Using M-PolKA to supporting QUIC Data Transmission through Dynamic Multicast Management

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Ingresso	2019.1
Qualificação	A definir
Defesa	A definir
Bolsista?	Não

Agenda

- Introduction/Motivations
- Some problems and main question
- Next steps

Introduction/Motivations

- Number of Internet users progressively increase, latency and speed have become significant concerns
- In 2022, the number of people watching digital videos in the US reached 254.4 million[1]
- The research community has question the use of TCP as a single solution for all scenarios

[1] *(Business Insider, 2022)*

some problems and main question

Unicast and Multicast with IGMP

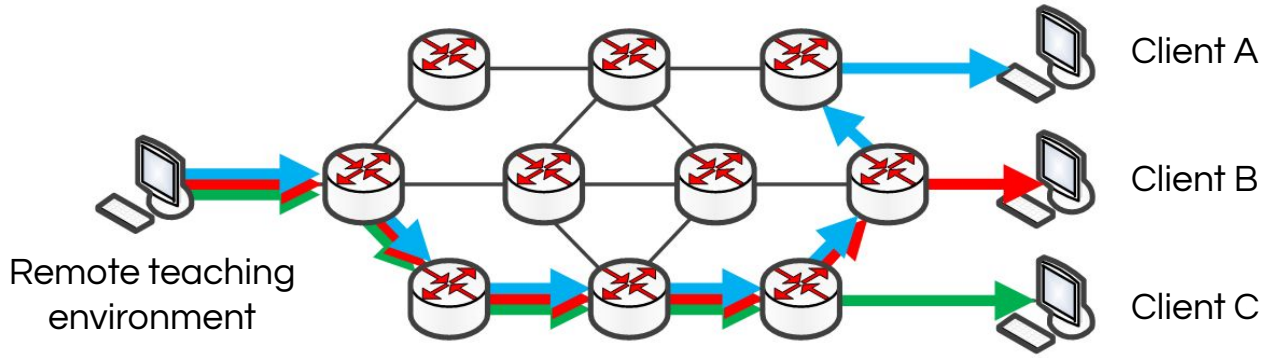


Fig. Example of data flow on a unicast IP network.

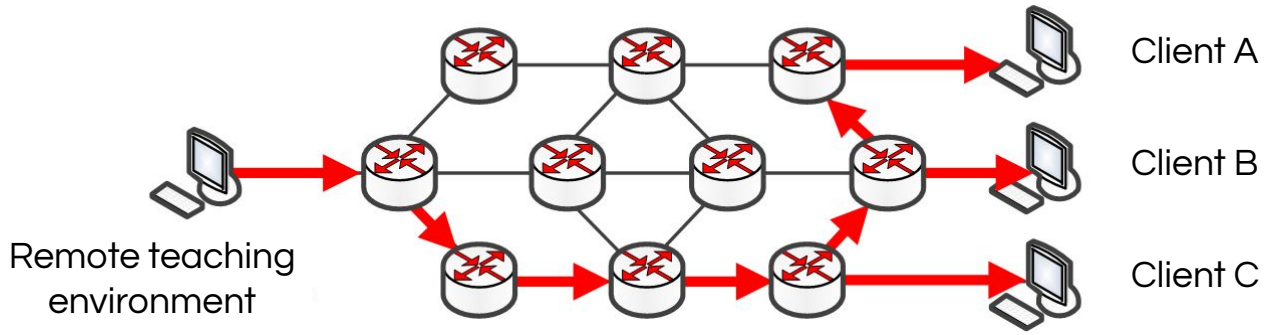
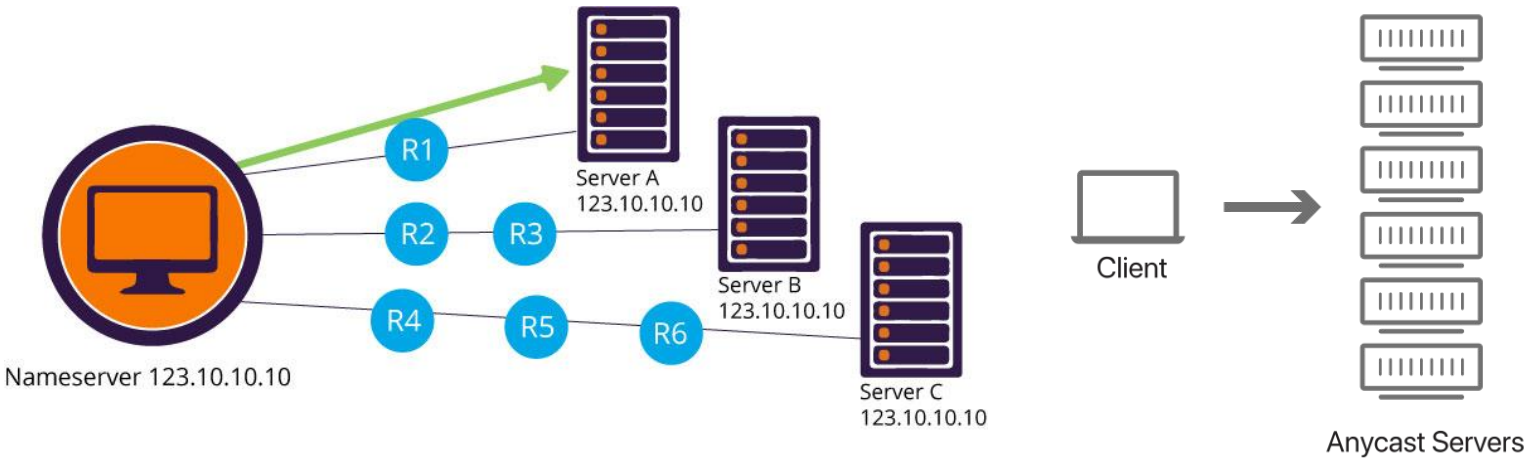


Fig. Example of data flow on a multicast IP network.

Some Problems:

- It does not offer efficient filtering and security
- Due to a lack of IP, it does not handle network congestion
- IGMP is vulnerable to some attacks, such as Denial-Of-Service

Anycast



Some Problems:

- Works “only” with IPv6
- Requires support on all intermediate nodes
- If any device does not recognize it, communication becomes broadcast

Thomas Koch, Ethan Katz-Bassett, John Heidemann, Matt Calder, Calvin Ardi, and Ke Li. 2021. Anycast In context: a tale of two systems. In Proceedings of the 2021 ACM SIGCOMM 2021 Conference (SIGCOMM '21). Association for Computing Machinery, New York, NY, USA, 398–417. https://doi.org/10.1145/3452296.3472891

Problems

- Limitations imposed by TCP cause waste of network resources
- UDP communications function as greedy algorithms
- Kernel-based solutions are harder to put into production
- User-based solutions are more flexible but slower

Main Question

How to explore today's multipath Internet environments to meet the dynamic communications requirements of the Internet of the Future?

Proposal: *Create a dynamic multicast connection manager capable of exploring the benefits of communications through UDP, muticast and multipath on the Internet.*

QUIC (**Q**uick **U**DP **I**nternet **C**onnections) Protocol

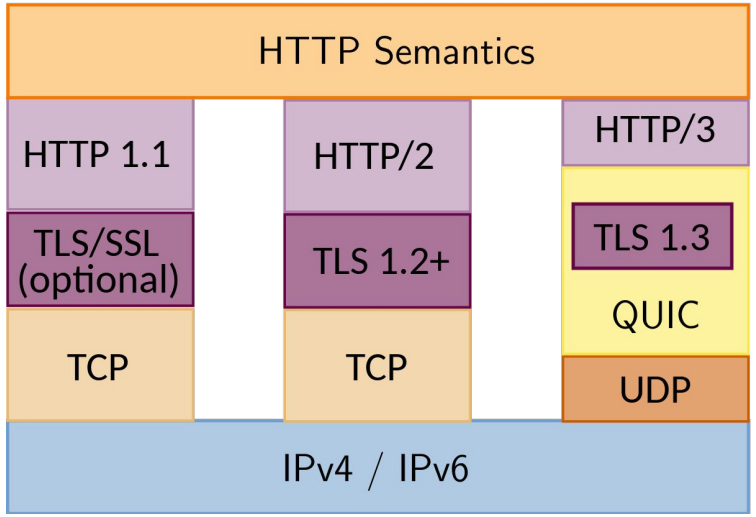


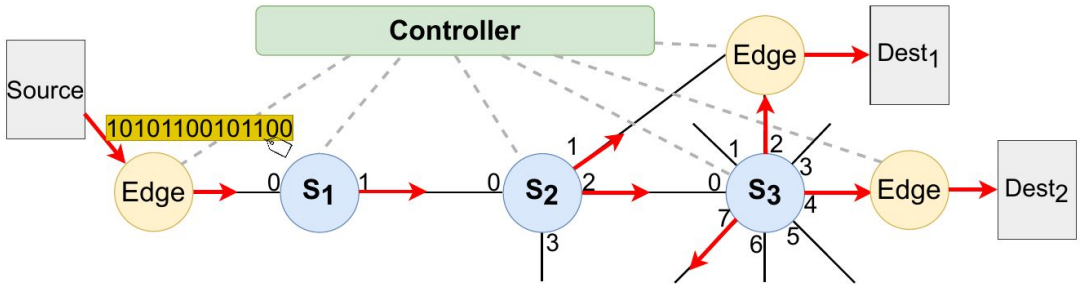
Figure: QUIC in TCP/IP stack.

Key features of QUIC:

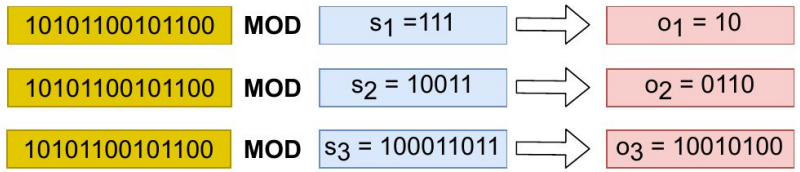
- A reliable, multiplexed transport over UDP
- Always encrypted
- Reduces latency
- Runs in user-space

J. Iyengar and M. Thomson, "QUIC: A UDP-Based Multiplexed and Secure Transport", in Internet Requests for Comments, RFC 9000, May 2021, RFC Editor, ISSN: 2070-1721.

M-PolKA



(a) Multipath tree example (in red).



(b) M-PolKA multipath forwarding

Figure: M-PolKA operation.

Some advantages over traditional routing schemes:

- Improve reliability;
- Reduced latency;
- Increased security.

Key features of M-PolKA:

- Topology-agnostic;
- Multipath;
- Source routing;
- Residue Number System (RNS) polynomial arithmetic.

R. S. Guimarães et al., "M-PolKA: Multipath Polynomial Key-Based Source Routing for Reliable Communications," in IEEE Transactions on Network and Service Management, vol. 19, no. 3, pp. 2639-2651, Sept. 2022, doi: 10.1109/TNSM.2022.3160875.

NAT rebinding + Connection migration

192.168.0.10:12345
Conn. ID: 0xC0FFEE

185.194.187.142:67890
Conn. ID: **0xC0C0A**

QUIC

0xC0FFEE
0xDECADE
0xDEC0DE
0xAD0BE
0xC0C0A

Connection #5

M-PolKA

0xC0FFEE
0xDECADE
0xDEC0DE
0xAD0BE
0xC0C0A

QUIC

Research scope

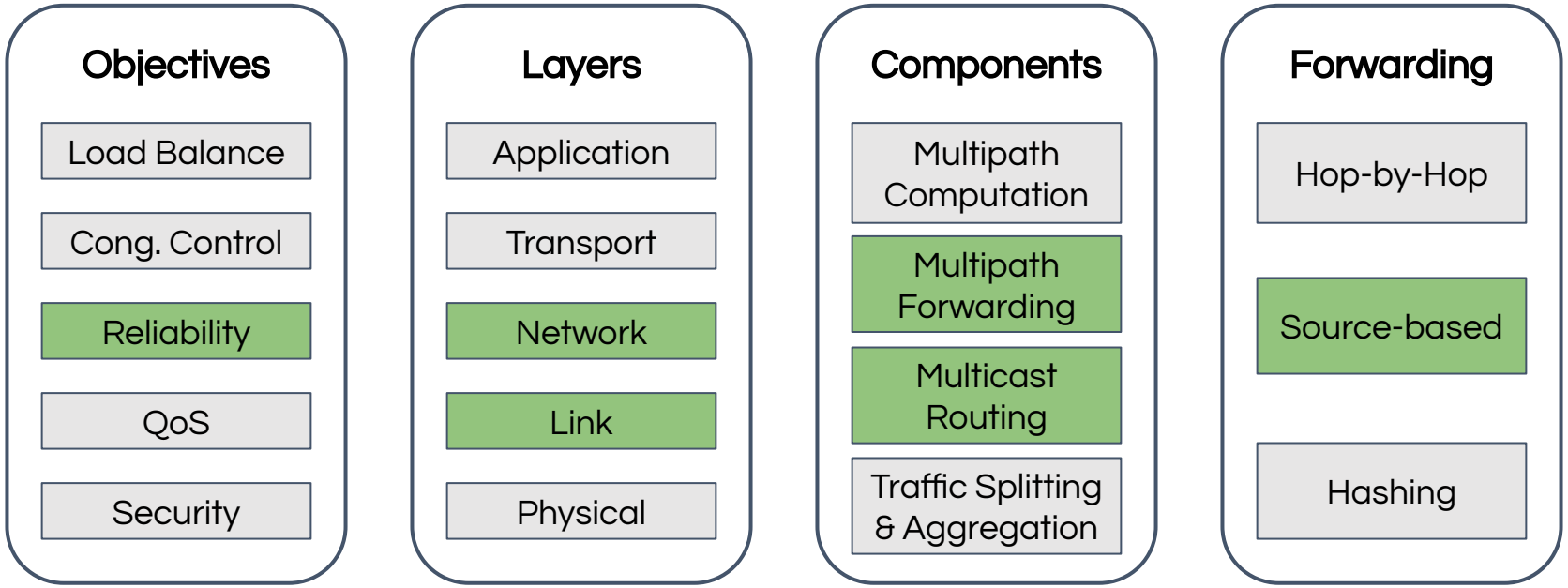


Figure: The scope of this work (in green), considering the classification of multipath protocols.

Future Digital World

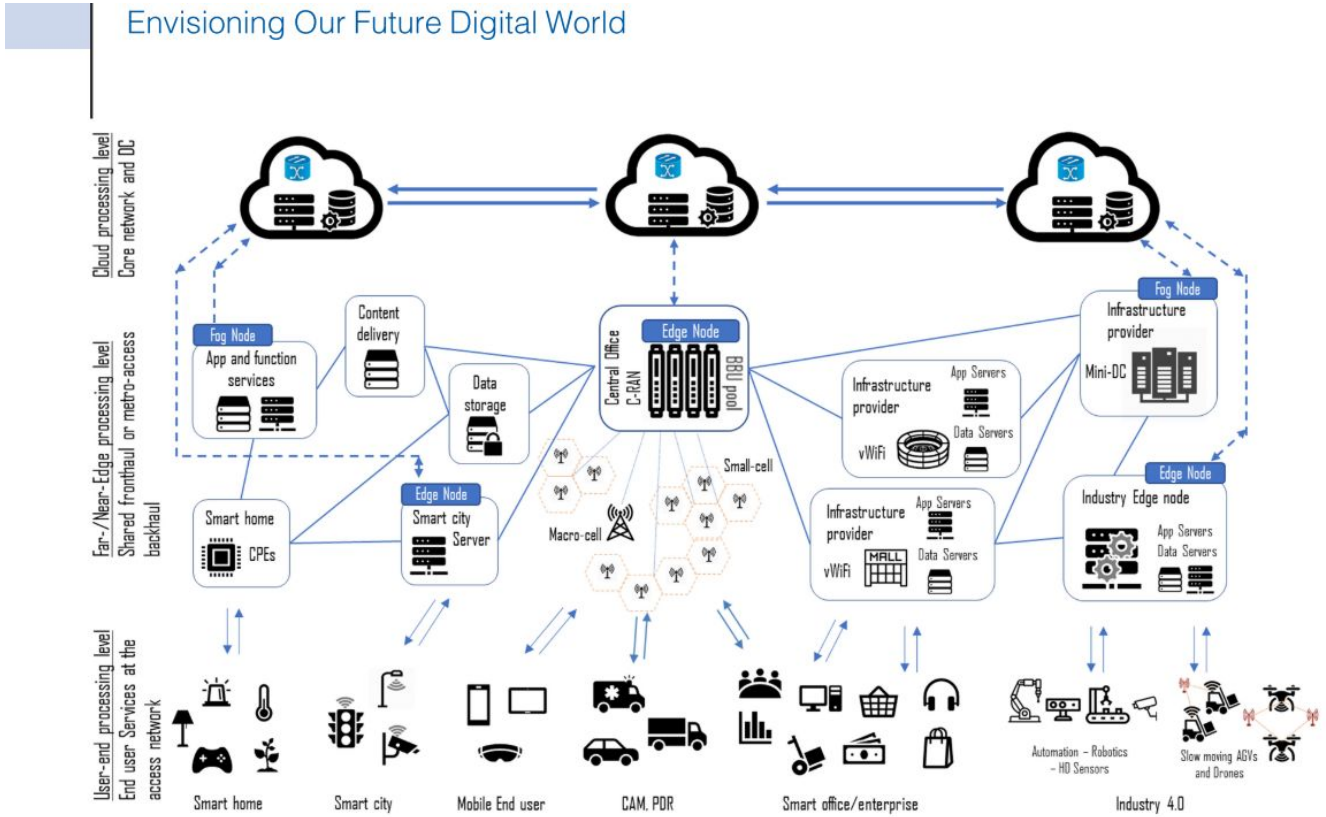


Figure. 1. Diverse set of service provisioning fields addressed by the edge computing concept in a generic 6G network model at the access with interconnection to the legacy centralized edge processing node and cloud.

I. Tomkos, D. Klonidis, E. Pikasis and S. Theodoridis, "Toward the 6G Network Era: Opportunities and Challenges," in IT Professional, vol. 22, no. 1, pp. 34-38, 1 Jan.-Feb. 2020, DOI: 10.1109/MITP.2019.2963491.

next steps

Next steps

- Formalize the model, hypothesis, and proof of concepts
- Experimental analysis
- Use of real datasets in different use cases

- Publications plan:
  - Main track SBRC 2024 (short term)
  - IEEE Journals and Magazines (long term)

References used in this presentation

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R. S. Guimarães et al., "M-PolKA: Multipath Polynomial Key-Based Source Routing for Reliable Communications," in IEEE Transactions on Network and Service Management, vol. 19, no. 3, pp. 2639-2651, Sept. 2022, doi: 10.1109/TNSM.2022.3160875.

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Questions?

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