Orchestrating a brighter world

NEC

Security & Transport Performance in 5G

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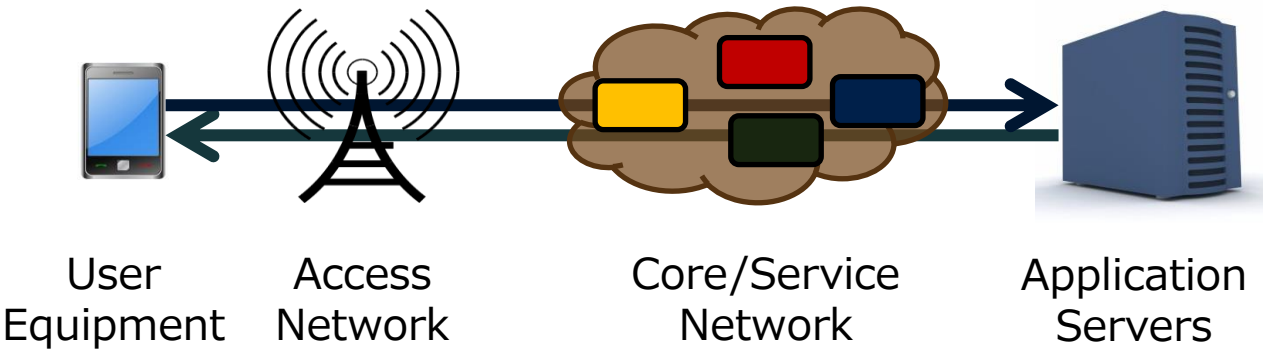
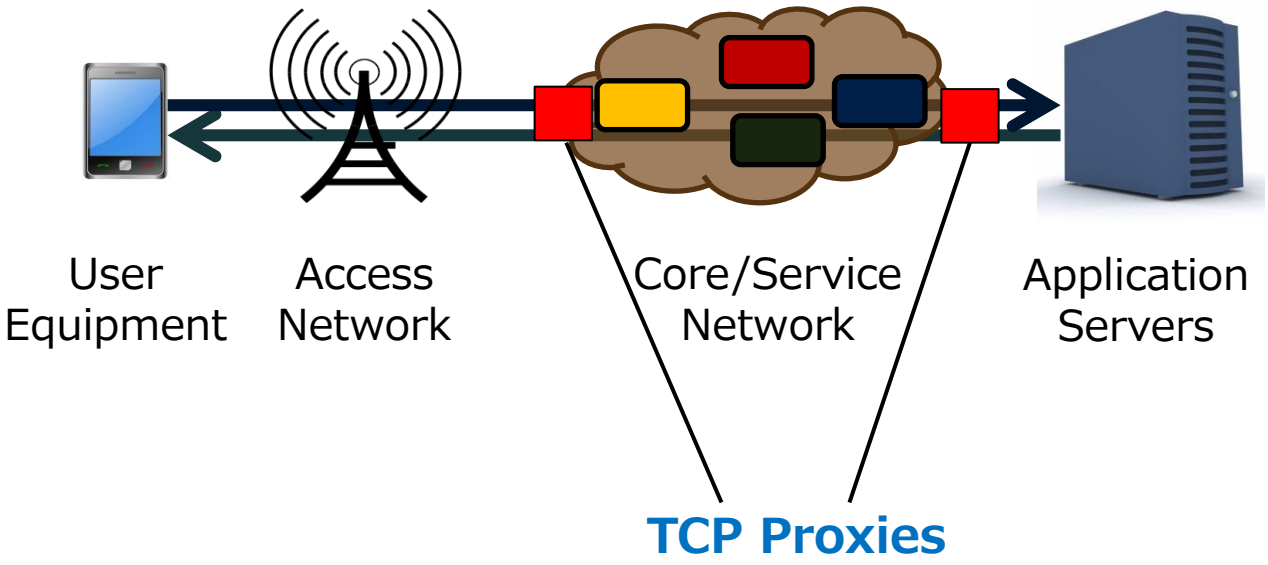
Chief Researcher Networking

NEC Laboratories Europe

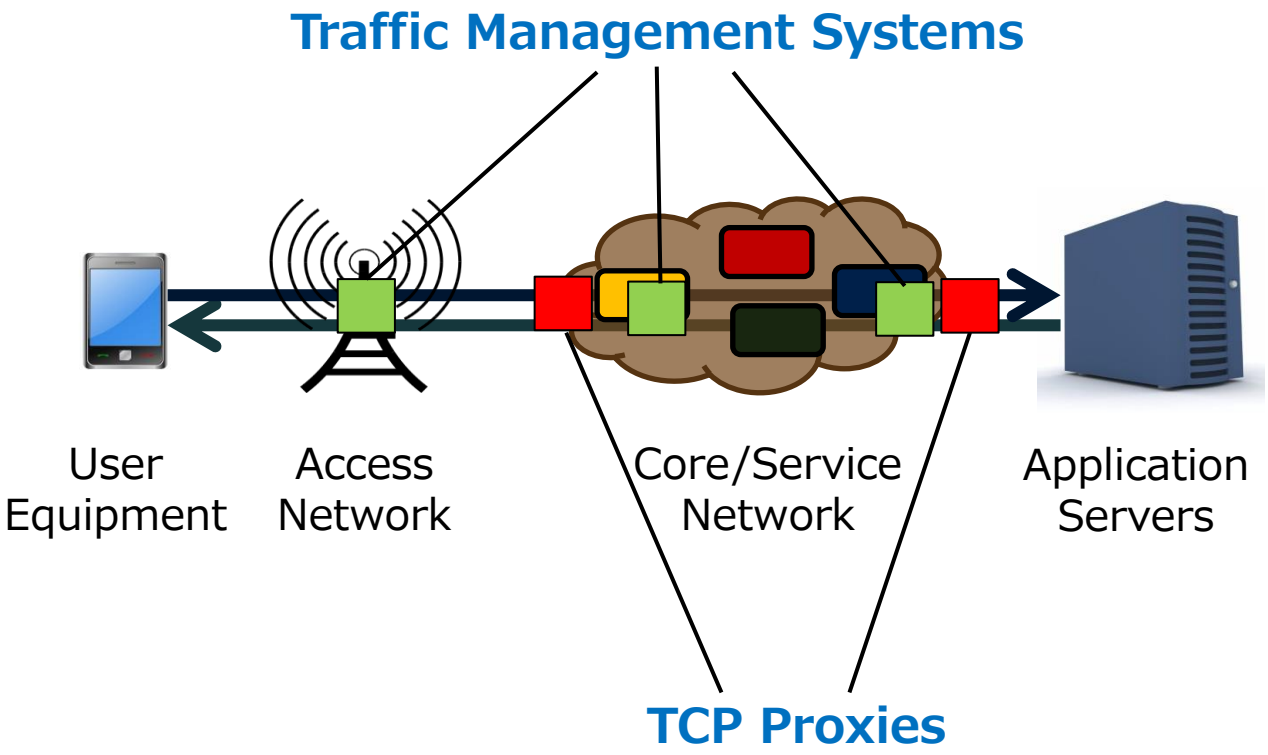
Performance and Security Today



Performance and Security Today



Performance and Security Today



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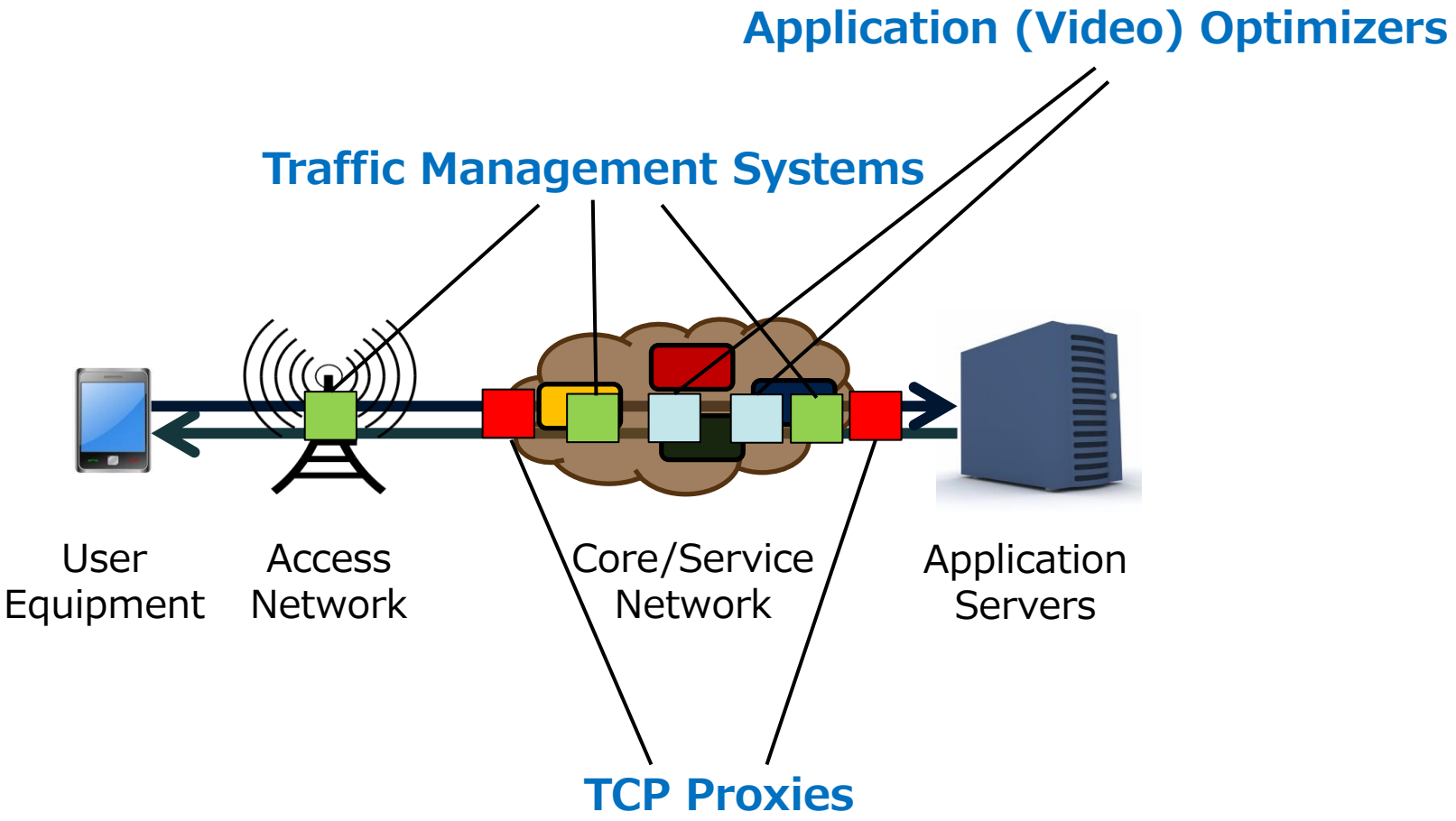

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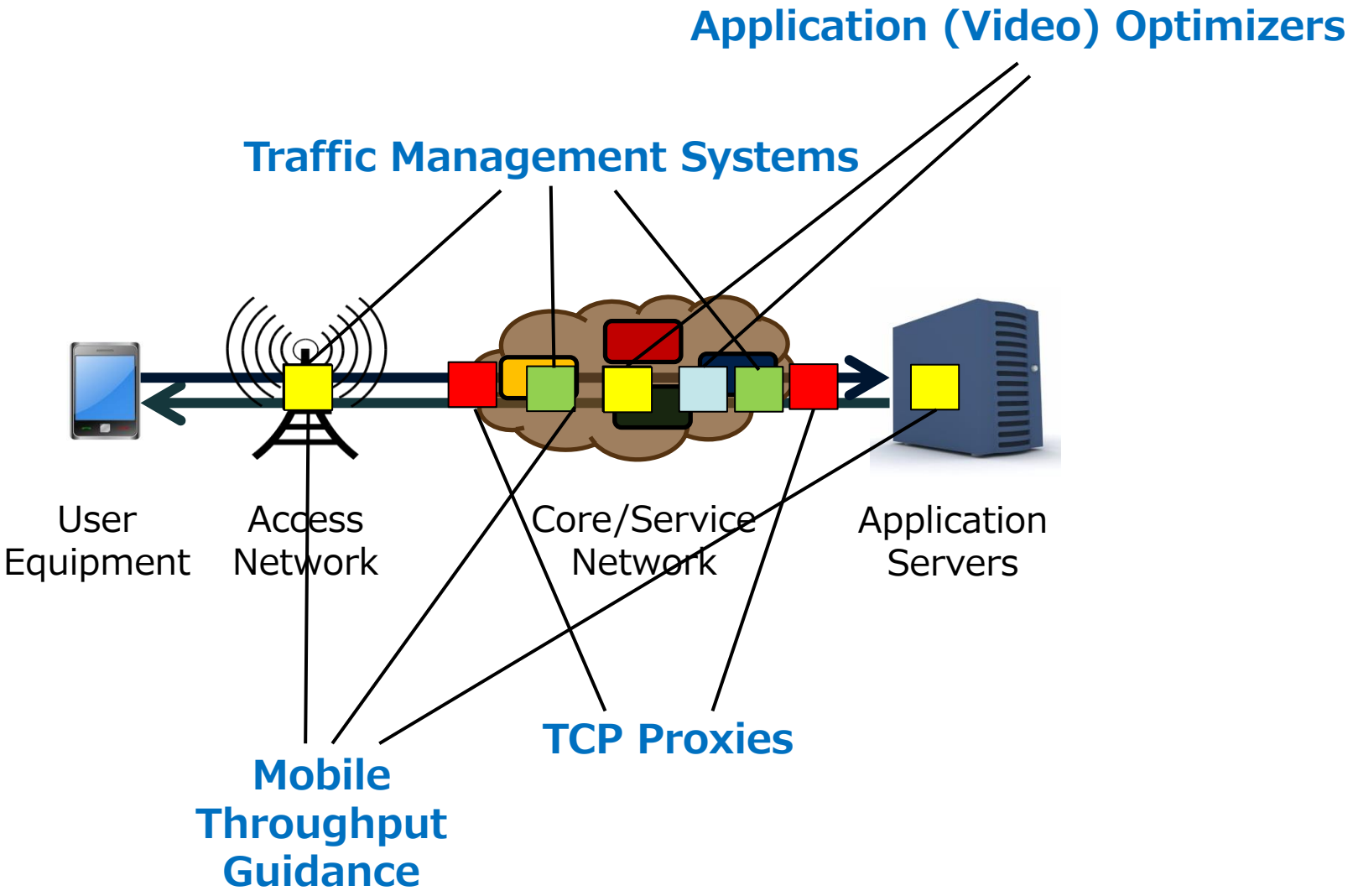


Motivation

TCP proxies

- Lack of AQM and ECN deployment
- Sub-optimal performance: e2e control loop over heterogenous networks

Traffic management systems

- Lack of AQM and ECN deployment
- Lack of incentives for adaptive applications
- Perceived need for policing applications depending on access network conditions

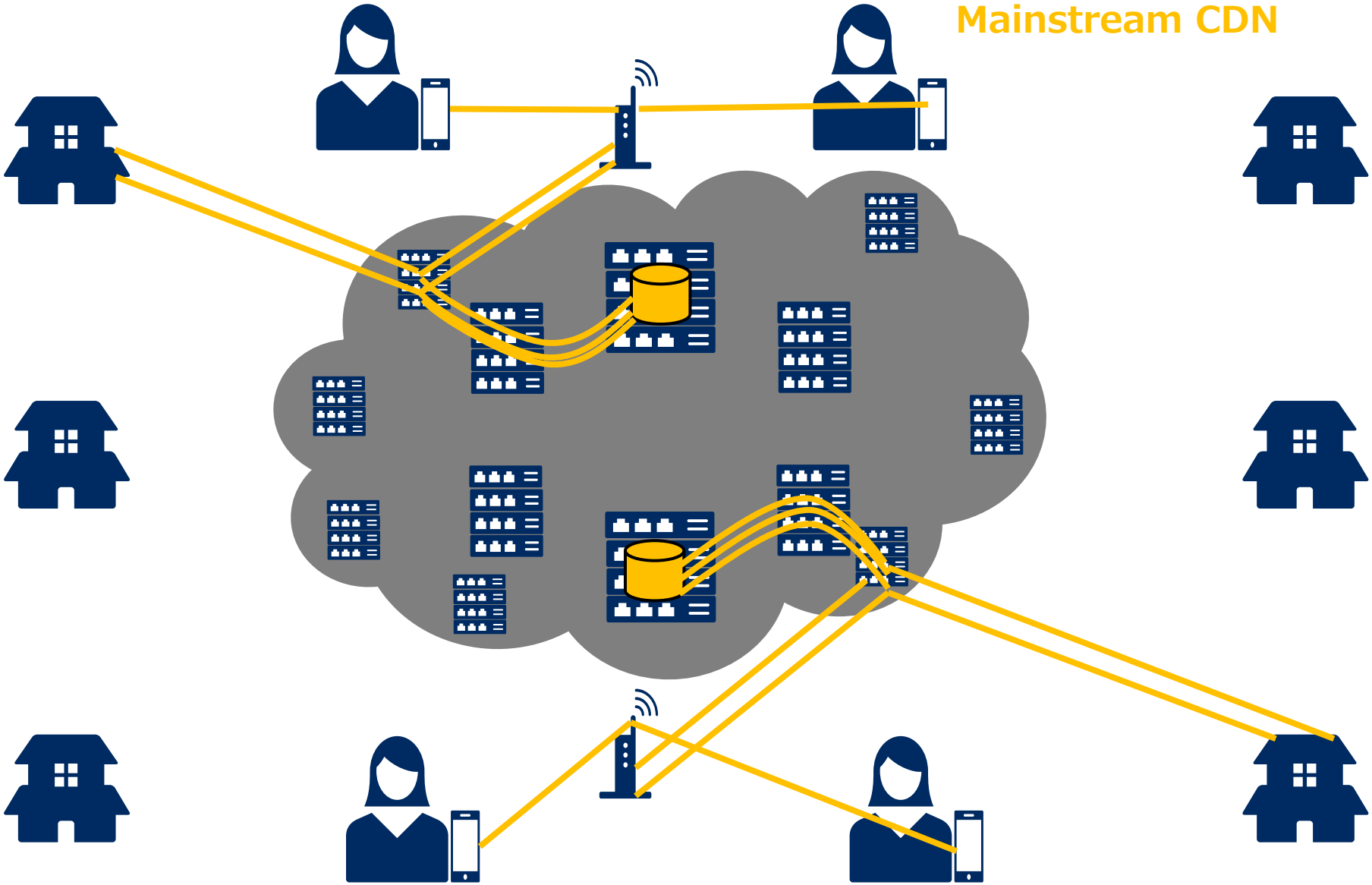
Application optimizers

- Operator resource conservation and performance concerns
- Access to user data for analytics

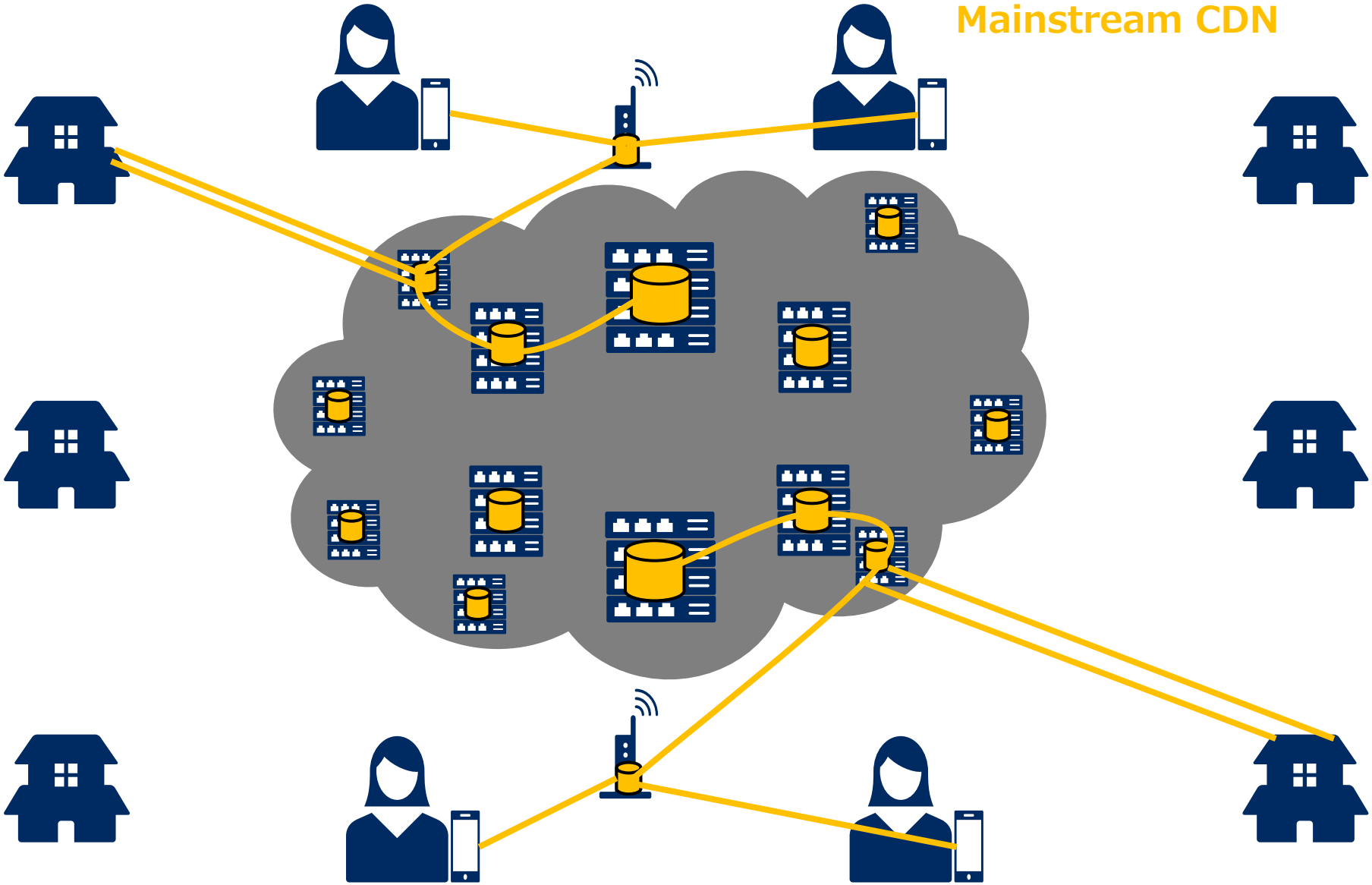
Mobile Throughput Guidance

- All of the above

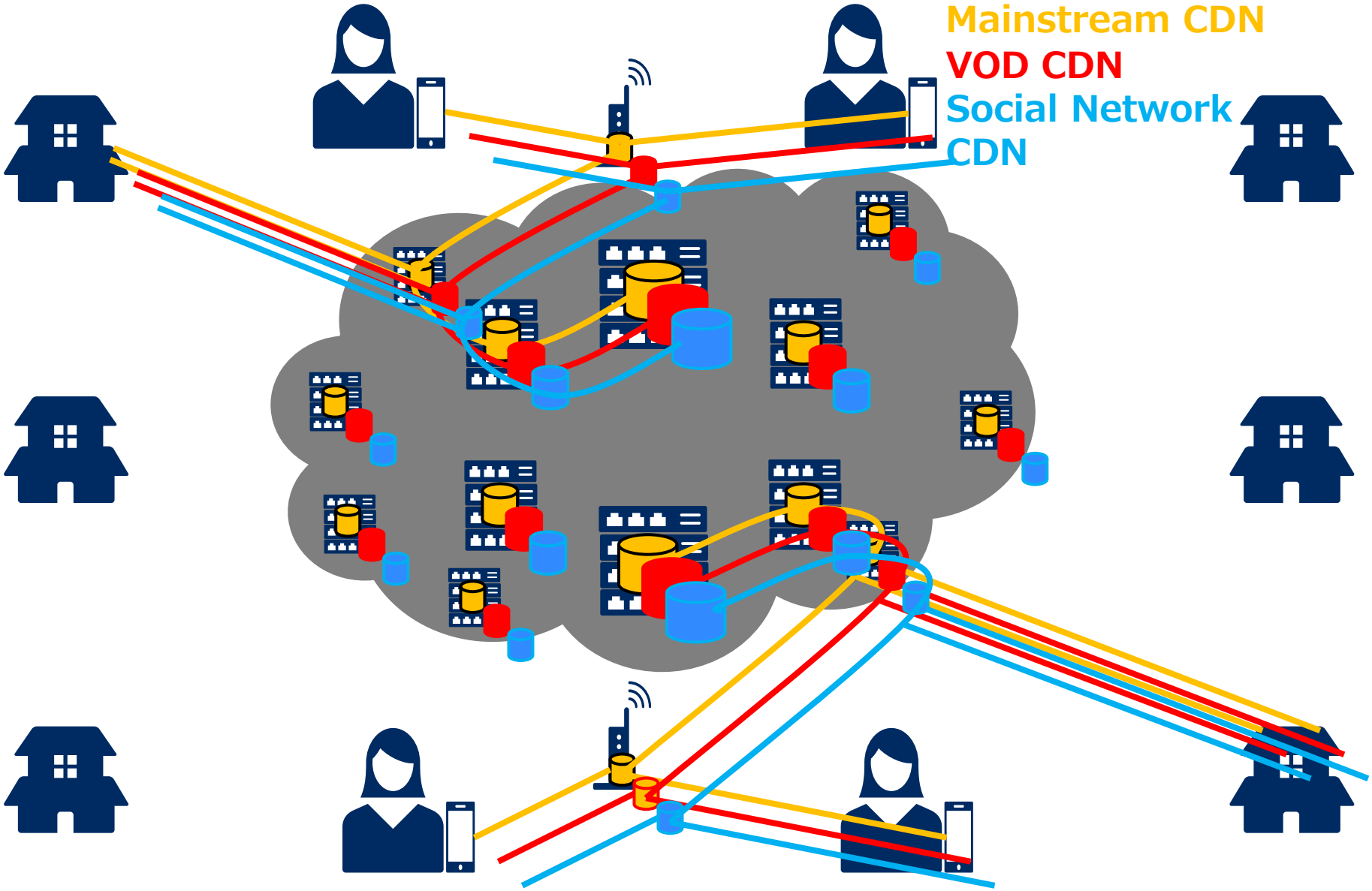
CDN Today



CDN Tomorrow



CDN Tomorrow: Silo Danger



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CDN
- Network offloading
- QoE improvement through latency reduction
- Moving data and computation closer to the edge
- Application-layer request/content routing policies

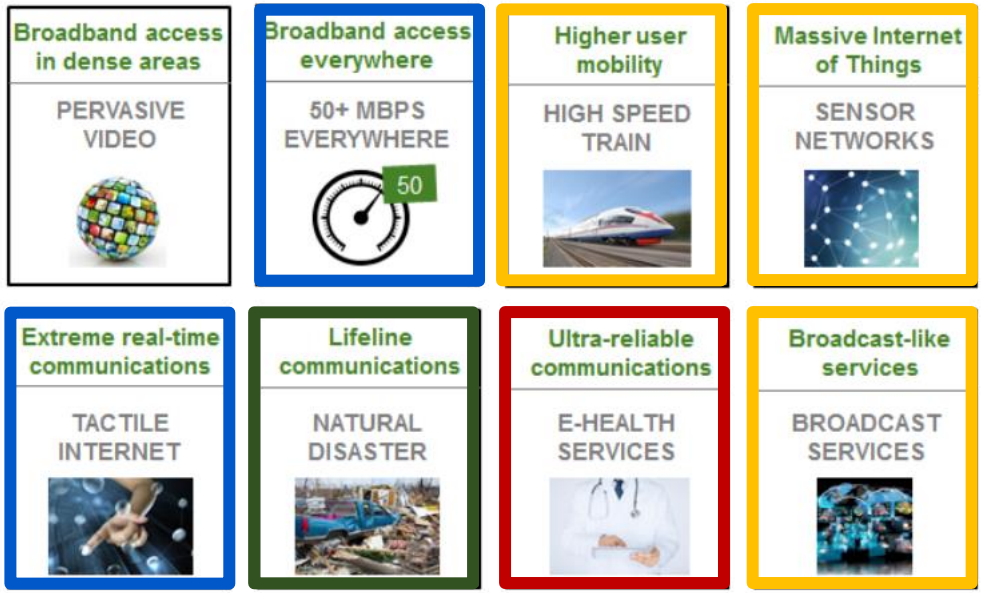
Observations

- Significant infrastructure required to make things „only work“ today
  - Overcoming TCP e2e performance issues in heterogenous networks
- Caching deemed important for scalable, low-latency data access
  - Deployment likely going to increase in next generation networks (edge caching)
  - General CDN and application-specific CDN deployments (new OTT services)
  - How many different CDN-like overlays will you have to run as an ISP?
- What does that mean for 5G networks?

NGMN 5G Use Cases

**Low latency,
local loop communication**

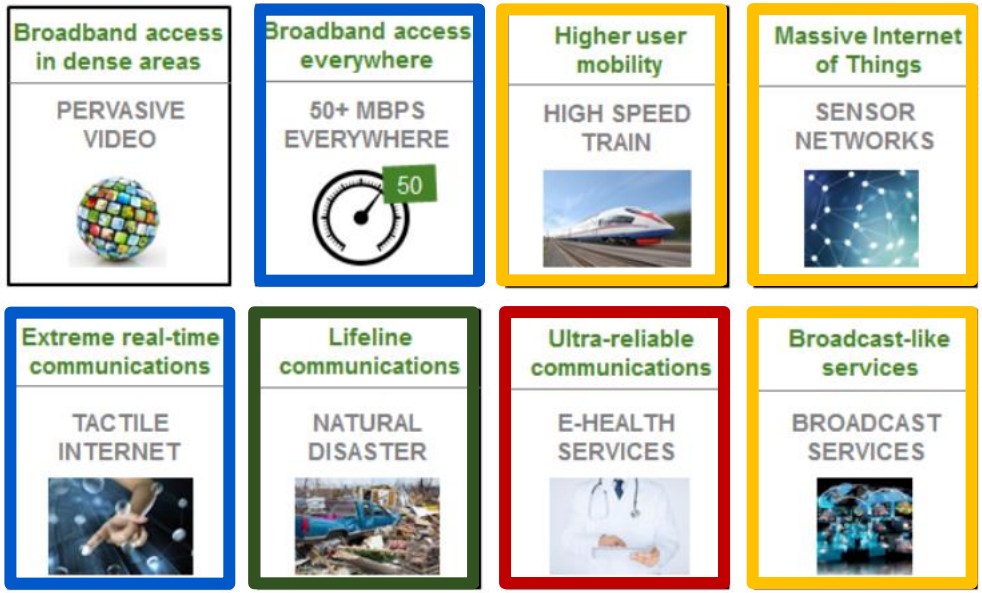
**Optimized Forwarding
for Heterogenous Access**



**Decentralized
Communication**

**Security,
User Privacy**

NGMN 5G Use Cases



Security,
User Privacy

Security & User Privacy

HTTP/2 is here to stay

- Connection-based encryption on transport layer (TLS)
  - Encrypt connection (and authenticate endpoints)
  - Encrypted channel for all communication
- De-facto ubiquitous (client implementations...)
- No (easy) way for traffic management (based on flow/application information)

Major concerns with network operators

- See recent GSMA/IAB workshop on Managing Radio Networks in an Encrypted World (MaRNEW)
- Many of the previously mentioned optimization become difficult/expensive/impossible

TLS and Future Deep CDN

CDN and TLS

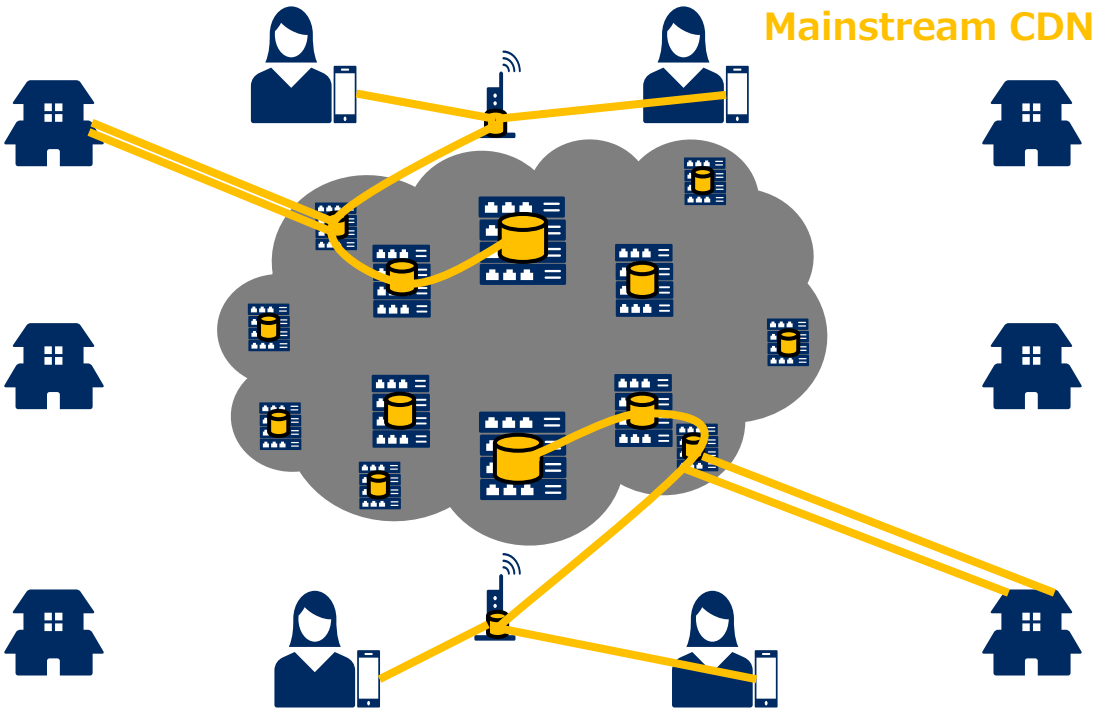
- CDN nodes maintain certificates on keying material on behalf of publishers
- Managing those certificates/keys is an important function of any CDN
- Protecting those certificates/keys is an important security requirement

Scaling CDNs

- More attack surfaces
- More challenges to certificate/key management
- User-privacy only guaranteed for connection to CDN proxy

Are there better ways?

- Object-based security
- Generic object caching & forwarding infrastructure



Optimized Forwarding for Heterogenous Access

Broadband access in dense areas

PERVASIVE VIDEO

Massive Internet of Things

SENSOR NETWORKS

Broadcast-like services

BROADCAST SERVICES

Higher user mobility

HIGH SPEED TRAIN

Low latency, high-bandwidth

- Fiber, new radios

Slow, ad-hoc, unpredictable

- Low-power radios, sleep/duty cycles
- Constrained devices

Massively scalable distribution

- Server-push or pub/sub style
- Possibly in-network adaptation

Variable performance

- Dynamically changing network conditions
- Disruptions and delays
- On-board caching for all applications & protocols

Optimized Forwarding for Heterogenous Access

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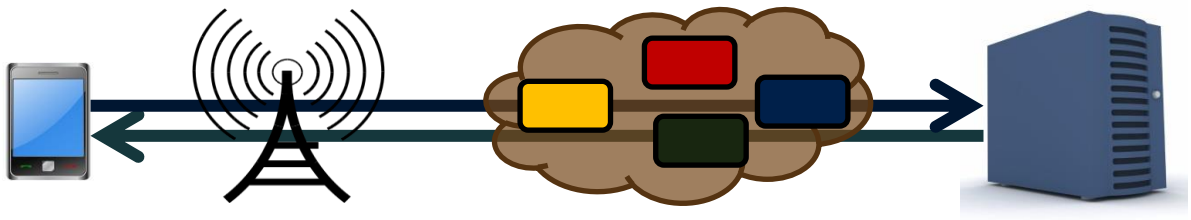


- Will be difficult to implement with TCP as is
- Remember: reduced deployment options for application-layer gateways
- Network of TCP proxies does not sound convincing

- **Need more powerful forwarding layer and transport services**
  - Potential for hop-by-hop forwarding strategies
  - Caching for local retransmissions

Information-Centric Networking

Accessing Named Data Objects (NDOs) in the network

- ADUs, chunks, fragments

Data-centric security approach

- Disentangled means for name-content binding validation, publisher authentication, confidentiality

Name-Content binding validation:

- Public-Key and hash-based schemes

Publisher authentication

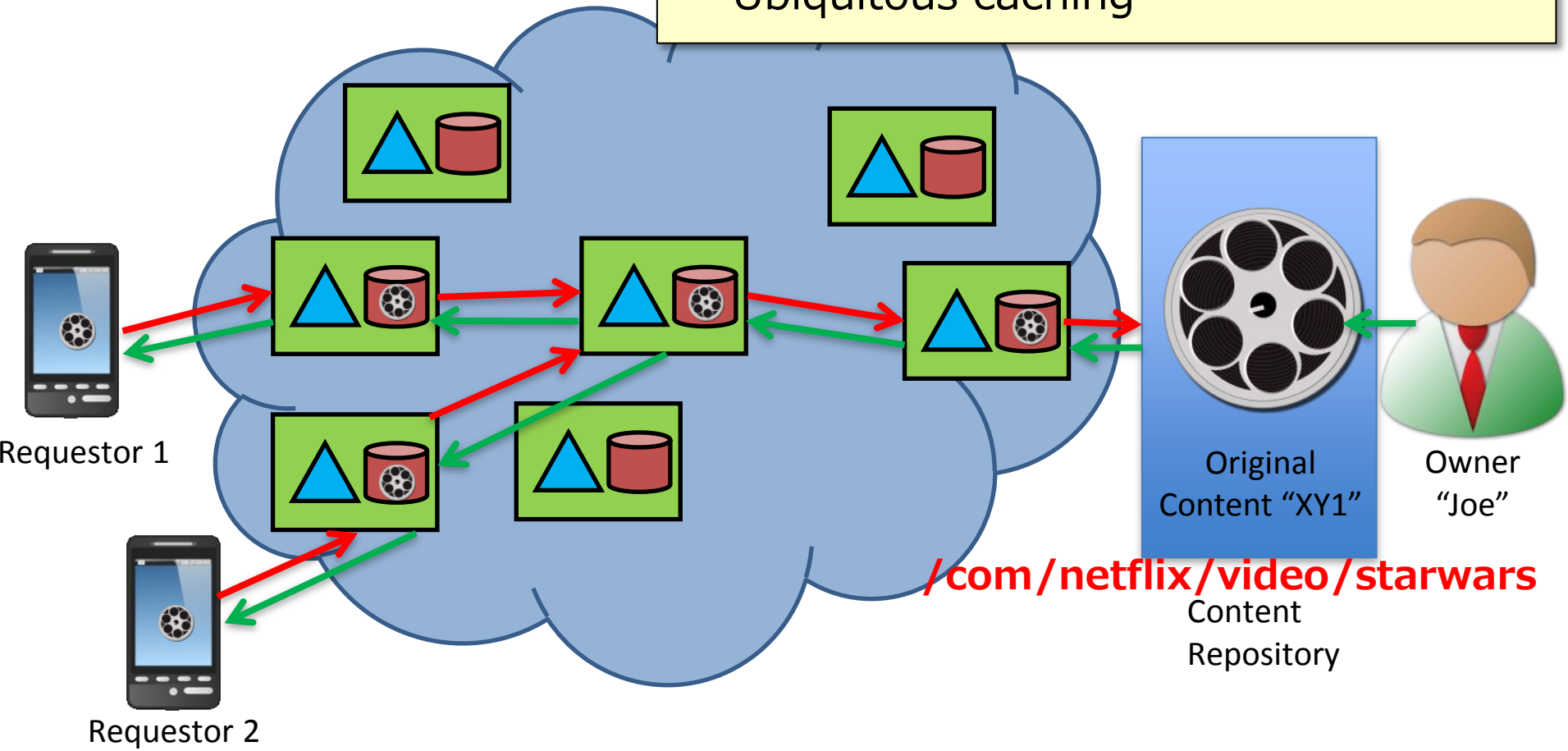
- One approach: publishers to sign NDOs, signature part of NDO meta data; trust model a la PKI

Confidentiality and access control

- Payload encryption

ICN Overview

- Request Response, Receiver-driven
- Pending Interesting Tables
- Forward-by-name (prefix)
- Per-node forwarding strategies
- Object-based security
- Ubiquitous caching



ICN Performance and Resource Management

Key ICN properties

- Requesting individual Named Data Objects
- Ubiquituous Caching

Implicit caching

- Every router can store NDO – depending on configuration, policy etc.
- Even with encrypted traffic, caching can help with local retransmissions, media re-play etc.

Simplified mobility management

- Request/Response model – eliminates need for tunnels

Flexible multipath communication

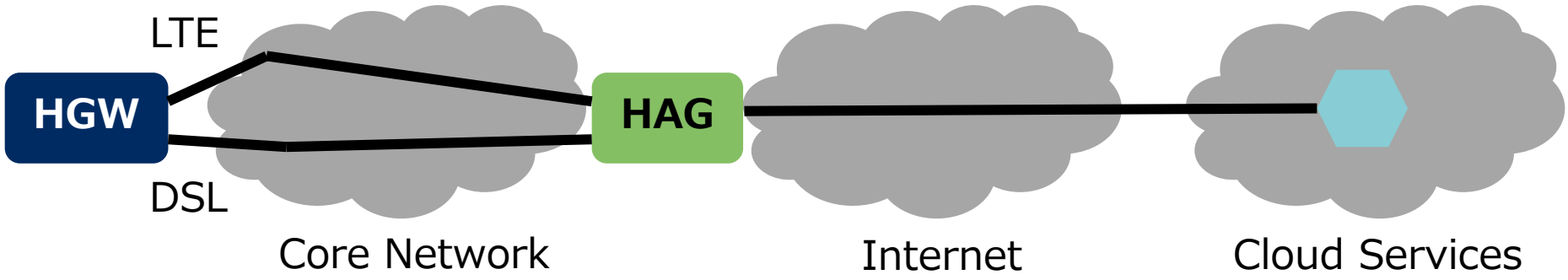
- **Powerful forwarding layer**
- Every router can make forwarding decisions depending on strategy, network characteristics, name prefix, policy

Easy policing and filtering

- Requestors, publishers and requestors see ICN requests and responses
- Policing without DPI
- Enabling other optimizations: in-network pre-fetching etc.

Proof-of-Concept

ICN for managing multi-path connectivity in Hybrid Access scenarios

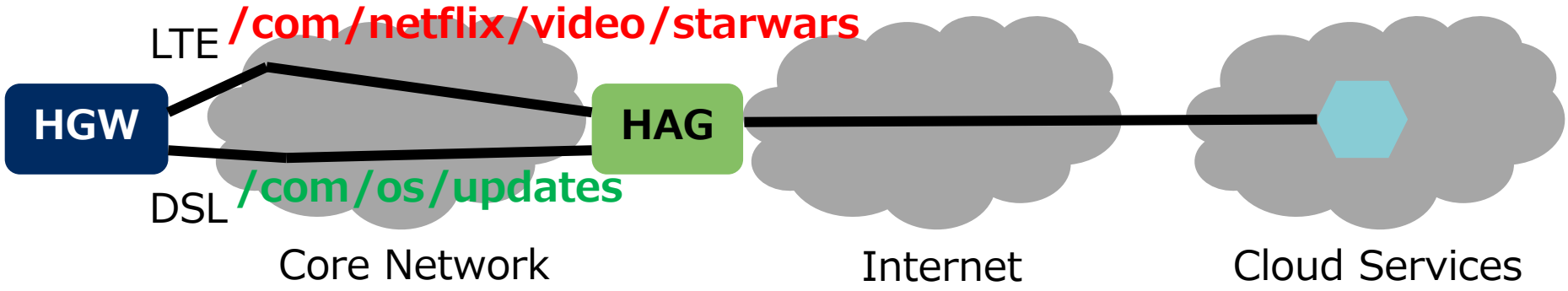


State of the art

- Connection Bundling over IP tunnels (GRE): poor performance with transport protocols
- MPTCP: better from transport perspective, but problematic interaction with CDN (DNS redirection per interface) and lack of policy control

Proof-of-Concept

ICN for managing multi-path connectivity in Hybrid Access scenarios



ICN approach

- **Routers have better visibility of interface performance** (can continously measure latency between requests and responses on a name-prefix basis)
- Easy to implement **policy based on request prefixes**
- Our implementation: **prioritizing critical applications** by constantly assessing interface performance and by assigning best interfaces to prioritized applications
- Works with **high degree of dynamicity** (mobile networks)

First results

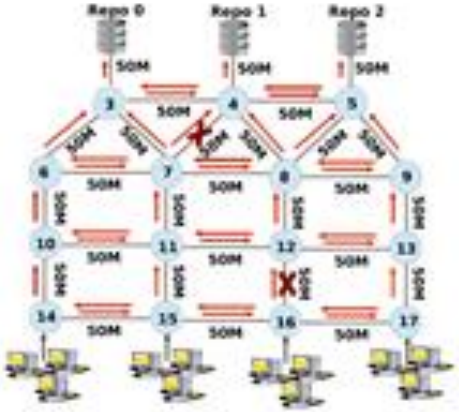
- Extremely fast response to congestion – on all nodes of a heterogenous path
- Constantly high capacity utilization
- Effective prioritization

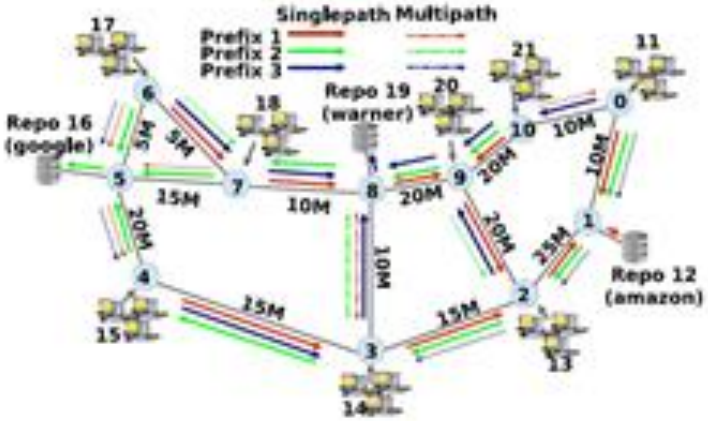
Other Recent Results

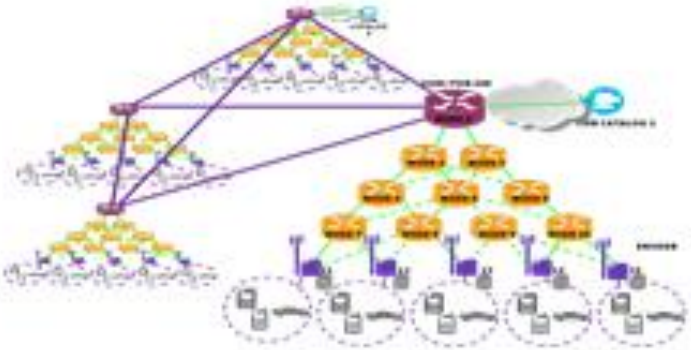
SystemX

Experiments

- **Large topologies**
  - Up to 100 physical nodes
  - More than 200 links
- **Realistic scenarios**
  - Mobile Backhaul







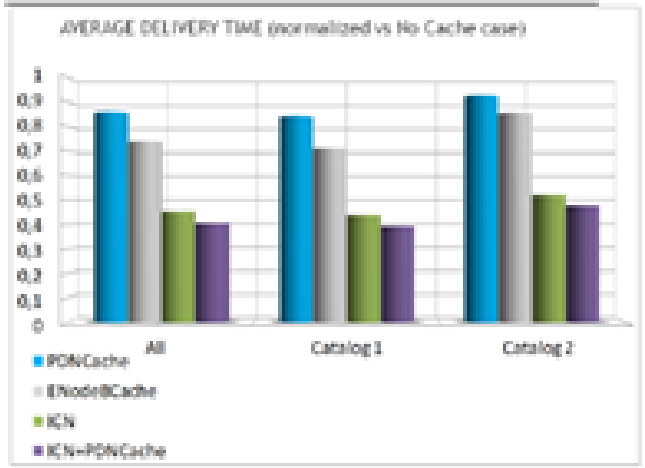
Alcatel-Lucent

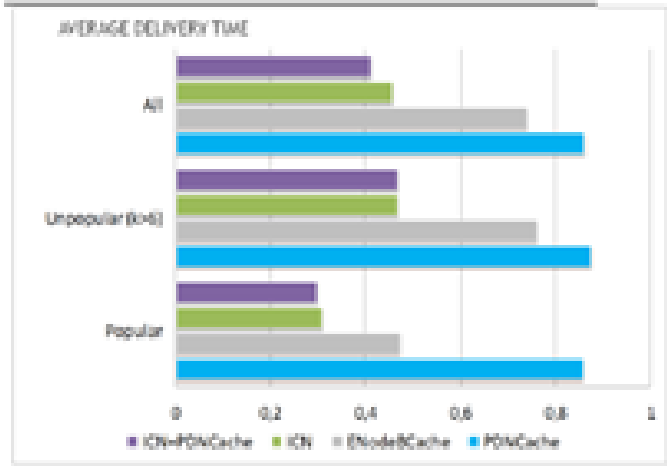
http://www.ietf.org/proceedings/interim/2014/09/27/icnrg/proceedings.html

Orange/ALU/SystemX Testbed Measurement Results

results – latency reduction

- ICN shows the better QoE in terms of delivery time
- Improved user QoE due to:
  - *in-network caching.*
  - *dynamic multipath transfer.*





– a factor 3 reduction in average delivery time

http://www.ietf.org/proceedings/interim/2014/09/27/icnrg/proceedings.html

5G Blueprint

Baseline IP e2e applications

M2M applications

In-network processing

IM, server applications

Interactive real-time

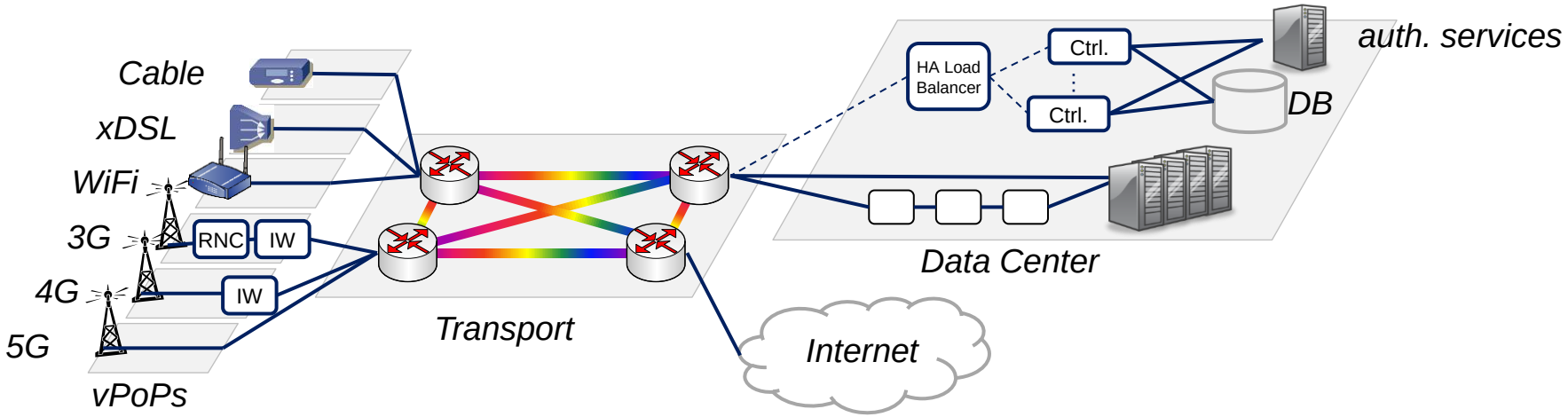
Video streaming, VOD

Caching, multicast

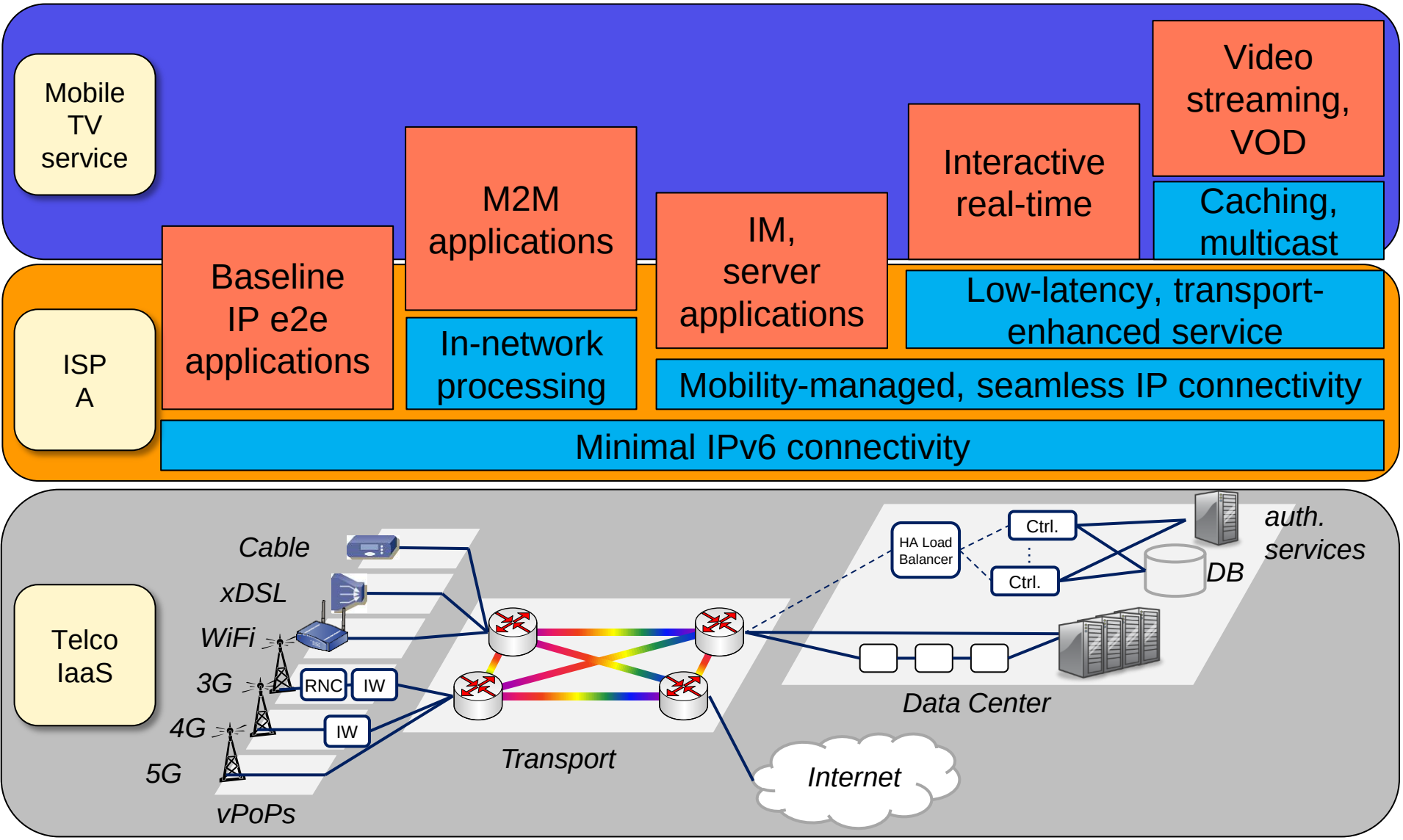
Low-latency, transport-enhanced service

Mobility-managed, seamless IP connectivity

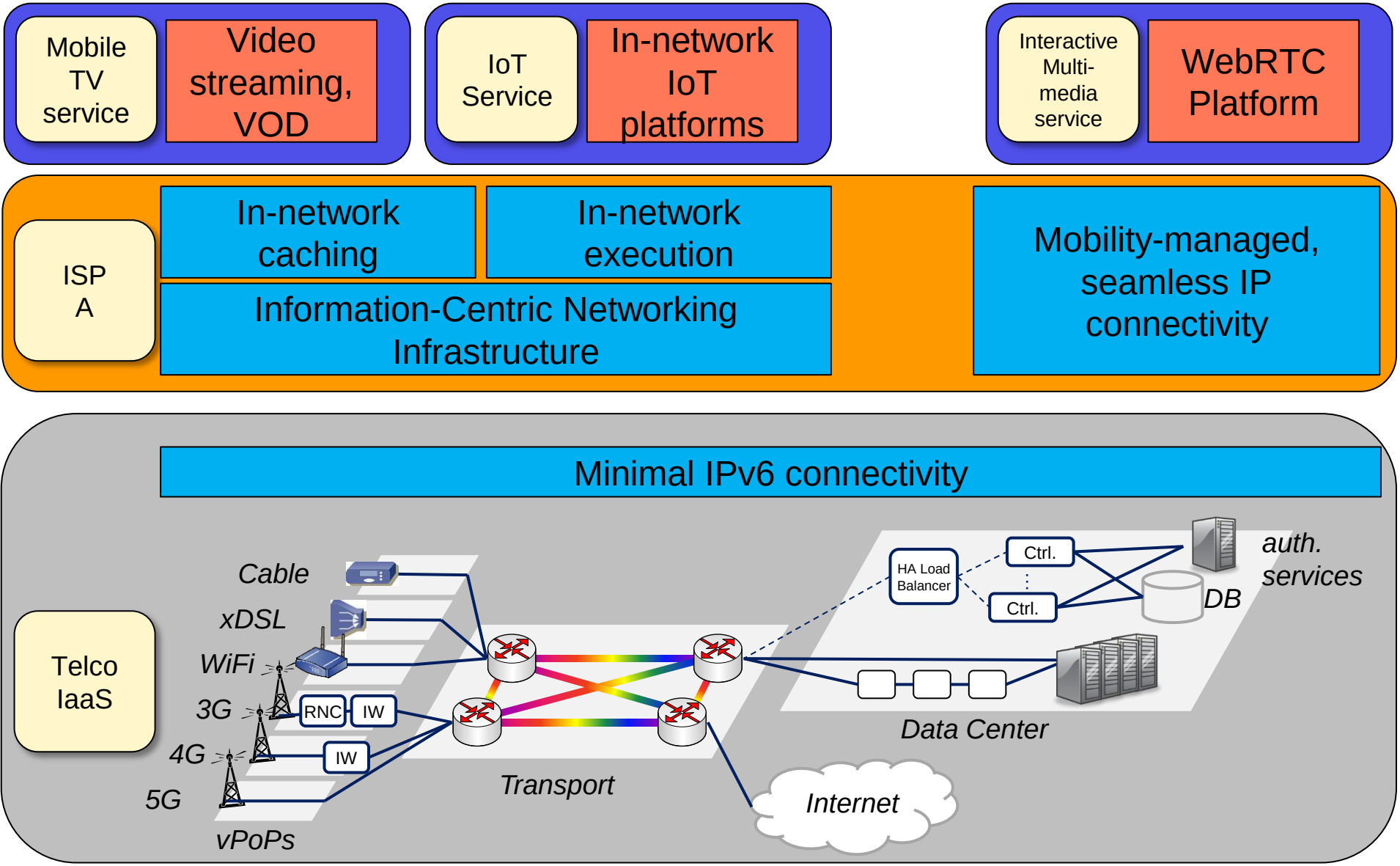
Minimal IPv6 connectivity



5G Multitenancy



Possible 5G ICN Deployment Option



Conclusions: 5G has challenges beyond SDN/NFV

Security

- User-privacy concerns one of the drivers for HTTP/2 (TLS) adoption
- Will reduce leverage for operators for „value-added service“, application-layer optimizations etc.
- Security challenges for TLS and (Deep) CDN

Performance

- 5G has potential for better performance due to new link layers and backhaul architectures
- But: heterogenous access and diverse use cases also imply new challenges

Information-Centric Networking

- **Data-centric communication** approach more suitable for secure and efficient communication
- **Powerful forwarding layer**: node-specific forwarding strategies thanks to better visibility of forwarding performance
- **Common infrastructure** for different types of applications: enabling efficient multi-tenancy operation without silos

IRTF ICNRG

Cross-project research community

- Not limited to a specific funding authority, project, protocol
- Sharing of research results, new ideas
- Documenting ICN scenarios, challenges, state-of-the-art solutions, gaps
- Specifying protocols and semantics for ICN
- Sharing implementation, experience from experiments

ICNRG and standards

- Not setting standards...
- But: helping to understand what needs to be standardized
- And: working on specifications

ICNRG Administrivia

- Web: http://irtf.org/icnrg
- Chairs
  - Börje Ohlman (Ericsson Research)
  - Dave Oran (Cisco Systems)
  - Dirk Kutscher (NEC Laboratories)

ICNRG Work Items

Scenarios, use cases

- Baseline scenarios (RFC 7476)
- Video distribution
- IoT
- Challenged networks and disaster scenarios

Challenges, evaluation

- Research challenges
- Evaluation Methodology

Protocol specifications

- CCNx Messages in TLV format
- CCNx Semantics

Newly proposed topics

- Manifests, chunking, fragmentation, versioning
- User privacy, access control
- Name resolution
- Named function networking

Documenting use cases & opportunities

Evolving research agenda & evaluation approaches

Creating interoperable platforms for experimentation

Evolving ICN concepts and technologies

Running Code

CCNx-1.0 (PARC)

- PARC license
- Developed by PARC
- Implements ccnx-messages and ccnx-semantics

CCN-lite (University of Basel)

- Open Source, free to use without restrictions
- Implements ccnx protocol
- Used by RIOT project

NDN NFD (NDN project)

- GPL-3.0
- Maintained by NDN project
- Implemented NDN protocol

Orchestrating a brighter world

未来に向かい、人が生きる、豊かに生きるために欠かせないもの。
それは「安全」「安心」「効率」「公平」という価値が実現された社会です。

NECは、ネットワーク技術とコンピューティング技術をあわせ持つ
類のないインテグレーターとしてリーダーシップを発揮し、
卓越した技術とさまざまな知見やアイデアを融合することで、
世界の国々や地域の人々と協奏しながら、
明るく希望に満ちた暮らしと社会を実現し、未来につなげていきます。


Orchestrating a brighter world
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