UMTS/GPRS system overview from an IP addressing perspective

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Introduction

- 1) Introduction to 3GPP networks (GPRS, UMTS)
  - Technical overview and concepts for 3GPP networks
    - Mobility
    - Network and network architecture
    - GPRS packet service
    - Roaming
- 2) Addressing concepts in 3GPP networks
  - What is the addressing model
  - Network element addresses
  - End-user addressing
  - Reasoning behind addressing models

Third Generation Partnership Project

- Global Partnership Project among regional SDOs
  - ETSI, ARIB/TTC, T1P1, CWTS, etc.
- Standardizing network systems on GSM and UMTS and beyond
  - Based on GSM legacy
  - 2G, 3G radio accesses
    - GSM radio interface
    - WCDMA UMTS radio interface
      - Upgrades: HSDPA/HUDPA
  - Currently looking at a new architecture with a new radio interface
- 3GPP does complete system specifications
  - The whole system from radio interface to management and charging

Some definitions

- GSM – Global System for Mobile communications (original name Global System Mobilé)
  - 2G Radio Access – GSM Radio Access Network - (GERAN)
  - Based on Time Division Multiple Access (TDMA)
- UMTS – Universal Mobile Telephony System
  - 3G Radio Access – UMTS Radio Access Network (UTRAN)
  - Based on Wide band Code Division Multiple Access (WCDMA)
- GPRS – General Packet Radio Service
  - The packet switched service for either GSM or WCDMA

What is difference between UMTS & GPRS ?

- There really isn't from an IP system perspective:

  GPRS is the packet switched service for UMTS & GPRS networks
  - The word GPRS is often used for a GSM network that supports GPRS
  - The radios for GSM & UMTS are different, but the IP network looks the same

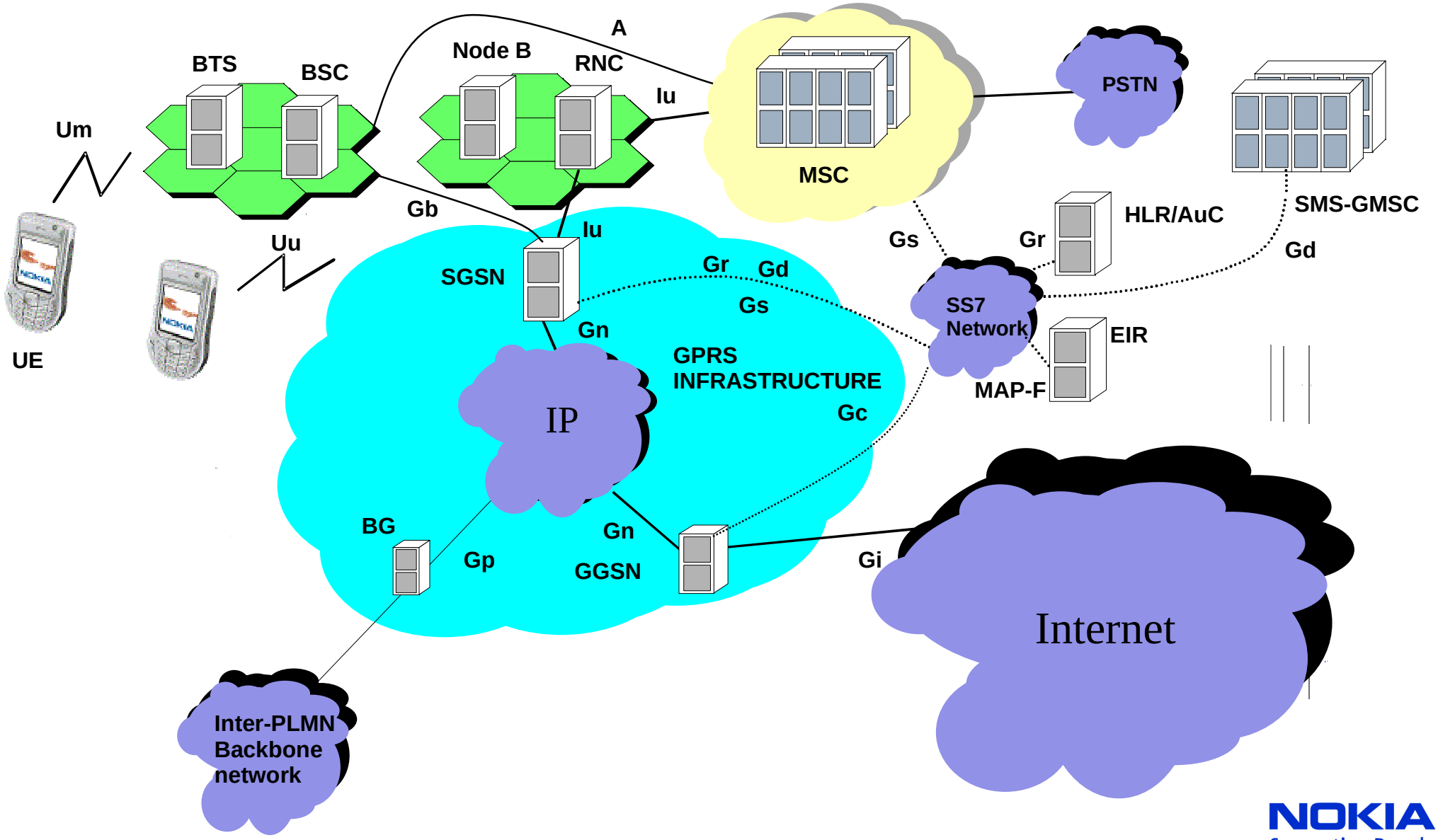
- IP in GPRS enabled GSM networks:
  - high latency, relatively slow
    - faster with EDGE
- IP in UMTS networks with WCDMA radios:
  - much lower latency, decent speeds
    - faster yet with HSPA (High Speed Packet Access)
      - HSDPA – High Speed Downlink Packet Access
        - Update to WCDMA for better downlink speeds
      - HSUPA – High Speed Uplink Packet Access
        - Update to WCDMA for better uplink speeds

Wireless versus Mobility

- Wireless & Mobility are NOT the same

- Mobility allows you to be on the move and keep your IP/voice connections alive
  - You cannot do this without adding complexity
  - GPRS uses tunnels to keep a stable IP address

3GPP Network Architecture



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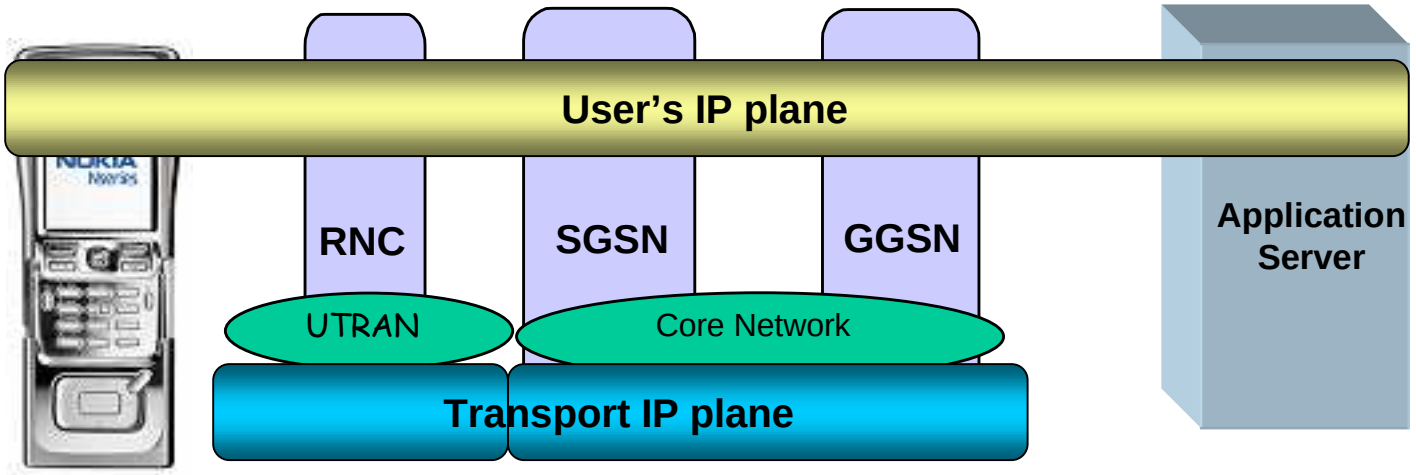
Some more definitions ...

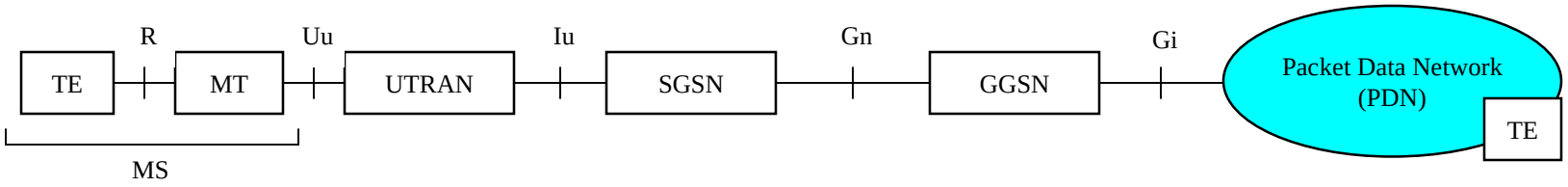
- BTS - Base Transceiver Station
  - A GSM network element that provides radio interface of the network
- BSC - Base Station Controller
  - A GSM network element that handles BRTS management and radio resource control
- Node B - Similar in function as BTS in GSM
- RNC - Radio Network Controller
  - In charge of controlling the use and the integrity of the radio resources
- UTRAN - Universal Terrestrial Radio Access Network
- SGSN - Serving GPRS Support Node
  - Gateway between the RNC and the core network
- GGSN - Gateway GPRS Support Node
  - A gateway from a cellular network to an IP network, access router for UE
- MSC - Mobile Switching Centre
  - A GSM network element that connects the GSM network to the PSTN

User’s packets vs. the network’s packets

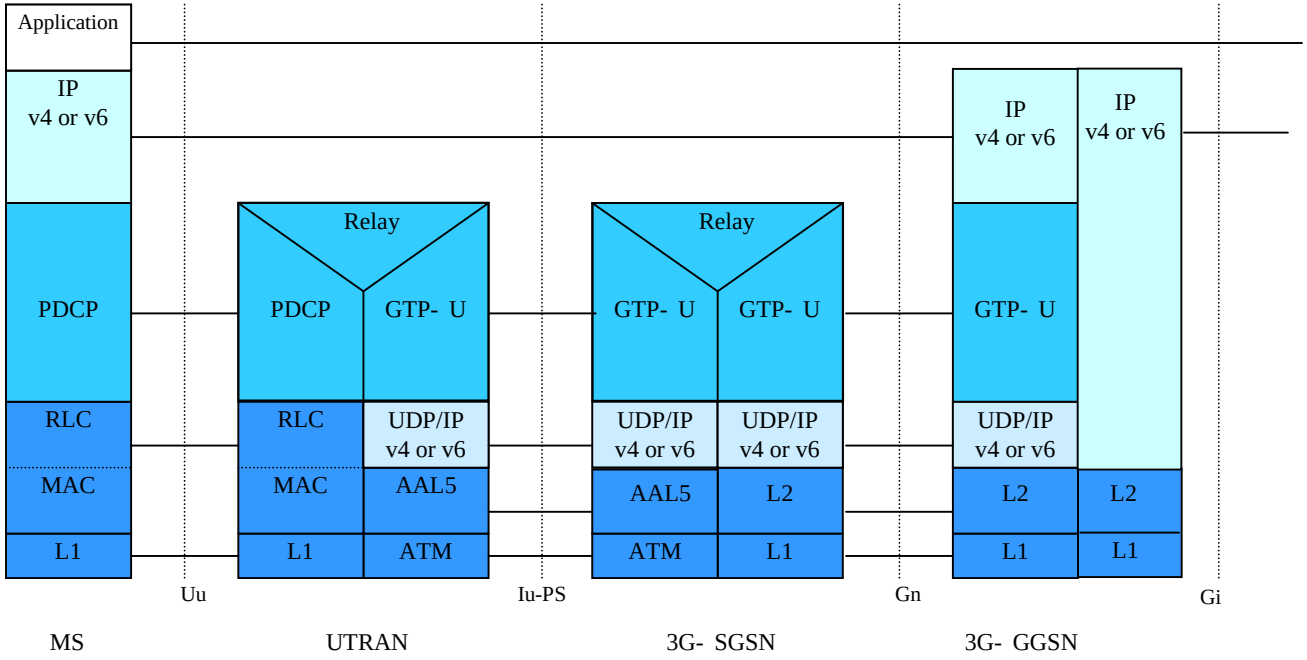


- User and transport planes are completely independent, i.e. the transport plane can run on a different IP version than the user plane
- UTRAN and Core Network transport can theoretically run on different IP versions

The Stack



PS Domain User Plane protocol stack



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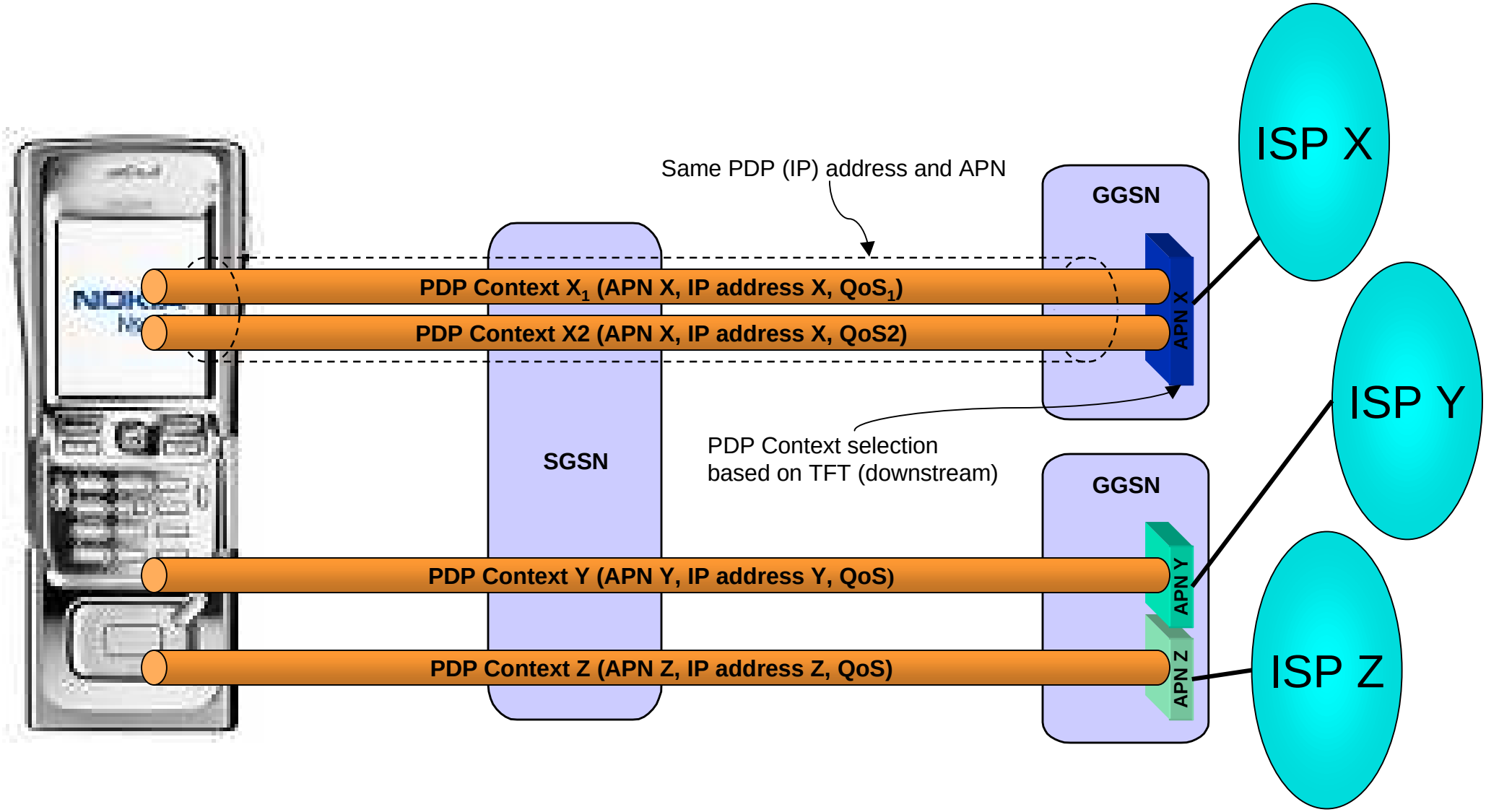
PDP Context



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The PDP Context

- When User Equipment (UE) attaches to the Network, the SGSN creates a Mobility Management state containing information pertaining to e.g., mobility and security for the UE

- At PDP (Packet Data Protocol) Context Activation, the SGSN and GGSN create a PDP context, containing information about the packet data session (e.g. IP address, QoS, routing information , etc.)

    - Each Subscriber may activate several PDP Contexts towards the same or different GGSNs. When activated towards the same GGSN, they can use the same or different IP addresses.

Access Point Name

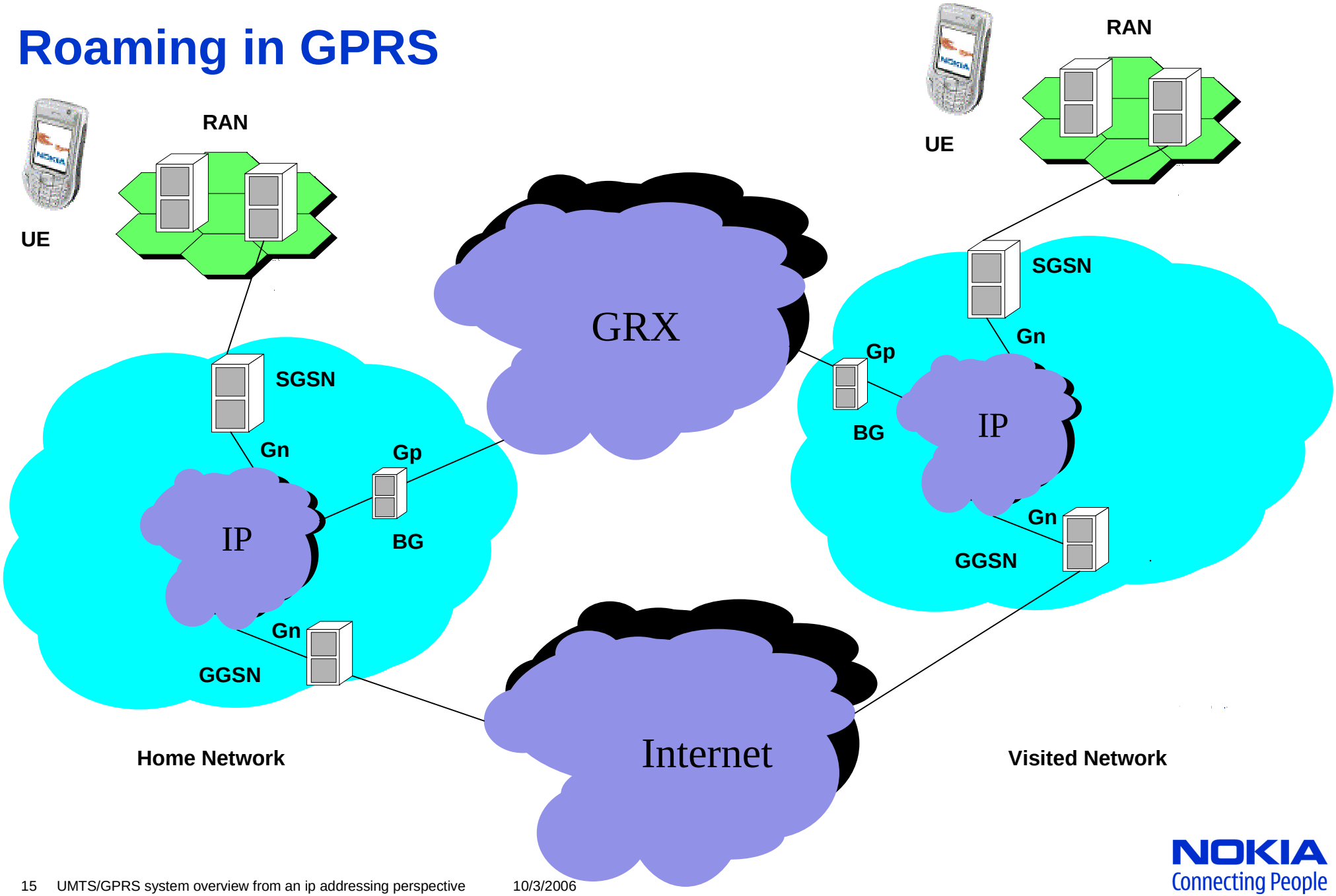
- The APN is a logical name referring to a GGSN. The APN also identifies an external network.
  - The syntax of the APN corresponds to a fully qualified DNS name.

- At PDP context activation, the SGSN performs a DNS query to find out the GGSN(s) serving the APN requested by the terminal

Roaming

- Historically, one of the key strengths of the GSM system is roaming capability
- User can use any GSM network in the world and use the GSM service like as if at home
  - Can make phone calls normally
  - Can receive phone calls normally – using the same MSISDN number
- This feature has been carried to GPRS for the packet service

Roaming in GPRS



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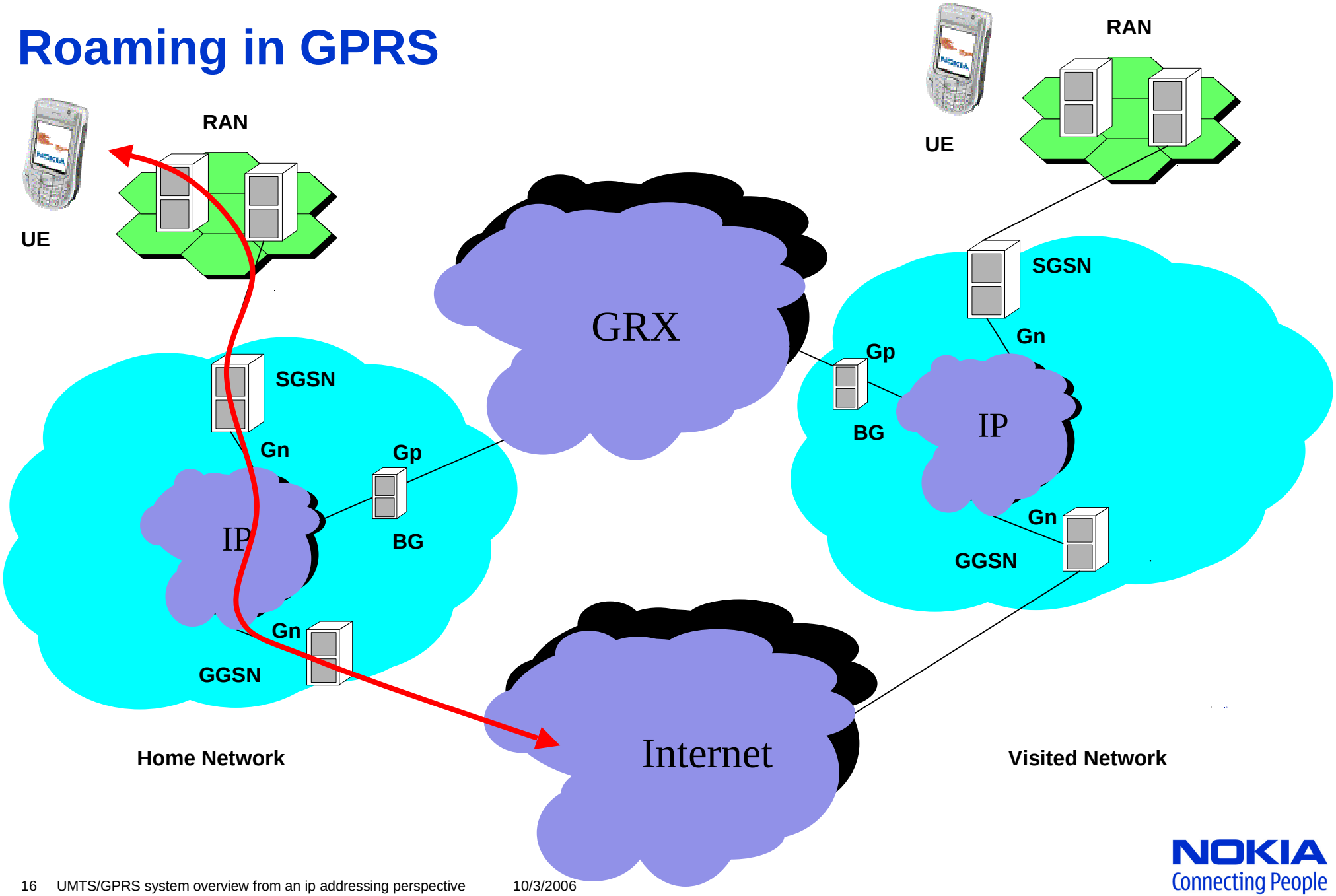
Roaming in GPRS



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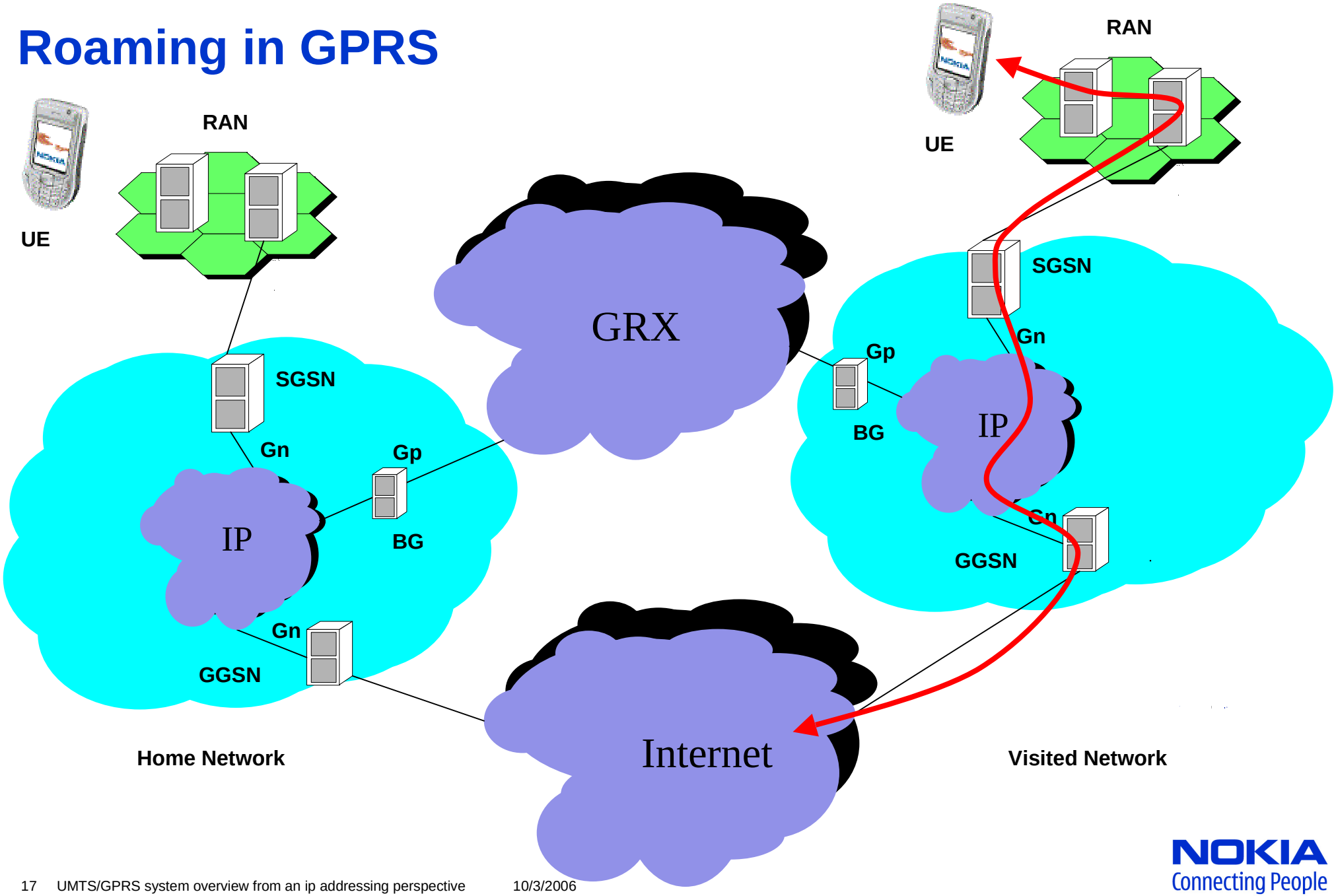
Roaming in GPRS



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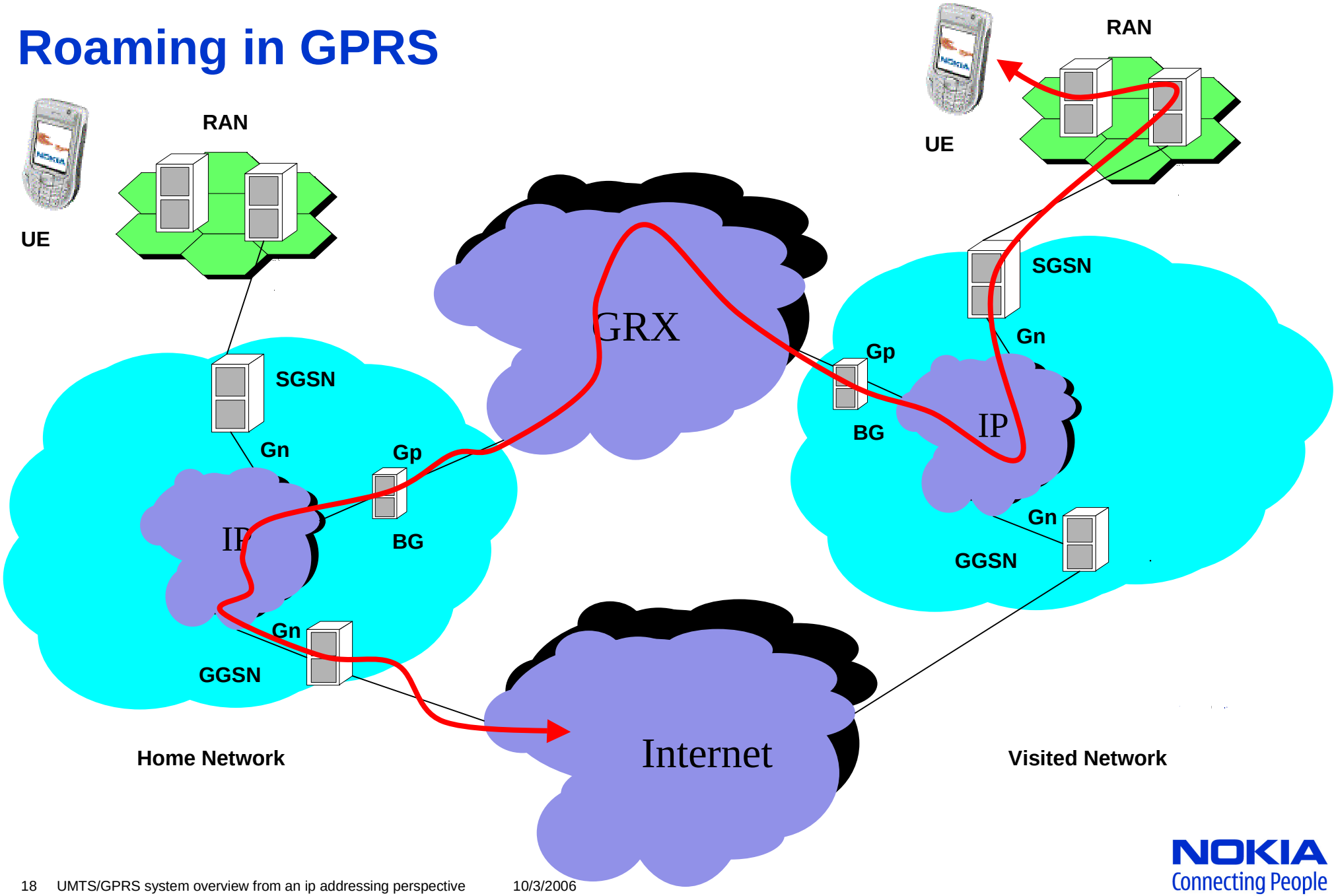
Roaming in GPRS



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Roaming in GPRS

- Visited GGSN
  - Not used much in real life
- Home GGSN
  - Uses GRX to transfer traffic between operators
  - Allows access to home services
    - Special access points
    - Special services (e.g. WAP, MMS)
  - Allows advanced charging models

GPRS Roaming Exchange (GRX)

- Inter-operator secured IP network
  - VPN between GPRS operators
- Designed to carry inter-operator traffic
  - E.g. Roaming traffic, MMS traffic
- GRX is not connected to the Internet

Addressing Models

- GPRS has two planes
  - Transport Plane
  - User Plane
- Transport and User planes are independent of each other
  - Addressing models are independent
  - IP versions are independent

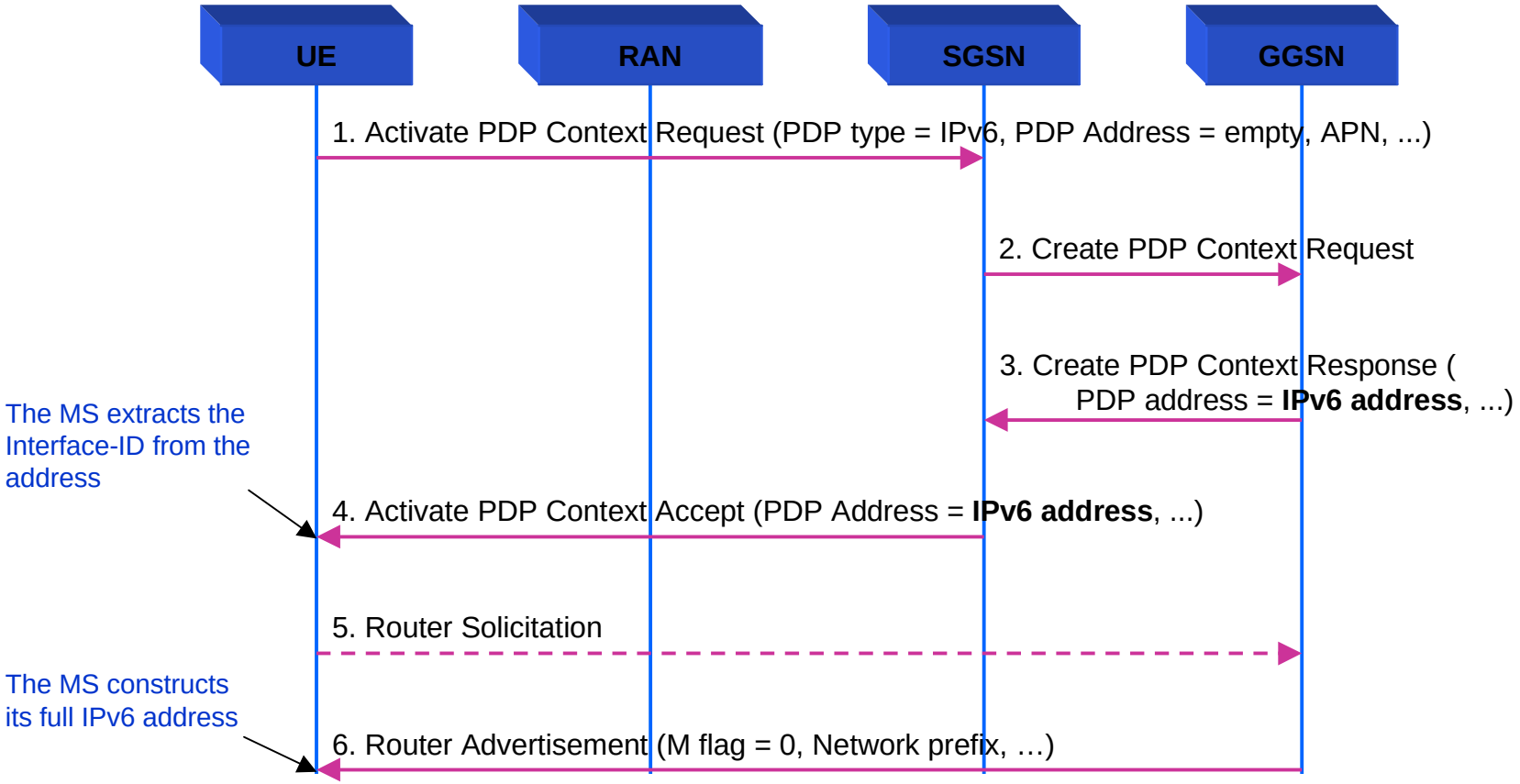
Network Element Addressing – Transport Plane

- Network elements sit in their own network
  - Intra-operator network
- They are usually connected via an inter-operator network
  - The GRX
- Due to GPRS security model GPRS intra and inter-operator networks are not connected to the Internet
- In interconnected GPRS network, different GPRS elements have to be able to connect directly to each other
  - Network element addresses have to be unique
  - Public IP addresses are used

End-User Addressing - User Plane

- Two types of PDP Contexts
  - Primary PDP Context and secondary PDP Context
- Each Primary PDP Context has its own IP address/prefix
  - Secondary contexts are related to a primary context and use that address
- Both IPv4 and IPv6 are supported in GPRS
  - One PDP Context can only carry one IP version
- Allocated addresses can be static or dynamic
  - Dynamic is used far more often than static
  - Dynamic address is allocated only for the duration of the PDP Context
- In IPv6, one /64 prefix is allocated per PDP Context

PDP Context Activation



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Further end-user addressing considerations

- IPv4
  - Commercial services are still IPv4 only
  - Sometimes RFC1918, sometimes public addresses
    - Operator and service dependent
- IPv6
  - Interest for IPv6 is increasing
  - /64 per PDP Context
    - IETF recommendation
- Most of new phones have GPRS
- Currently MMS, browsing, and VPN are the most used applications
  - Relatively short lived PDP Contexts → UE does not have an IP address all the time
- Emerging applications include IM, presence, PoC, IMS
  - Always-on PDP Context → UE has to have an address all the time

All the regular problems with NAT and more ...

- Many operators use private IPv4 addresses for their GPRS service
- All the standard issues with NAT and more:
  - Many mobile operators have more than 16 million customers
    - exceeds the pool of available ipv4 private addresses if we move to always on services
      - problems for peer-to-peer connection within one operator
      - complex management issues when using multiple instances of the same private address space pool within the same operator
  - Keep alives are necessary to maintain connections
    - drains battery

Summary

- 2G/3G IP usage will increase in the future
- Address usage will change from short time to always on
- Currently IPv4 is used for end-user addresses
  - Increasing demand for IPv4 addresses
- Increasing interest for IPv6
  - Increasing number of requests for IPv6 address space from mobile operators