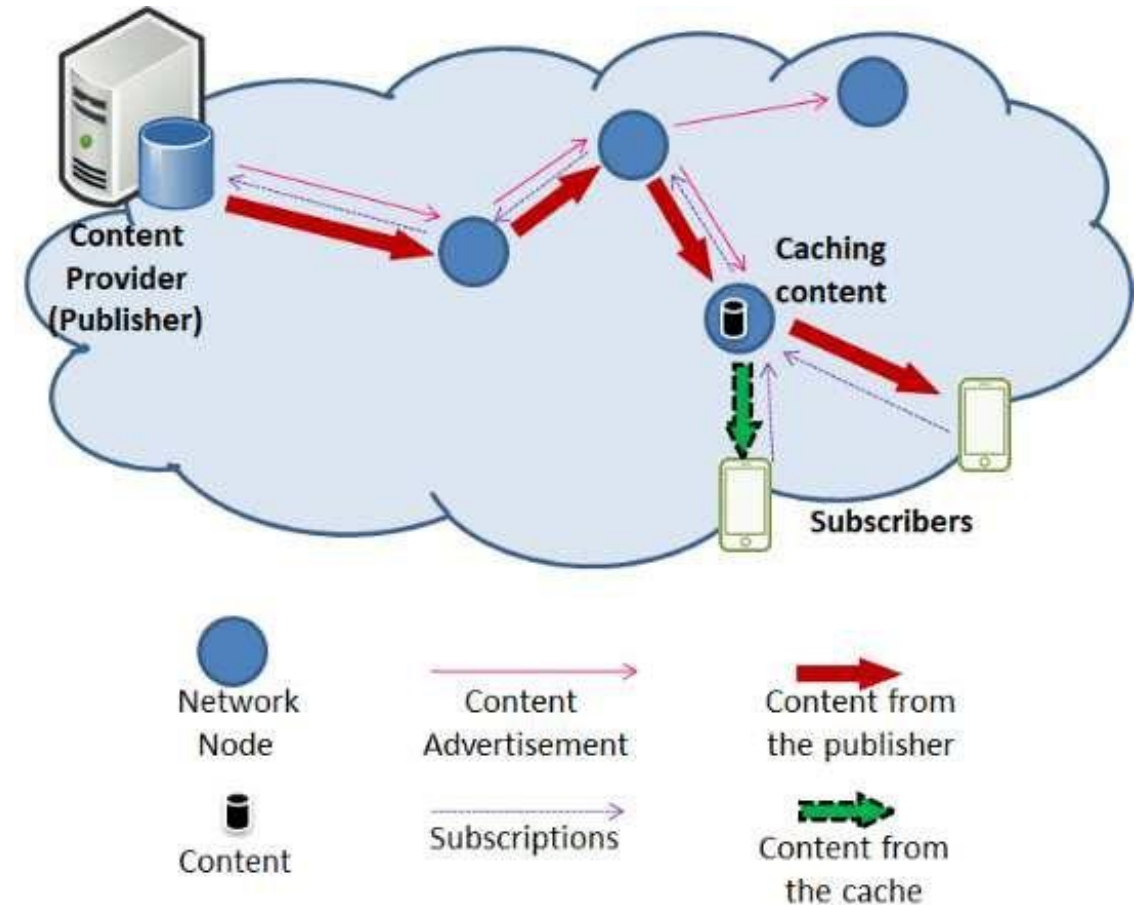


Cloud synchronization

- Applications:
 - Trading exchanges for high-frequency trading:
 - Algorithms place orders at microsecond granularity
 - Need nano-second accuracy in ordering transactions
 - Fairness between participants
 - Latency arbitrage considered worth 5B USD
 - Scalable, replicated databases

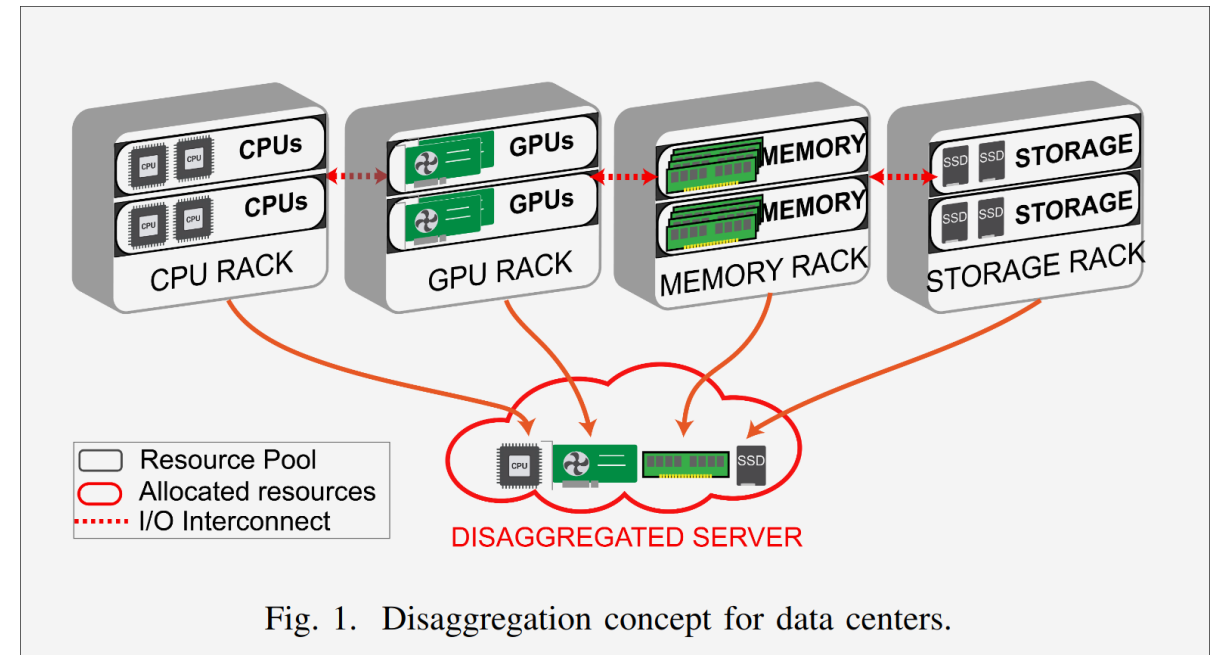
Information-centric network

- Objects addressed by the content itself
- Subscribers can get the content from the nearest cache
- The network figures out the location of the content



All-optical data center

- Latency and power requirements of optical-electrical interconnects is sub-optimal
- AI processing, storage, and memory need lower latencies and higher throughput
- All-optical—down to the CPU package—interconnect can help create a *disaggregated data center*
 - Nanosecond switching
 - Up to 50% reduction in power
 - Better utilization of resources



Quantum Internet

- **Communication security**
 - Quantum key distribution: exchanging keys that cannot be intercepted
- **Sensor networks**
 - High-precision instruments generating massive data
- **Scaling up quantum computing**
 - Connecting quantum computers as one conglomerate

