



# **Trends in Mobile Network Architectures**

**3GPP LTE | Mobile WiMAX | Next Generation Mobile Networks**

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**SIEMENS**

# Outline

1 Next Generation Mobile Networks

2 New Radio Access Network Architectures

3 Some Technology Trends

4 Conclusions

# Next Generation Mobile Networks

## Siemens NGMN Vision

**Mobile broadband network architecture that delivers services at fixed line quality with costs of IP technologies**



- **IP-optimized mobile network for all types of communications services**
  - Enables network and service consolidation on IP technology
  - Simplified architecture in order to reduce total cost of ownership
  
- **New packet-optimised radio technologies for mobile broadband**
  - Evolution beyond UMTS and High Speed Packet Access (HSDPA/HSUPA)
  - Full support of mobility, security and quality of service
  - Improved throughput, latency and cost per bit



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# New Radio Access Network Architectures

Emerging mobile broadband radio technologies:

- IEEE 802.16-2004/802.16e (Portable and **Mobile WiMAX**)
- **3GPP Long Term Evolution** (“Evolved UTRA and UTRAN”)
- **Others** (e.g. Flash-OFDM and WiBro) with proprietary RAN architectures

Corresponding Radio Access Network Architectures:



## WiMAX Network Working Group's **WiMAX RAN Architecture**

- Aligned to **DSL/cable architecture** and regulatory issues of broadband access
- Allows **separation of business roles**: Network **Access** Provider, **Network Service** Provider and **Application Service** Provider
- Based on **functional entities** and **reference points** that ensure interoperability without mandating specific network implementations



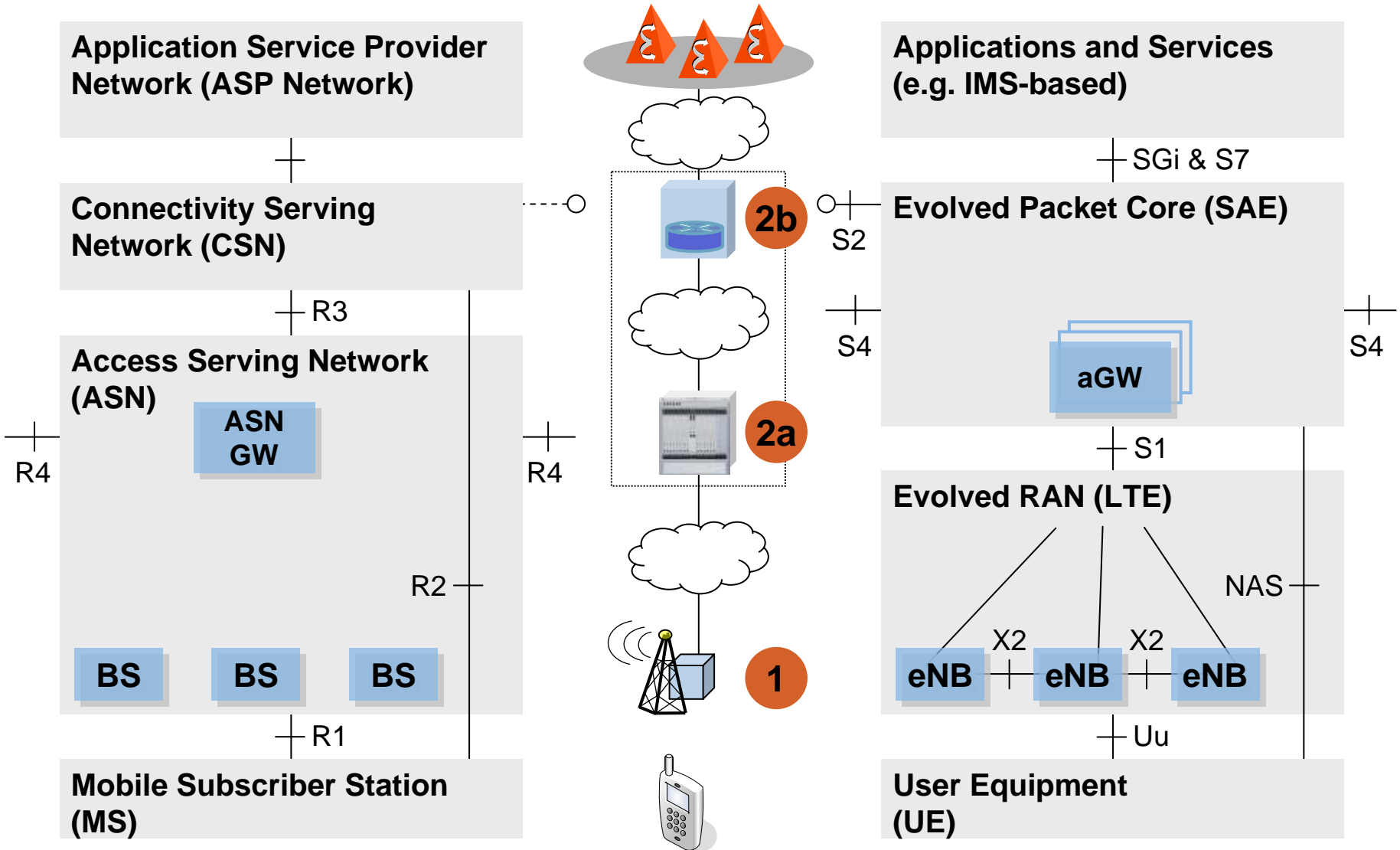
## **Evolved UTRAN (LTE)** accompanied by 3GPP System Architecture Evolution (SAE)

- Aligned to **existing 3GPP network deployments** and service architectures
- **Simplified architecture** for QoS-enabled high throughput / low latency services
- **Handover and interworking** with other 3GPP Radio Access Technologies (e.g. UMTS, HSPA and HSPA+) for a **smooth service introduction**

# Network Architectures have 2 or 3 Types of Nodes

## A) WiMAX Network Architecture

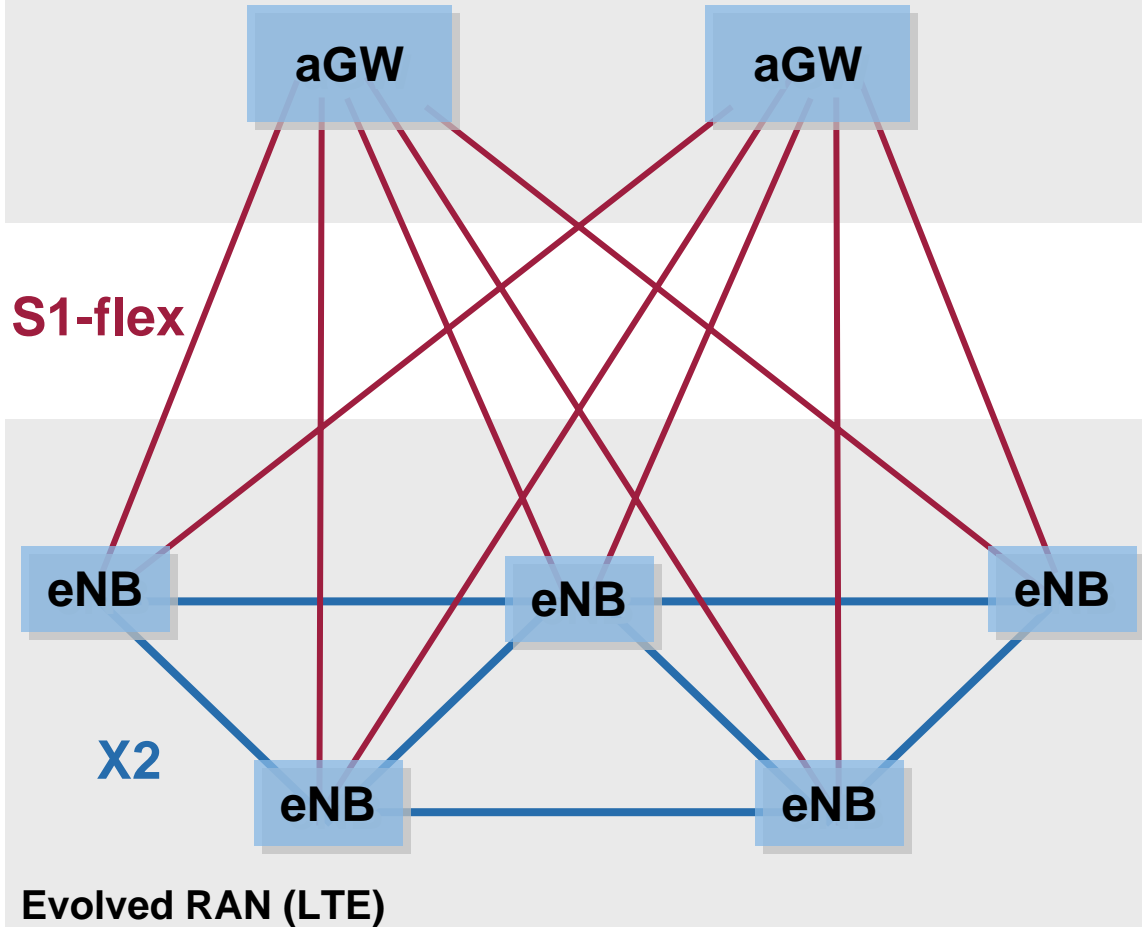
## B) 3GPP LTE/SAE



# 3GPP LTE Network Architecture

Evolved  
Packet  
Core (SAE)

**Note:** aGW may be decomposed into  
Mobility Management Entity (MME)  
and User Plane Entity (UPE)



## Two types of interfaces:

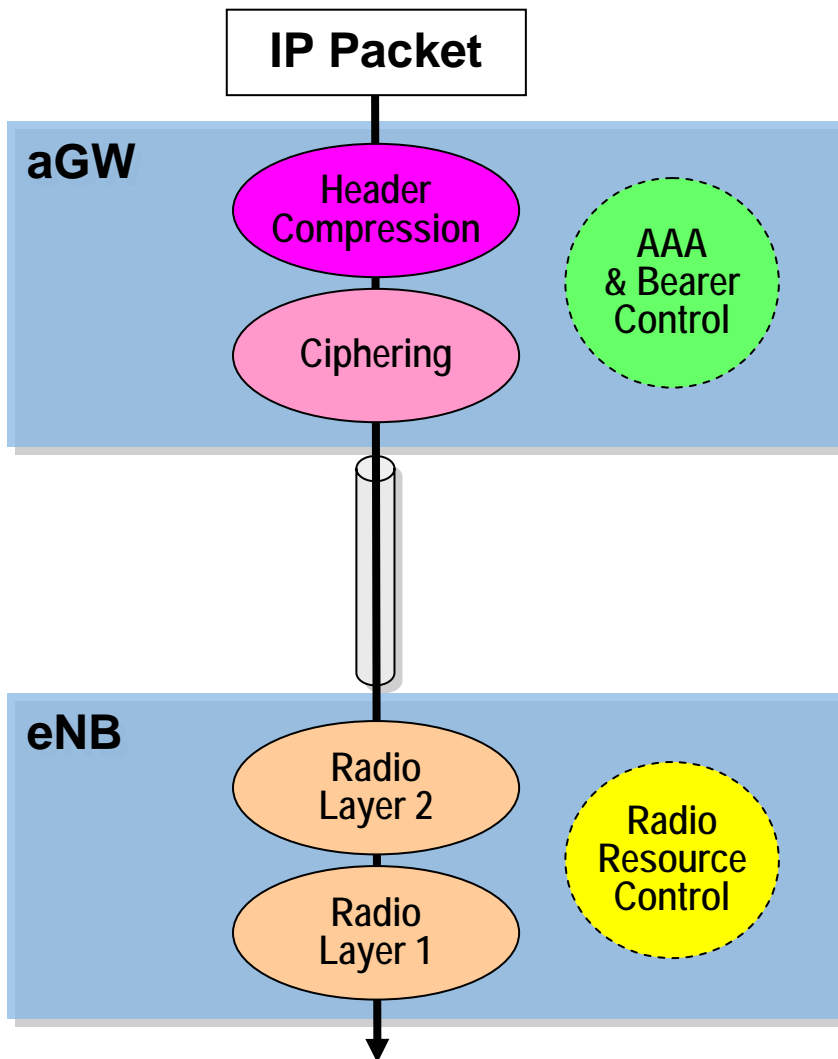
- **S1-flex:** Many-to-many relationship between “enhanced NodeBs” (eNB) and core network nodes (**Access Gateways, aGW**)
- **X2:** Direct interfacing between adjacent eNBs for handover and RRM

## Advantages:

- Minimises single points of failure above eNBs
- All radio-related issues are handled in the RAN
- Allows RAN Sharing



# 3GPP LTE Network Architecture: Function Split



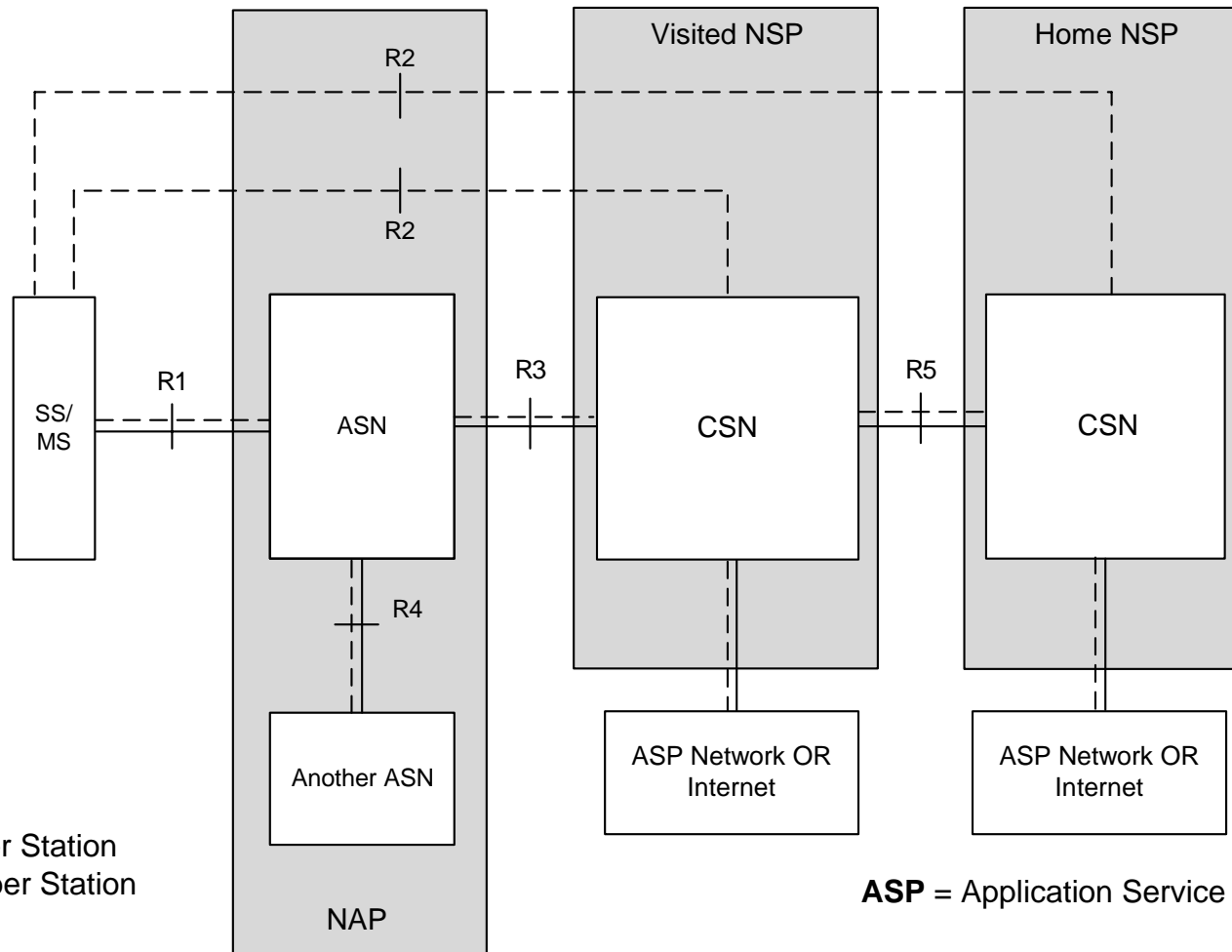
## Strong security architecture:

- Sensible functions in the aGW:
  - Ciphering of User Traffic
  - Authentication and Authorisation of users and services
- Base stations can be connected over less secure networks
- (Successful) attacks on the base station have small impact

## All radio-related functions in the eNB:

- high throughput / low latency packet-based scheduling
- operation of RAN is relatively autonomous from the core network (e.g. basis for RAN Sharing)

# WiMAX Network Reference Model (NRM)



**SS/MS** = Subscriber Station / Mobile Subscriber Station

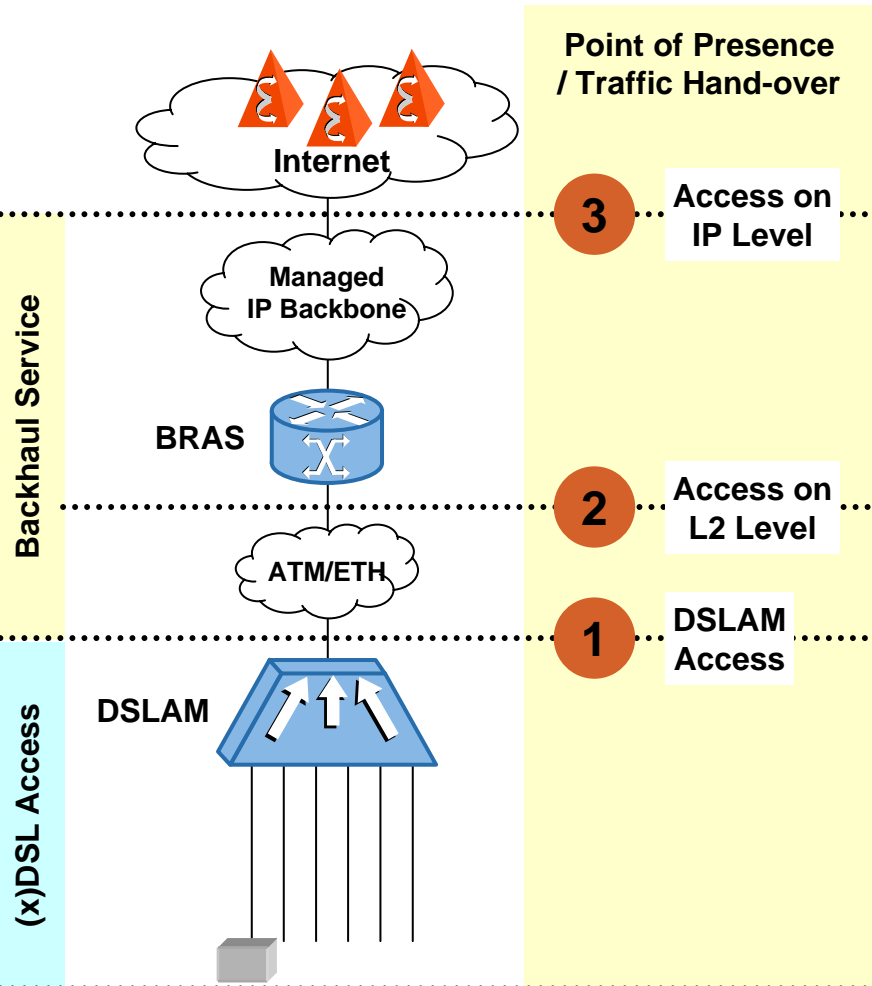
**ASP** = Application Service Provider

**NAP** = Network Access Provider  
**ASN** = Access Serving Network

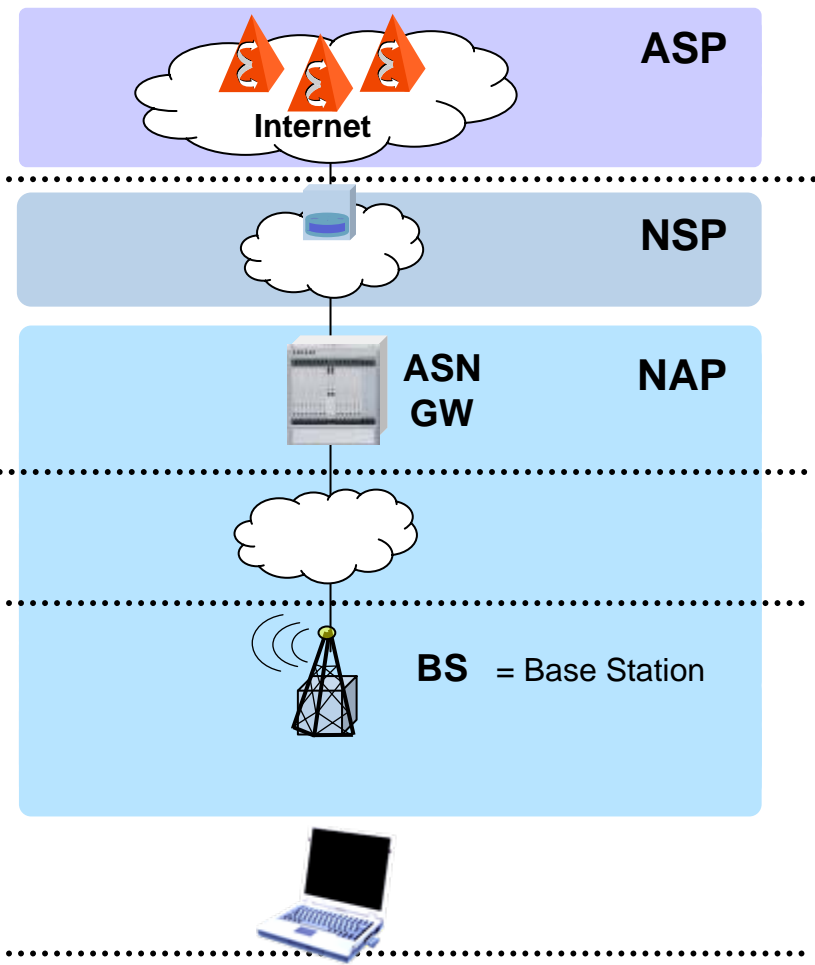
**NSP** = Network Service Provider  
**CSN** = Connectivity Serving Network

# WiMAX addresses the DSL/cable business

## DSL Architecture

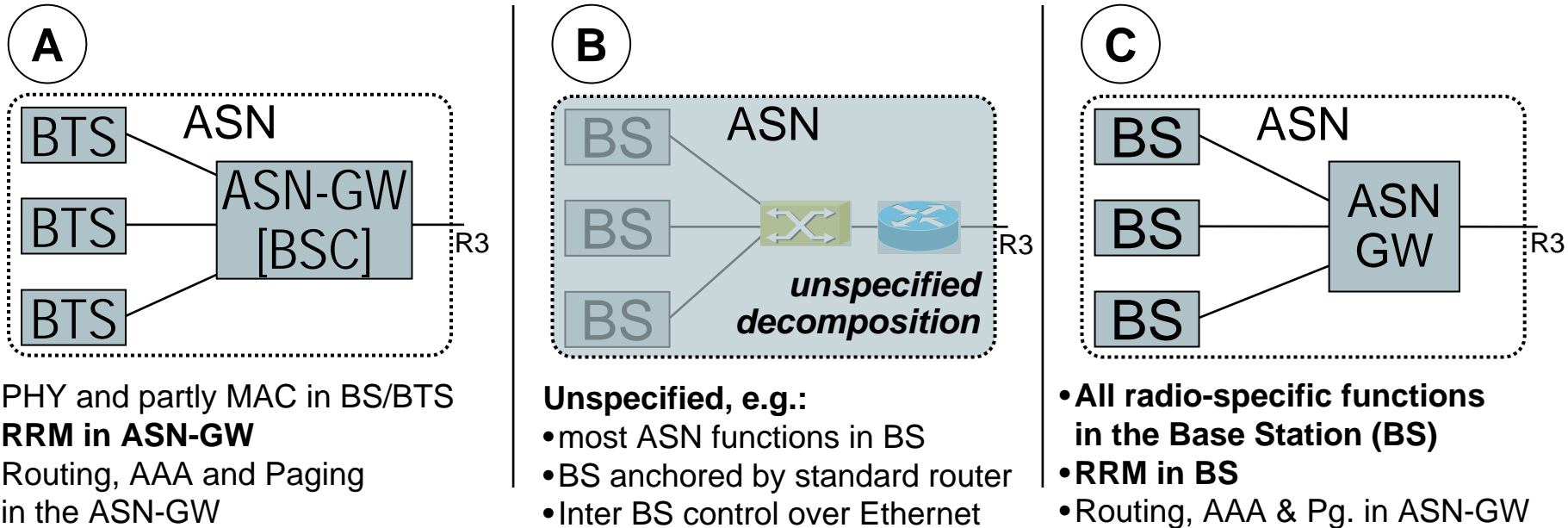


## WiMAX NWG Architecture

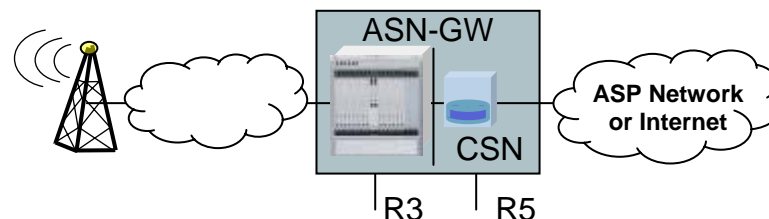


# Function Split in the WiMAX Network Architecture

Three profiles defined for the Access Serving Network in Release 1:



**Real deployments** may combine parts of different functional entities within on network element. Example: ASN-Gateway with incorporated CSN functionality:



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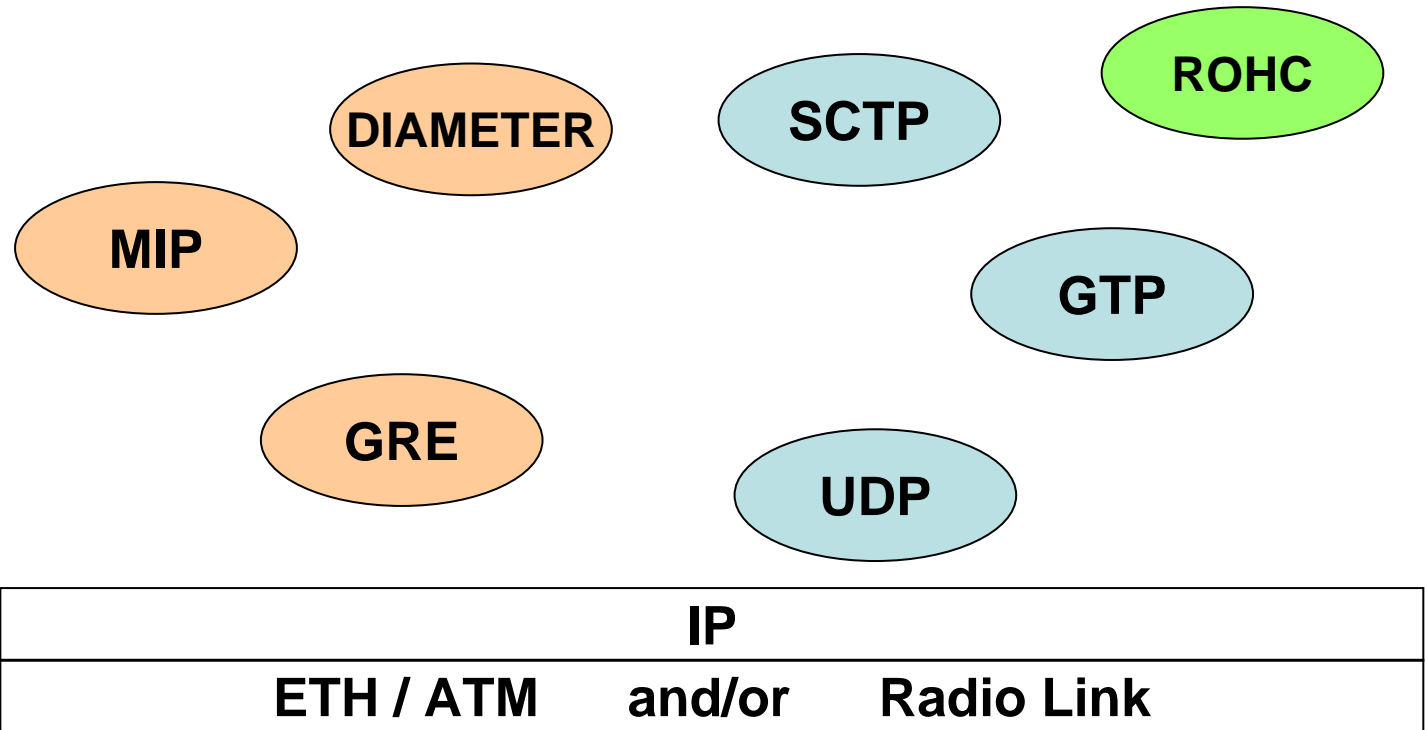
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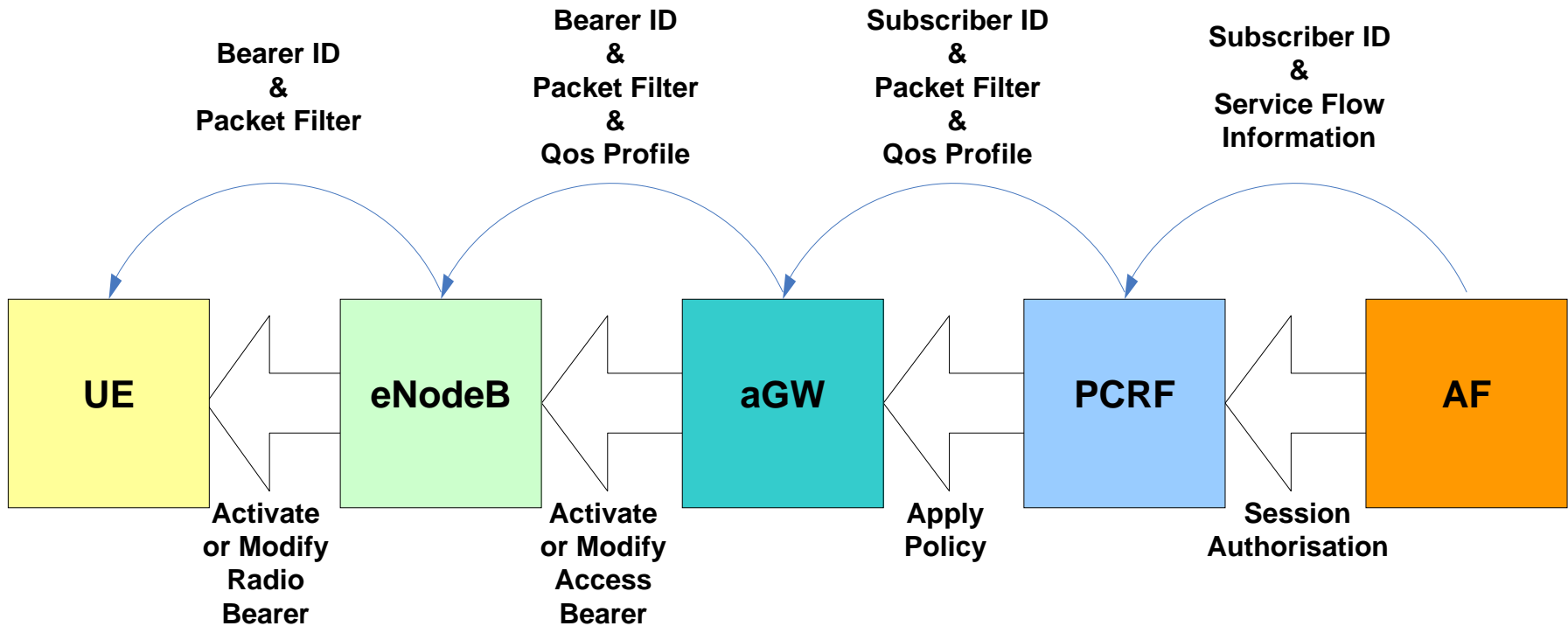
# IP-based Transport and use of IP Protocols



All protocols relevant for LTE have already been introduced in 3GPP. Some (e.g. SCTP) are however used in a slightly different way.

# Possibility to push QoS Profiles into the network (from the application layer within the network)

## LTE/SAE QoS Architecture:



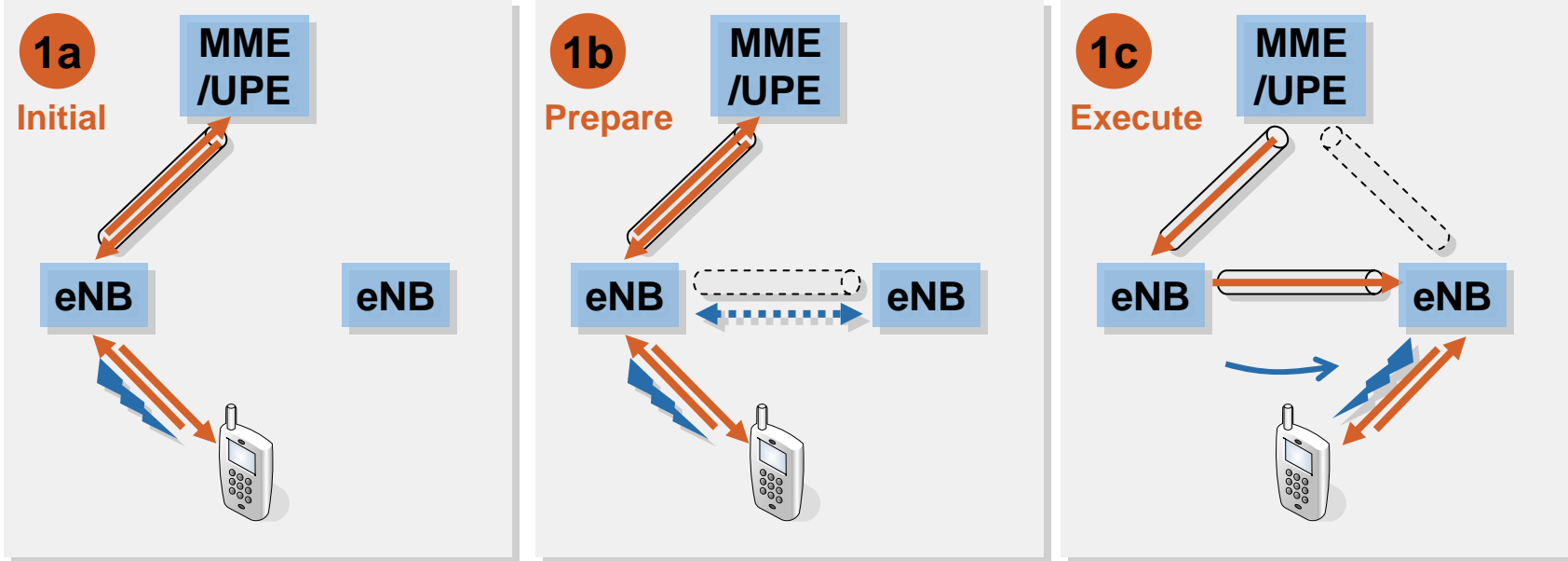
(similar approach in WiMAX)

**PCRF** = Policy & Charging Rules Function  
**AF** = Application Function

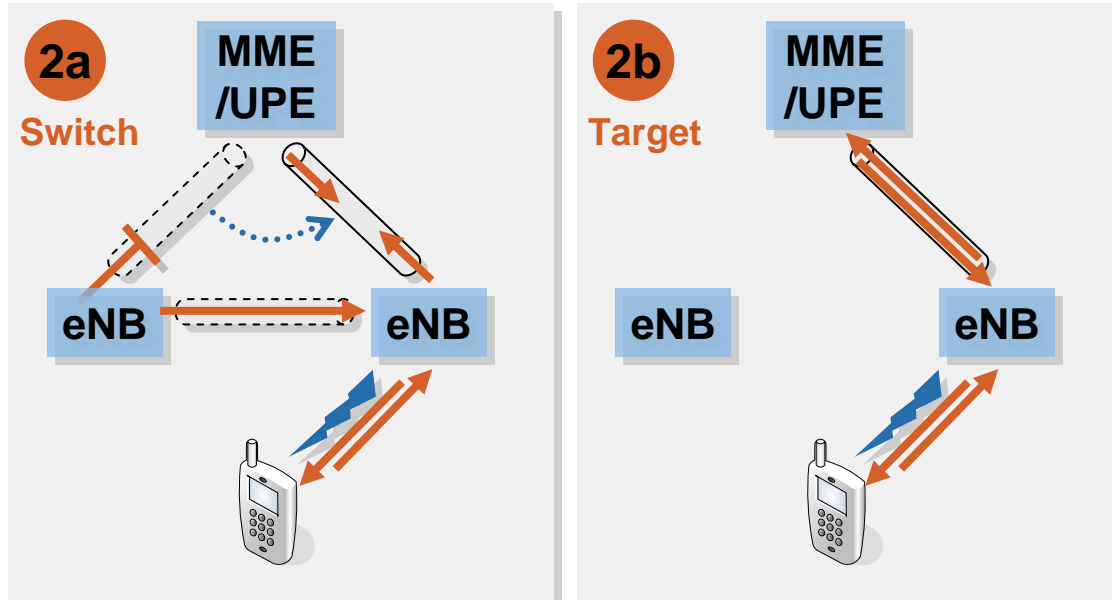
# Mobility mainly handled in the Access Network

## c.f. Handover in 3GPP LTE

### Phase 1: Radio Handover



### Phase 2: Path Update





## Challenges (1/2)

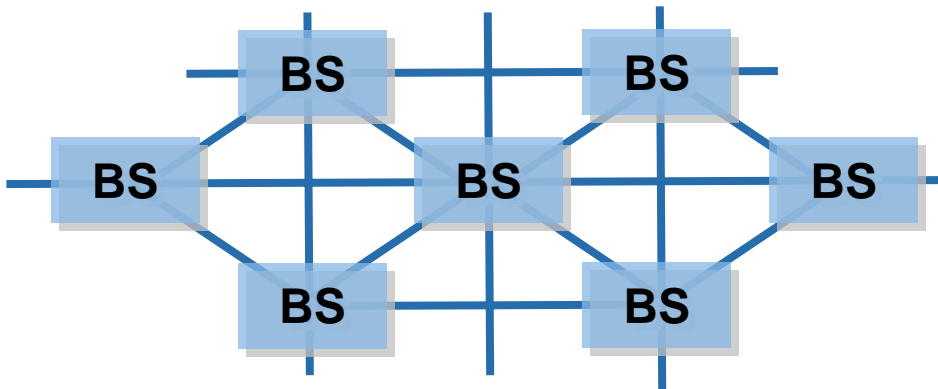
# Inter-Cell Radio Resource Management (RRM)

Adjacent cells usually use the same frequency band.

**Interference avoidance** through co-ordination of radio resource usage between base stations is recommended.

**Different approaches** are conceivable:

- Semi-static (controlled by O&M)
- More dynamic / adaptive
  - Time-scale is in the order of seconds or higher (e.g. minutes)
  - Communication / co-ordination between base stations



Peer-to-peer?

Hierarchical?

RRM Server?

## Challenges (2/2)

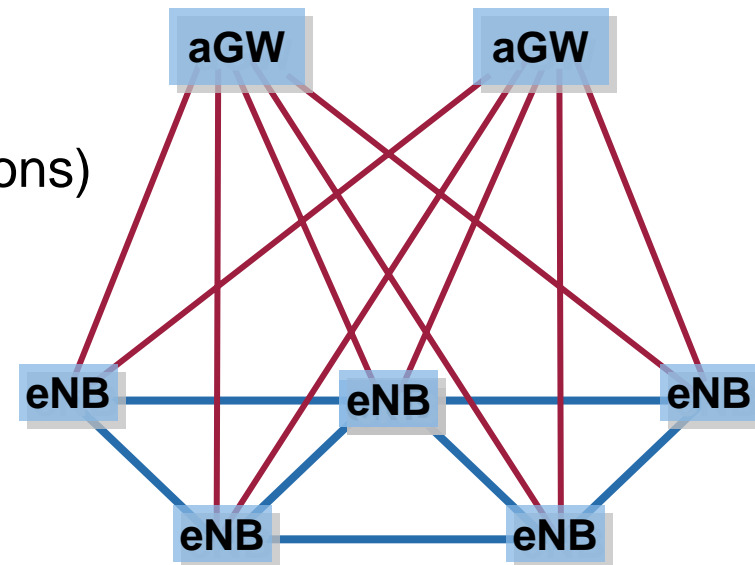
### Operation and Maintenance

Many interfaces

Many relationships (e.g. security associations)

Many parameters

No central “controllers” (e.g. RNC)



#### Approaches:

- Controlled by Operation and Maintenance Centre (OMC)  
+ maybe some kind of “Logical O&M Server”
- More dynamic approaches (probably in addition to OMC):
  - Self optimisation (c.f. RRM)
  - Self testing and self healing
  - Maybe even self-configuration (“Plug-and-Play”)

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# New trends are already visible in recent UMTS Releases

**Already in the UMTS Releases after Release 99** (i.e. Rel'4, Rel'5 & Rel'6), new trends in mobile network architectures set in:

- **IP-based transport** between network elements
- **Separation of Control and User Plane** in the Core Network
- **HSPA services towards the packet domain only**
- **Many-to-many relationships** between RAN and Core Network (lu-flex and RAN Sharing / Multi-Operator Core Network)
- **More functions in the base stations** (Node Bs):
  - for fast packet-based scheduling (HSPA)
  - with Hybrid-ARQ techniques
  - based on constantly increasing processing performance

# New trends are continued and emphasised in NGMNs

**Radio Access Network Architectures for NGMN** continue these new trends and emphasise them:

- **Use of IP-based protocols** throughout the system
- **Separation of Control and User Plane** in nodes above the base station (at least as an option in 3GPP systems)
- **Packet domain services only** (for all types of applications)
- **Flat / distributed network architectures** with less types of network nodes and peer-to-peer & many-to-many interfaces
- **Support of RAN Sharing** to get radio coverage cheaper/faster and to satisfy business models / regulatory requirements
- **Most or all radio-related functions in the base stations:**
  - for fast and flexible packet-based scheduling and QoS-enabled high throughput / low latency services
  - no centralised network node / exploiting economy of scale

# The End



Thank you for your attention.

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