Voice Over LTE (VoLTE) Technology
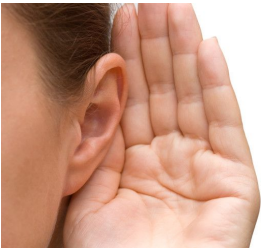
July 23, 2018
Tim Burke

Range of Frequencies Humans Can Hear

20 Hz   **20,000 Hz**

Human Hearing

8,000 Hz   10,000 Hz   12,000 Hz   14,000 Hz

Range of Frequencies Designed For Entertainment

50 Hz   **7,000 Hz**

AM Radio

20 Hz   **14,000 Hz**

FM Radio

20 Hz 50 Hz   **14,000 Hz**   **20,000 Hz**

Video Streaming

Range of Frequencies Designed For Communications

300 Hz   **3,400 Hz**

Telephony

50 Hz   **7,000 Hz**

HD Voice

50 Hz   **20,000 Hz**

HD Voice & Music

Mobile phones have codec's built into the device to reproduce voice

What is a Voice Codec (Coder-Decoder) ?

A codec converts an audio signal (your voice) into compressed digital form for transmission and then back into an uncompressed audio signal for replay.

Analog Signal carrying Data

Convert analog signal (waveform) into 1's and 0's by sampling signal at set points in time

- **Technology is called Pulse Code Modulation (PCM) is a waveform codec**
- **"Brute Force" technique for digitizing analog voice**

Most Current Codec's Use Synthesis Techniques
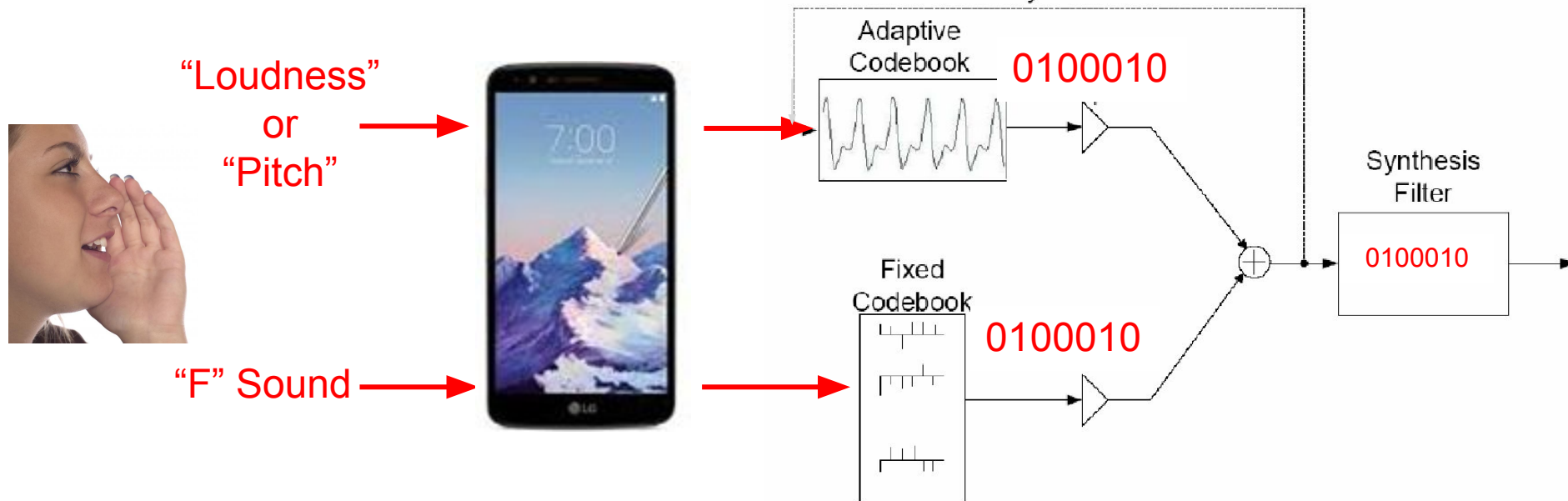
Convert analog signal into 1's and 0's by analyzing sounds, pitch, volume and performing sophisticated "look-up's" in Codebooks (databases)

Current Mobile Phone Voice Codecs

Standard Voice (GSM & 3G)

AMR-NB codec
12 kbps
3,400 Hz

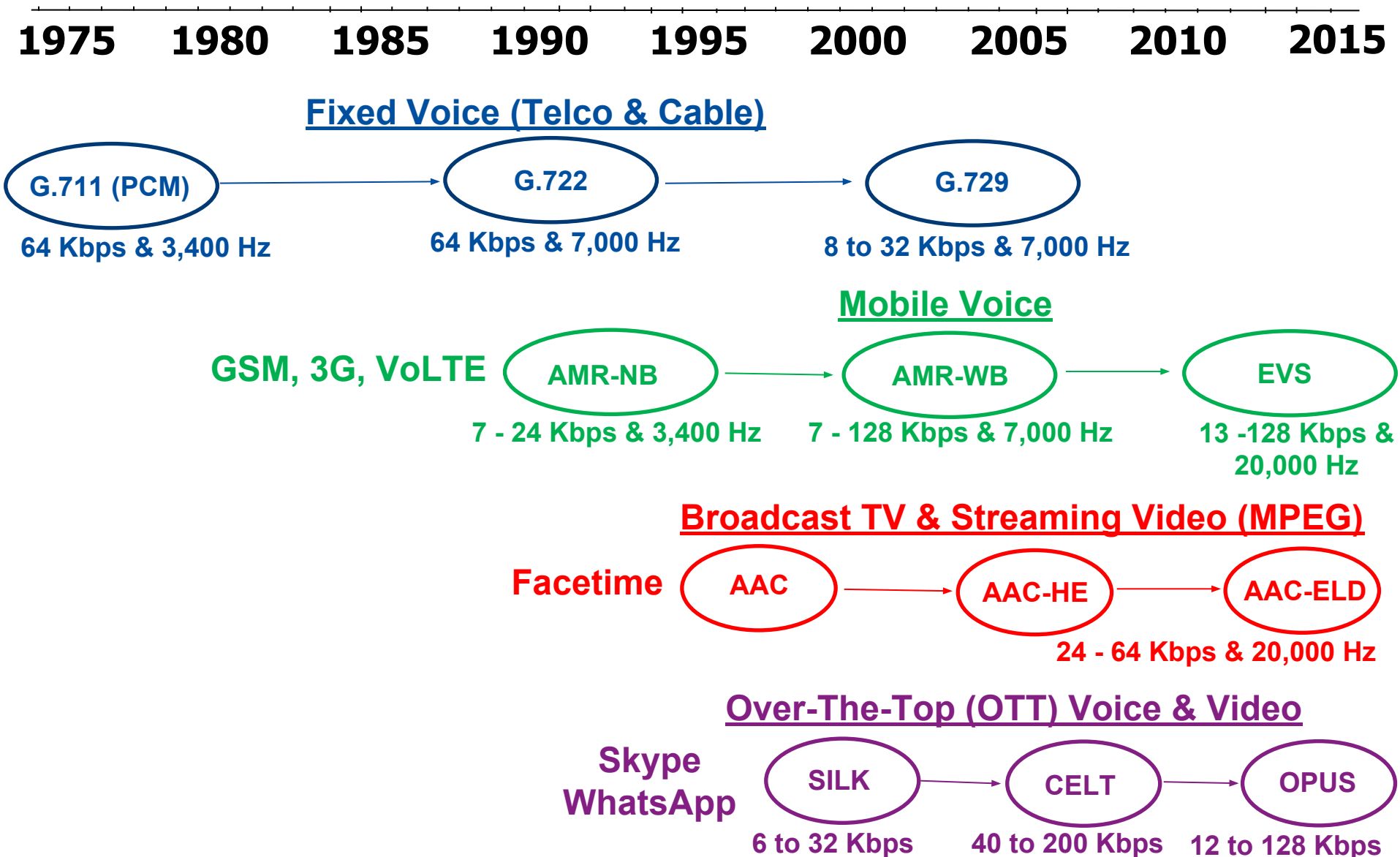**HD Voice (VoLTE)**

AMR-WB Codec
12 kbps
7,000 Hz

GSM, 3G and VoLTE use Quality of Service (QOS) technology to guarantee service levels

Music over Skype or WhatsApp

OPUS Codec
8 kbps and 4,000 Hz
increasing to
64 kbps and 20,000 Hz

Digital Voice Codec Standards and Protocols

1975 1980 1985 1990 1995 2000 2005 2010 2015

Fixed Voice (Telco & Cable)

G.711 (PCM) → **G.722** → **G.729**

64 Kbps & 3,400 Hz   **64 Kbps & 7,000 Hz**   **8 to 32 Kbps & 7,000 Hz**

Mobile Voice

GSM, 3G, VoLTE   **AMR-NB** → **AMR-WB** → **EVS**

7 - 24 Kbps & 3,400 Hz   **7 - 128 Kbps & 7,000 Hz**   **13 -128 Kbps & 20,000 Hz**

Broadcast TV & Streaming Video (MPEG)

Facetime   **AAC** → **AAC-HE** → **AAC-ELD**

24 - 64 Kbps & 20,000 Hz

Over-The-Top (OTT) Voice & Video

Skype WhatsApp   **SILK** → **CELT** → **OPUS**

6 to 32 Kbps   **40 to 200 Kbps**   **12 to 128 Kbps**

Mean Opinion Scores (MOS)

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Codec	MOS
PCM or G.711 (64 kbps)	4.2
G.722 (64 kbps)	3.9
G.729 (8 kbps)	3.7
AMR NB (12.1 kbps)	3.6
AMR WB (12.6 kbps)	4.0
AAC - HE (16 kbps)	3.9
OPUS (16 kbps)	4.1

Circuit Switching Versus Packet Switching

Circuit Switching

"Mr. Watson, Come here I need you"

"Mr. Watson, come here I need you"

"Mr. Watson, Come here I need you"

Original message → Routed across a fixed and dedicated network path → Original message
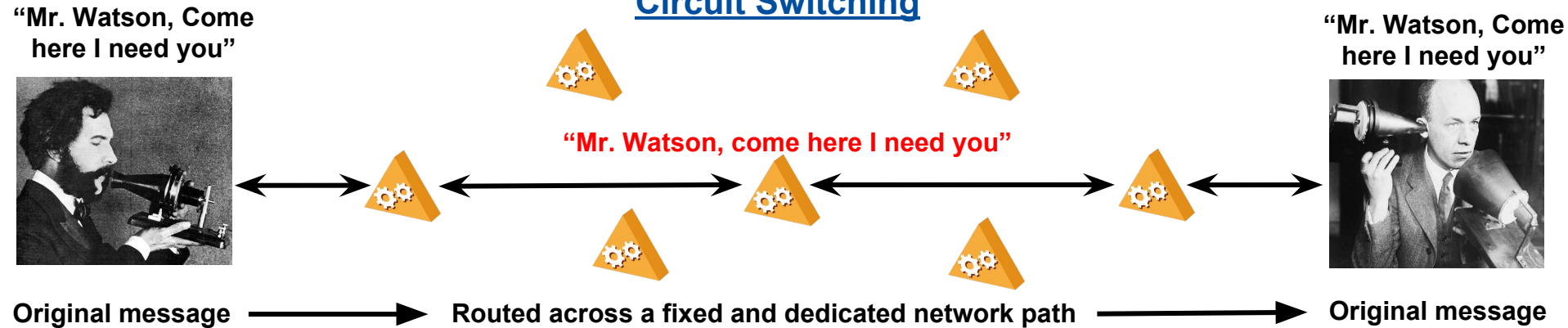
GSM and 3G Voice are circuit switched technologies

Packet Switching

"Mr. Watson, Come here I need you"

"I need you"   "I need you"   "Mr. Watson,"   "Mr. Watson,"

"Mr. Watson,"   "I need you"

"Come here"   "Come here"   "Come here"

"Mr. Watson, Come here I need you"

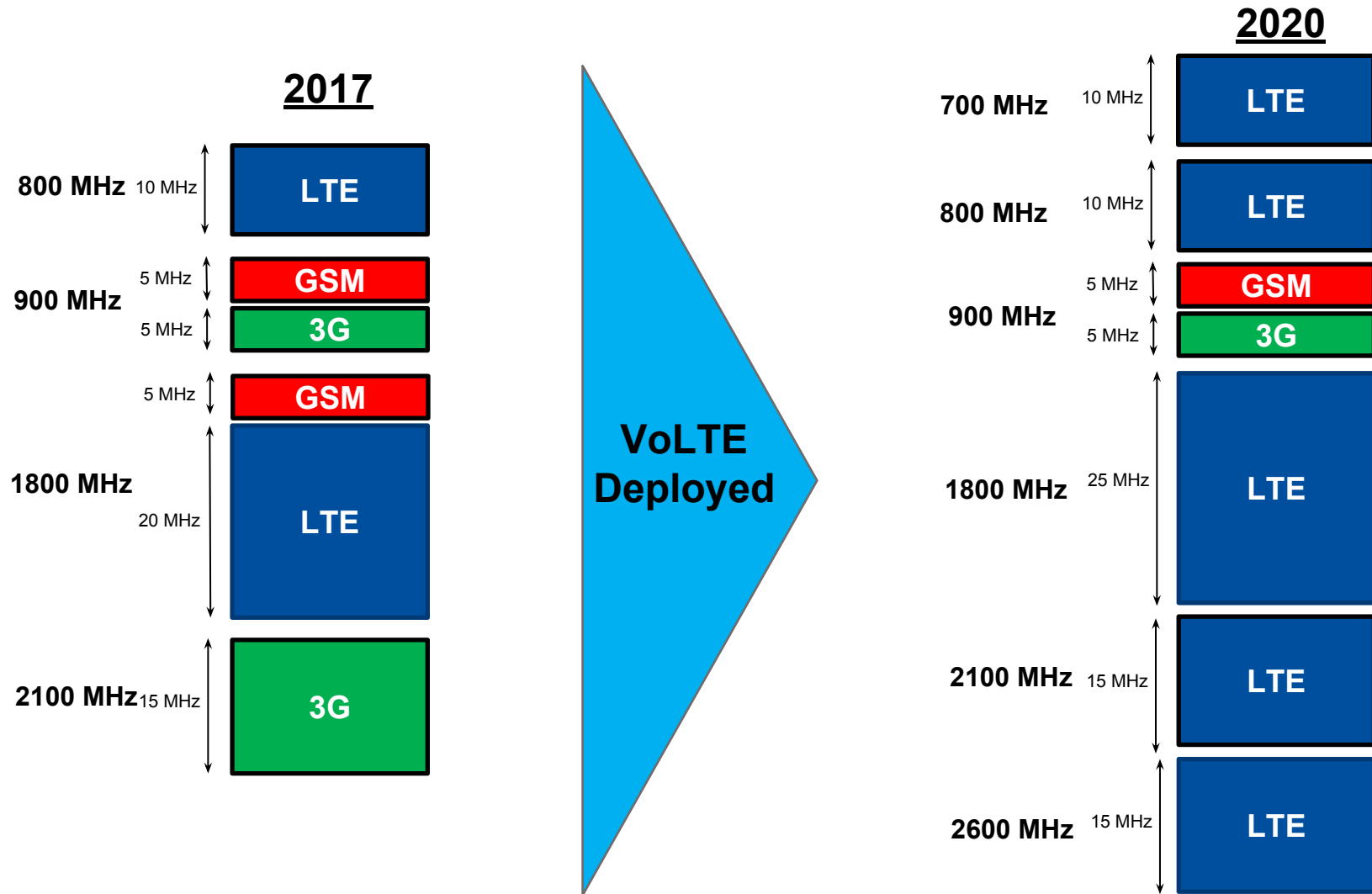Original message → Broken into packets → Routed across changing network path → Reassembled to form original message
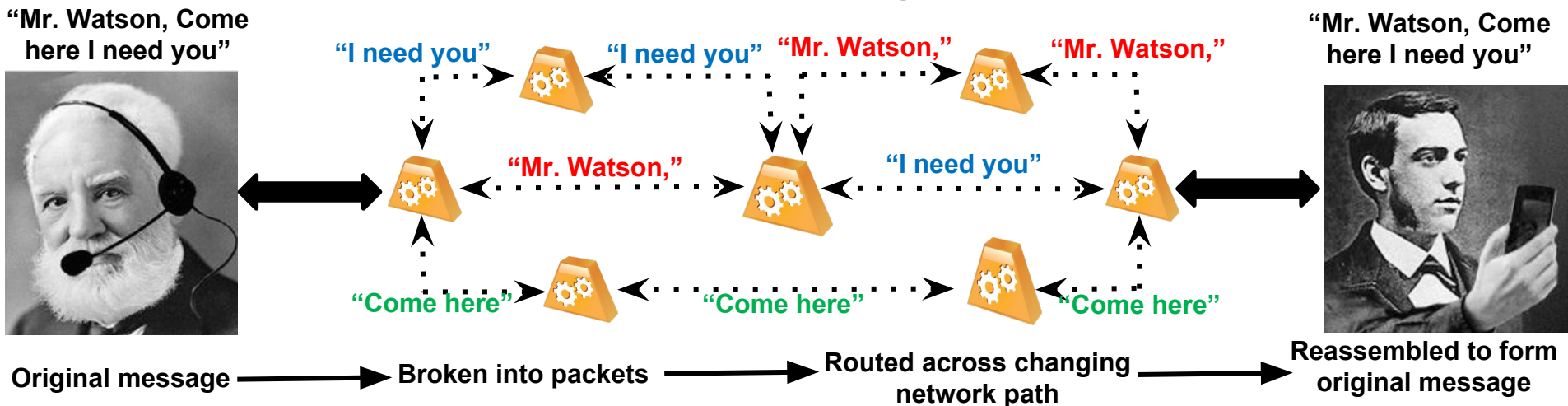
VoLTE is a packet switched technology … needs IMS technology

Interoperability of GSM, 3G and VoLTE Voice Services

3G voice "hand-down" to GSM outside 3G coverage

LTE data on 1800 MHz

3G voice operating in 2100 MHz

GSM voice operating in 900 MHz spectrum

A voice call "hands-down" to 3G voice
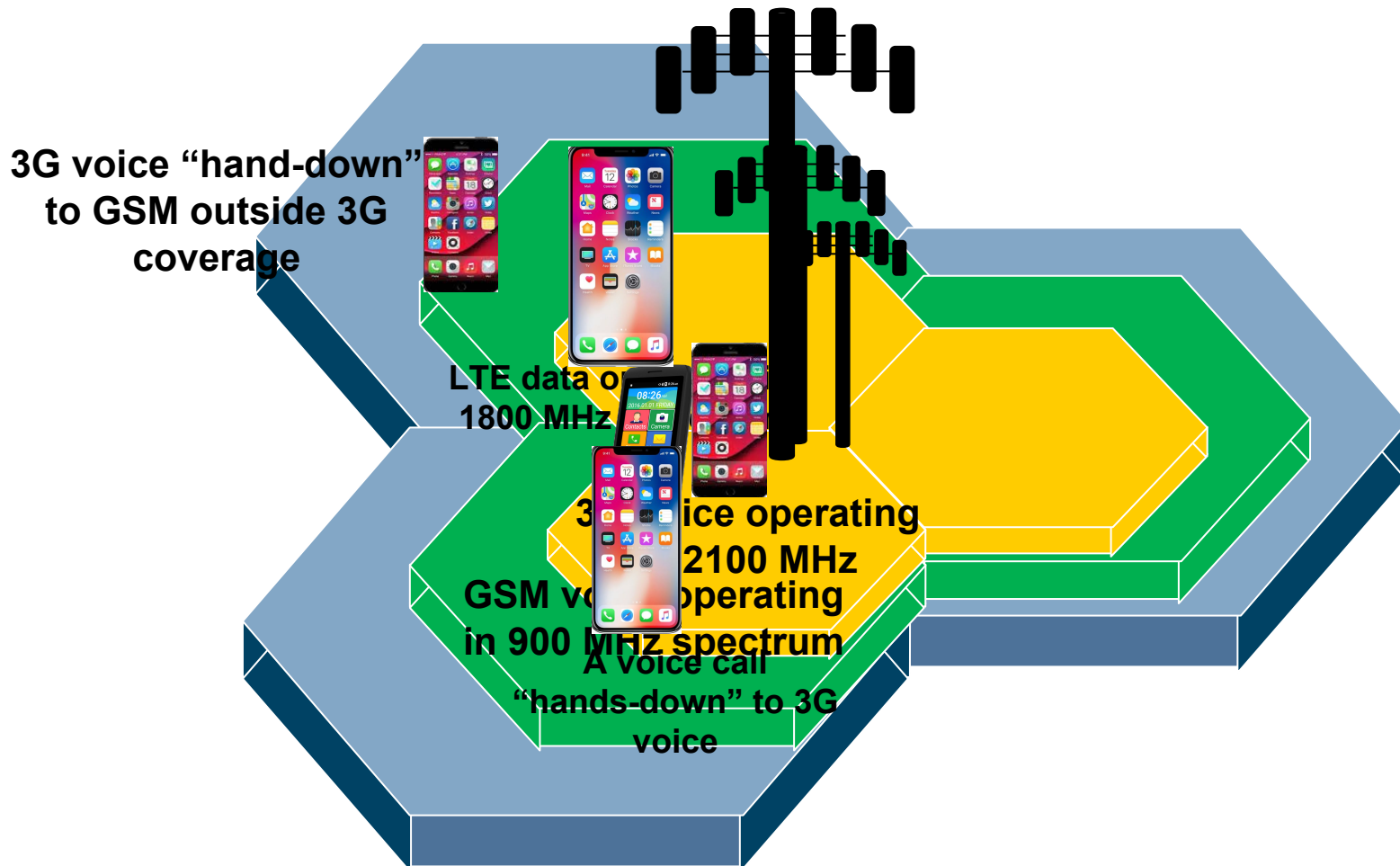
- **Once operators LTE coverage matches 3G coverage then VoLTE is deployed ... no longer a need to hand-down to 3G voice in LTE coverage**
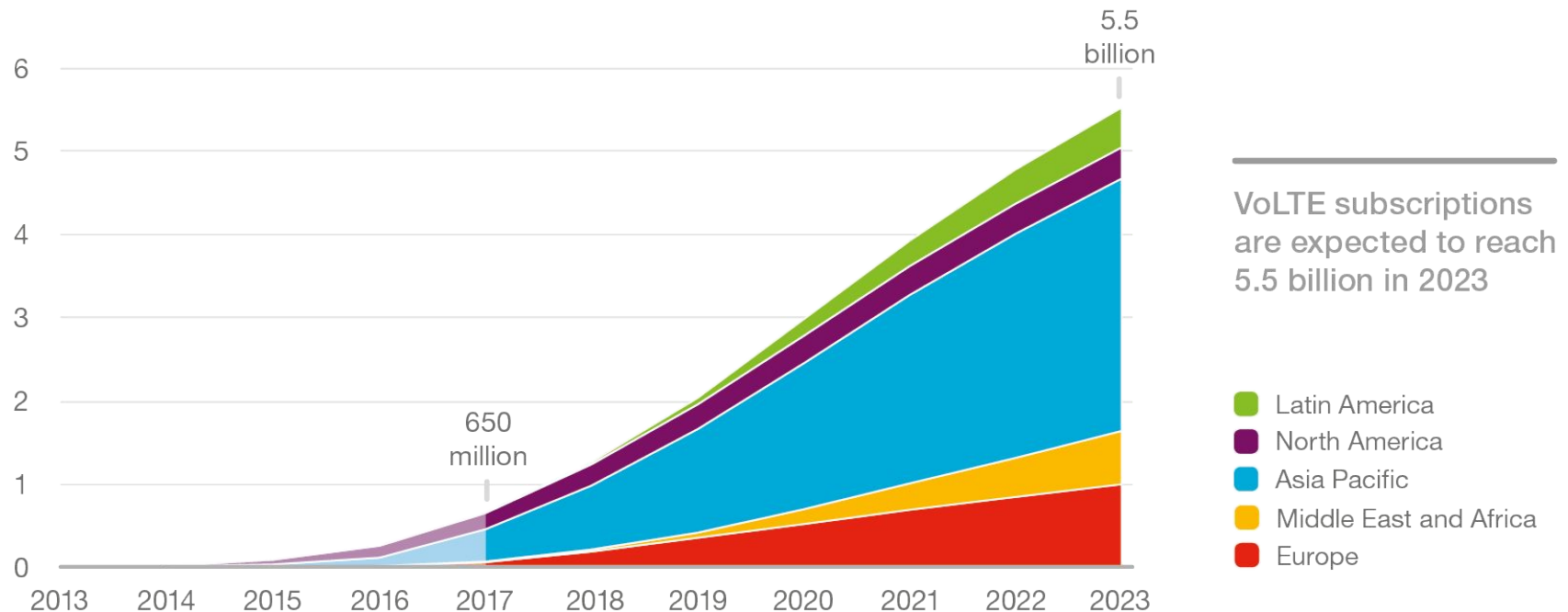
Spectrum Re-Farming - Belgium Example

2017

800 MHz 10 MHz	LTE
900 MHz 5 MHz	GSM
5 MHz	3G
5 MHz	GSM
1800 MHz 20 MHz	LTE
2100 MHz 15 MHz	3G

VoLTE Deployed

2020

700 MHz 10 MHz	LTE
800 MHz 10 MHz	LTE
900 MHz 5 MHz	GSM
5 MHz	3G
1800 MHz 25 MHz	LTE
2100 MHz 15 MHz	LTE
2600 MHz 15 MHz	LTE

- **Re-farming of spectrum to LTE all voice and data will be on LTE**
- **Resulting in substantial CAPEX and OPEX cost savings**

Appendix

VoLTE Subscriptions On The Rise

VoLTE subscriptions by region (billion)

5.5 billion

650 million

| 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |

VoLTE subscriptions are expected to reach 5.5 billion in 2023

- Latin America
- North America
- Asia Pacific
- Middle East and Africa
- Europe

VoLTE - Strong Market Uptake Expected

- **VoLTE launched in > 125 networks in over 60 countries**

- **More than 1300 VoLTE-enabled device models available**

- **VoLTE subscriptions grew 3X in 2017**

- **Forecast 5.5 billion VoLTE subscriptions by 2023**

- **VoLTE support in IoT Cat-M devices**
  - IoT use cases it is valuable to make basic voice calls (VoLTE)
  - Alarm panel in an elevator or call a lost dog via its IoT enabled collar.
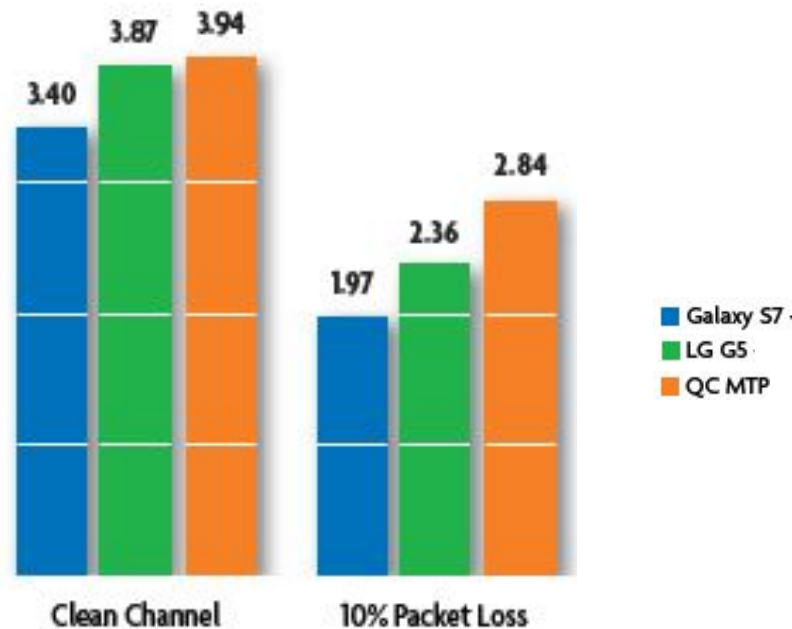
Implications

Subscribers

- Better user experience
  - HD voice, HD voice+ and video calling with simultaneous LTE surfing, faster call set-up times
- Seamless voice handover between LTE and Wi-Fi
- IP messaging, sharing of content (e.g. pics, maps) during calls and call establishment
- Enabling new services like multi-device using one number and call transfer between smartphones, tablets, laptops, watches …

Operators

- Enables building new user services based on IMS/VoLTE platform
- Improved spectrum utilization:
  - Free up spectrum from 2G/3G to utilize for LTE
  - Migrate 2G/3G voice to VoLTE
  - Reduce bandwidth required for voice over LTE

Mobile Voice (VoLTE) Quality Approaches Landline

- **U.S. VoLTE Mean Opinion Scores (MOS): 3.9**
- **Landline MOS Targets: 4.1**
- **VoLTE call setup time matches fixed voice (< 3 seconds)**

Clean Channel: 3.40, 3.87, 3.94
10% Packet Loss: 1.97, 2.36, 2.84

Legend: Galaxy S7, LG G5, QC MTP

Source: Signals Ahead, VoLTE Testing Report, T-Mobile USA, June 2016

Launch FaceTime

- **Also, OTT Video Calling gains wide acceptance at decreasing speeds**

VoLTE Feature Phone At $20

- **4G VOLTE Capable**
- **GSM (900/1800)**
- **LTE (Bands 3, 5, 40)**
- **Supports Android Applications (Android 6.0)**

- **Dual core 1.2Ghz**
- **Size: 121mm x 51mm x 15 mm**
- **2.4" Screen (QVGA)**
- **VGA Camera**
- **2000mAh Battery**
- **4GB Memory**
- **No WiFi**