Evolving Network(s) for the Future

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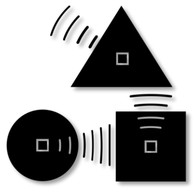
Usage Models Requirements/Constraints

- Over the years use cases driving technology developments have similar requirements
  - Higher bandwidth / throughput to carry ever larger amount of data
  - Lower latency
  - Scalability to ever increasing number of devices



Massive M2M

Reliable Low Latency

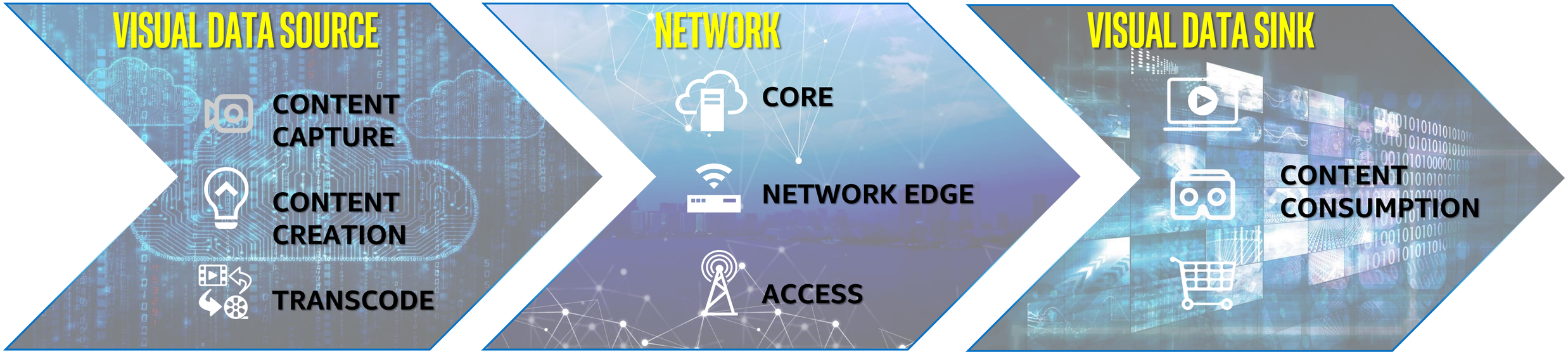
Enhanced Mobile Broadband

Holograms

Visual Cloud

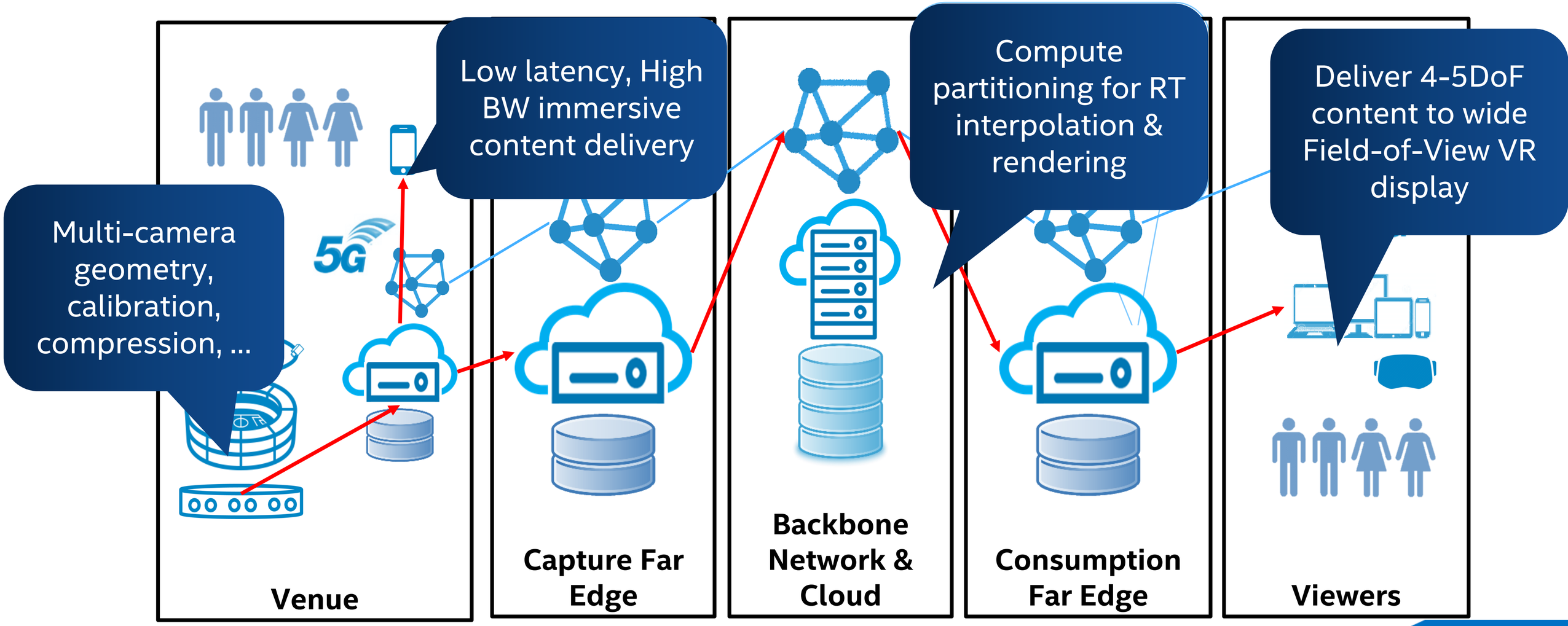
Network architecture is evolving toward Edge Computing to address these usage models

Visual Cloud – A Compelling Workload (1/2)



Visual Cloud – A Compelling Workload (2/2)

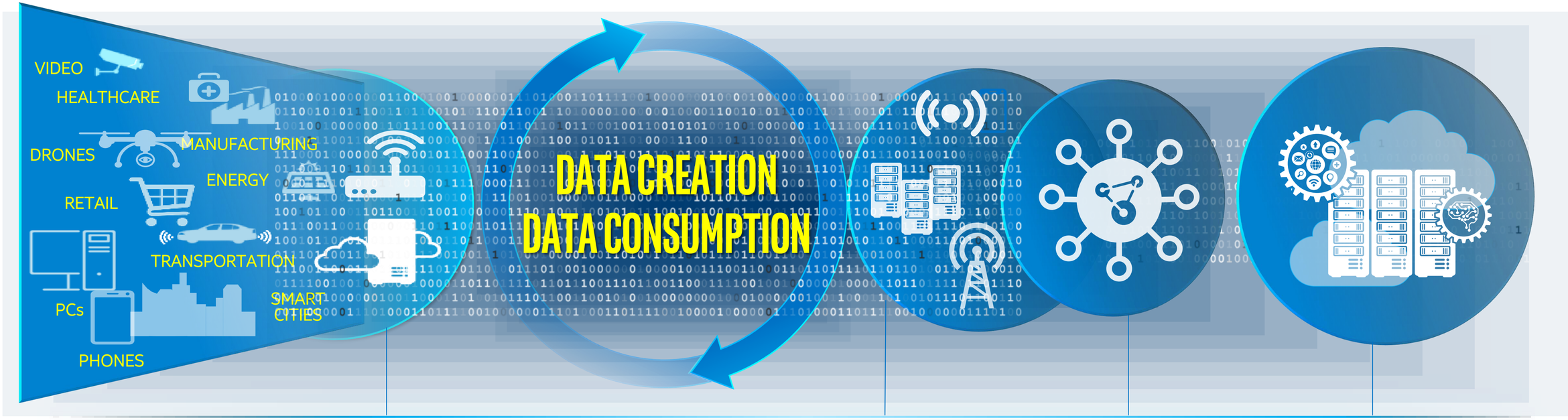
Immersive Media



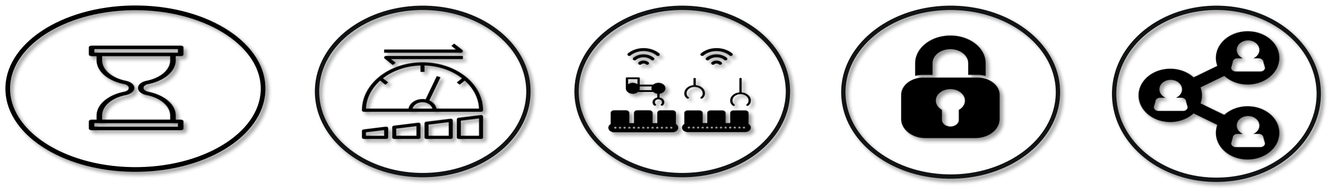
Network 2030 ?

But Transition Toward Network Edge Architecture and Computing is Happening

Where is the Edge and What is the Edge ?

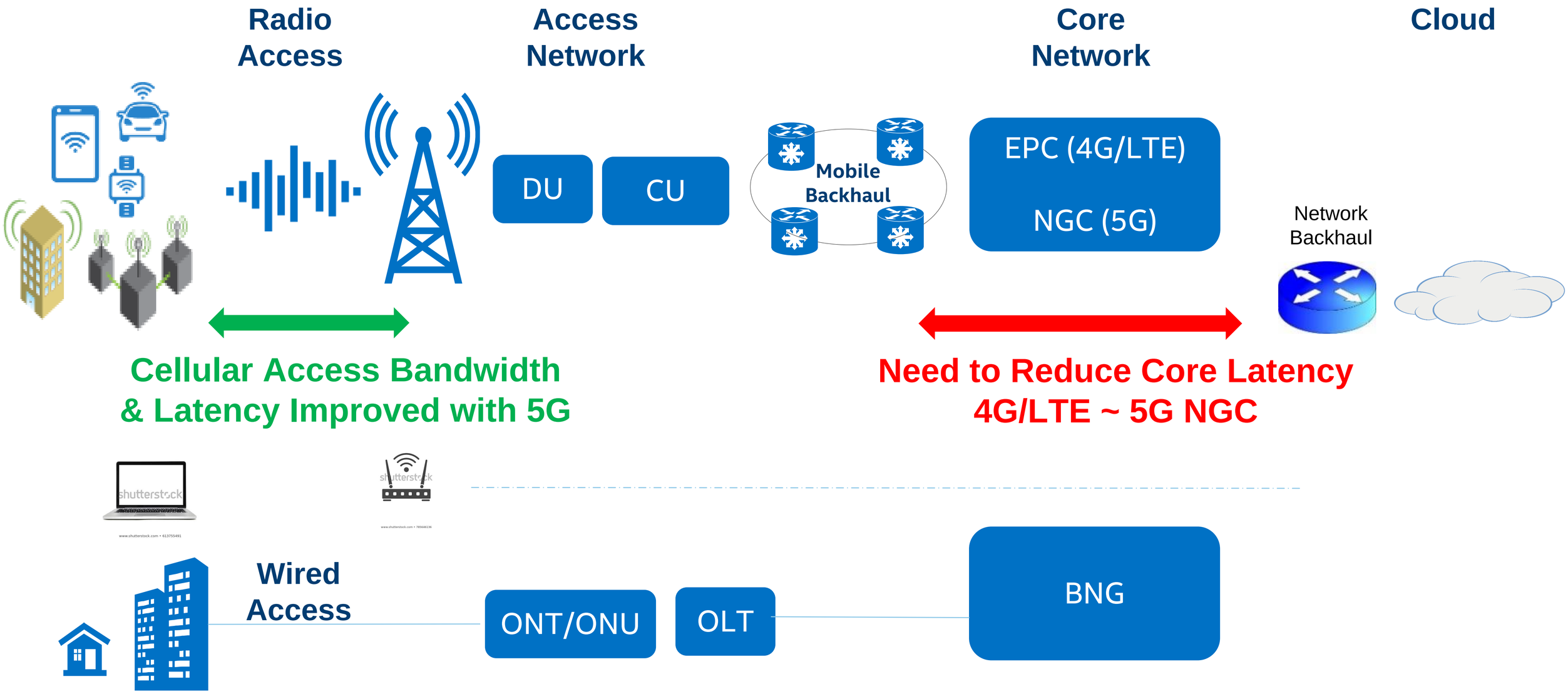


There is not “one” edge --- Different Edges from Client/Needs Point of View



LATENCY REDUCTION | RESOURCE EFFICIENCY | LOCALIZED SERVICES | PRIVACY & SECURITY | MULTI-TENANCY | ...

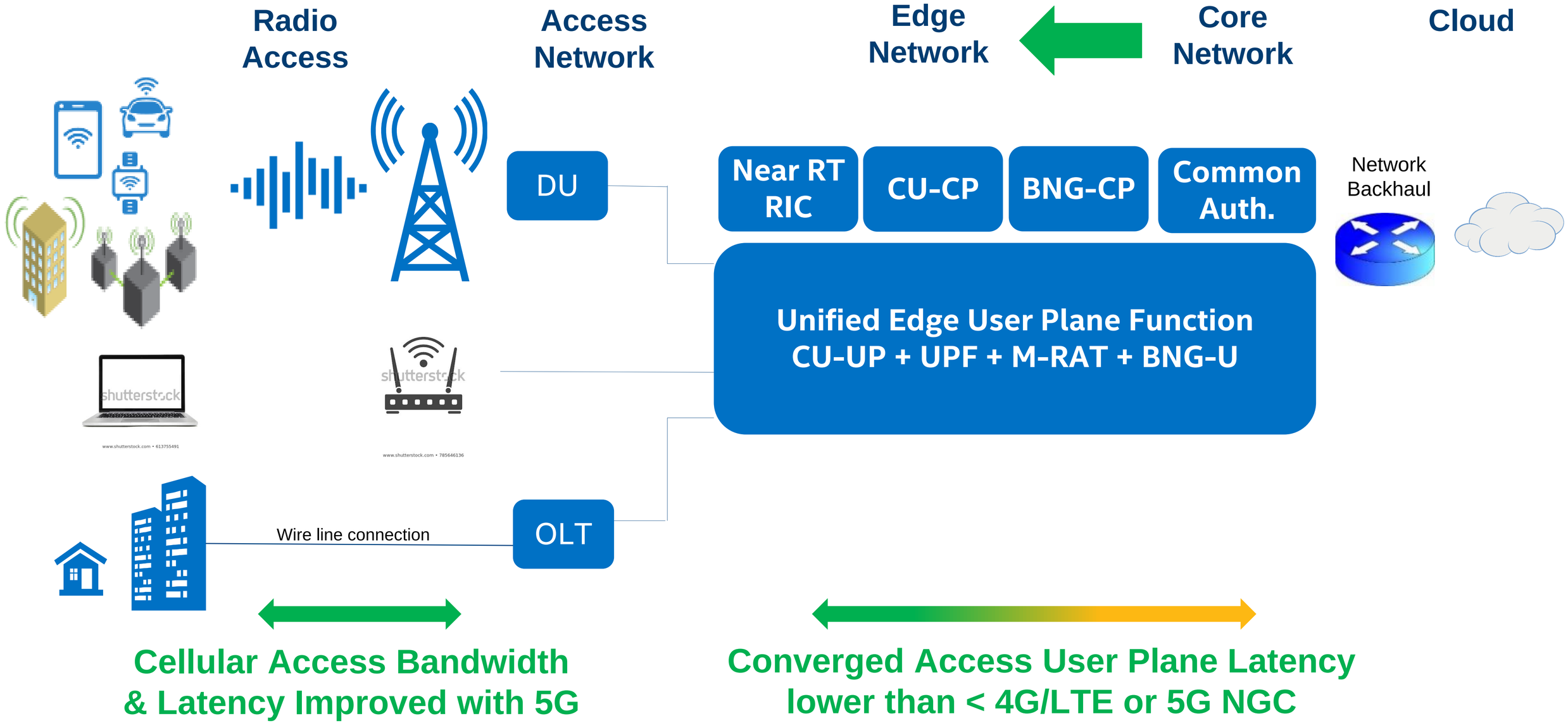
Converged Access Cores Toward the Edge (1/2)



DU: Distributed Unit (e.g. Radio Resource Head)
CU: Central Unit
EPC: Evolved Packet Core
NGC: Next Generation Core

ONT/ONU: Optical Net Terminal/Optical Net Unit
OLT: Optical Line Termination
BNG: Broadband Network Gateway

Converged Access Cores Toward the Edge (2/2)

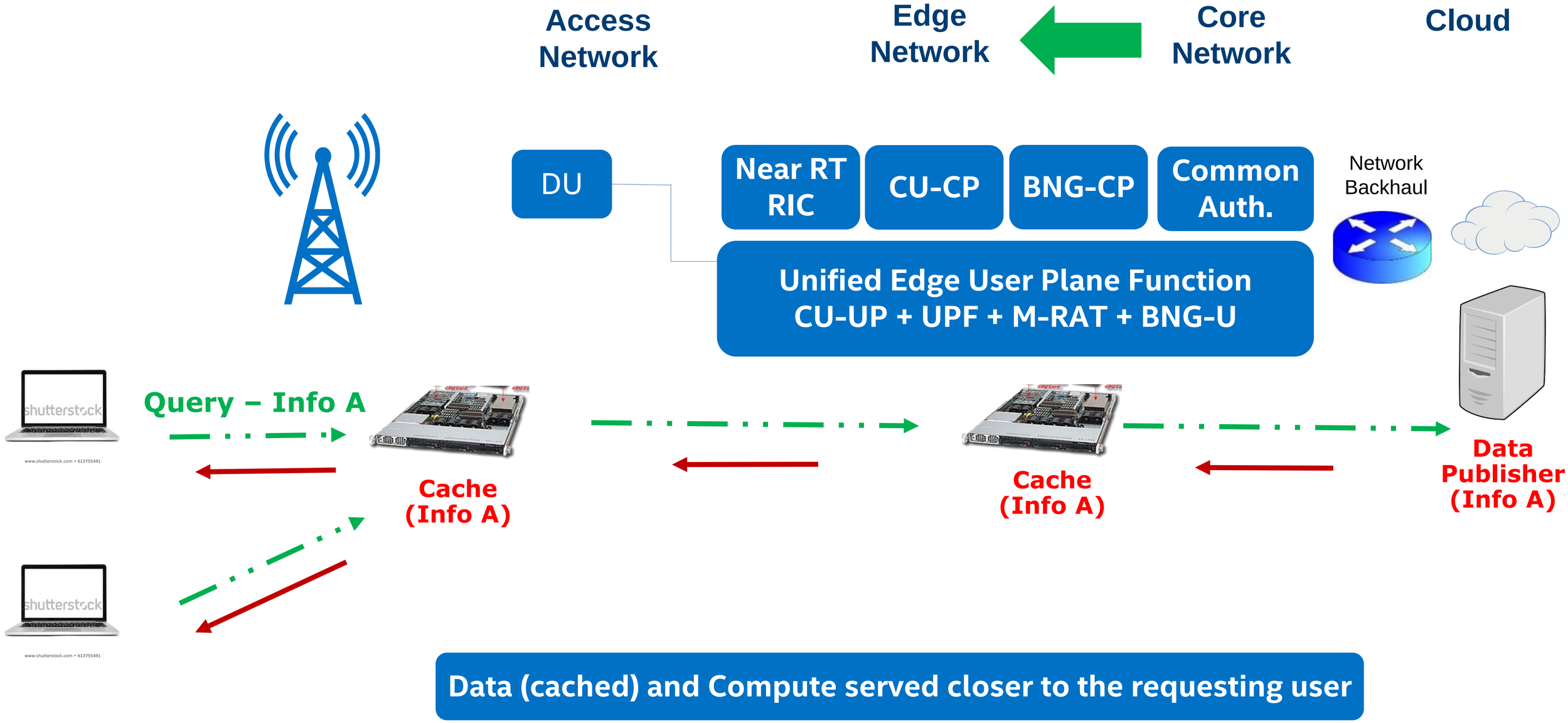


M-RAT: Multi Radio Access Technology, e.g. 5G + WiFi
CU-UP: Central Unit – User Plane

Near RT RIC: Near Real-Time RAN Intelligent Controller
CU-CP: Central Unit – Control Plane

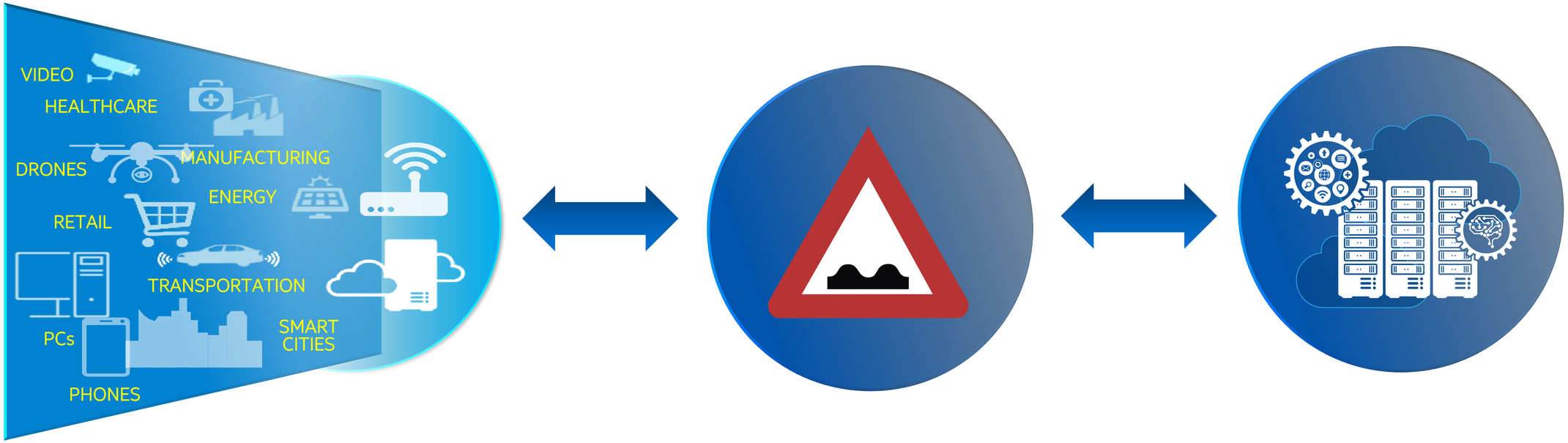
UPF: User Plane Function
BNG-U: BNG User Plane

Information Centric Network (ICN*)



*
ICN: Information Centric Netwrok (e.g. Content Centric Network)

Edge Brings a Paradigm Shift from Client-Cloud Compute Model …



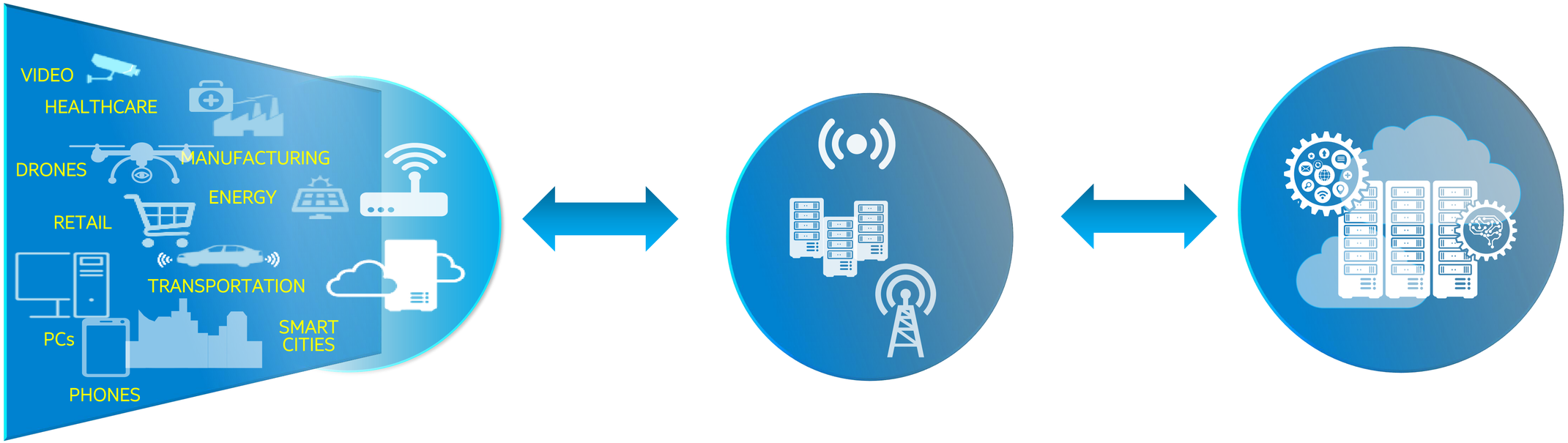
CLIENT

CONNECTIVITY

CLOUD

STATELESS APPS COMPUTE

… To Client-Edge-Cloud Compute Model



CLIENT

EDGE

CONNECTIVITY

STATEFUL APP-CENTRIC COMPUTE

STORAGE

CLOUD

Paradigm Shift Brings new set of challenges …

Client-Edge-Cloud Architecture Implications

- How does this redefine the notion of ‘correctness?
  - End-to-end, under mobility, failure, etc
- Storage introduces a whole slew of new challenges
  - Persistence, replication, availability, …
- Multi-tenancy under a constrained heterogeneous environment
- Orchestration and Management challenges
- Security and Isolation
- Robust SW frameworks needed to enable an ecosystem around this paradigm

Creating an Open End-to-End Testbed

EDGE COMMON SOFTWARE STACK

OPEN SOURCE ECOSYSTEM

- Developer Environment & Platform
- Cloud Agnostic Edge with Orchestration
- Differentiated Edge Frameworks
- Industry Standard Interfaces with Optimized Perf Libraries

NETWORK FUNCTIONS

ENTERPRISE & CLOUD CPE
(Routing, SD-WAN, Network Security, Application Delivery, Analytics)

WIRELESS ACCESS
(Basestations)

CABLE
(vCCAP & PON)

EDGE CENTRAL OFFICES
(vBNG, vEPC, CDN)

SILICON & PLATFORM TECHNOLOGIES

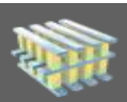
Intel® Xeon® Processor

Intel® Atom™ Processor

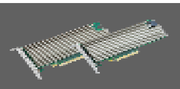
Intel® Ethernet Controller

Altera® FPGA

Intel® SSD



Intel 3D XPoint



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Intel® Quick Sync Video

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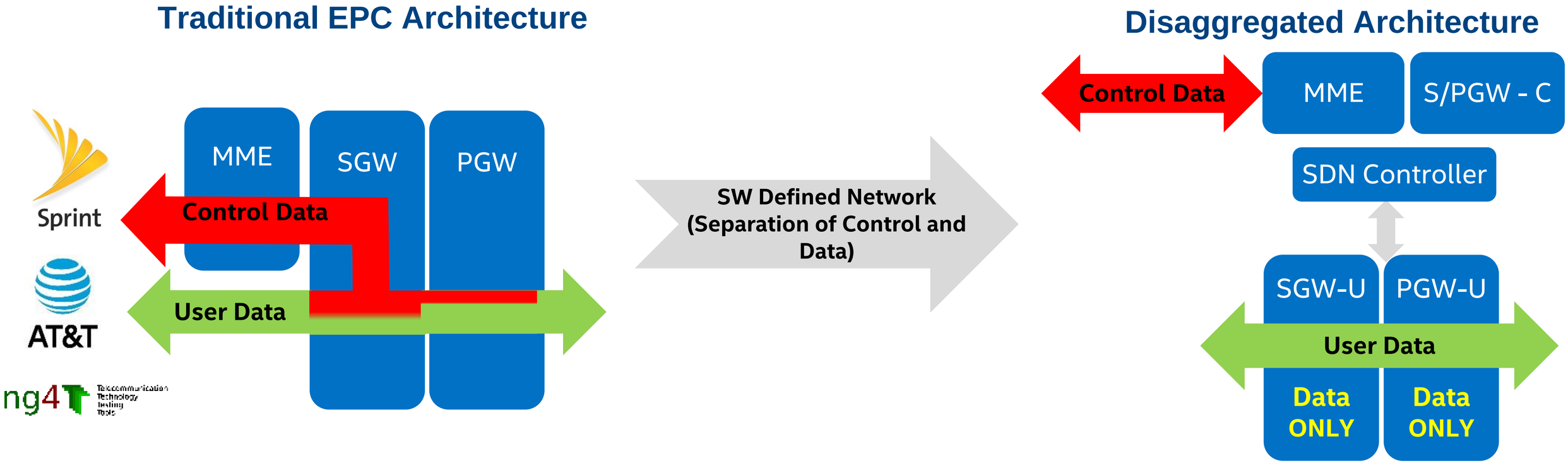
NEW ARCHITECTURES (E.G. NEUROMORPHIC)?

Next Gen Infrastructure Core (NGIC)

Wireless Infrastructure Core Disaggregation
@
Open Networking Foundation

Intel Labs

Next Generation Infrastructure Core (NGIC)



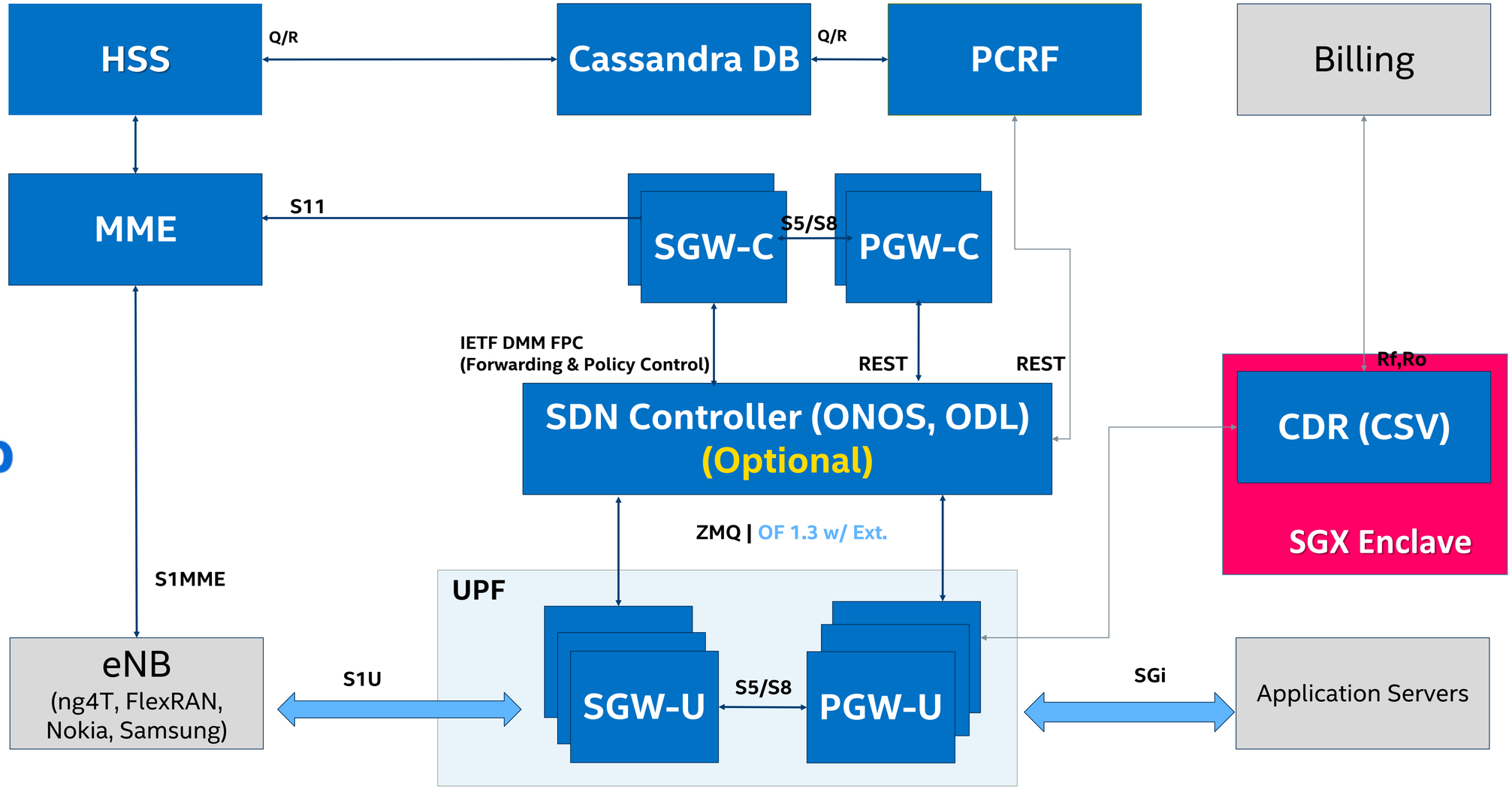
- Operators' real traffic (San Jose, Houston, Chicago, …)
- Identified system's bottleneck
  - "Understanding Bottlenecks in Virtualizing Cellular Core Network functions", IEEE LANMAN '15
- No independent control or data scaling

- SDN based architecture
- High Perf Match/Action semantic data plane
- Independent & scalable control & data
- Functional EPC per operator's requirements

NGIC

Open Source

Proprietary



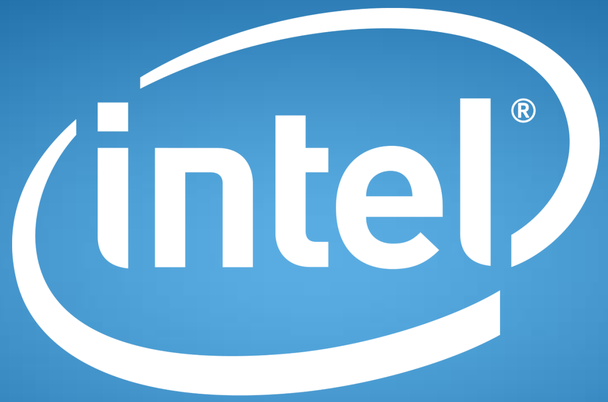
- Components operate as bare-metal, VMs or containers

NGIC is an open source reference implementation, not a product

Summary

- Network processing is moving toward the edges, needs to simulate/emulate and test the pros/cons of various approaches
- Wireless and Wired Core converging, opportunities for lower latency (and CAPEX/OPEX savings)
- ‘Edge’ demands a New Infrastructure paradigm than simply extending the Cloud
- Visual Cloud Workloads offer unique insights for system partitioning challenges
- An ‘open’ E2E testbed – a necessity for creating an Agile and Vibrant ecosystem

Thank You



experience
what's inside™