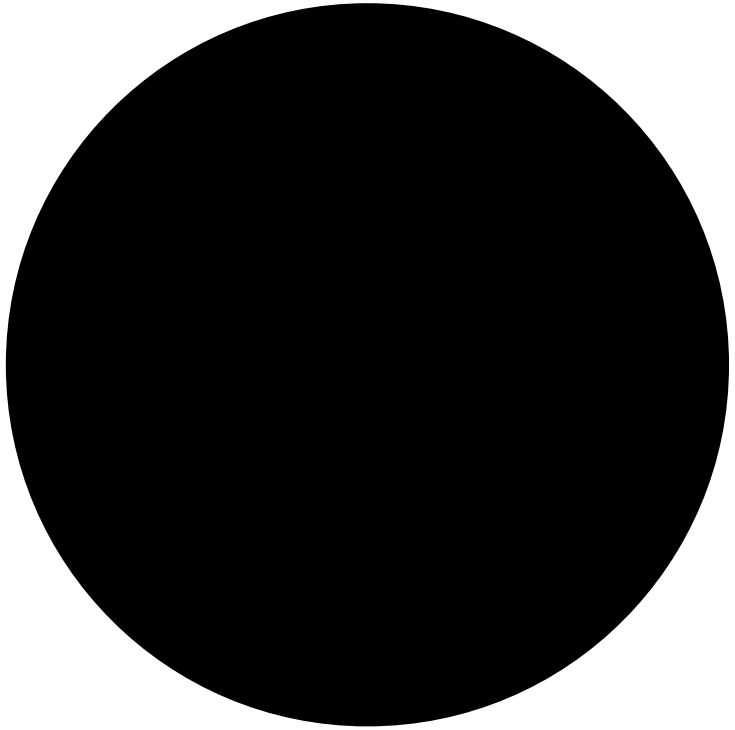
Understanding mobile service usage and user behavior pattern for MEC Resource Management (assignment, scaling, and migration)



Sabidur Rahman

Friday group meeting

Netlab, UC Davis

Jan 26, 2018

Overview

Application usage pattern in Mobile Network

C. Marquez, M. Gramaglia, M. Fiore, A. Banchs, C. Ziemlicki, Z. Smoreda. “Not All Apps Are Created Equal: Analysis of Spatiotemporal Heterogeneity in Nationwide Mobile Service Usage.” CoNEXT, 2017.

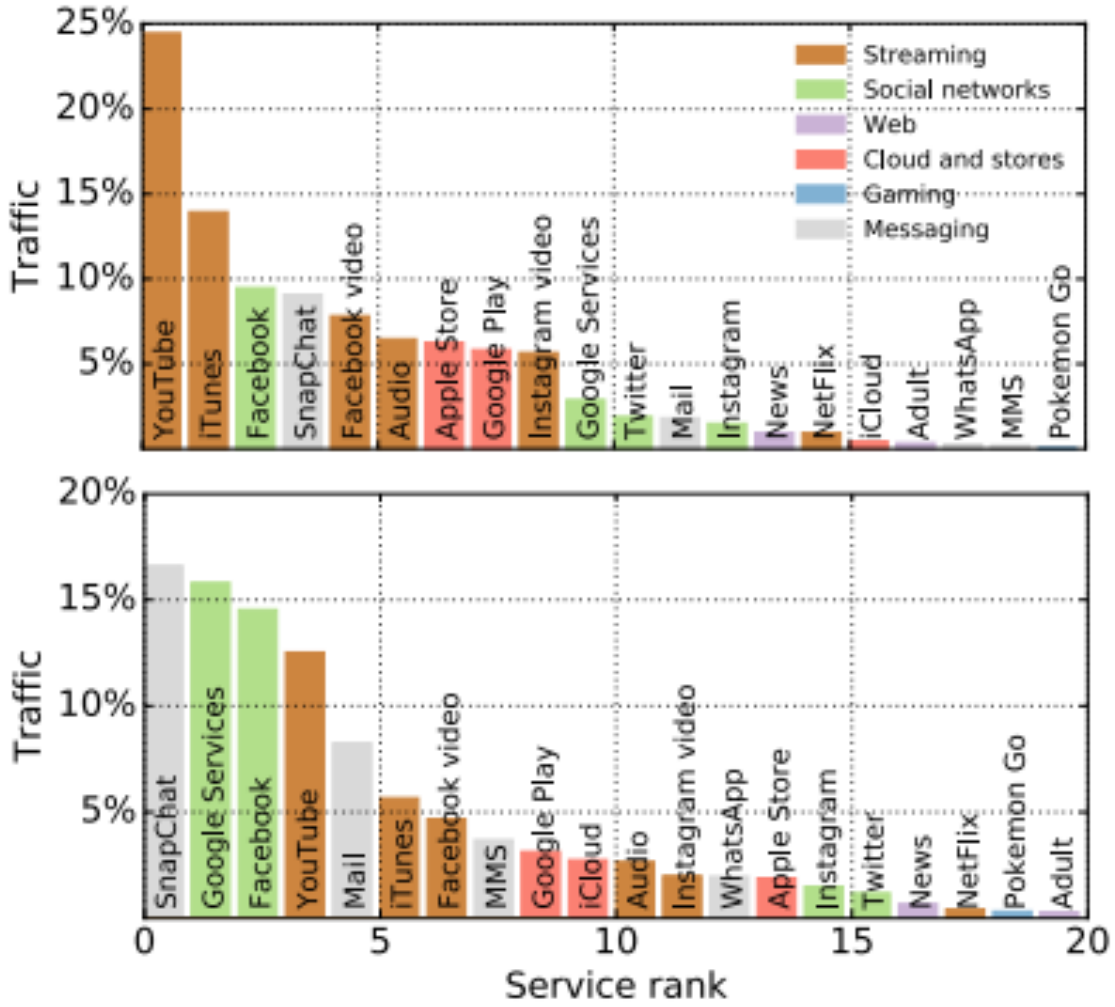
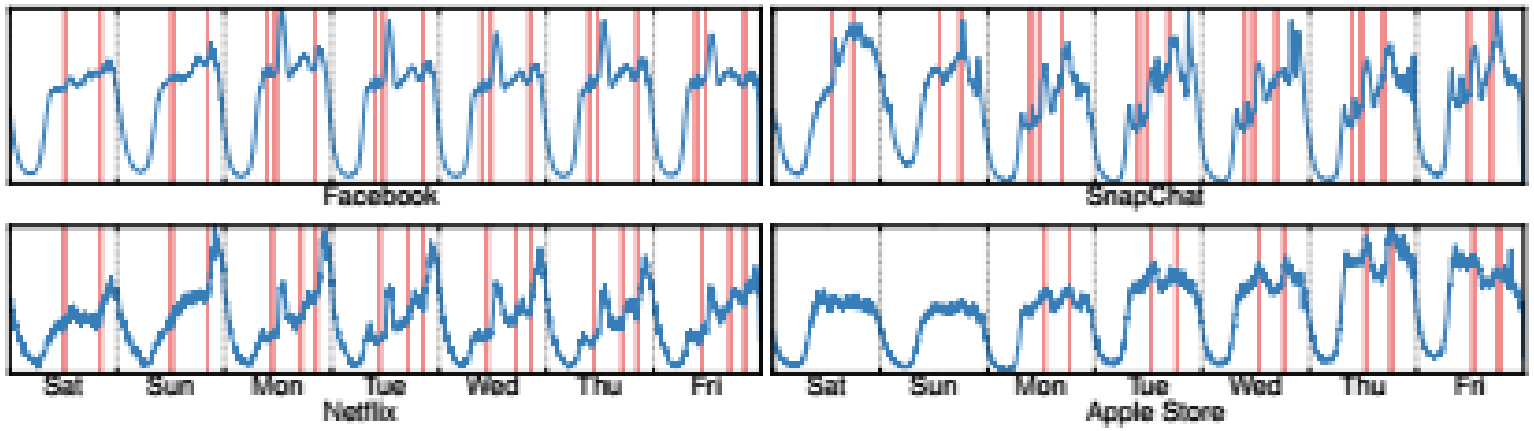


Figure 3: Selected mobile services, ranked on downlink (top) and uplink (bottom) traffic volume.

C. Marquez, M. Gramaglia, M. Fiore, A. Banchs, C. Ziemlicki, Z. Smoreda. “Not All Apps Are Created Equal: Analysis of Spatiotemporal Heterogeneity in Nationwide Mobile Service Usage.” CoNEXT, 2017.

Temporal Effect (which service/App at what time?)



Activity peak detected in sample time series.

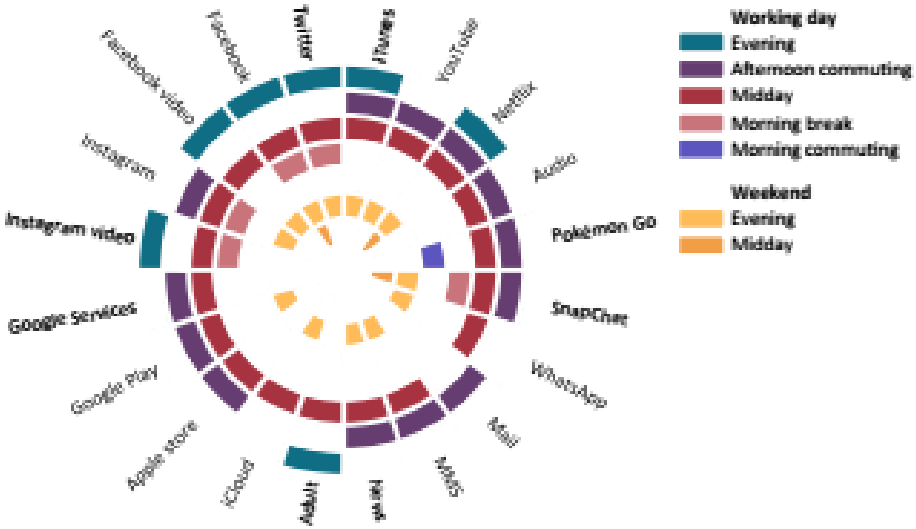


Figure 6: Activity peak times of mobile services.

C. Marquez, M. Gramaglia, M. Fiore, A. Banchs, C. Ziemlicki, Z. Smoreda. “Not All Apps Are Created Equal: Analysis of Spatiotemporal Heterogeneity in Nationwide Mobile Service Usage.” CoNEXT, 2017.

Spatial Effect (which service/App where?)

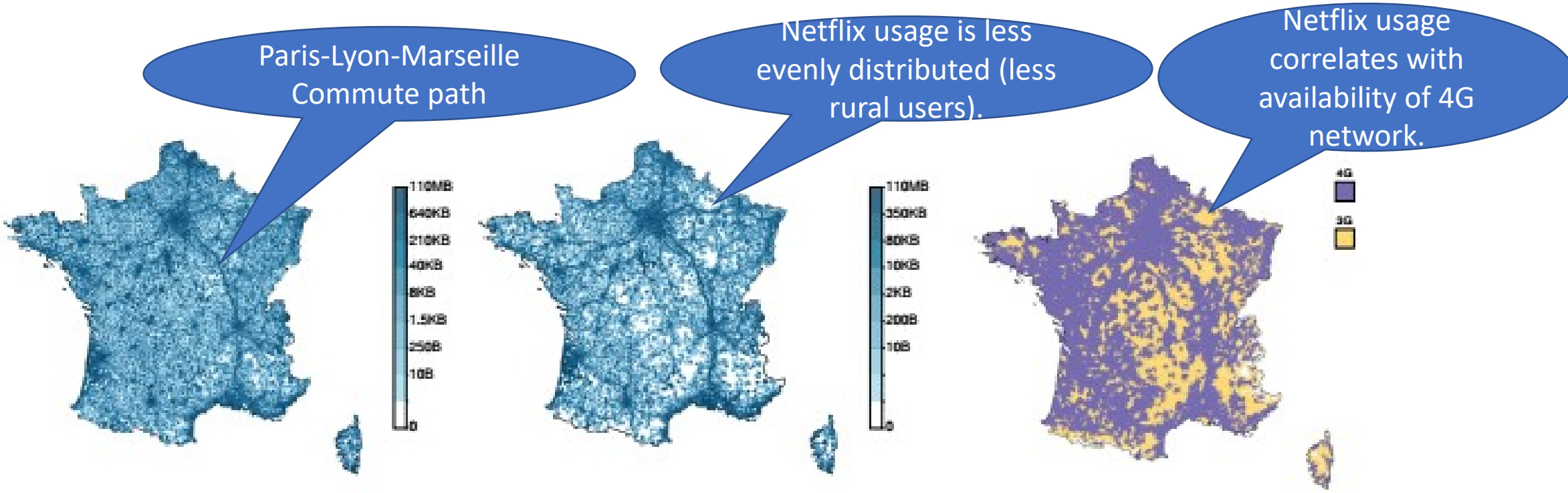


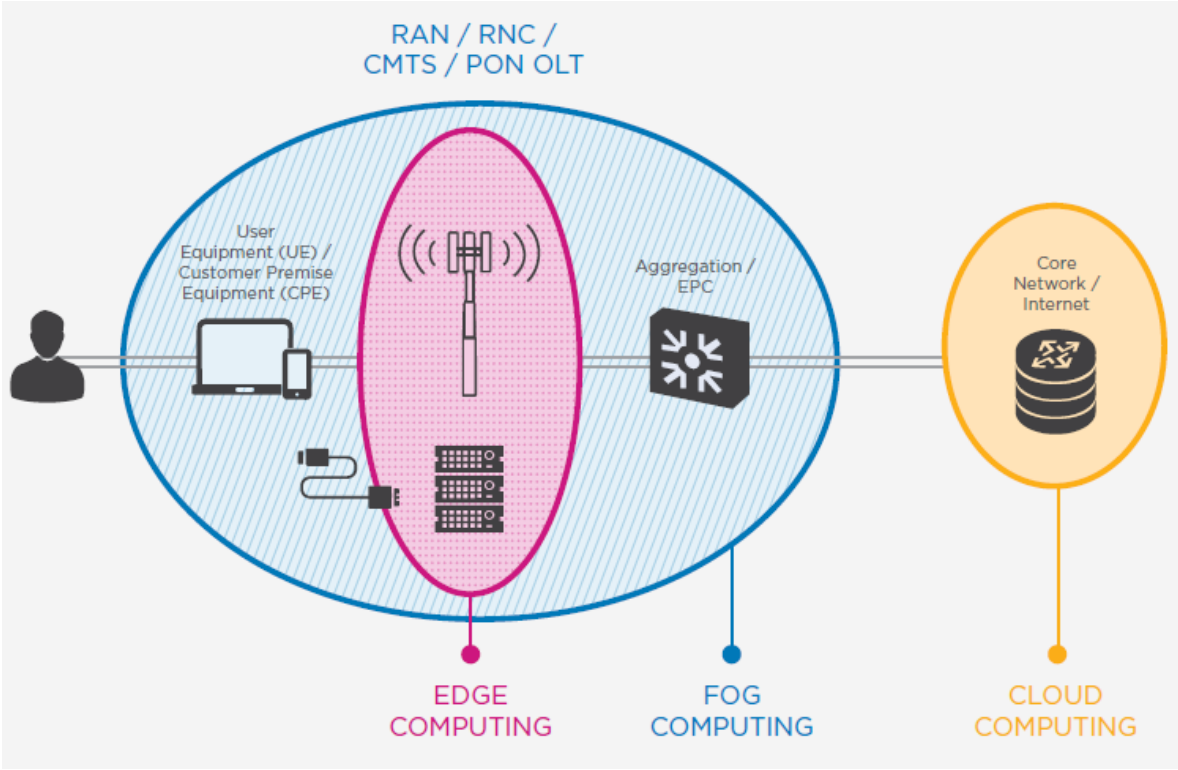
Figure 9: Maps of the average per-subscriber activity for downlink Twitter (left), Netflix (middle). Coverage of Orange 3G and 4G cellular technologies in France (right).

User behavior -> Resource Management in Mobile Edge Computing

What is MEC?

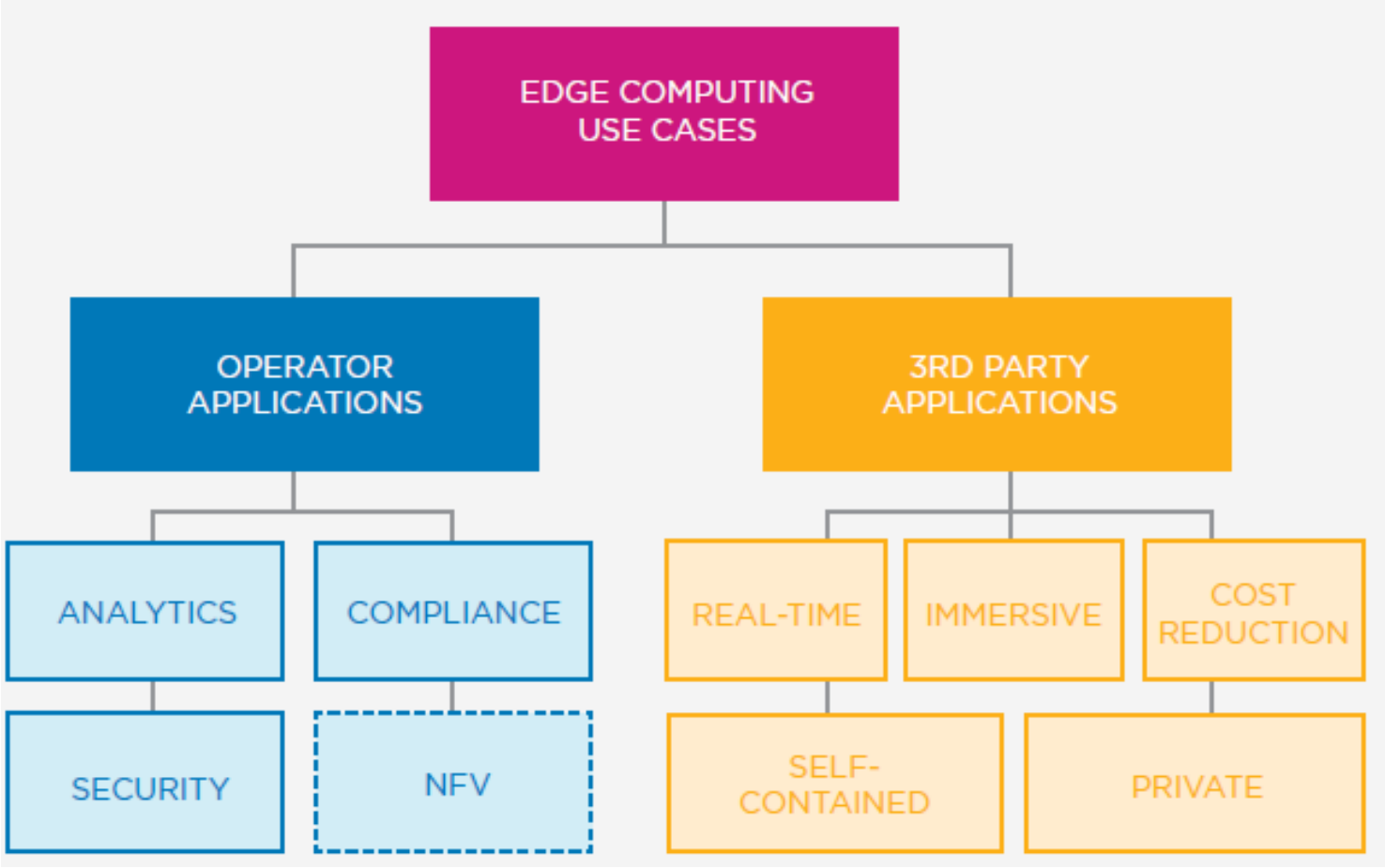
- Multi-access/Mobile Edge Computing (MEC), or simply edge computing, is the application of cloud architecture principles to compute, storage and networking infrastructure close to the user, at the edge of a network.
- Edge computing is typically located at the access point, *one hop away from the user*.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

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



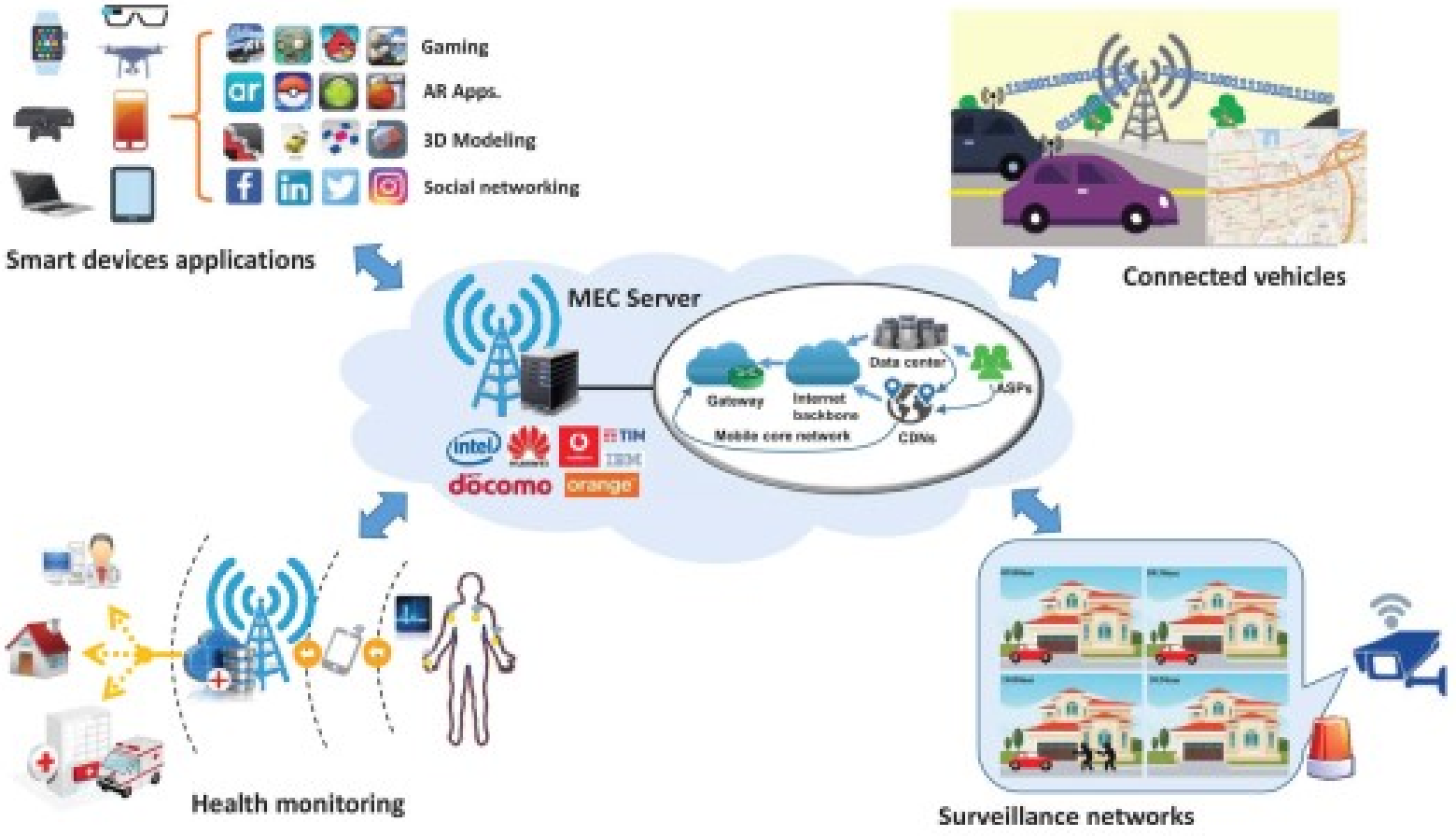
Review of Industry report by SDxCentral:
https://www.sdxcentral.com/reports/mec-edge-computing-download-2017/

Edge Computing Usecases



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

Architecture of MEC system



Y. Mao, C. You, J. Zhang, K. Huang, K. B. Letaief, “A survey on mobile edge computing: The communication perspective.” IEEE Communications Surveys & Tutorials. Aug 2017

Central office re-architected as a data center (CORD)

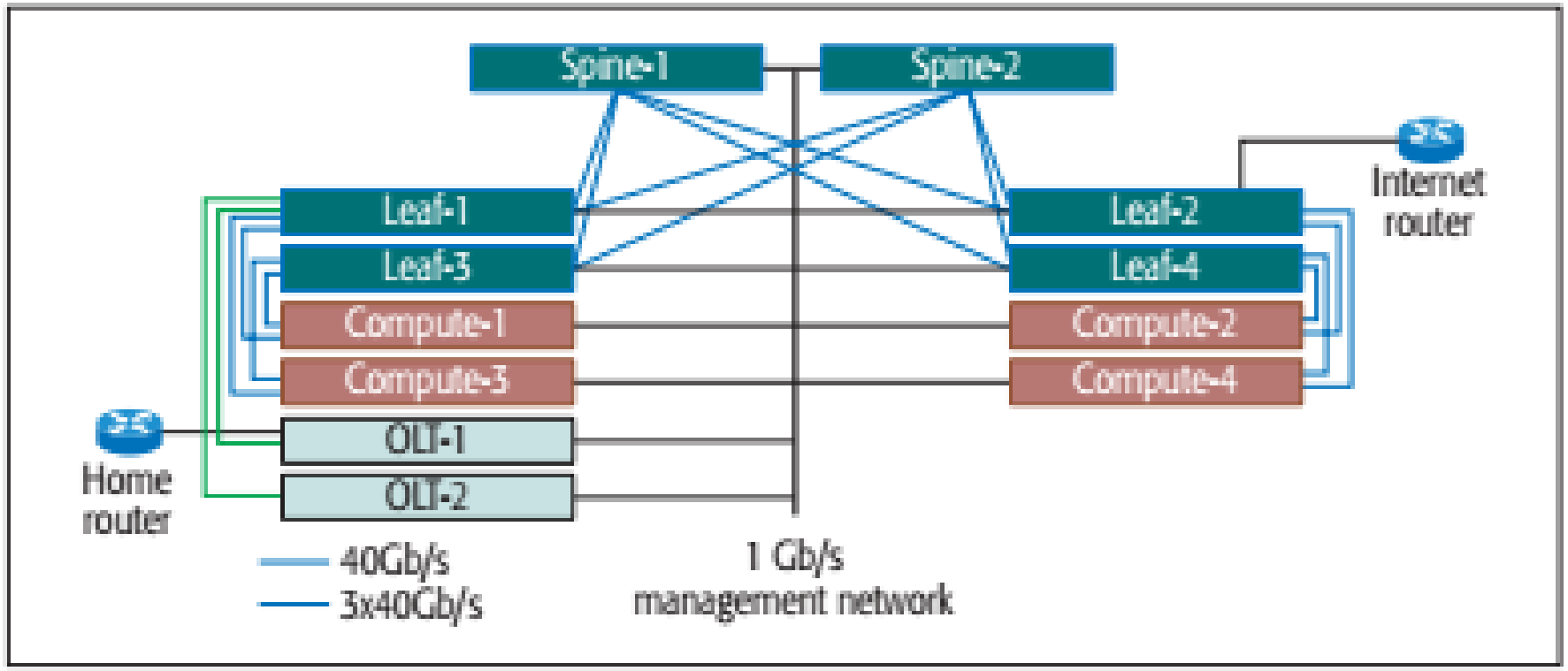


Figure 1. Target hardware POD built from commodity servers, I/O blades, and switches.

L. Peterson, A. Al-Shabibi, T. Anshutz, S. Baker, A. Bavier, S. Das, J. Hart, G. Palukar, and W. Snow. "Central office re-architected as a data center," *IEEE Commun. Magazine*, vol. 54, no. 10, pp. 96-101, Oct. 2016

MEC Resource Management Problem

- **Placement/Allocation Problem:** For an incoming/expected service load (from user) how to decide where to serve/place the request?
- **Scaling Problem:** How to scale resources (CPU/MEM/Network) when load goes up/down?
- **Migration Problem:** How to migrate contents/VMs when user location changes?
- **Constraints to consider:** Limited hardware (CPU/Mem/Network) resources, Latency, User priority class.
- Understanding of user behavior/usage-pattern helps. For example, if Netflix is used less during office hours and Twitter/Fb/Youtube used more. Does that help in Mobile resource allocation?

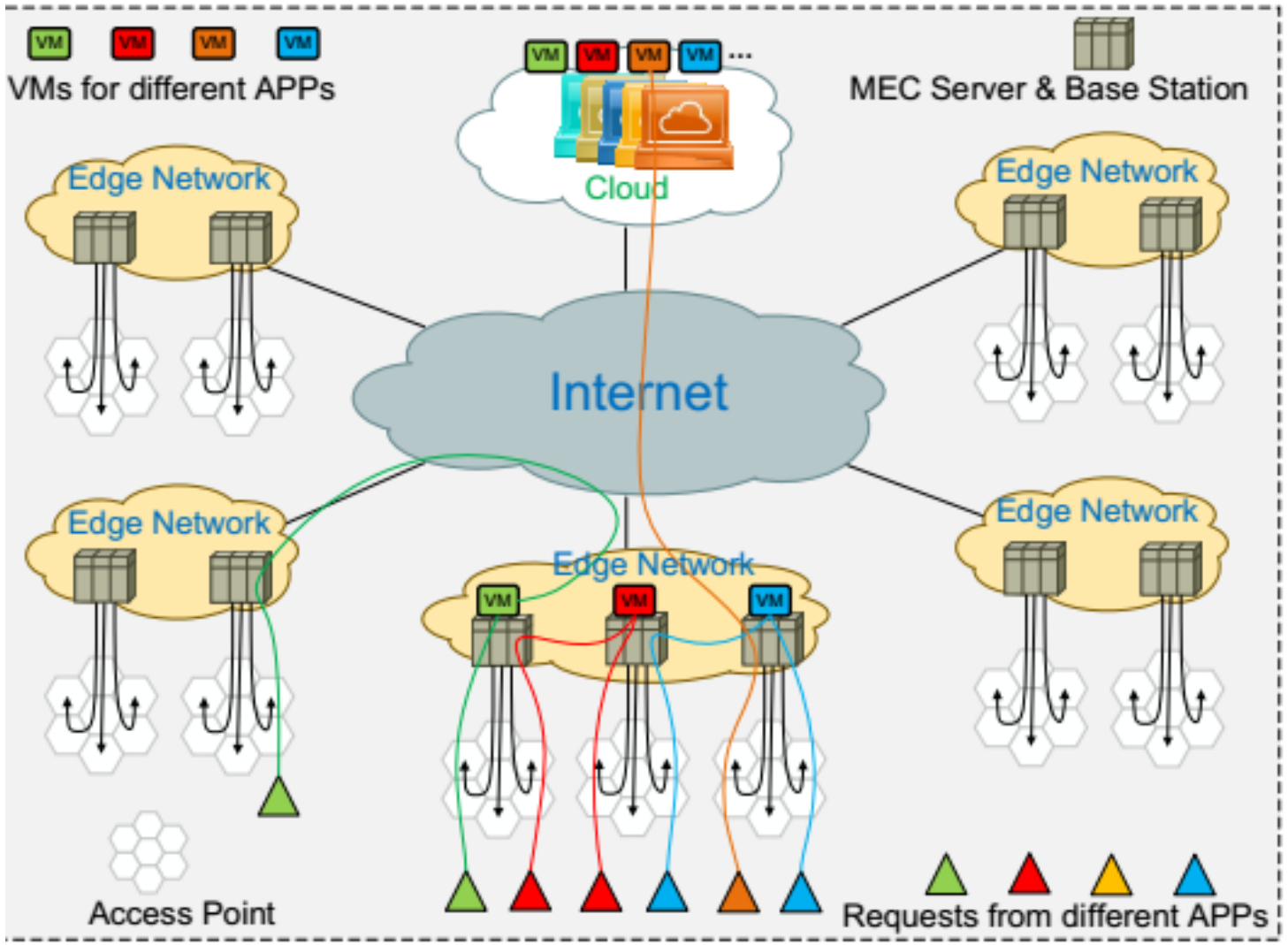


Fig. 1. Overview of a VM-based MEC system.

W. Wang, Y. Zhao, M. Tornatore, A. Gupta, J. Zhang, and B. Mukherjee. "Virtual machine placement and workload assignment for mobile edge computing," In Proc. 6th IEEE Cloud Networking (CloudNet), Sep. 2017.

Who's Problem?

What is the motivation for MEC tenants (Twitter/Netflix)?

- As a tenant of MEC, why would 3rd party application/service providers (for example, Twitter/Netflix) be interested to place application servers/contents closer to users? Why would they pay for MEC?
- MEC is closer to user (low latency, local processing, better QoS).
- Users are mobile. Mobile users (for example, commuters) can benefit from moving service points.

What is the motivation for MEC owners (AT&T/Verizon/Akamai)?

- Flexible pay-per-use revenue model for tenants/enterprise customers.
- Lower latency, better QoS.
- Off-loading traffic from the Core/Central Cloud Data Centers.
- Mobile user/traffic management.
- Dynamic resource management: how much resources to deploy: where? What time? For which tenant?
- Use of collected data: this can be a practical usage of the collected usage data from all over the network.

http://www.verizonenterprise.com/products/networking/sdn-nfv/virtual-network-services/

Problem Statement

Thanks!