Applying Follow Me and Service Migration & Continuity Features in Cloud-based LTE Systems

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SEVENTH FRAMEWORK PROGRAMME

MCN
Mobile Cloud Networking

- Introduction

- Follow Me Cloud and Service Continuity

- Possible Follow Me Cloud Technologies

- Conclusions & Future Work
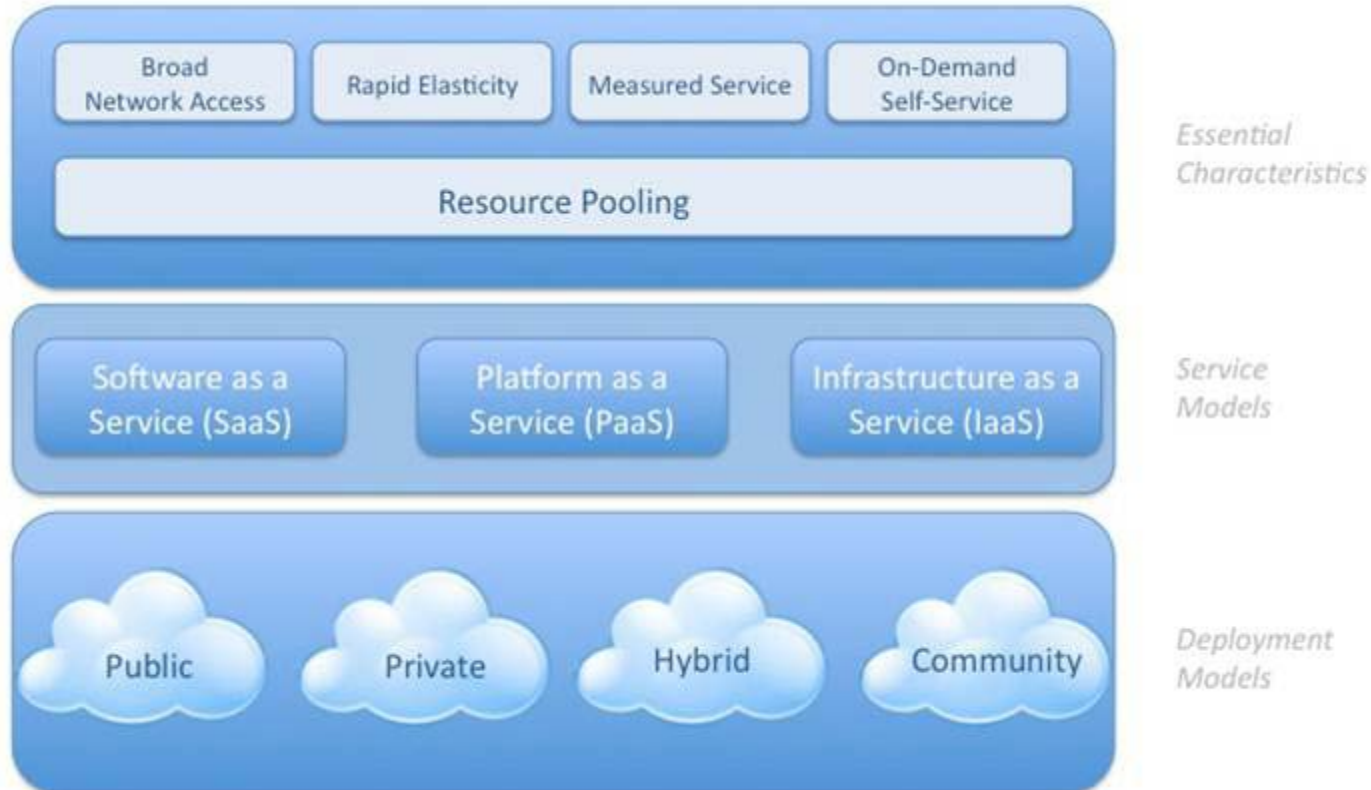
- Long Term Evolution:

  - 4th generation (4G) cellular system that enhances performance of UMTS (Universal Mobile Telecommunications System) with e.g., higher bandwidth support (up to 100 Mbps) and eliminates circuit switched communications

Introduction: LTE-based Cellular System
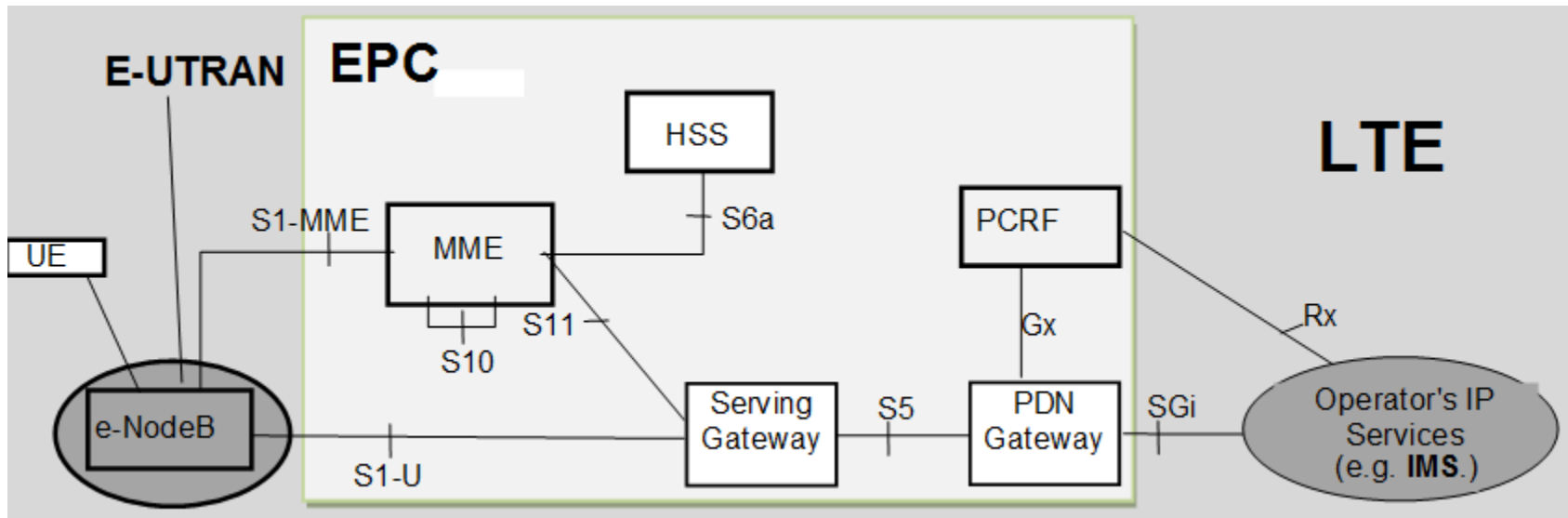
- E-UTRAN is the Radio Access Network of LTE
- Evolved Packet Core (EPC) is the Mobile Core Network of LTE
- Operator's IP services are deployed and run in data centers

- Problem:
  - Today's mobile cellular networks are highly centralized and not optimized for high-volume data applications:
    - ✓ High bandwidth requirements on core network equipment
   - ✓ Long communication paths between users and servers

- Solution:
  - Introduce cloud computing in LTE to offer decentralized computing, smart storage, on-demand elastic and Pay-as-you-Go services to third party operators and users
  - Support Follow Me cloud and Service Continuity features where content and services are following users
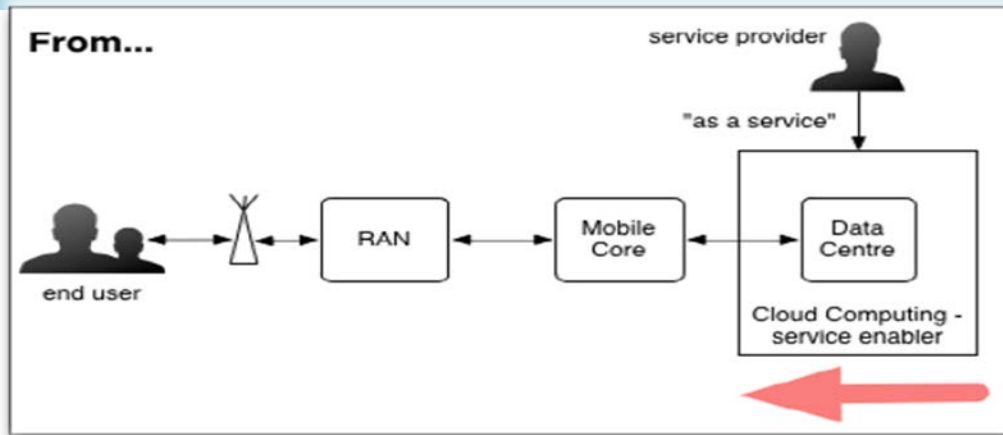
Extend the Concept of Cloud Computing Beyond Data Centers …

… towards mobile end-user
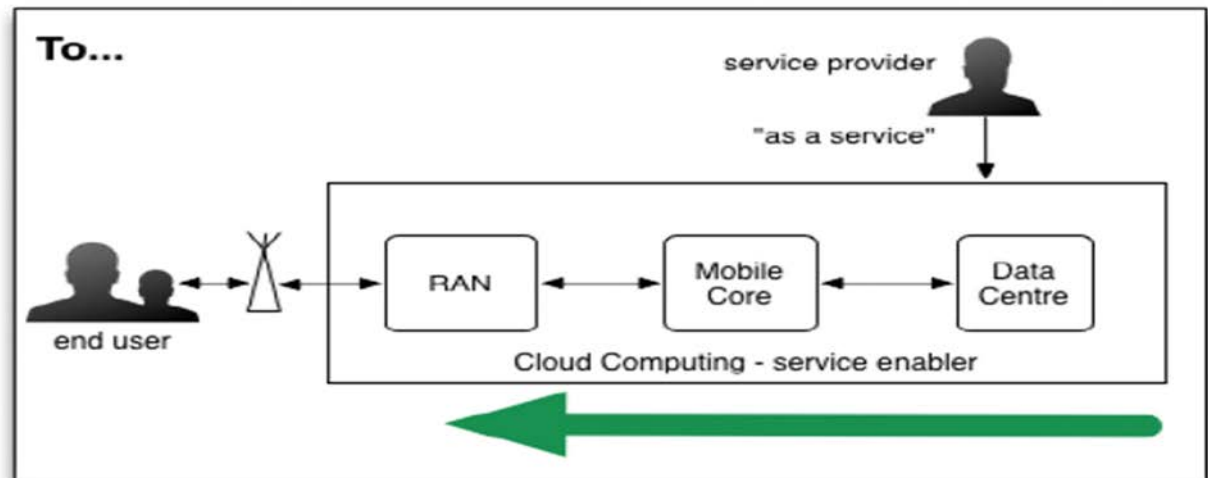
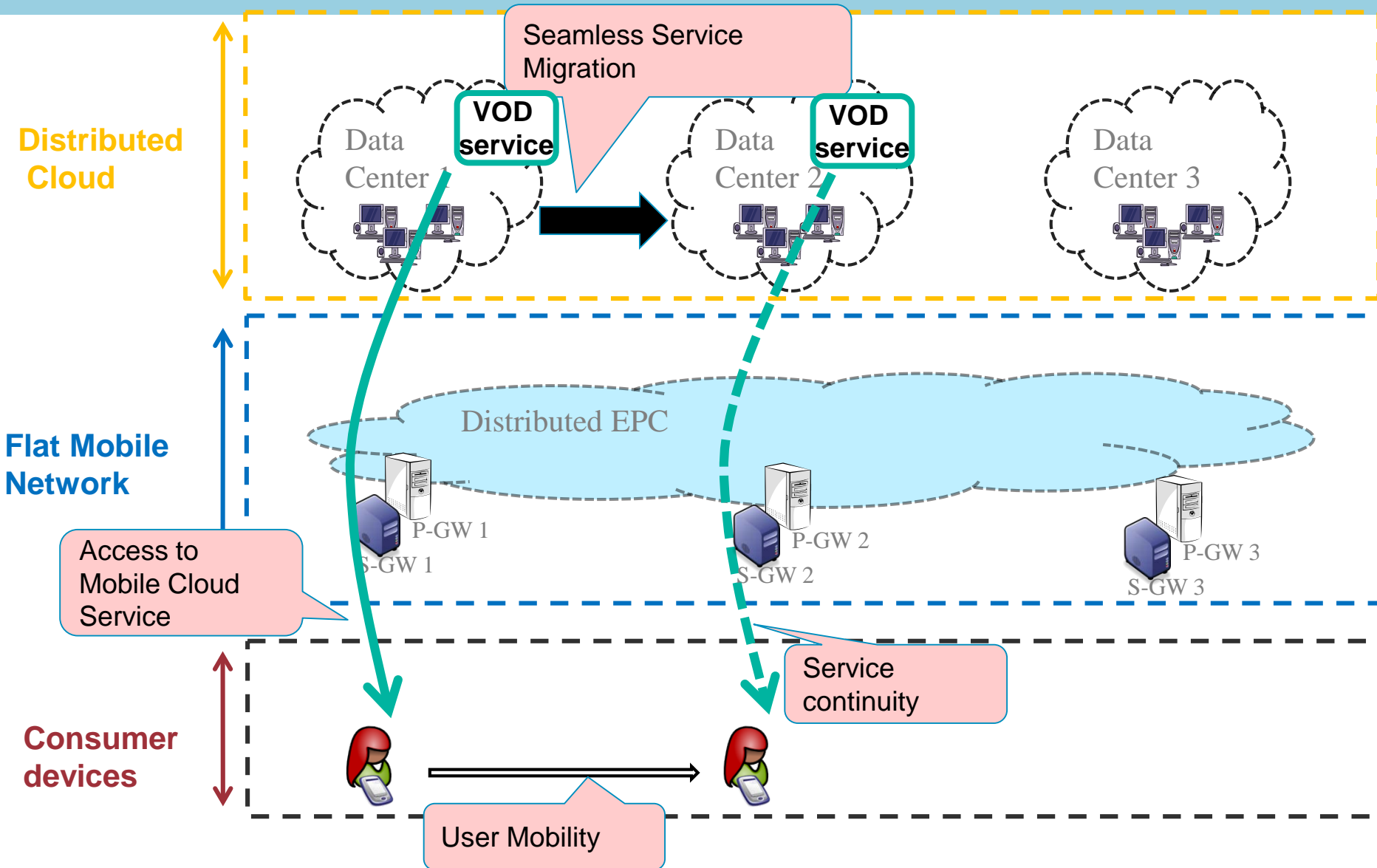**Not only content/data but also service is following the user …**

… as close as possible
… as fast as possible
… and at the most affordable cost

Follow me Cloud and Service Continuity: Optimal Distribution of the Mobile Core

Inefficient "mobile connectivity service" in the absence of an optimal E2E connectivity

Data Center

Access of mobile service from a distant location

Cloud-based Distributed Mobile Network

Mobile network being also **distributed**, being **owned by a carrier or provided as a cloud service**

Distributed EPC

P-GW 1
S-GW 1

P-GW 2
S-GW 2

P-GW 3
S-GW 3

Consumer Devices

UEs implementing **specific application logic** that **minimizes user's intervention** to receive the service
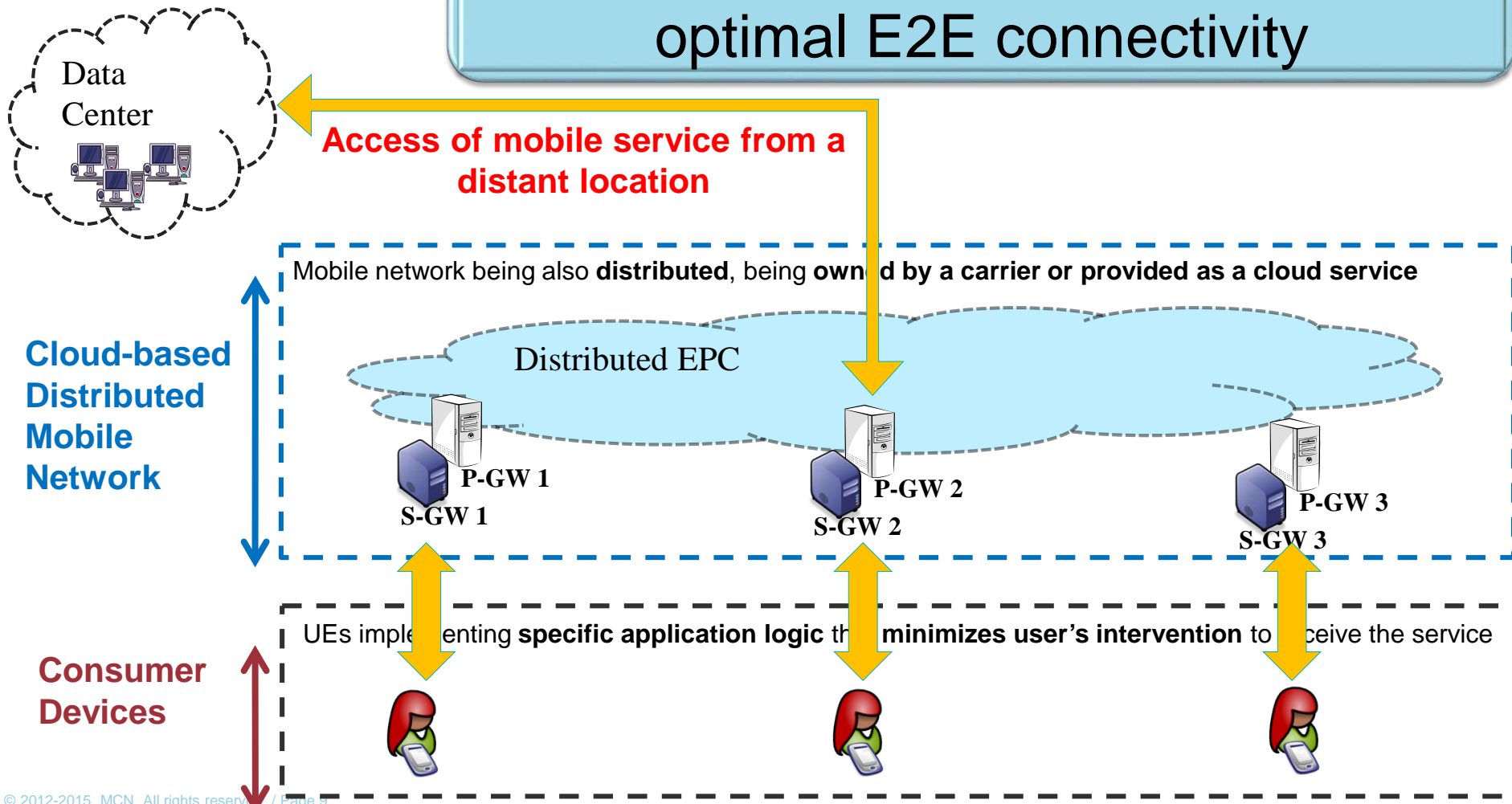
Follow me Cloud and Service Continuity: Follow Me Cloud Concept: "Service Mobility"
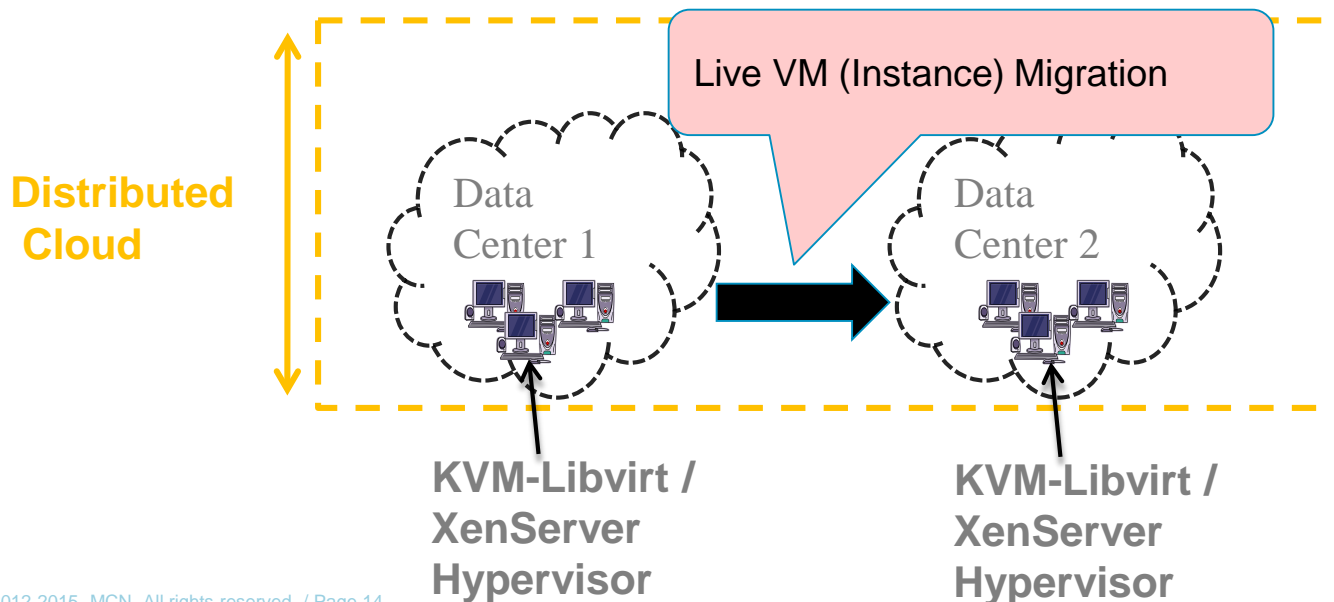
- Development of technologies (e.g., enhanced OpenStack KVM-Libvirt or XenServer live migration, ICN, mobile CDN):
  - migrate content/ data & services between (micro) data centers
- Optimal PDN-GW selection mechanisms:
  - enable a user to be always connected to the optimal data anchor and mobility gateways
- Efficient Mapping of 3GPP Access Point Names (APNs) to:
  - specific geographical locations (Data Center locations, S-GW service areas, MME pool areas)

- ## Service Migration Triggering Decision:
  - ### Decision on whether to migrate a service or not:
    - ✓ user expectation,
    - ✓ network operator policies,
    - ✓ service migration cost associated with:
      - ❖ initiation of a new VM at target DC
      - ❖ release of resources at source DC
      - ❖ Bandwidth consumption due to traffic to be exchanged between DCs and service migration functions
      - ❖ time needed to transfer a VM between DCs (optional)
      - ❖ time required for converting a VM (particularly if DCs are not using the same hypervisor)
      - ❖ time required for transferring service (VM) over the network
      - ❖ Estimate of cost/overhead vs. benefits

- Optimal target (micro) Data Centre
- Service Migration Decision and Realization:
  - Decision on what and how to migrate
    - full or partial migration (a service may consist of multiple cooperating sessions and pieces)
    - Forms of service migration (e.g., state, data, images, etc)
   - Migration technologies (e.g. enhanced OpenStack KVM-Libvirt or XenServer live migration, ICN, mobile CDN)

- Enhanced KVM-Libvirt and/or XenServer hypervisors [2]:
  - Shared storage based live migration: both hypervisors have access to a shared storage
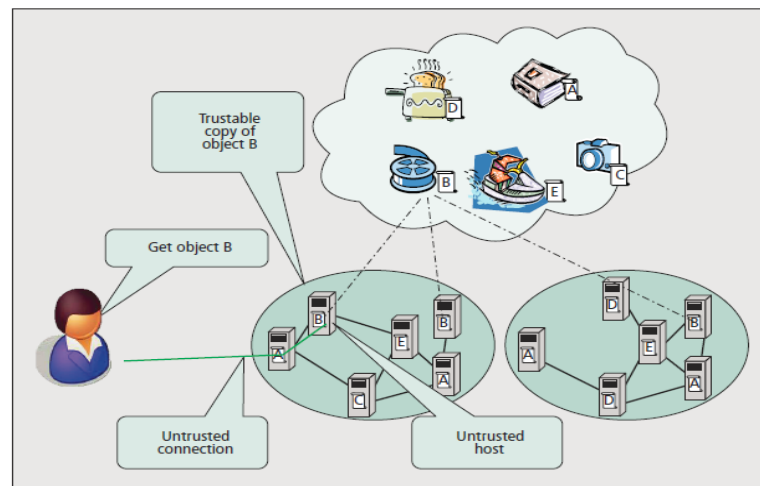 - Block live migration: no shared storage is required

Distributed Cloud

Live VM (Instance) Migration

Data Center 1

Data Center 2

KVM-Libvirt / XenServer Hypervisor

KVM-Libvirt / XenServer Hypervisor

- deployment and distribution of Cache Servers in Internet to enable distribution of load in serving an increasing number of requests of content, such as web content, video content or software

- integrate Cache Servers with mobile operator's core network or even with its access and backhaul network to move caches server and content sources closer to mobile users
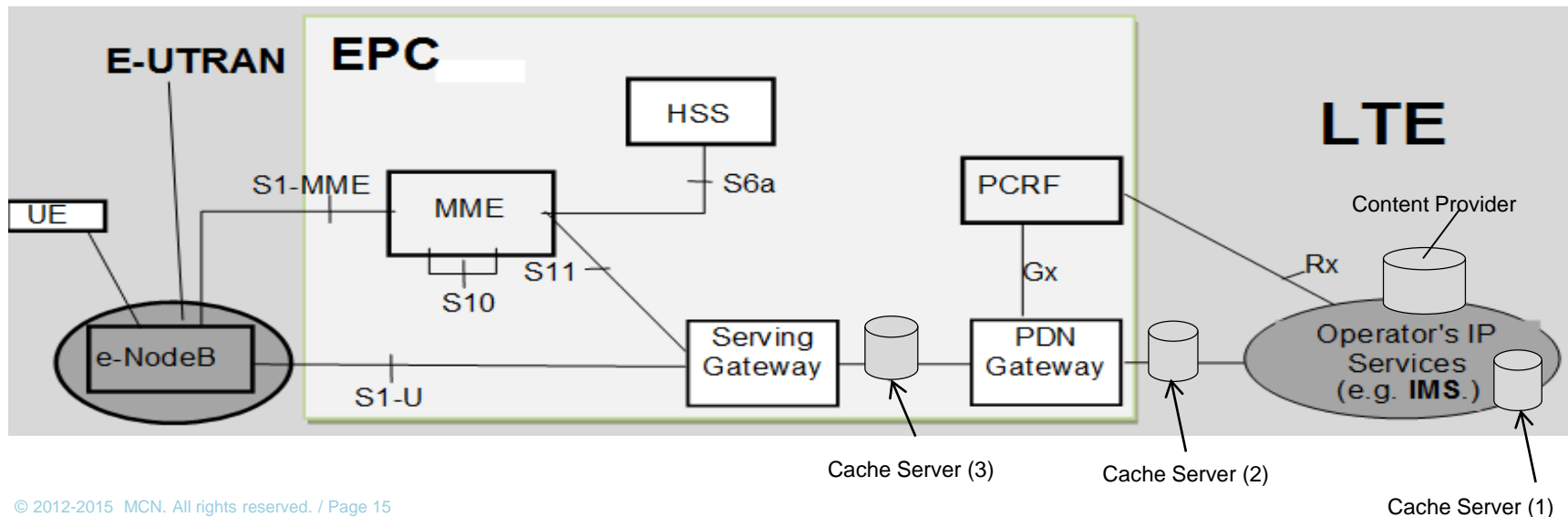
Cache Server (3)

Cache Server (2)

Cache Server (1)

- approach in Internet architectures based on named data objects (NDOs), since services do not need to be addressed via IP addresses but via names

- changes focal point of the network architecture from "end host" to "information" (content or data)

- leverage in-network storage for caching, multiparty communication through replication, and interaction models that decouple senders and receivers
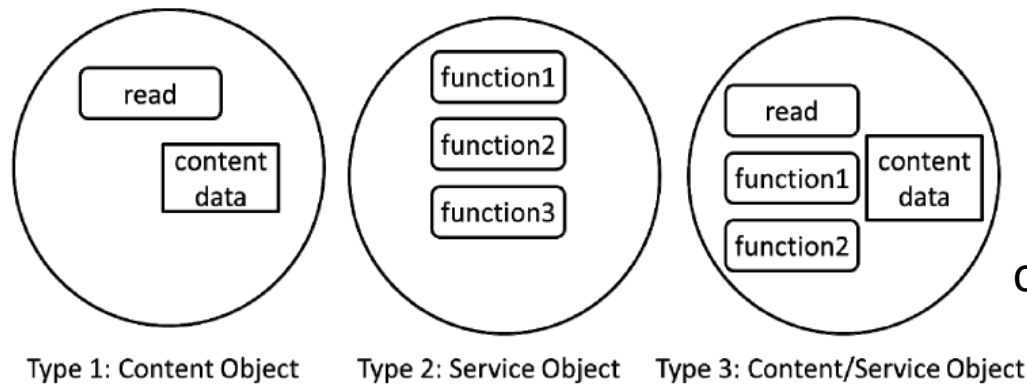

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- Data-Oriented Network Architecture (DONA) [4]
- Publish-Subscribe Internet Routing Paradigm (PSIRP) [5]
- Network of Information (NetInf) [6]
- Translating Relaying Internet Architecture integrating Active Directories (TRIAD) [7]
- Content-Centric Networking (CCN) [8]
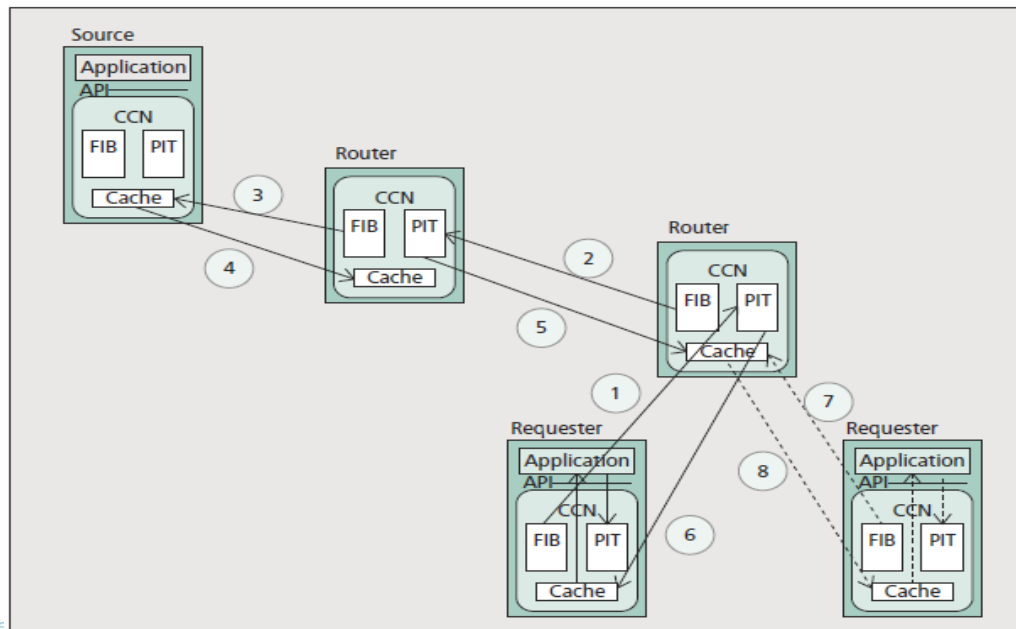
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# Possible Follow Me Cloud Technologies: Service-Centric Networking (SCN [9])

- extension of CCN which is designed by using an object oriented approach, in which content and service are considered as an object

- data or content not only can be retrieved but also can be processed before being delivered to users.

Type 1: Content Object   Type 2: Service Object   Type 3: Content/Service Object

copied from [9]

- Open Networking Foundation (ONF) defined Software Defined Networking (SDN) as an emerging network architecture where network control is decoupled from forwarding and is directly programmable

- supports network virtualization since underlying network infrastructure can be abstracted from applications and network services

- enhance service continuity, mainly traffic redirection/offloading
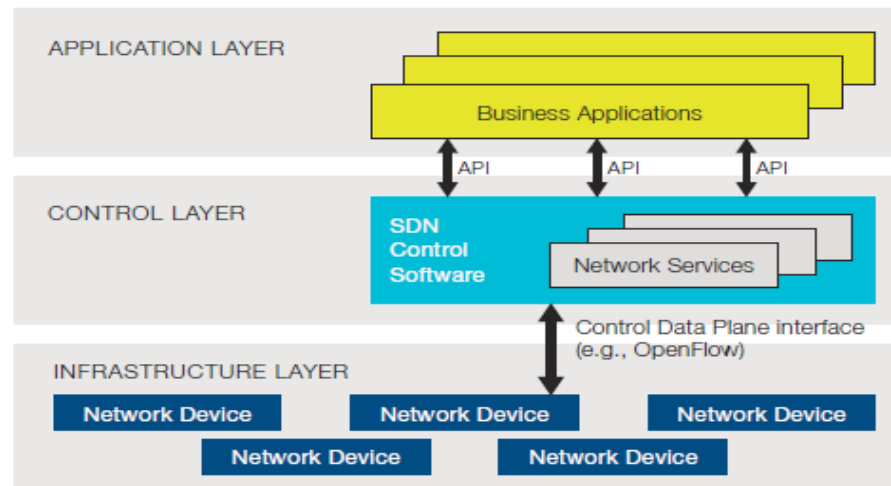
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Conclusions & Future Work

- Conclusions:
  - Useful to integrate cloud computing concept within LTE based cellular systems
  - Follow Me Cloud needed to enable content/data & service to follow user whenever is moving
  - Several challenges need to be solved, e.g., service migration triggering and realization, efficient technologies to migrate content & services
  - Combination of virtualized ICN and Mobile CDN technologies a possible solution

- Future Work:
  - EU FP7 Mobile Cloud Networking need to solve Follow Me Cloud challenges

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- [2] Openstack configuring migrations (visited on June 2013), http://docs.openstack.org/trunk/openstack-compute/admin/content/configuring-migrations.html

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- [9] T. Braun, V. Hilt, M. Hofmann, I. Rimac, M. Steiner and M. Varvello, "Service-Centric Networking", Proc. of 4th International Workshop on the Network of the Future, 2011.

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- [11] M. Liebsch, Z. Yousaf, Runtime Relocation of CDN Serving Point – Enabler for Low Costs Mobile Content Delivery, WCNC 2013

- [12] Open Networking Foundation,"Software-Defined Networking: The New Norm for Networks", April 2012