Innovations in Edge Computing and MEC

Latest in Multi-access Edge Computing, Fog Computing, Distributed Clouds

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Review of Industry Report by sdx central

Agenda

- Introduction to Edge Computing and MEC
- Why Cloud is not enough?
- Edge computing usecases: operator and 3-rd party applications
- MEC Infrastructure Ecosystem (Hardware and Software)
- Barriers to Adoption
- Edge Computing and MEC Products

Review of Industry report by SDxCentral:
https://www.sdxcentral.com/reports/mec-edge-computing-download-2017/

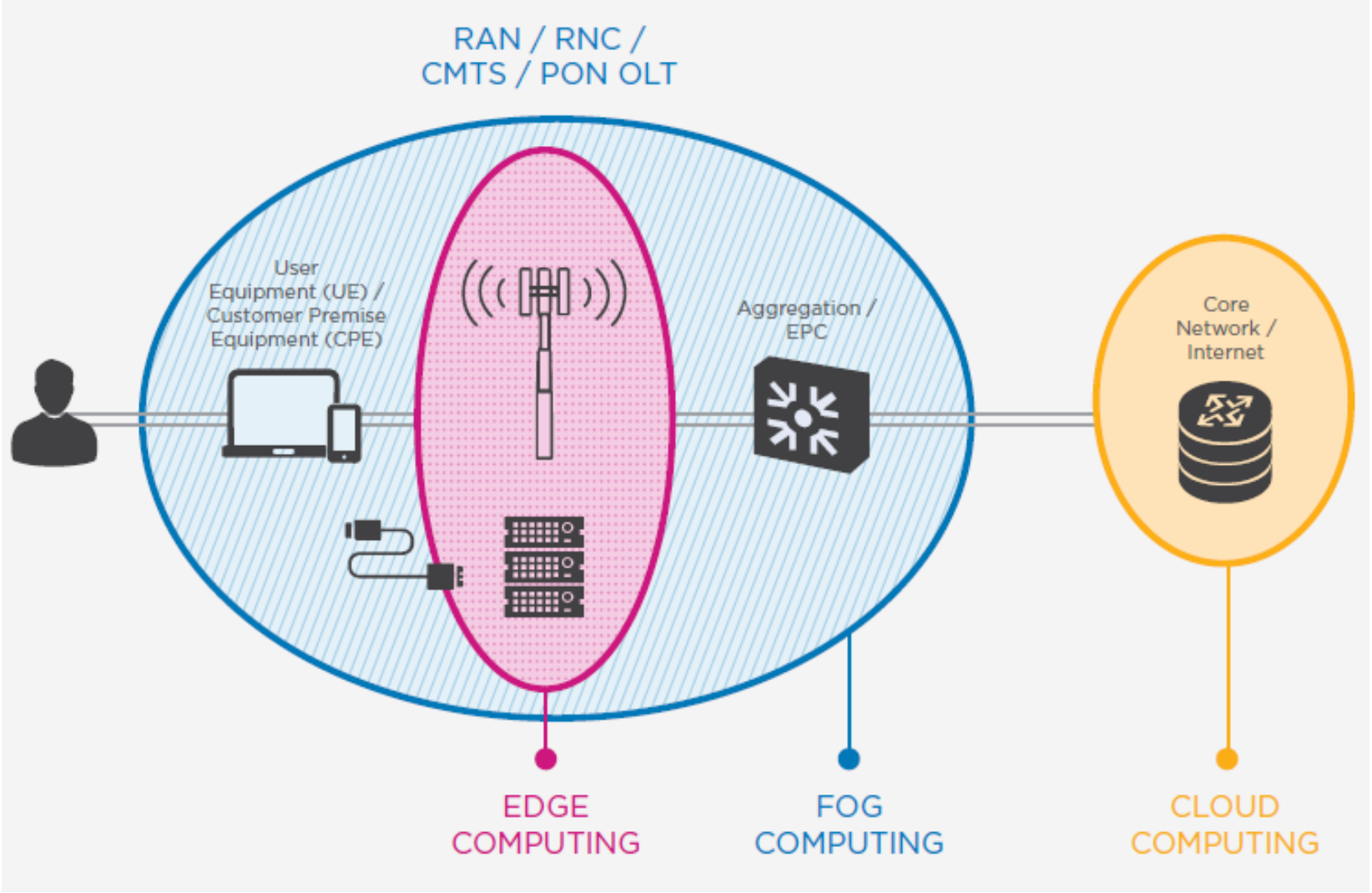
Introduction

- 5G is enabling new applications for enterprises and consumers including
  - augmented reality
  - virtual reality
  - IoT
  - autonomous vehicles and more!
- Communications service providers (CSPs) worldwide have recognized need for **compute, storage and networking infrastructure** to be placed close to the locations where these applications are consumed
- The benefits of MEC and Edge Computing
  - reduced latency,
  - improved throughput,
  - better security and isolation,
  - data reduction
  - context- and location-awareness

Definition of MEC

Radio Area Network (RAN) for LTE/5G
Radio Network Controller (RNC) for WiFi
Cable Modem Termination System (CMTS) for cable
PON OLT for fiber

- Multi-access Edge Computing (MEC), or simply edge computing, is the application of cloud architecture principles to compute, storage and networking infrastructure close to the user, at the edge of a network.
- Edge computing is typically located at the access point, *one hop away from the user*.
- Fog computing is a superset of edge computing, and *essentially includes everything that is not a cloud.*



Why cloud computing is not adequate for all requirements?

1. **Latency**: Edge can provide latency in milliseconds (compare CDNs in 50-150ms range)

2. **High throughput**: Throughput available to the user from the edge, served via cached or locally generated content

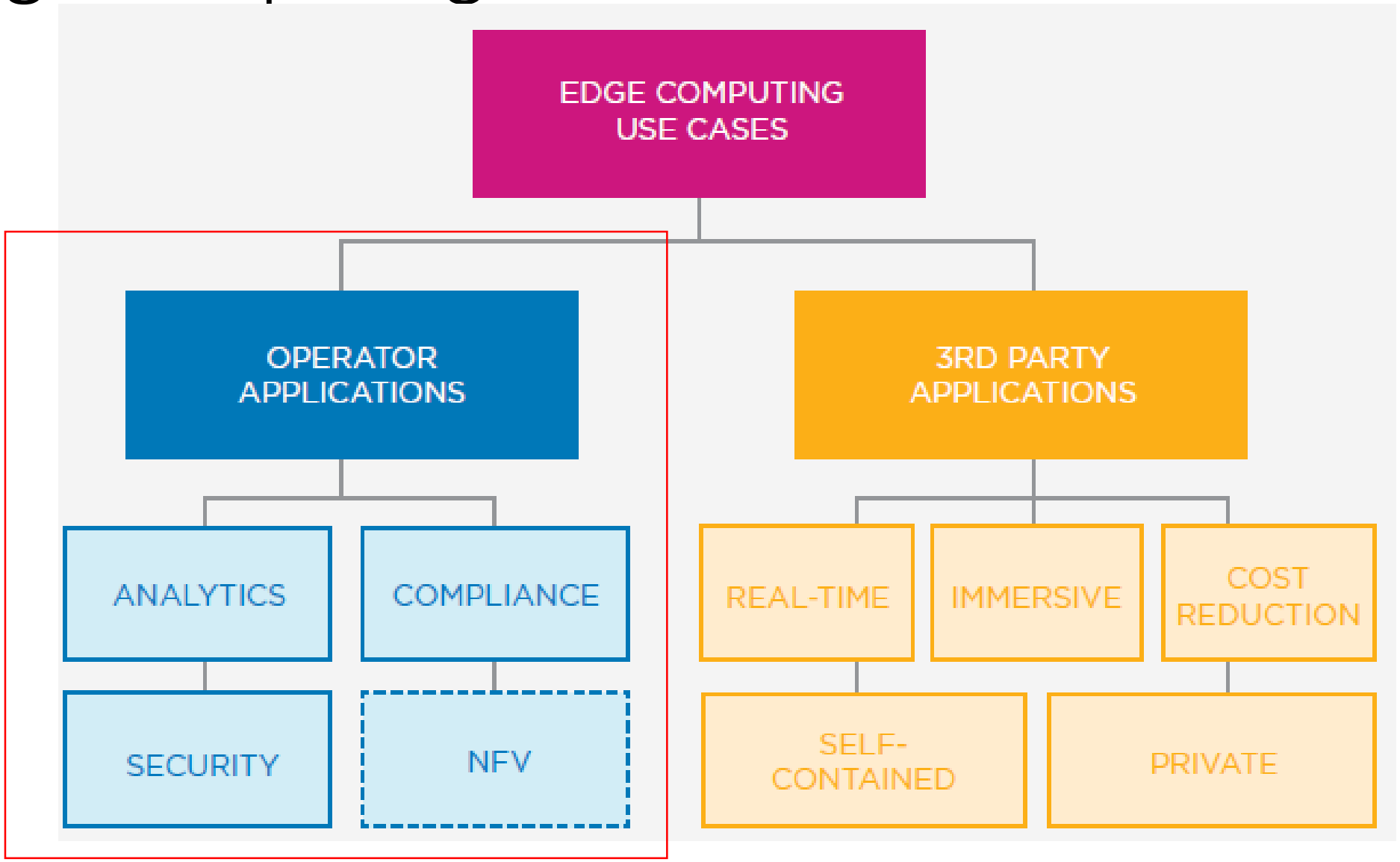
3. **Data reduction**: By running applications such as data analytics at the edge, operators and application vendors can substantially cut down the amount of data that has to be sent upstream -> **cost reduction**

4. **Context awareness**: Edge has access to radio network, user and location information that is provided by RAN. This information can be used by edge applications

5. **Security**: CSPs can protect their networks against attacks from user equipment (UE) or customer premise equipment (CPE) using edge security applications

6. **Isolation**: A number of environments are not always connected to the Internet over high speed links. An edge cloud is able to provide services during periods of degraded or lost connections -> **disaster resilience**

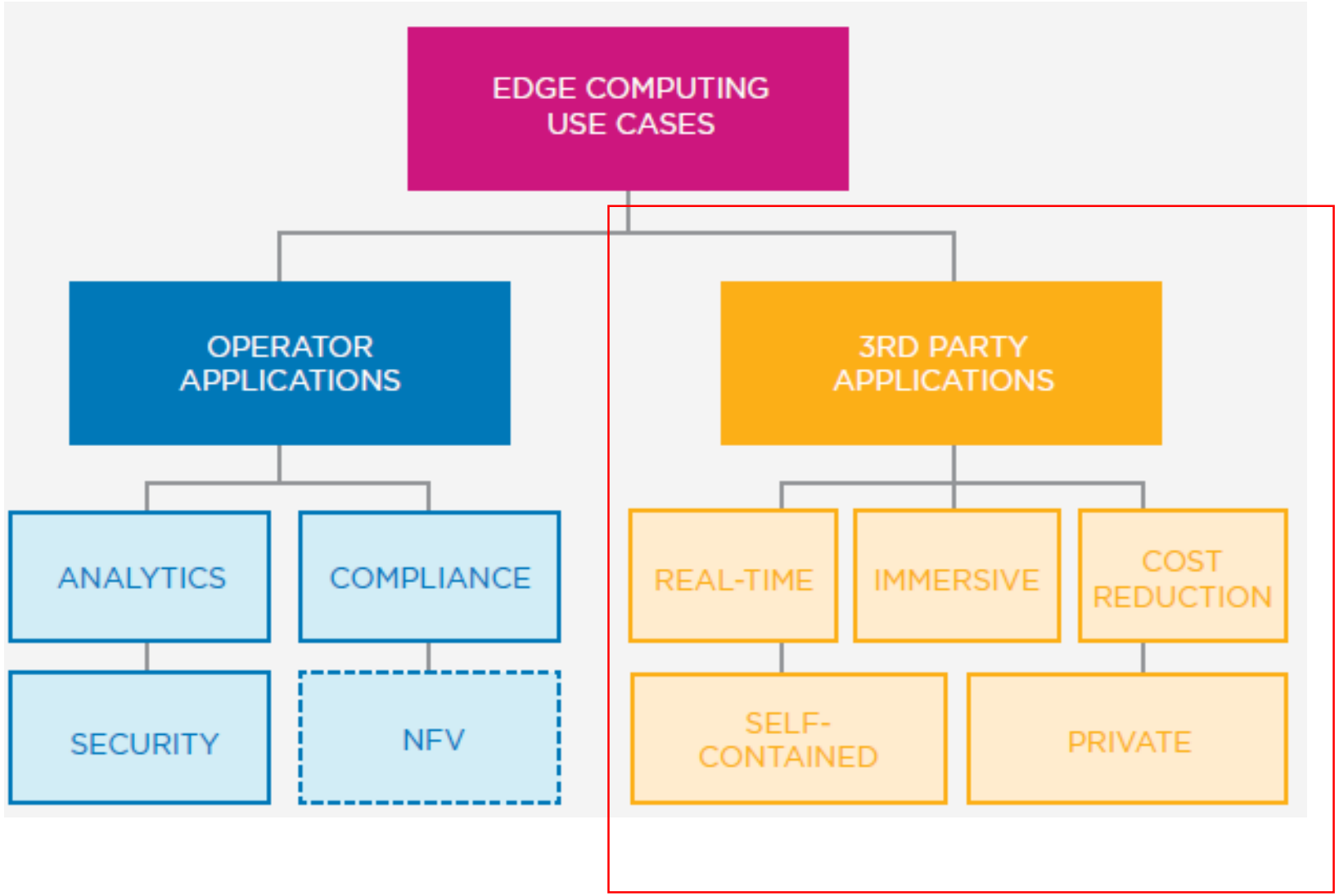
Edge computing usecases



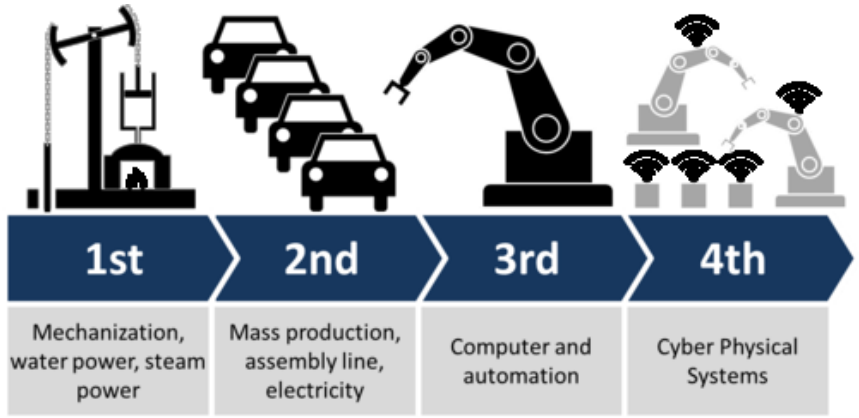
Operator Applications

- **Analytics**: Edge collects a large amount of data about users, network conditions, local context, consumer behavior etc. that can be invaluable to *automation, big data applications, machine learning* etc.
- **Compliance:** ranges from *copyright enforcement to geographical data placement*. Copyright enforcement comes in play during concerts, plays, sports events etc. where an audience member does not have the rights to transmit the event video via their cell phone. An edge application could either disable the upstream transmission completely or reduce the resolution to make the transmission compliant.
- **Security**: Edge computing allows for applications such as DDOS and cyber security to prevent these types of attacks, and moves the security perimeter closer to the source.
- **NFV:** Network Functional Virtualization (NFV) is not an edge application, strictly speaking. However, access virtual network functions (VNFs) such as vRAN, C-RAN, vCMTS, vOLT need to run at the same location as edge computing.

Edge computing usecases

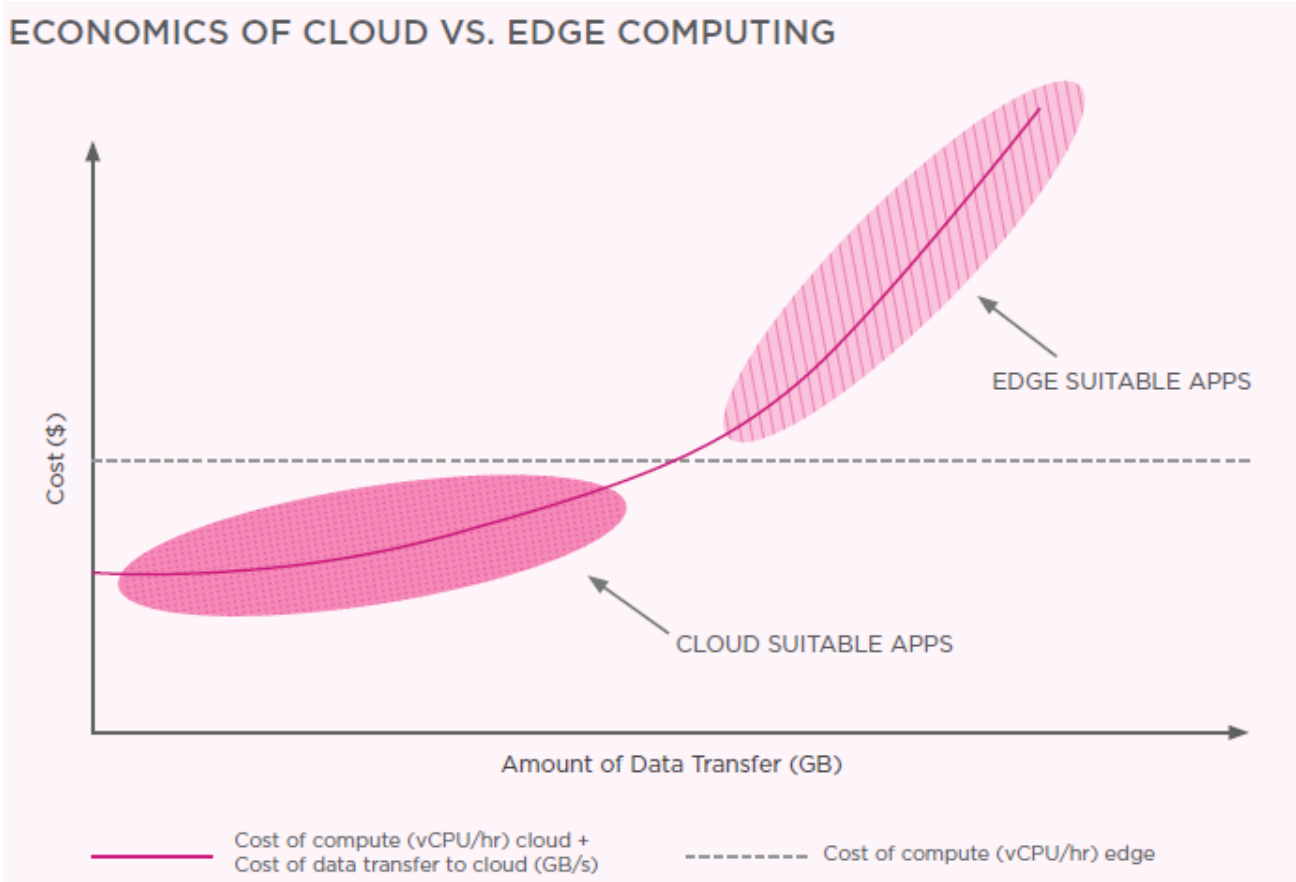


3-rd Party Applications



- **Real-time**
  - Increasing number of applications are real-time in nature and cannot tolerate *latency* more than in the order of 10's of milliseconds.
  - Applications are also sensitive to *jitter* (the variation in latency).
  - AR/VR, connected cars, tactile internet, *Industry 4.0* and smart cities.
- **Immersive**
  - Bandwidth available from the MEC to the UE/CPE will create a wide range of new immersive applications.
  - Premium HD, 360° and 4K video can be cached and optimized at the edge.
  - Network level metrics (round-trip-delay, packet loss, etc.) can improve by 30-60%.

3-rd Party Applications



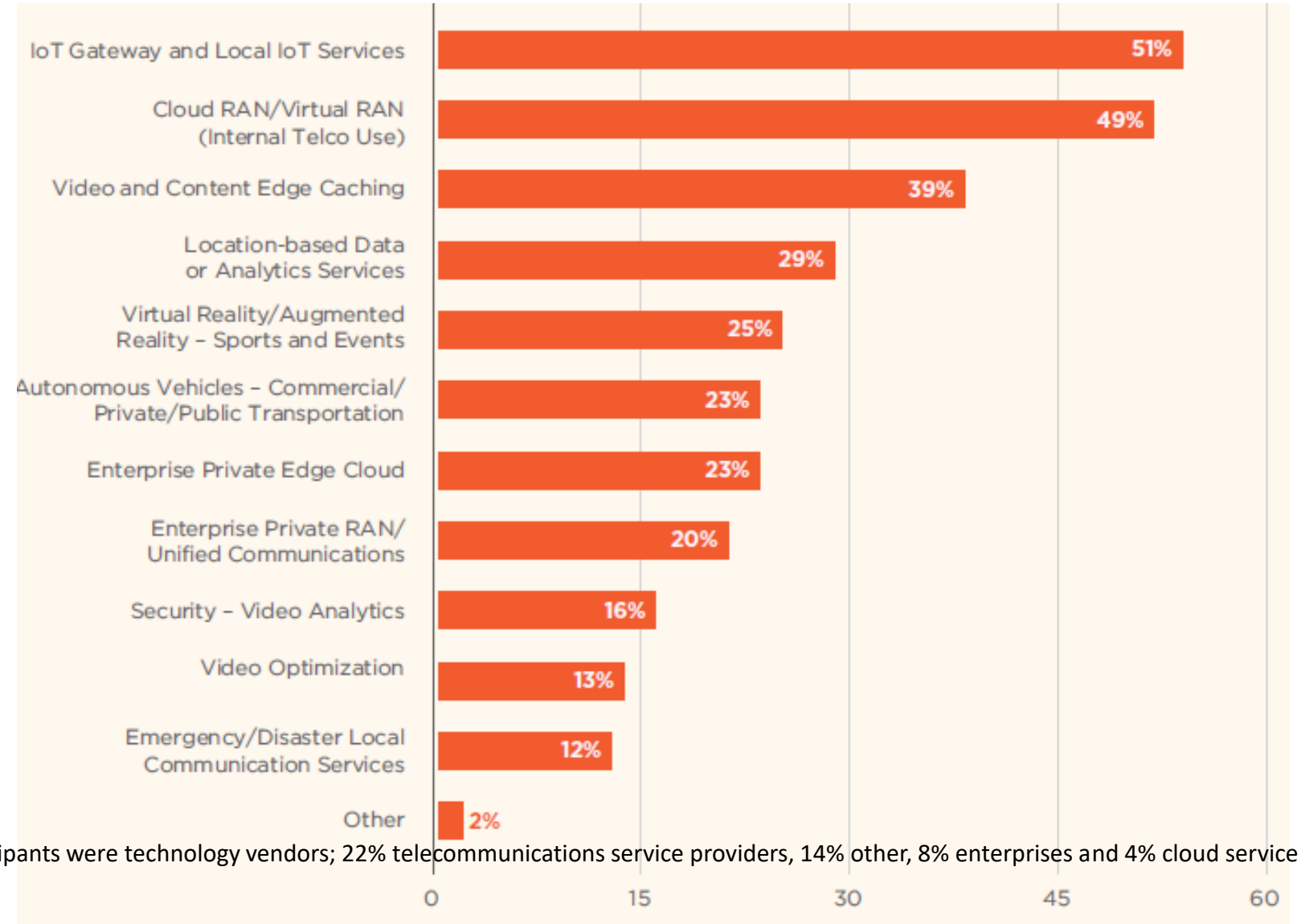
Cost reduction

- Video surveillance, face recognition, vehicle number plate recognition, IoT gateway, big-data analytics.
- For example, in video surveillance, it would be exorbitantly expensive to send all video feeds from all cameras to the cloud. Instead, Edge can perform motion detection and threat recognition to send only relevant frames to the cloud.
- In an IoT gateway, where even though the bandwidth may not be high, sending billions of events to the cloud would be expensive and inefficient vs. handling them at the edge with an IoT gateway.

3-rd Party Applications

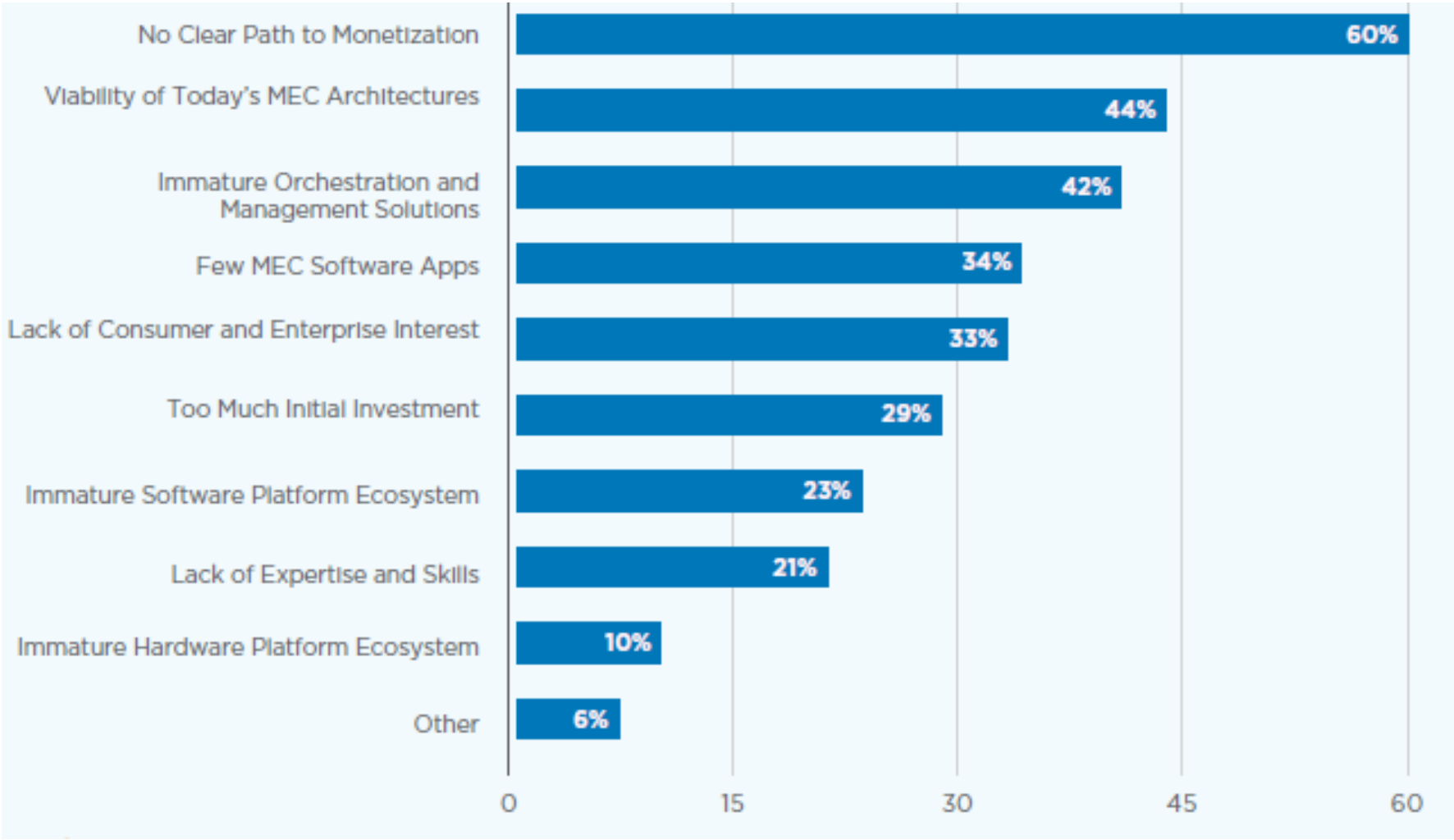
- **Self-contained**
  - Cruise ships, planes, mines, farms, oil rigs, trains, pipelines, wind farms, solar power plants, electric grids etc.
  - Flights offering movies over WiFi is an early example of this use case. Data from these locations could ultimately be synchronized with the cloud when connectivity is available, e.g. when a ship docks or a plane lands.
  - Stadiums, concerts, airports, places of worship, universities and smart buildings where the edge can offer local services. For example, an edge application could allow stadium viewers to watch a game from numerous perspectives and offer them personalized high-definition content without burdening upstream/backhaul bandwidth. It would be impractical to do this from the cloud.
- **Private** (Enterprise usecases)
  - If an enterprise wants to provide connectivity directly from the RAN to the enterprise for security reasons, the edge provides an excellent platform.
  - The edge, especially when it includes vCPE, is also an excellent location to provide branch connectivity and other enterprise services.
  - Privacy may also be addressed by other third-party applications such as medical applications that need to anonymize personal health information (PHI) before sending it to the cloud.

Key Edge Computing and MEC Usecases



52% of the survey participants were technology vendors; 22% telecommunications service providers, 14% other, 8% enterprises and 4% cloud service providers

Barriers to Adoption



Edge Computing and MEC Infrastructure Ecosystem

- Hardware
  - **Universal customer premises equipment** (uCPE): With VNFs and edge services running at a customer premise, devices such as uCPE, that offer a certain amount of compute, possibly storage and different network connections are likely to get popular.
  - **Edge compute nodes**: A new breed of ruggedized servers and server chambers are emerging that will be co-located with the radio e.g. eNodeB.
  - **Servers optimized for the central office**: Several vendors are targeting a CORD or virtual central office (VCO) with optimized servers (see OCP below).
  - **Micro data centers and Micro-Modular data center**: A smart city could require a location next to a highway as the edge; examples such as these will require micro datacenters (< 100kW, < 20 racks) in a wide range of locations.
  - **Data plane acceleration**: Edge will have to be extremely efficient given the fixed and limited amount of real-estate available. For this reason, data plane acceleration ranging from SmartNICs, GPGPU for machine learning and FPGA accelerators will gain popularity.

Edge Computing and MEC Infrastructure Ecosystem

- Software
  - **Analytics software**: Given the hierarchical and autonomous architecture of the edge, a variety of analytics solutions will be required all the way from the edge to a central location
  - **Management and orchestration**: Comprehensive management and orchestration solutions will be required to manage a very large number of edge compute instances. If these locations need NFV as well, an interesting trend to watch might be the convergence of edge application management and orchestration with ETSI NFV MANO (management and orchestration) platforms
  - **Security**: We expect a variety of security software solutions to emerge
  - **Edge node software**: Software that powers clouds may be too heavy for the edge. We expect innovations that will extract maximum efficiency out of the edge platform
  - **Application hierarchy management**: Applications will span multiple tiers, all the way from on-premise to the cloud. Application developers will need tools to distribute their application across different locations based on latency, performance, cost and other parameters

Edge Computing and MEC Products

- **Intel**
  - Intel Network Edge Virtualization (NEV) SDK is the first kit of its kind to provide an NFV platform targeted for Mobile-Edge Computing application and services
  - NEV SDK includes an Intel Atom or Intel Xeon processor-based server that is fully configurable with real time virtualization software
  - Intel's Edge Computing reference libraries for directing radio traffic information to the virtual machines
- **Nokia**
  - Nokia Multi-access Edge Computing (MEC) platform takes full advantage of the telco cloud, enabling new possibilities to serve the operator's radio network and to coexist with our other VNFs
- **Vasona**
  - The software-based architecture enables MEC deployments
  - *Provides APIs* to let third-party application developers access RAN characteristics and traffic functions, such as details about real-time cell congestion conditions for MEC deployments that span IoT, streaming video and more

Edge Computing and MEC Products

- **Ericsson**
  - Ericsson SSR 8000 family of Smart Services Routers, provides operators with a highly scalable, consolidated platform that offers services for both fixed and mobile network infrastructure
  - It offers services such as IP/MPLS edge routing and Evolved Packet Gateway functionalities
- **HPE**
  - HPE Intelligent Edgeline portfolio enables organizations to extract business value from the massive amounts of data produced in a plant, branch office, retail outlet, or Internet of Things (IoT) edge
  - Edgeline EL1000 provides edge compute, precision data capture and control, data center-class security, device and systems management, and large storage capabilities in one converged box
- **Huawei**
  - Huawei CloudEdge is a mobile broadband (MBB) solution developed based on Network Functions Virtualization (NFV), service oriented architecture (SOA), and cloud architecture

Edge Computing and MEC Products

- **Dell EMC**
  - micro Modular Data Centers (MDCs) for service providers who want to enable edge computing
  - Dell EMC micro MDCs are small, nimble datacenters that are pre-integrated with compute, storage, networking, power & cooling and even IoT gateways
  - Dell EMC micro MDCs can be placed virtually anywhere in the world to speed the analysis of local data while providing rapid installation and quick time to value
- **Saguna**
  - The Open-RAN product is a SW solution which is optimized for High performance and low latency.
  - a 1RU entry level server, 20Gbps throughput, less then 400 microseconds latency
  - A full Mobile Edge Platform manager to dynamically automate the whole lifecycle management of the deployed applications
- **ASOCA**
  - The vBS transforms all layers and functions of the traditional base-station from proprietary hardware to software virtualized on standard COTS servers
  - An open and interoperable platform that allows for dynamic and automated capacity allocation, capacity additions via software configuration and a 5G -ready platform

Summary

- Cloud is not adequate for many existing and emerging applications
- Adoption towards MEC (architecture, monetarization, hardware, software) is not figured out yet
- MEC provides more data to be analyzed, more decisions to be made and new research problems to be solved

Thanks!