Paper Review:
MOBILE NETWORK ARCHITECTURE EVOLUTION TOWARD 5G

BY

P. ROST, C. MANNWEILER (NOKIA NETWORKS); A. BANCHS (IMDEA NETWORKS); I. BERBERANA (TELEFONIA I+D); M. BREITBACH, H. DROSTE (DEUTSCHE TELEKOM); M. DALL (NOKIA); M. A. PUENTE (ATOS); K. SAMDANIS (NEC EUROPE LABS, UK); B. SAYADI (ALCATEL LUCENT, FRANCE)

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Introduction

- Third Generation Partnership Project (3GPP) Evolved Packet System (EPS) is a logical architecture
- Composed of Radio Access Network (RAN) and Evolved Packet Core (EPC)
- Current goal of 3GPP EPS has been provisioning of mobile broadband service
- Focused on efficient use of spectrum

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- Some past releases studied integration of small data services and machine type communication (MTC) services.

- Cloud technology integration into 3GPP leads to novel services.

Problems with 3GPP EPS

- Static assignment of functionality to network elements
- Strong functional dependencies with each network element

Reasons to improve 3GPP

- Support for diverse service such as eHealth, Internet of Things (IoT), and vehicular-to-everything (V2X)
- Support novel radio access interfaces such as millimeter-wave (mmWave) or centimeter-wave transmission
- Accommodate new paradigms like Multi-Access Edge Computing (MEC) and Cloud-RAN (C-RAN)
- Enable flexible deployment patterns based on small, micro and macro cells
- Programmability for different requirements of latency, throughput, and robustness

Objectives of Evolved 3GPP EPS

- **Multi-service and context aware adaptation**
  - Adapt operation based on service requirements
  - Awareness of deployment properties, transport network properties, service properties and available RAN technologies

- **Mobile network multi-tenancy**
  - CAPEX and OPEX reduction by sharing spectrum and infrastructure

Functionalities required

- Network of functions
- Network slicing
- Software defined mobile network control

3GPP EPS

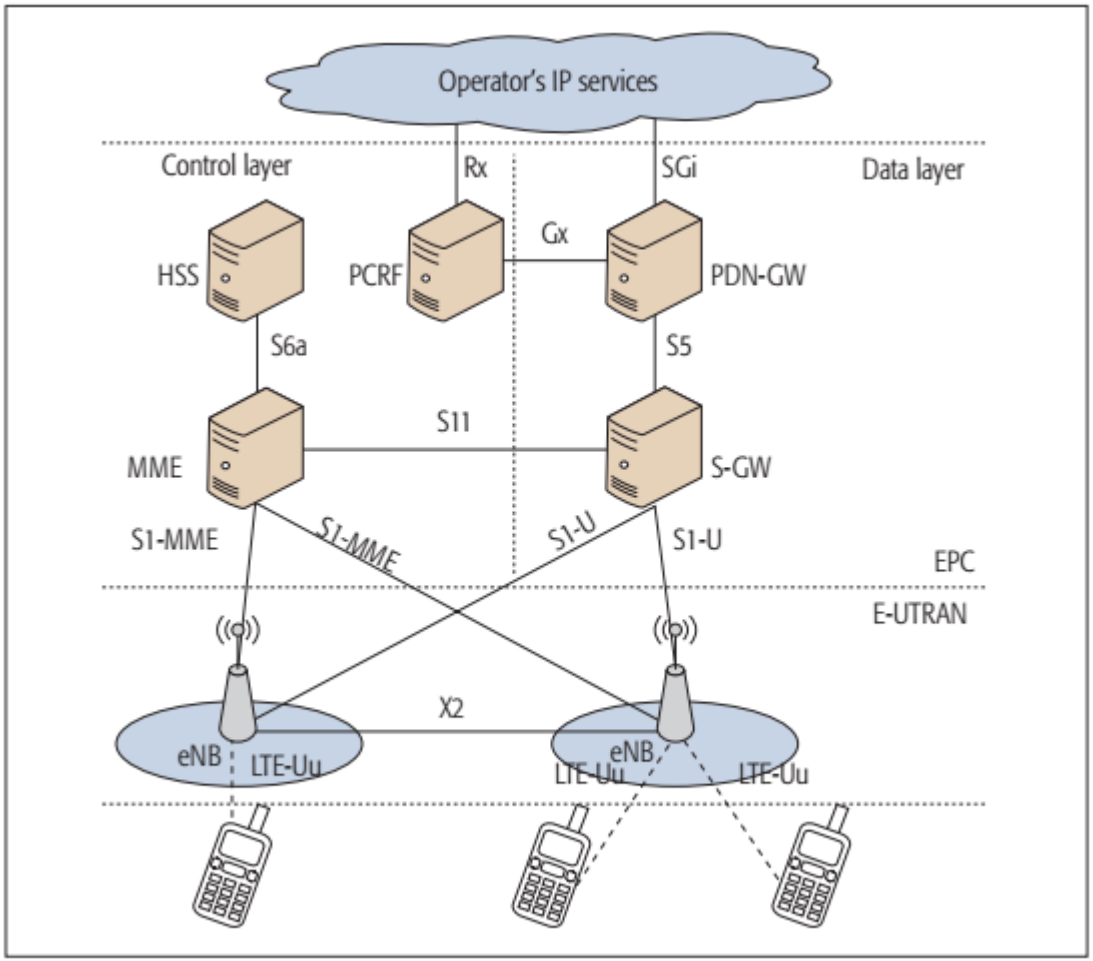

Figure 1. The (basic) 3GPP evolved packet system.

Network of functions

- Mobile network architecture need to support different technologies and enable different use cases
- This means enabling the right functionality at the right place and time
- Network of functions enables decomposition of mobile network functionality into smaller function blocks that are flexibly instantiated
- Optimizes through dedicated implementations

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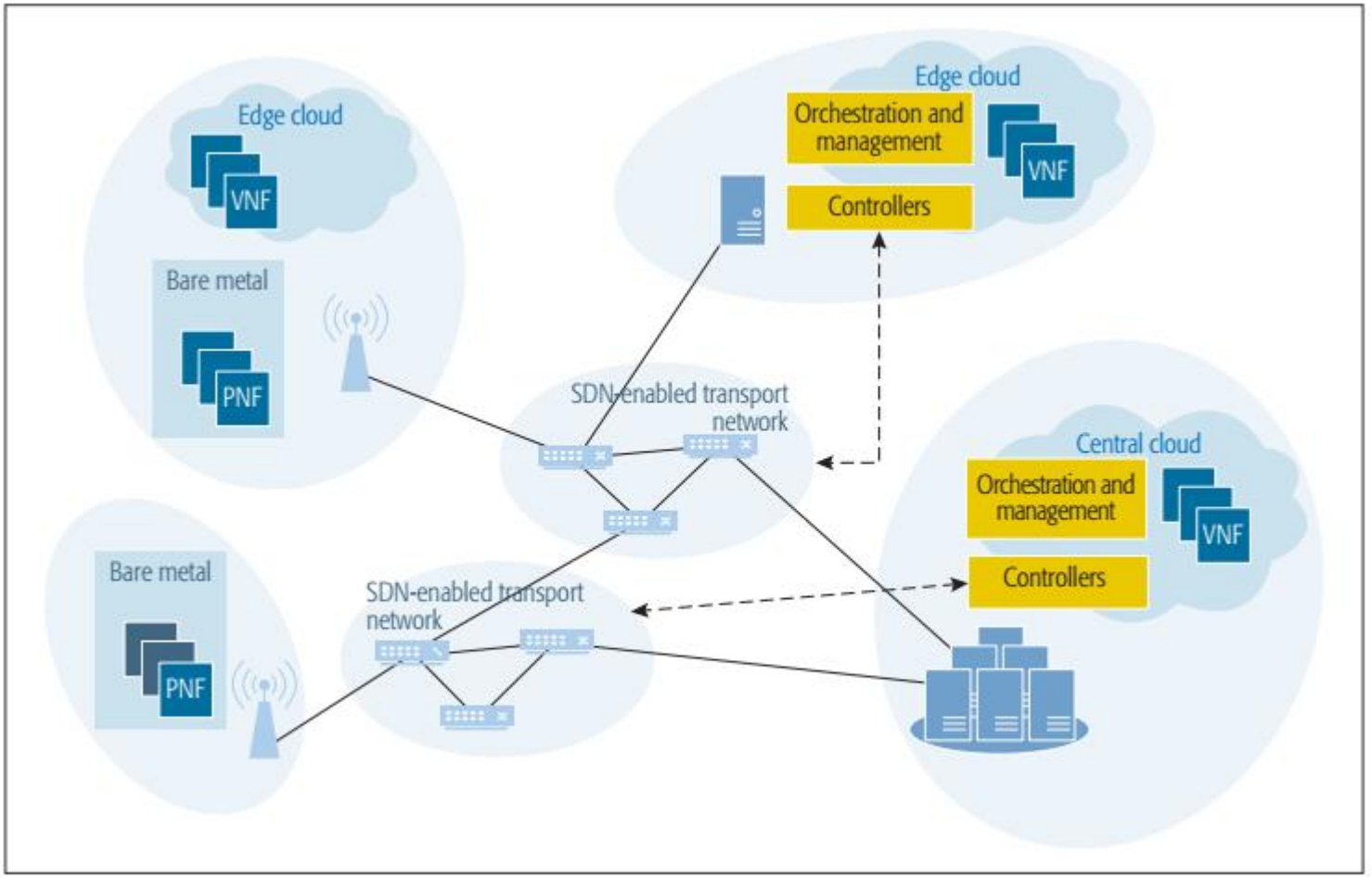

Figure 2. Relationship of functional assignment and physical architecture.

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Network functions	Relevant parameters
Cell discovery	Highly depends on carrier frequency (e.g., sub-6 GHz or mmWave), MIMO technologies (e.g., beamforming).
Mobility	Mobility may not be required by some services (metering), or only very locally (enterprises), in groups (trains), or at very high speed (cars).
Carrier aggregation	Carrier aggregation may not be needed in each scenario as it also impacts battery consumption; it could further include very distinct spectrum.
Multi-connectivity	Multi-connectivity could include different network layers (micro/macro), different technologies (WiFi/LTE), and different spectrum (sub-6 GHz/mmWave). It may further be implemented at very different layers (e.g., among others) depending on deployments.
Connectivity model	The actual connectivity may be based on bearers (high throughput) or connectionless (IoT). In the connectionless case, many non-access stratum (NAS) functions are not needed.
Coding	Coding techniques may vary depending on the use case, for example, block codes for short (sensor) transmissions or turbo codes for high throughput.
Multi-cell cooperation	Depending on the current load, deployment, and channels, tighter cooperation (joint Tx/Rx) or looser cooperation (ICIC) is possible.
Spectrum access	Depending on the use case requirements and available spectrum, possibly different spectrum access strategies may be required (e.g., licensed, unlicensed, license-assisted).
Authentication, authorization, accounting (AAA)	Depending on the applicable access control and accounting/charging policies, AAA functionality is different and may be placed/instantiated in different locations.
Parental control	Depending on the user context (children) and the requested service, the parental control function becomes part of the service chain for according service flows.

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Network Slicing

- Deploy multiple dedicated logical mobile networks on same infrastructure
- A network slice is a collection of mobile network functions and a specific set of radio access technologies/configurations
- A network slice is end-to-end logical mobile network
- Supports multi-tenancy and service-specific network composition

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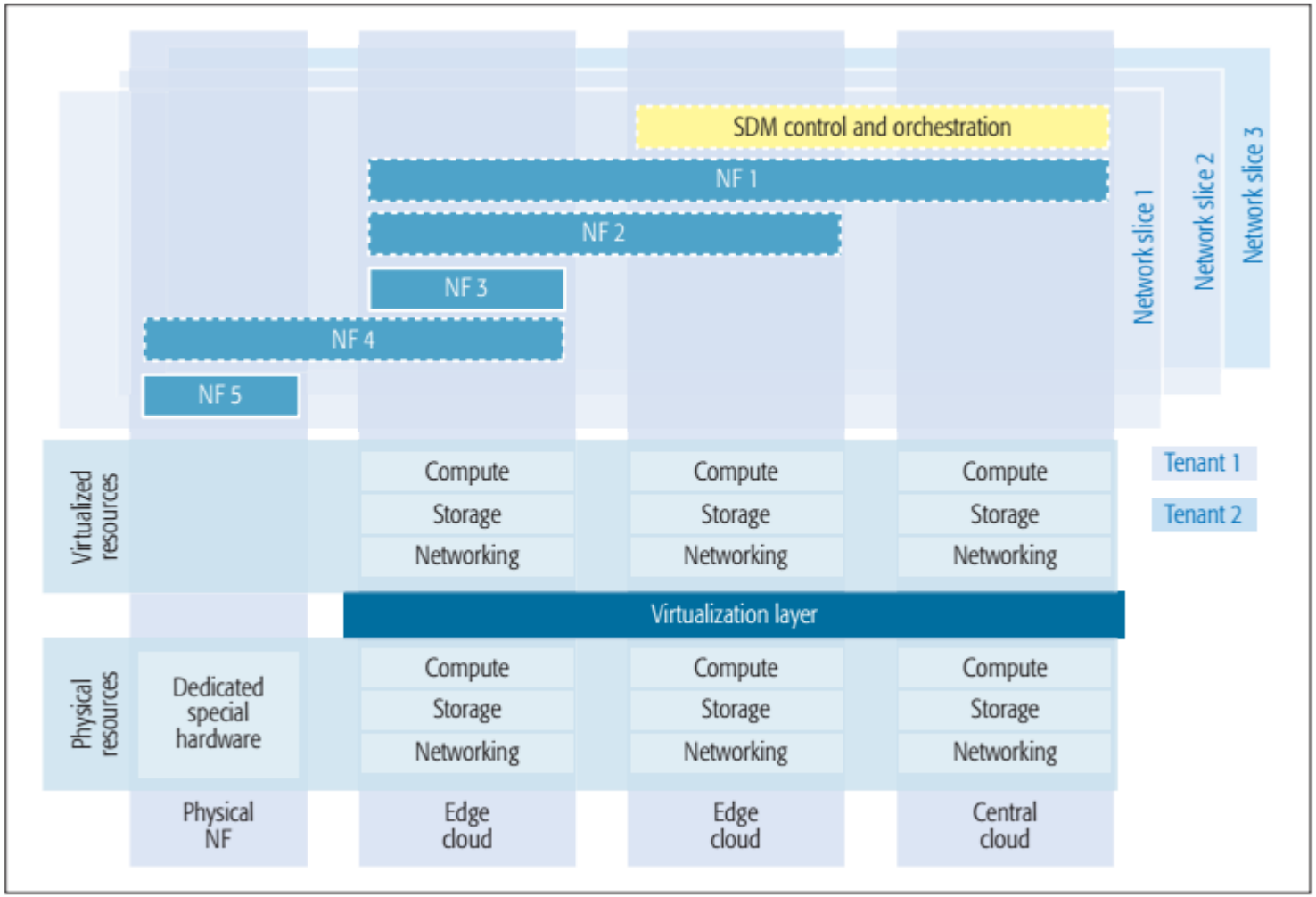
SDM control and orchestration
NF 1
NF 2
NF 3
NF 4
NF 5
Network slice 1
Network slice 2
Network slice 3
Virtualized resources
Compute
Storage
Networking
Compute
Storage
Networking
Compute
Storage
Networking
Tenant 1
Tenant 2
Virtualization layer
Physical resources
Dedicated special hardware
Compute
Storage
Networking
Compute
Storage
Networking
Compute
Storage
Networking
Physical NF
Edge cloud
Edge cloud
Central cloud

Orchestration and Management

- Software-Defined Mobile Network Control (SDMC)
- SDMC concept used to control mobile network functionality and not just data plane functions
- Keep the orchestration interface less complex
- Not introduce multiple interfaces

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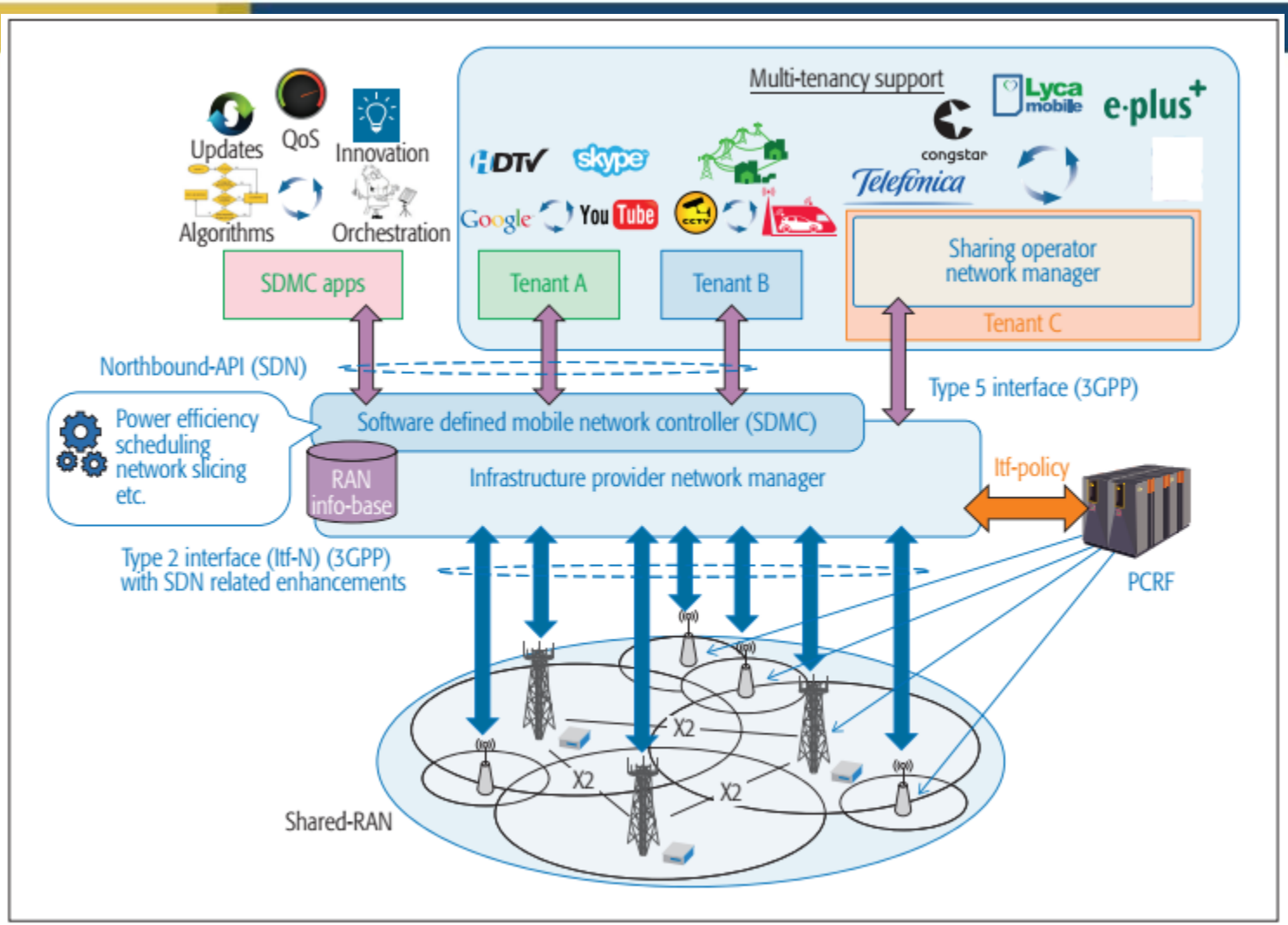

Figure 4. SDMC architecture and operations.