Architectural Considerations for Delivering Latency Critical Communication over the Internet

https://tools.ietf.org/html/draft-xia-latency-critical-communication-00

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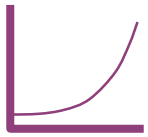
Low Latency
Critical Communication Challenges

Avalanche of
Traffic Volume

Further expansion of mobile broadband

Additional traffic due to communicating machines



“1000x in ten years”

Massive growth in
Connected Devices
“Communicating machines”

“50 billion devices in 2020”

Large diversity of
Use cases & Requirements

Device-to-Device Communications

Car-to-Car Comm.

New requirements and characteristics due to communicating machines

Low Latency Critical Communication Motivation

- Low latency applications are still likely to be end-to-end and traverse multiple network domains and involve multiple network layers.
- Current standard work focus on particular protocol, link, layer, etc., rather than the latency from user's perspective.
  - **Disclaimer**: Multiple network domains doesn't necessarily mean cross-ISP deployment
  - **Disclaimer**: Not to introduce the tension between application and network layers

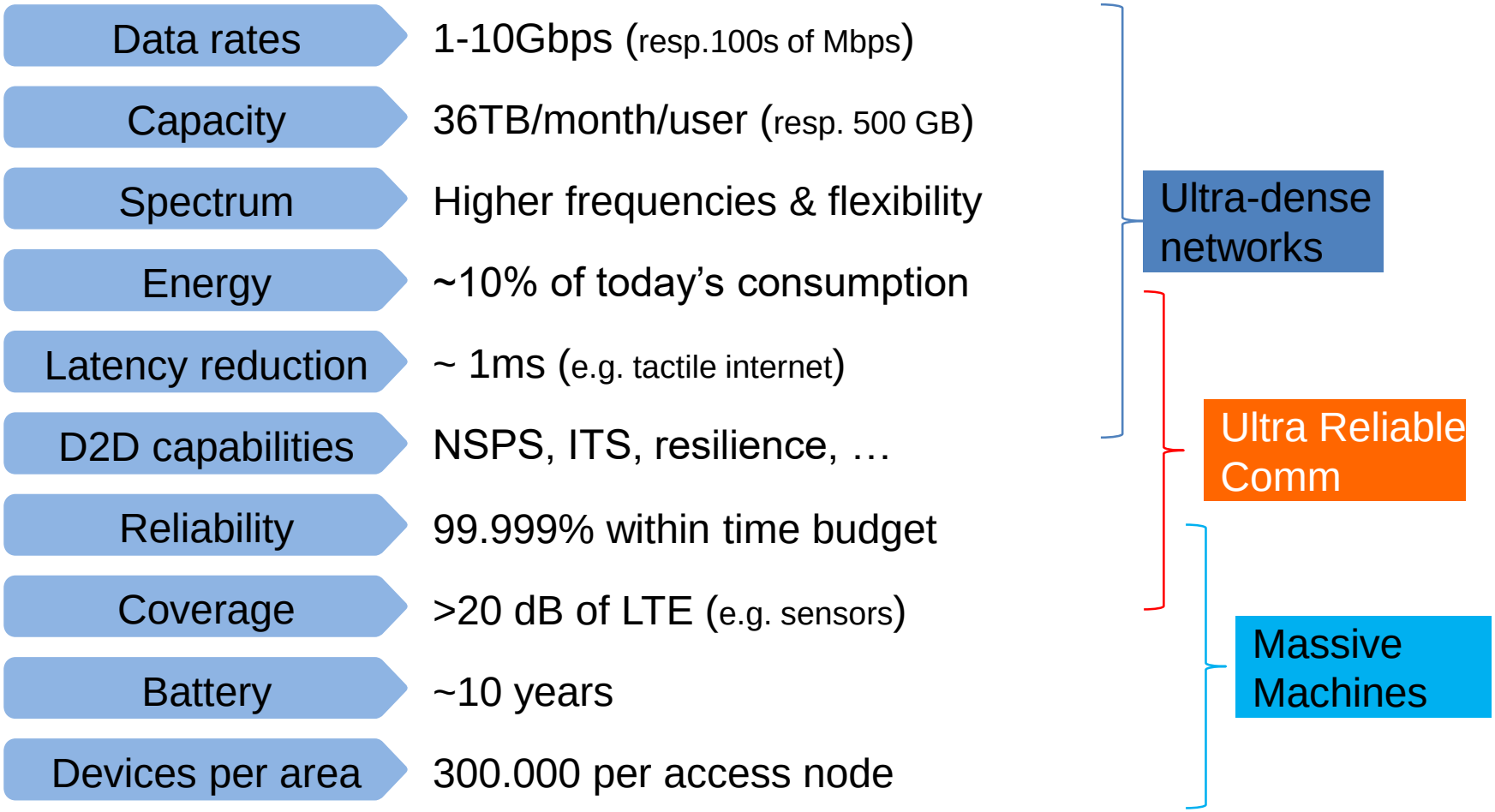
- It would be beneficial to define end-to-end low latency delivery architecture to coordinate and orchestrate multiple low latency tools, in order to facilitate end-to-end low latency characteristics.
  - **Disclaimer**: Not to reinvent new low latency tool, but reuse / orchestrate existing tools

- It would be useful to analyze the gap and challenges to existing low latency tools
  - Including new emerging low latency requirements
    - Ultra high-reliability and Low-latency Communication (URLLC) and Broadband Assured IP Service (BAS)

European Research and Industry Investigation

- https://5g-ppp.eu/5g-ppp-phase-1-projects/

Low Latency
Critical Communication Requirements



Low Latency Critical Communication Categories

- Various 5G projects agree on the following 5G Use Case categories:
  - **Extreme Mobile Broadband (xMBB)**: high speed and low latency mobile broadband
  - **Ultra-reliable Machine-type Communication (uMTC)**: reliability is the key service requirement of these services
  - **Massive Machine-Type Communication (mMTC)** and **Massive IoT (mIoT)** massive M2M and IoT connectivity
  - **Critical Connections/ Ultra Reliable Low Latency Connections (CriC/URLLC):** low latency and ultra-reliable communications
- For each category of use case, specific KPIs are identified for clustering requirements:

Device density:
- High: ≥ 10000 devices per km2
- Medium: 1000 – 10000 devices per km2
- Low: < 1000 devices per km2

Mobility:
- No: static users
- Low: pedestrians (0-3 km/h)
- Medium: slow moving vehicles (3 – 50 km/h)
- High: fast moving vehicles, e.g. cars and trains (> 50 km/h)

Infrastructure:
- Limited: no infrastructure available or only macro cell coverage
- Medium density: Small number of small cells
- Highly available infrastructure: Big number of small cells available

Traffic type:
- Continuous
- Bursty
- Event driven
- Periodic
- All types

User data rate:
- Very high data rate: ≥ 1 Gbps
- High: 100 Mbps – 1 Gbps
- Medium: 50 – 100 Mbps
- Low: < 50 Mbps

Latency
- High: > 50 ms
- Medium: 10 – 50 ms
- Low: 1 – 10 ms

Reliability
- Low: < 95%
- Medium: 95 – 99%
- High: > 99%

Availability (related to coverage)
- Low: < 95%
- Medium: 95 – 99%
- High: > 99%

Cross-SDO Investigation has started

- Critical low latency communications are clearly needed, various activity across SDOs
  - Work has started to review requirements, use cases and consider applicability of existing technologies:

- IETF
  - draft-dunbar-e2e-latency-arch-view-and-gaps-01 (high level view and gap analysis)
  - draft-arkko-arch-low-latency-02 (high level and architecture view)
  - Detnet / L4S / ACTN / etc. (low latency tools in various network domains and/or layers)

- 3GPP / 5GPPP / NGMN
  - 3GPP TS 38913 (Requirements for Next Generation Access Technologies)
  - 5GPPP Requirements on URLLC services, such as self-driving cars, industrial control and real-time gaming
  - NGMN 5G white paper

- IEEE 802.1 TSN Task Group
  - Time sensitive networking

- BBF BAS
  - WT 387/388 (Broadband Assured IP Services Architecture)

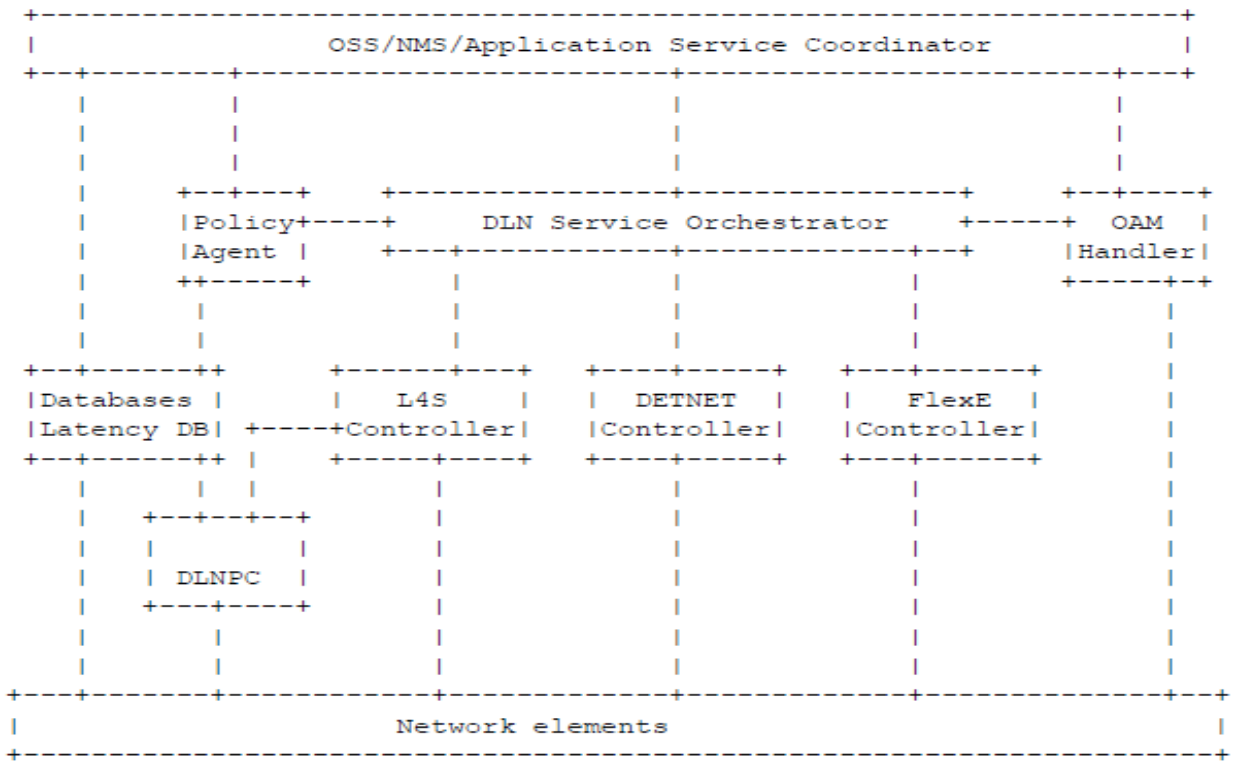
However,
Too many use cases…

Use Case Name	Type of Vertical or Mass Market	Application Scenario	Requirement Category
Cloud Robotics - Service robots dealing commercial tasks (professional service robot) or services for the person, usually at home (personal service robot).	Cloud Services (including Service Robotics)	Everywhere	CriC/URLLC (and xMBB)
Assisted driving	Automotive	Road network	CriC/URLLC
Autonoumous/Cooperative driving	Automotive	Road network	CriC/URLLC
Tele-operated driving	Automotive	Road network	CriC/URLLC
Info mediation - Road safety and traffic effiency	Automotive	Road network	CriC/URLLC
On board Infotainment	Automotive	Road network	CriC/URLLC (and xMBB)
Nomadic nodes (vehicle that becomes a small cell itself)	Automotive	Road network	CriC/URLLC (and xMBB)
BB Communication services on High Speed train	Transports and logistics	Railway network	CriC/URLLC
BB Communication services on Flying plane	Transports and logistics	Sky fligth paths	CriC/URLLC
Drone/ robot delivery service	Transports and logistics	Smart City	CriC/URLLC
Mobile video surveillance for public security	Public safety & Environment	Smart City	CriC/URLLC
Connected Drones for public security or environment monitoring - by means of missions in UMT (Unmanned Aerial System Traffic Management)	Public safety & Environment	Smart City	CriC/URLLC
Emergency management - Natural disaster and Emergencies (terrorism, fire, explosions, etc.)	Public safety & Environment	Everywere	CriC/URLLC
Tactile Internet - remote actuator (haptic device maneuvered by a human) and a slave robot for operating in a dangerous context.	Public safety & Environment	Smart City	CriC/URLLC
Process automation - analogue industrial processes such as one handling fluids or gas - (chemical and petrochemical industries)	Industry 4.0	Industrial Plant	CriC/URLLC (and mIoT)
Smart Factory - Automated and programmable product line - Robotics	Industry 4.0	Industrial Plant	CriC/URLLC (and mIoT)
Remote Human Assistance	Industry 4.0	Industrial Plant	CriC/URLLC
Assisted Surgery	Health and Wellness	Hospital	CriC/URLLC
Remoted Surgery	Health and Wellness	Hospital	CriC/URLLC
Info-mediation (f. i. patient check-in and check-out automated with the aid of sensors)	Health and Wellness	Hospital	CriC/URLLC (and mIoT)
Automated Farm machinery (autonomous drive of tractors etc.)	Agriculture	Agricultural land	CriC/URLLC
Fast/real time cooperative media production in a crowd location	Media and Entertainment	Crowd location	CriC/URLLC (and xMBB)
Cooperative Games (incl. VR/AR)	Media and Entertainment	Everywere	CriC/URLLC (and xMBB)
New media experience (i. e. using 4K/ 8K displays, immersive 6DoF displays, HMDs, voice/ video recognition, VR, AR and tactile/ 4D))	Media and Entertainment	Indoor hotspots	CriC/URLLC (and xMBB)

We need to focus discussion on a few (2-3?) Use Cases

- In our discussion document
  - draft-xia-latency-critical-communication-00
- Document highlights three use cases
  - Cloud-based Virtual Reality (6-Degrees)
  - Live-TV Distribution in Virtualized CDN environments
  - Remote Surgery
- Document investigates
  - Measurement of Latency
  - Mechanisms to achieve low latency flows
  - Alternatives to existing low latency networking
  - Privacy and security considerations
- Document provides strawman architecture
  - See next slide

Critical Low Latency Delivery Architecture



- Orchestration architecture
  - Receive application requirements (e.g. URLLC requirements, BAS QoE)
  - Translate into various network service configurations (e.g. L2SM, Detnet Service Model, FlexE control model, etc.)
- Provides description of key functional components and interactions

Is this a worthy discussion?

- Q1. Does ongoing investigation and discussion of critical low latency communication add value?
  - Do we already have low latency tools and architecture in IETF?
  - It is difficult for cross-ISP deployment to carry QoS, and cross-layer communication?

- Q2. Is it useful for IETF to start gap and challenge analysis to existing low latency tools, especially network service configuration models?
  - In order to support URLLC and BAS requirements?

- Q3. Should we develop an IAB workshop on this topic?

- Q4. Would cross-SDO communication be beneficial?
  - 3GPP, BBF, ETSI, all have requirements, use cases and ideas, but…

Thank You!

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