

# User-Centric Approach to Always-Best-Connected Networks

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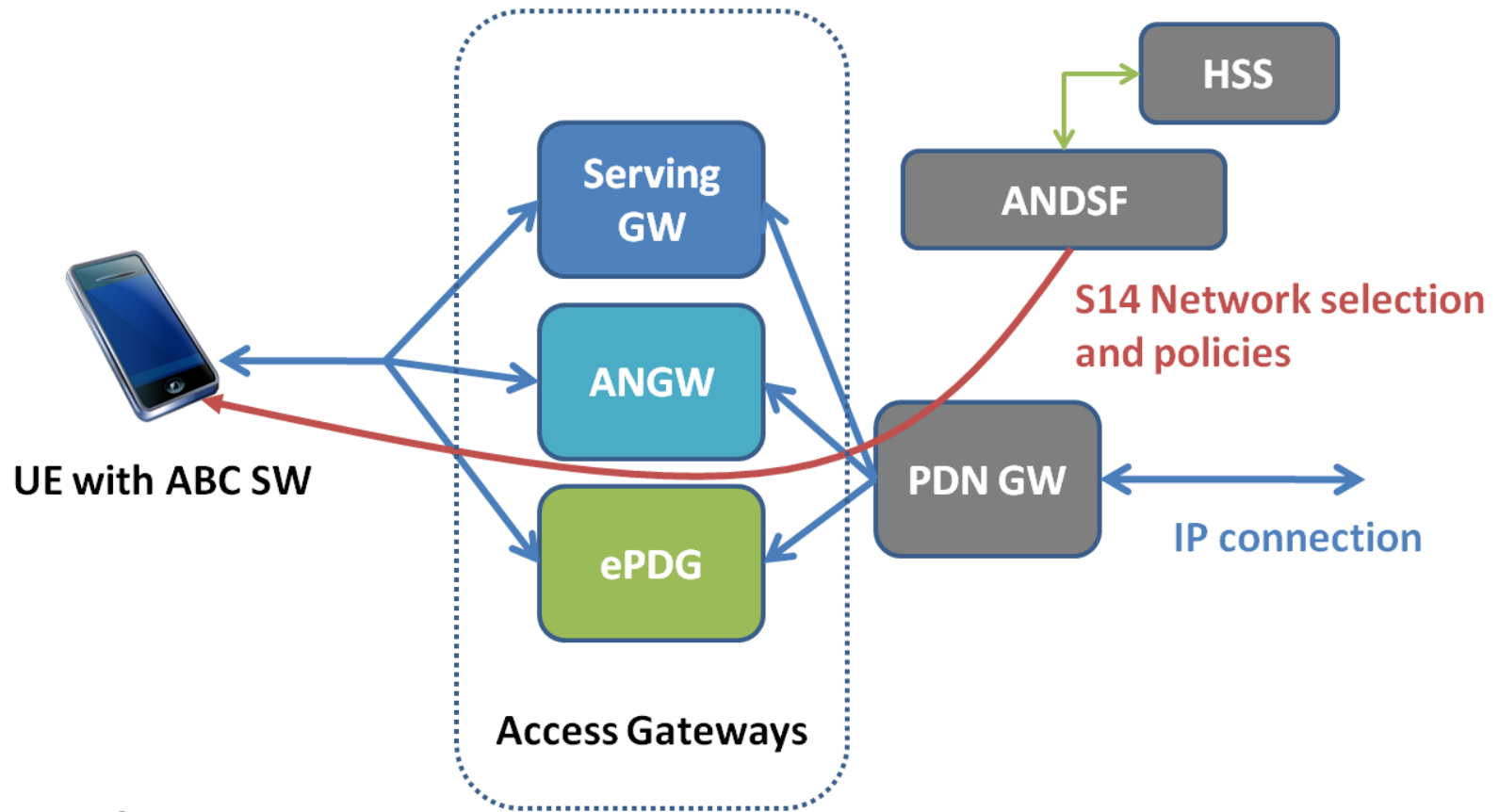
# Research Problem

- Creation of software architecture that can enable always most suitable connection to IP network (in a heterogeneous network environment)
- Always Best Connected (ABC) IP Network: what is the best/most suitable
  - In term of cost, throughput, latency, current consumption and large number of other criteria?
- User-Centric
  - User should be in control (?)
  - User preferences should be taken into account: for example use of selected network in home, work; some applications must use fixed access point
- Co-operation with existing/coming standards
  - The proposed solution must work in co-operation with 3GPP and IETF standards such as: Evolved Packet Core, Proxy Mobile IPv6

# Background

- End user devices (mobile phones, tablets) are equipped with more than one radio access (e.g. cellular, WiFi, Bluetooth)
- Number of hotspot style networks (specially WiFi) has increased
  - Traditional hotspots such as in airports, hotels, coffee shops
  - And they are also available in large number in home and in companies
- The Evolved Packet Core (EPC) was introduced in 3GPP Release 8 in 2008 along side with LTE. Key improvements from architecture point of view was all IP model and a simplified structure in every way
- Most significantly (regarding to ABC) it allows connectivity from non-3GPP access types, such as WiMAX, cdma2000 and WiFi
- Utilizes IETF protocols such as Proxy Mobile IPv6 for seamless handovers between different radio access networks (vertical handovers)

# Always Best Connected in terms of EPC



Access Gateways: different depending on radio access e.g. LTE, trusted non-3GPP and untrusted non-3GPP

Access Network Discover and Selection Function ANDSF will help UE to find suitable access

Pros: UE don't need to turn on multiple radios in order to discover networks

Cons: User is not in control, dictated by the operator

# Implementation and Measurements

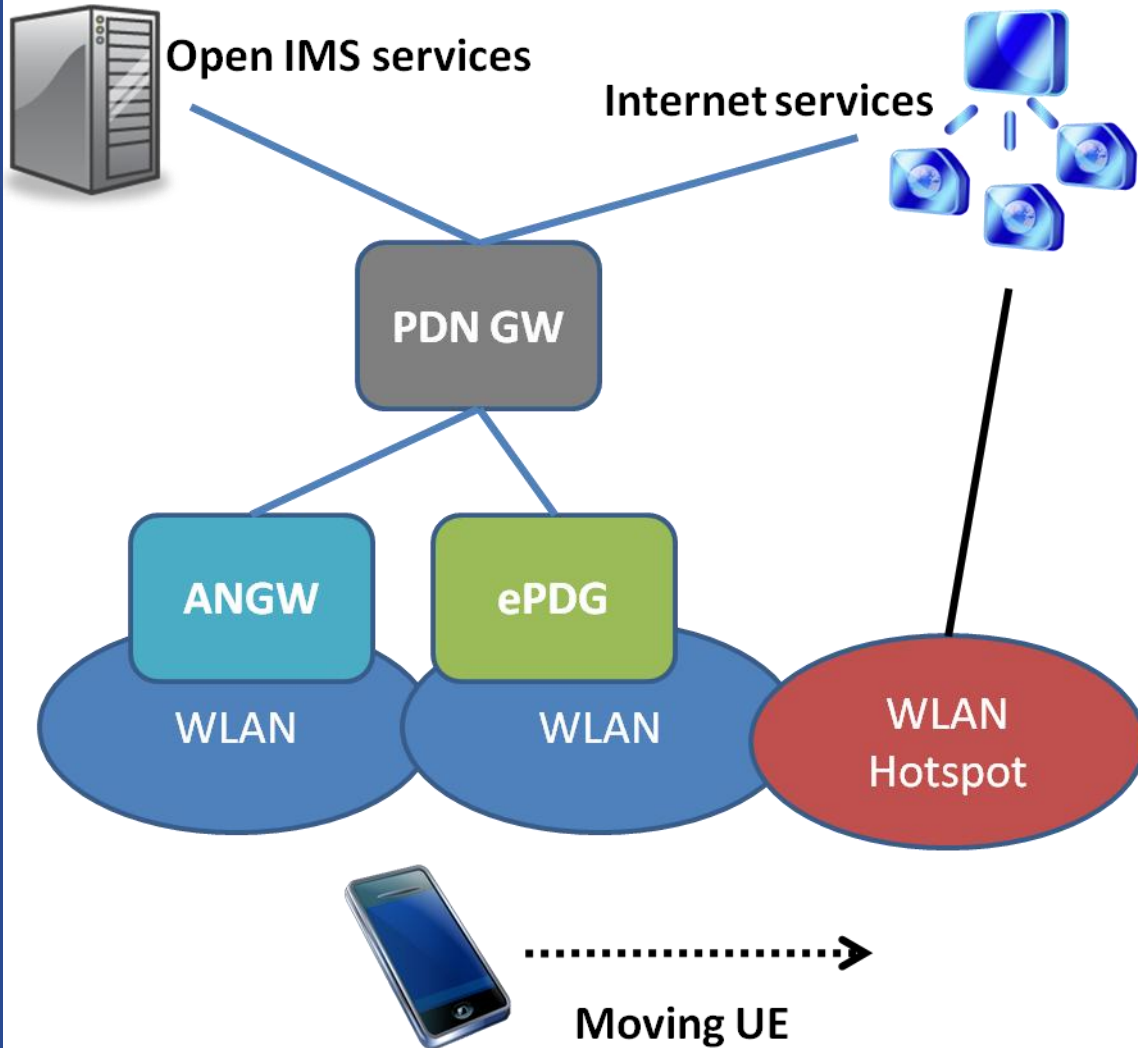
## Implementation

- Two clients: one Android one Qt based
- Applications can
  - Scan available networks
  - Can switch between networks
  - Prioritize networks
  - Show user applications
  - Show which of the user applications use network
- Networks are prioritized:
  1. Known protected WiFi
  2. Cellular access if expected throughput => HSDPA
  3. Open networks
  4. Other networks



# Implementation and Measurements

## Test Setup



ψ [Wi-Fi icon] [Cellular signal icon] [Battery icon] 09:43

ABCApplication

Get UIDs Scan Permissions

Level [dBm]	SSID	Frequency [MHz]
-65	pilotti	2412
TODO	Tel. network	UMTS
-82	agora-open	2462
-82	agora-open	2412
-87	agora-open	2462
-82	jyu-guest	2412
-83	jyu-guest	2462
-82	agora-open	2462
-82	agora-open	2412
-87	agora-open	2462
-82	jyu-guest	2412
-83	jyu-guest	2462
-82	agora-open	2462
-82	agora-open	2412
-87	agora-open	2462

# Implementation and Measurements Results

- Test done without any optimization and without Mobile IP
- Android based (Samsung Galaxy S2):
  - WiFi to WiFi – average connection switch time ~ 850 ms
  - WiFi to HSDPA – average connection switch time ~ 2500 ms
- Qt based (Nokia N900)
  - WiFi to WiFi – average connection switch time ~ 1550 ms
  - WiFi to HSDPA – average connection switch time ~3500 ms
- Service continuity was dependent on application implementation as the IP address was changed during the network



# Conclusions and Future Work

- ABC application was created to actively find most suitable networks.
- Yet the solution is 3GPP EPC compatible as it can intrepid the ANDSF information from the operator
- Basic prioritization of network was done by the ABC application
  - Simply known fast networks first, open and unknown networks at last
- Network switch performance was implementation dependent and by default way too slow for real-time communication
- In future:
  - EPC should be simulated for seamless vertical handover (with Proxy Mobile IP and IPSec tunnels)
  - Network selection algorithm and mechanism improvements
  - Performance measurements with simulated EPC