



VoLTE: VoIP for Mobiles

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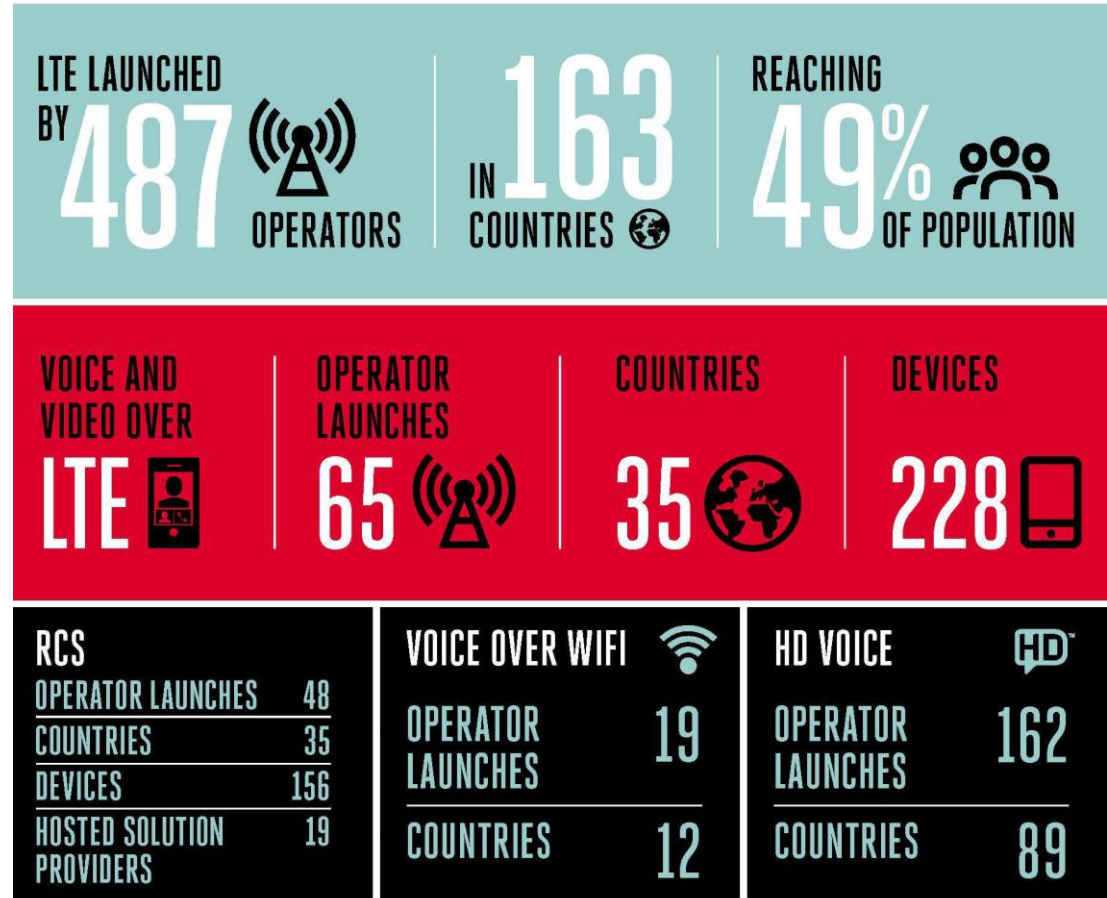
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Yes, its VoLTE

- VoIP on the Mobile network by the operator, using the native dialer, with your phone number as your id. It is called **VoLTE**
- All operators are offering it
 - O2 (April 2015)
 - Vodafone (May 2015)
 - T-Mobile (Jan 2016)



DELIVERING AN ALL-IP WORLD



Advantages for the end user

- Ultra fast call setup time
- Battery consumption
- HD-Voice
- Native dialer and transparent to the user
- Reachability (compared to VoIP apps)



Advanced Calling: The benefits

Speed
You benefit from a consistently high surfing speed, even when making calls. From dialling a number to the phone ringing out takes just two to three seconds.

Energy-saving
The new technology saves your mobile phone battery. You stay in the 4G network permanently and energy-intensive switching to the 3G or 2G network is seldom necessary.

Voice quality
Enjoy crystal-clear voice quality – as if you were standing right next to the person.

Availability
You always make calls over the best available connection (4G or WiFi). So wherever WLAN is available, customers always have network access.

Name display
Take advantage this year already of having the names of persons and companies listed in the telephone directory displayed when you make calls.

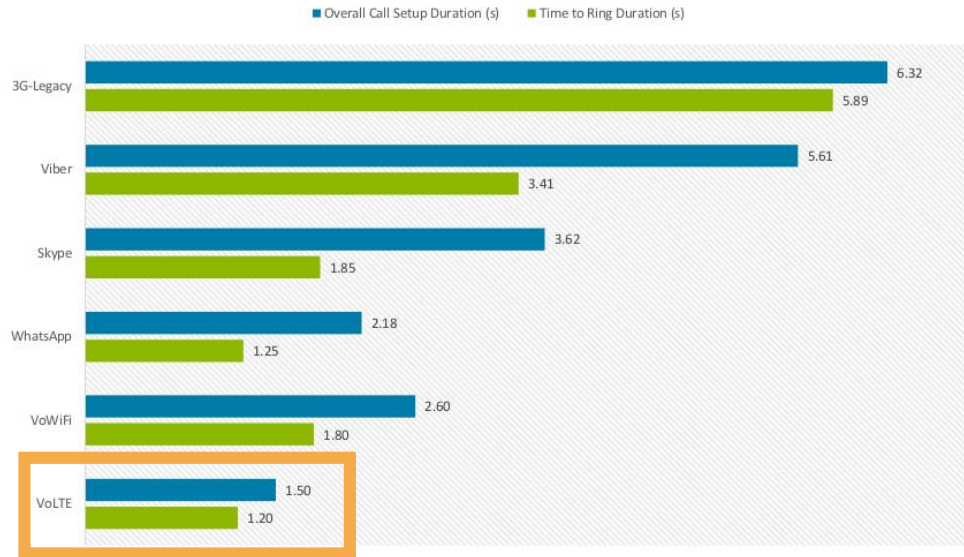
WiFi Calling
With WiFi Calling you can make calls over both the mobile and WLAN network. To use WiFi Calling you have to activate it in the [Device settings](#).

VoLTE
VoLTE allows customers with 4G/LTE-ready smartphones to make calls directly over the 4G/LTE network and not as previously over the 3G or 2G network.

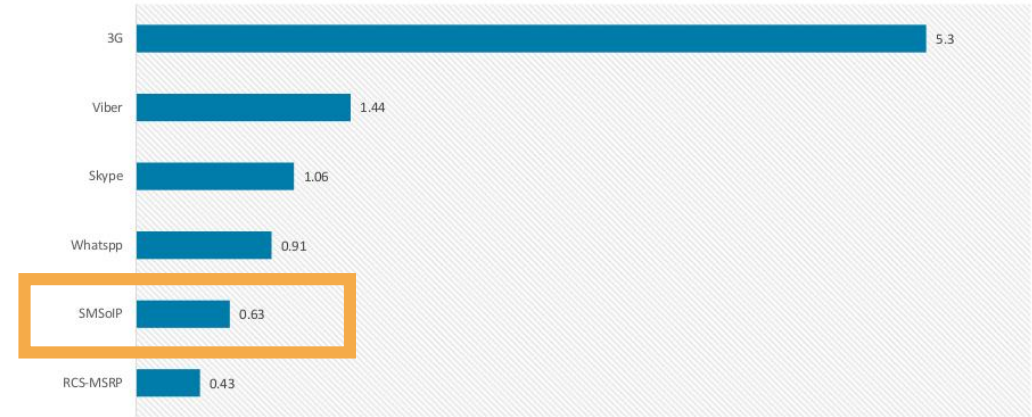
By Swisscom

Studies show it

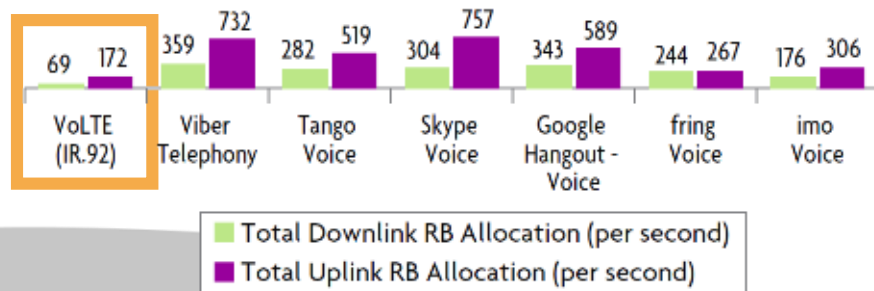
CallSetup vs. Time to Ring Durations



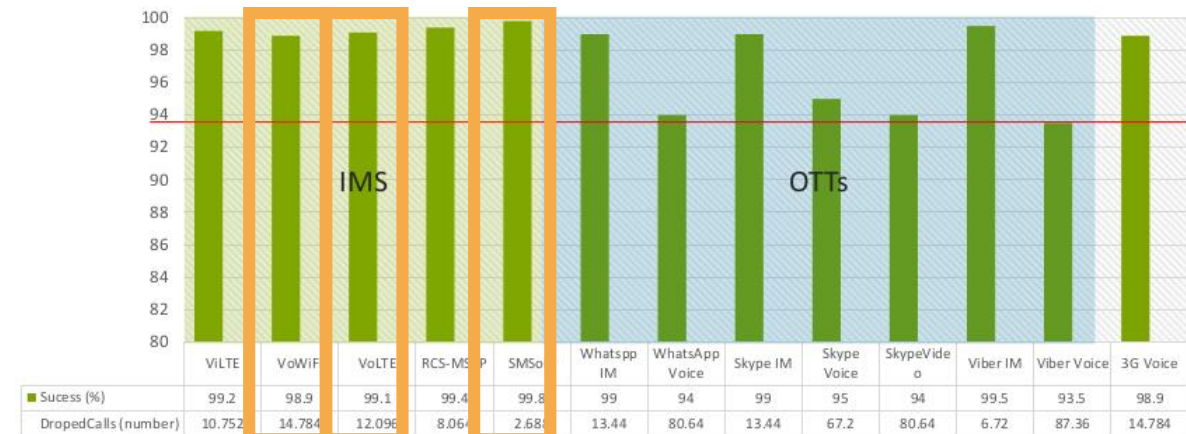
Messaging Delivery time



Radio Resources Usage

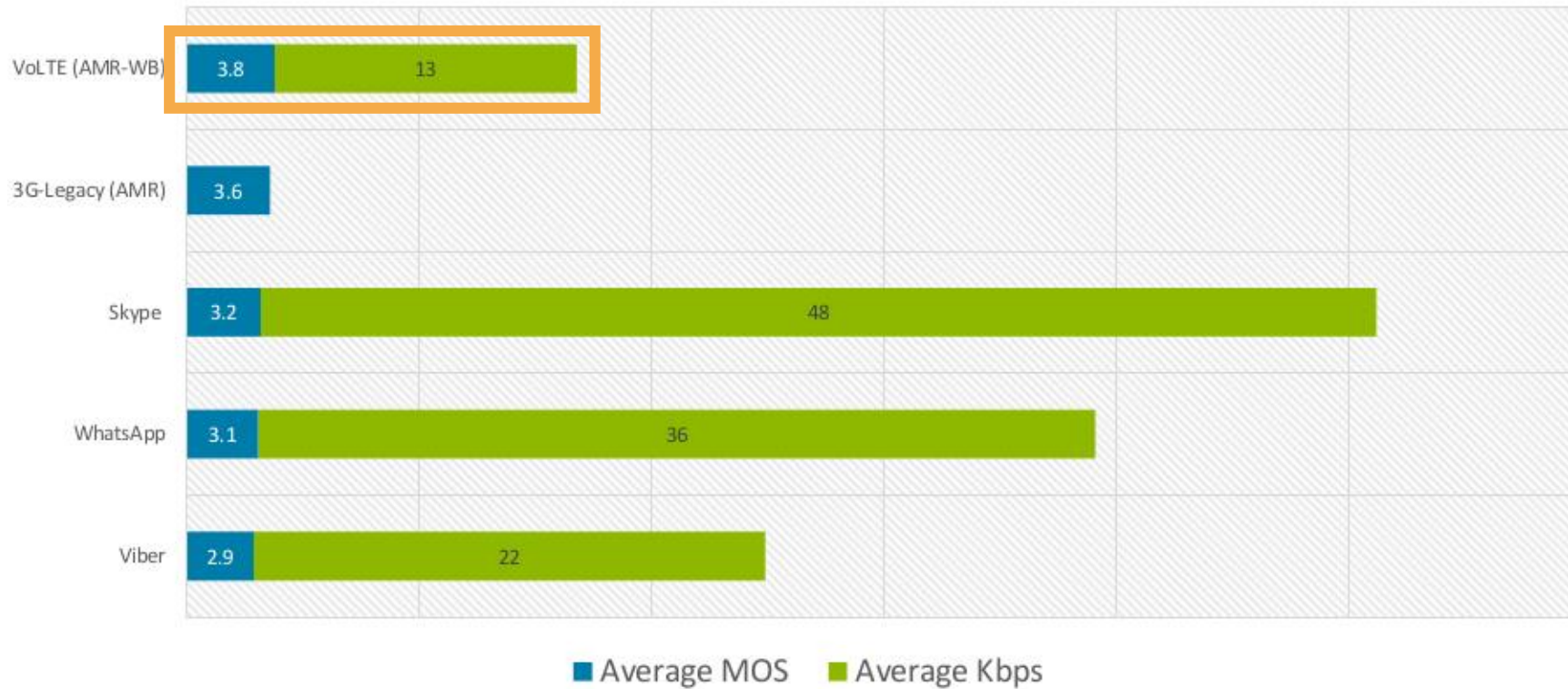


Service Success Rate (%)



Users notice it

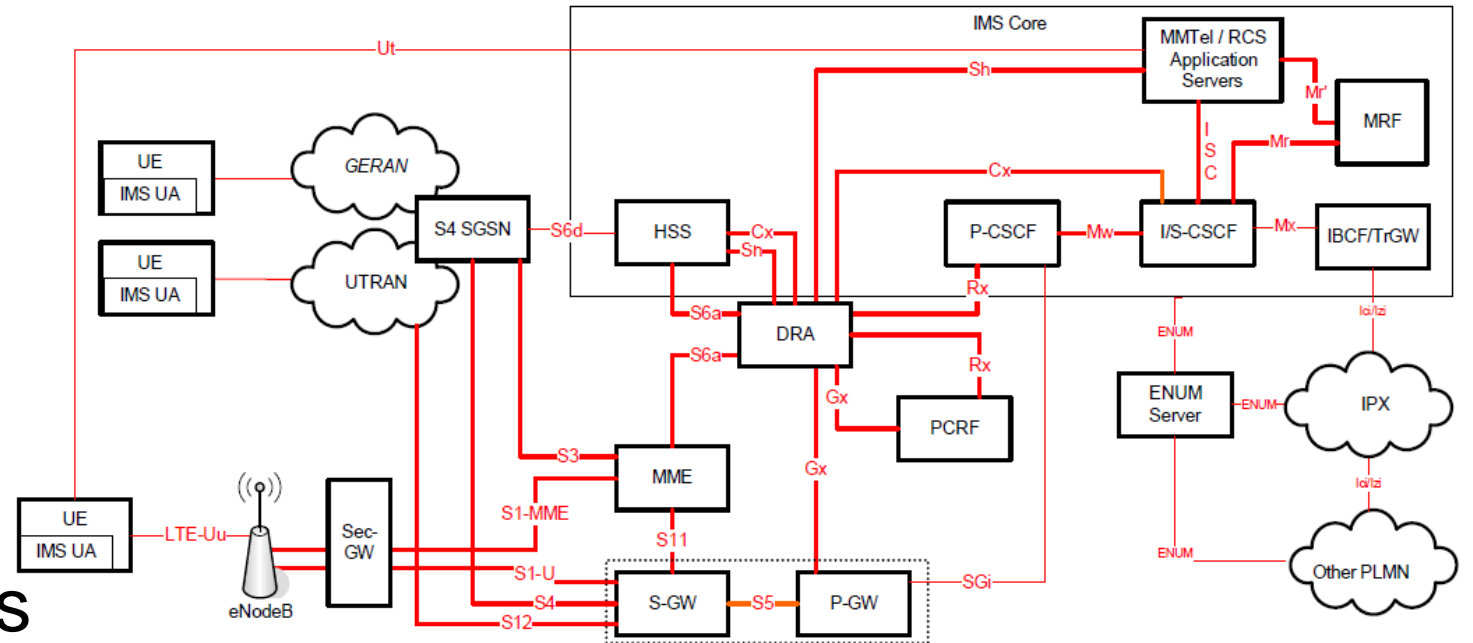
Average P.863 POLQA MOS vs. Average Bitrate



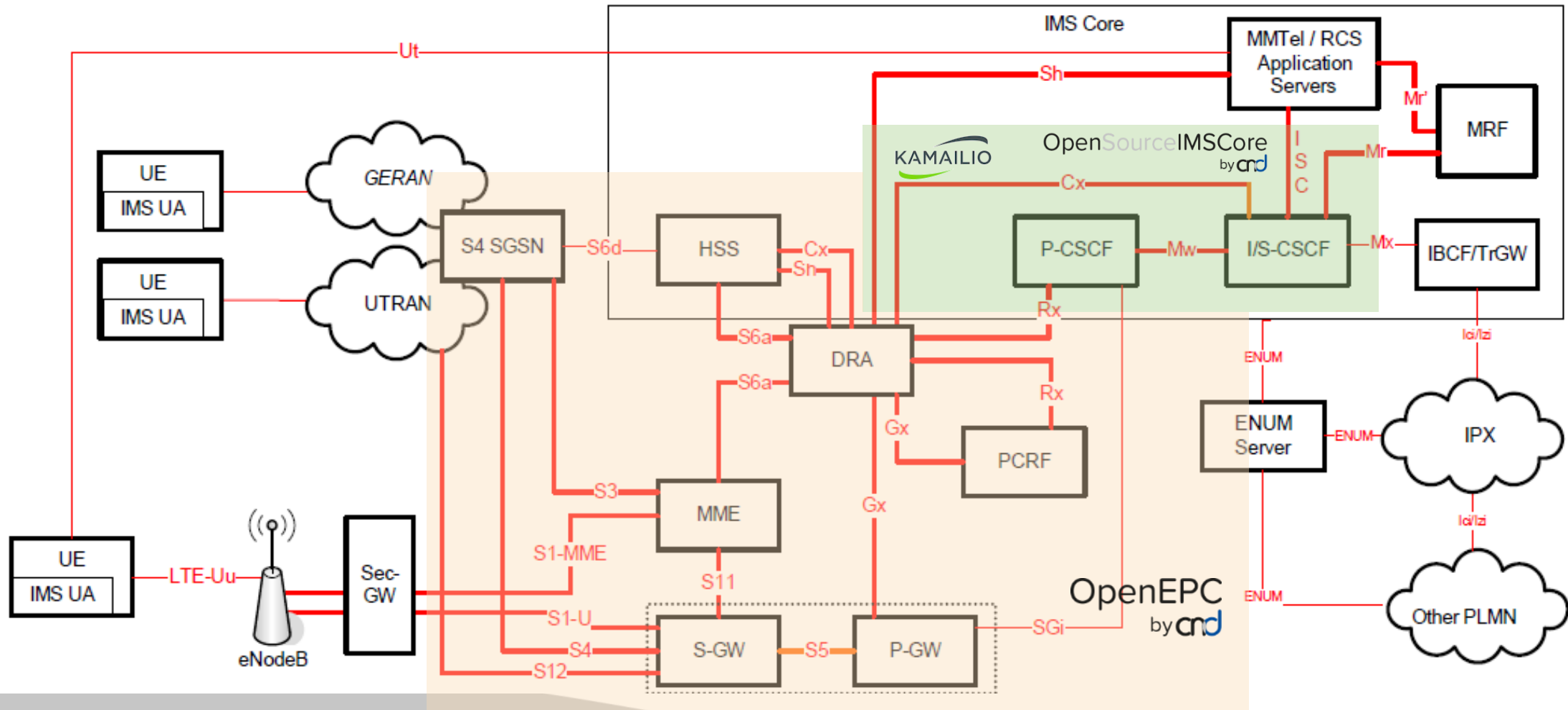
What's behind it?

- 
 IR.92

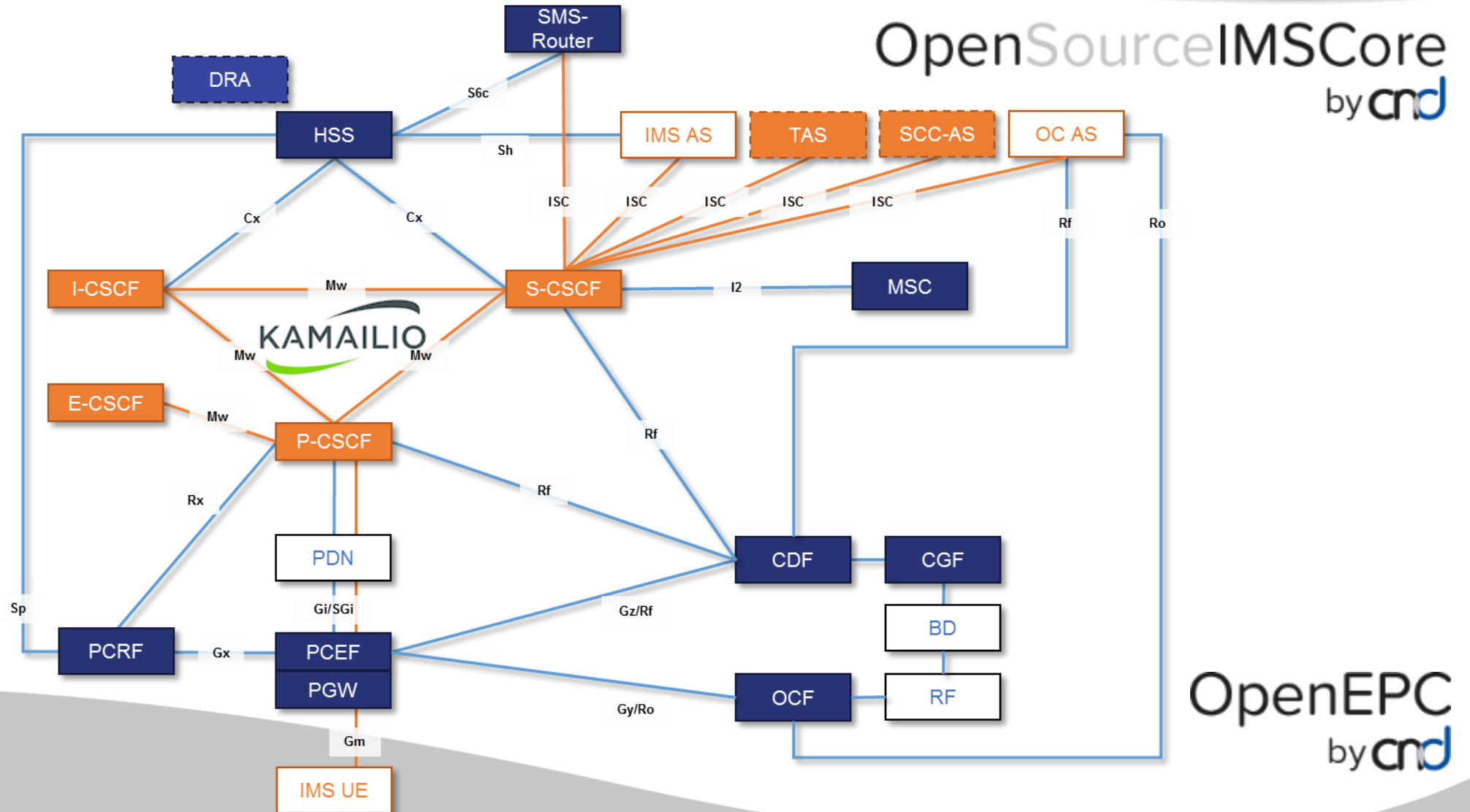
- IMS Requirements
- EPC Requirements
- Radio Requirements
 - RoHC
 - DRX
 - QCI 1, 5, 8/9
- Supplementary Services
- Mobile Phone Requirements



How have we done it?



OpenIMS with OpenEPC 7



Kamailio part

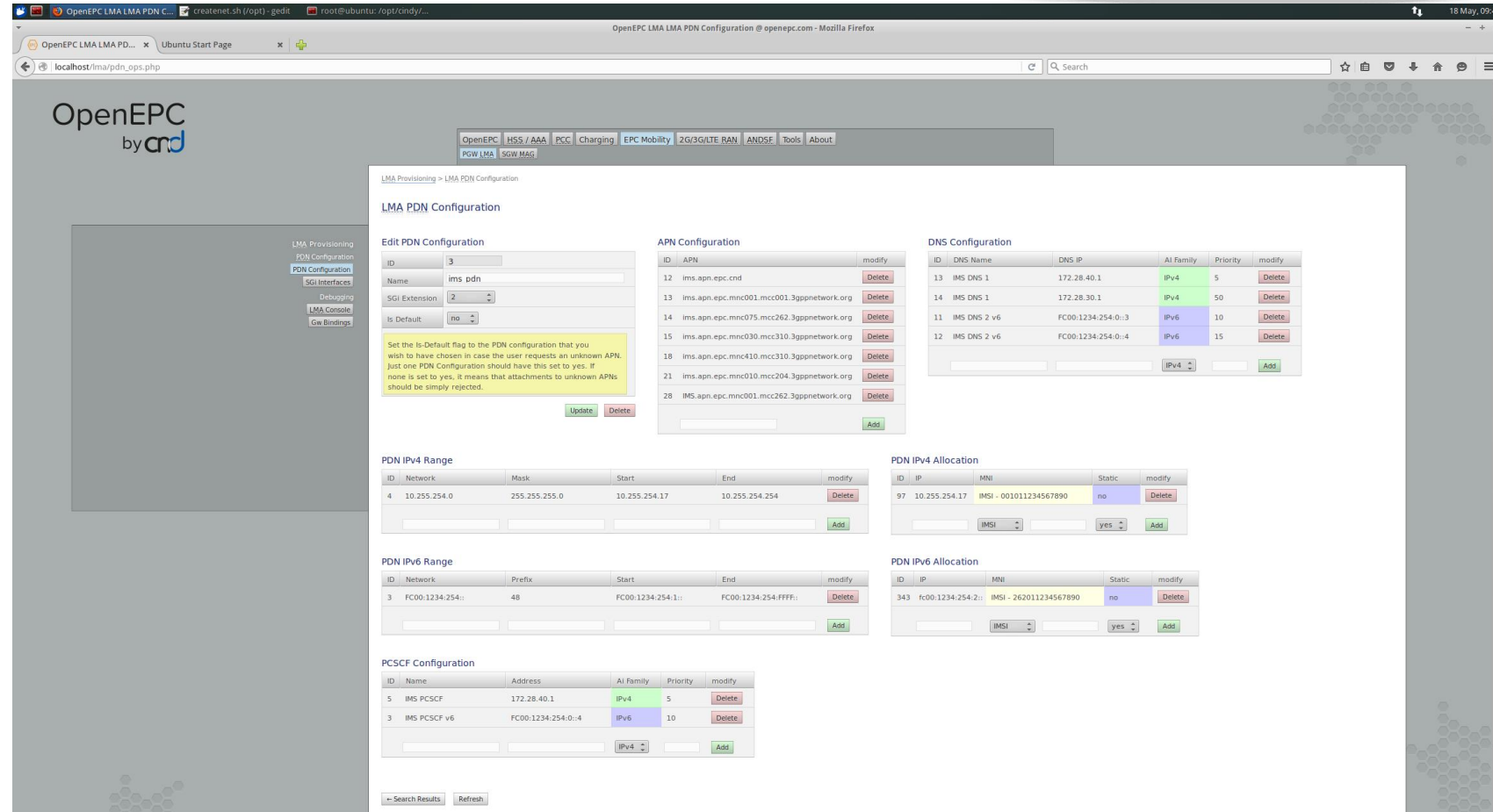
- Configuration
 - Domain names as in standard
 - Switch to TCP
- Authentication
 - No AKA because of missing IPSec
 - Using now just EPC security
- Voice Call
 - Fixing P/I/S-CSCF bugs
 - Issues with check Via/Contact
 - Rx interface from P-CSCF – Mandatory
- Messaging
 - Using sms_ops
 - (issues with SMS Payload Codec)

```

> Frame 201: 1476 bytes on wire (11808 bits), 1476 bytes captured (11808 bits) on interface 0
> Ethernet II, Src: Airspan_cc:aa:18 (00:a0:0a:cc:aa:18), Dst: DavidE
> Internet Protocol Version 4, Src: 192.168.4.91, Dst: 192.168.4.15
> User Datagram Protocol, Src Port: 2152 (2152), Dst Port: 2152 (2152)
> GPRS Tunneling Protocol
> Internet Protocol Version 4, Src: 10.255.254.18, Dst: 10.255.254.4
> User Datagram Protocol, Src Port: 5060 (5060), Dst Port: 5060 (5060)
Session Initiation Protocol (REGISTER)
  Request-Line: REGISTER sip:openepc.test SIP/2.0
  Message Header
    Content-Length: 0
    User-Agent: SM-G925F-XXS3DPDF Samsung IMS/5.0
    Supported: sec-agree,path_gwuu
    Proxy-Require: sec-agree
    Require: sec-agree
    Contact: <sip:alice@10.255.254.18:5060>;q=1.00;+g.3gpp.icsi-ref=
    Max-Forwards: 70
    CSeq: 1 REGISTER
    Call-ID: 1341963770@10.255.254.18
    To: <sip:alice@openepc.test>
    From: <sip:alice@openepc.test>;tag=948546483
    [truncated]Security-Client: ipsec-3gpp;prot=esp;mod=trans;spi-c
    Authorization: Digest username="dave@openepc.test",realm="openepc.test",nonce="1341963770@10.255.254.18:5060",uri="sip:alice@openepc.test",algorithm=MD5
    Expires: 600000
  P-Preferred-Identity: sip:262011234567890@ims.mnc001.mcc262
  Max-Forwards: 70
  User-Agent: iOS/9.3.1 (13E238) iPhone
  Router: sip:172.20.10.1,172.20.10.1;transport=udp
  Content-Type: application/sdp
  Content-Length: 834
  Message Body
    
```

EPC part

- Configuration
 - Setup well-known APN (IMS)
 - QoS QCI
 - PCOs with P-CSCF address and indication of Voice over PS
- Setup
 - Deploy PCRF (QoS)



The screenshot shows the OpenEPC LMA PDN Configuration web interface. The main content area is divided into several sections:

- LMA PDN Configuration:** Includes an "Edit PDN Configuration" form with fields for ID (3), Name (ims pdn), SGI Extension (2), and Is Default (no). Below the form is a yellow warning box: "Set the Is-Default flag to the PDN configuration that you wish to have chosen in case the user requests an unknown APN. Just one PDN Configuration should have this set to yes. If none is set to yes, it means that attachments to unknown APNs should be simply rejected." There are "Update" and "Delete" buttons.
- APN Configuration:** A table listing APNs with columns for ID, APN, and a "Delete" button.

ID	APN	modify
12	ims.apn.epc.crd	Delete
13	ims.apn.epc.mnc001.mcc001.3gppnetwork.org	Delete
14	ims.apn.epc.mnc075.mcc262.3gppnetwork.org	Delete
15	ims.apn.epc.mnc030.mcc310.3gppnetwork.org	Delete
18	ims.apn.epc.mnc410.mcc310.3gppnetwork.org	Delete
21	ims.apn.epc.mnc010.mcc204.3gppnetwork.org	Delete
28	ims.apn.epc.mnc001.mcc262.3gppnetwork.org	Delete
- DNS Configuration:** A table listing DNS entries with columns for ID, DNS Name, DNS IP, AI Family, Priority, and a "Delete" button.

ID	DNS Name	DNS IP	AI Family	Priority	modify
13	IMS DNS 1	172.28.40.1	IPv4	5	Delete
14	IMS DNS 1	172.28.30.1	IPv4	50	Delete
11	IMS DNS 2 v6	FC00:1234:254:0::3	IPv6	10	Delete
12	IMS DNS 2 v6	FC00:1234:254:0::4	IPv6	15	Delete
- PDN IPv4 Range:** A table listing IPv4 ranges with columns for ID, Network, Mask, Start, End, and a "Delete" button.

ID	Network	Mask	Start	End	modify
4	10.255.254.0	255.255.255.0	10.255.254.17	10.255.254.254	Delete
- PDN IPv4 Allocation:** A table listing IPv4 allocations with columns for ID, IP, MNI, Static, and a "Delete" button.

ID	IP	MNI	Static	modify
97	10.255.254.17	IMSI - 001011234567890	no	Delete
- PDN IPv6 Range:** A table listing IPv6 ranges with columns for ID, Network, Prefix, Start, End, and a "Delete" button.

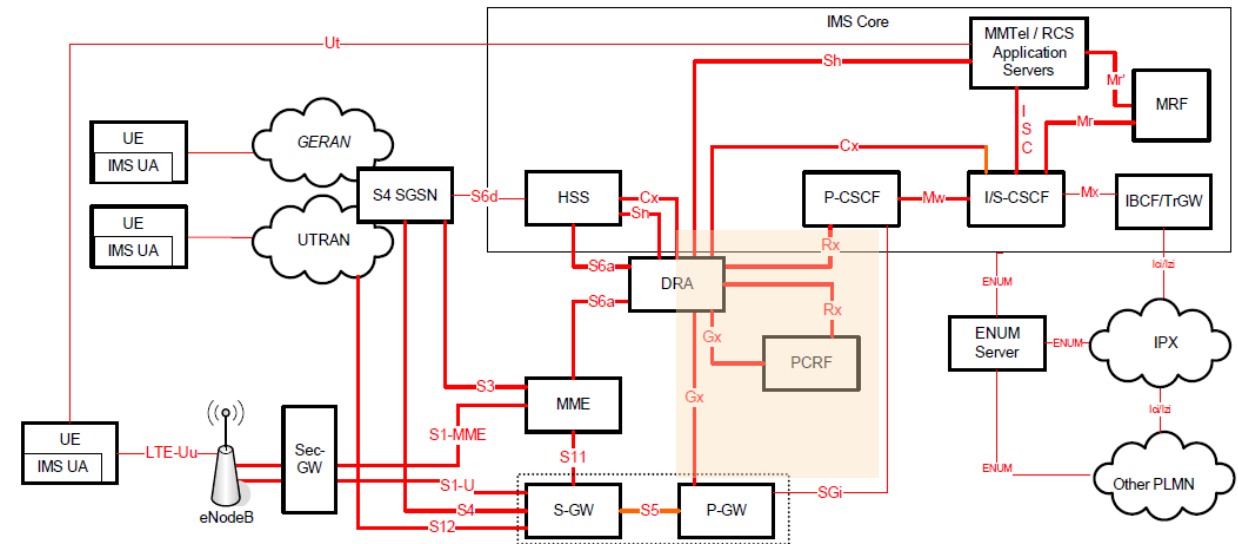
ID	Network	Prefix	Start	End	modify
3	FC00:1234:254::	48	FC00:1234:254:1::	FC00:1234:254:FFFF::	Delete
- PDN IPv6 Allocation:** A table listing IPv6 allocations with columns for ID, IP, MNI, Static, and a "Delete" button.

ID	IP	MNI	Static	modify
343	fc00:1234:254:2::	IMSI - 262011234567890	no	Delete
- PCSCF Configuration:** A table listing PCSCF entries with columns for ID, Name, Address, AI Family, Priority, and a "Delete" button.

ID	Name	Address	AI Family	Priority	modify
5	IMS PCSCF	172.28.40.1	IPv4	5	Delete
3	IMS PCSCF v6	FC00:1234:254:0::4	IPv6	10	Delete

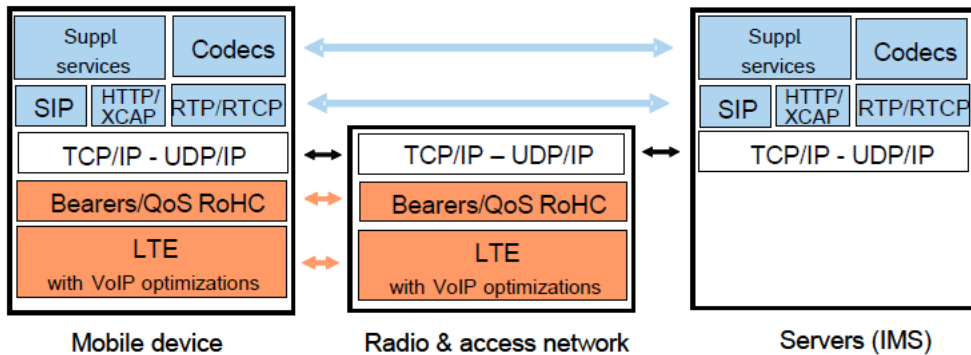
Quality of Service

- Key difference between VoLTE and VoIP is the usage of QCI 1 (GBR) for voice connection
- Setup of QCI 1 bearer requires a PCRF and interaction between IMS and EPC (Rx/Gx)
- Using OpenEPC 7 PCRF optimized for VoLTE



The phones

- VoLTE is supported in the baseband/firmware but only for pre-configured networks
- We did nothing to the phones!



iPhone (iOS 9.3.1)
 USIM/ISIM
 Dedicated Bearer
 Qualcomm
 MDM9625/MDM9635



Samsung Galaxy S7
 ISIM
 Different chipset,
 similar (?) SIP stack

The Demo



Virtualized
OpenEPC LTE Core Network software
& Kamailio IMS



AirSpan LTE FDD Small Cell



RF Shielded box with
standard Samsung S7
and iPhone 6 using
CND SIM Cards but
faking a T-Mobile network



A VoLTE call with the native dialers!

Roadmap

- Kamailio
 - CSCFs with ultimate performance, scalability and flexibility
 - MMTel-AS, SCC-AS, etc
 - Security: IPSec / TLS
- OpenEPC
 - ICS
 - SRVCC
 - CSFB
 - VoWiFi
- Supplementary Services
 - MMTel Application Server
- Phones
 - Further models and configurations
 - VoWiFi, Vo3G
- Convergence with PS
 - OpenEPC MSC
 - Directly emulating IMS UEs when connected on 2G/3G

Roadmap Functional Items

A. Diameter Interfaces

1. Upgrade of Cx to Rel.12
2. Upgrade of Sh to Rel.12 for Kamailio - client_sh
3. Upgrade of Rf to Rel.12 for Kamailio - client_rf
4. Upgrade of Ro to Rel.12 for Kamailio - client_ro

B. Mobile devices

1. iPhone carrier profile for experimentation
2. Android devices, unfortunately per vendor: Samsung, Google Nexus, LG, HTC, Sony, etc

C. VoWiFi - how to enable in phones and test

D. CSCF state

1. Dialog state saving, to enable full horizontal scalability.
2. Performance considerations, if any

E. GSMA VoLTE specs

1. IR.92 - how much can be covered today and do a priority list on the rest
2. IR.88 & others

F. SMS Center

1. Extensions maybe for full codec support, encodings, etc
2. What interfaces to add? Closed source

implementations available for SMPP, Diameter, MAP, etc

3. We have Diameter (SGd) interfacing and can offer OpenEPC as a platform for NAS/GSM-L3 delivery as alternatives

G. IMS Centralized Services - telephony core for 2G/3G legacy networks

1. Single core for both VoLTE/VoWiFi and 2G/3G PS voice & SMS

H. IPSec

1. Proper implementation of the Security-Client/Server/Verify headers
2. Implementation of Ipsec
3. Use of TLS as alternative

I. USSI/USSD support

Missed something? Let us know and join us!