

# System Architecture 2018 Fall Intro LTE (Chap1 and part of Chap2)

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# Previous LTE : two different radio waves

- ▶ UMTS : Universal Mobile Communication System
- ▶ GSM : Global System for Mobile Communications

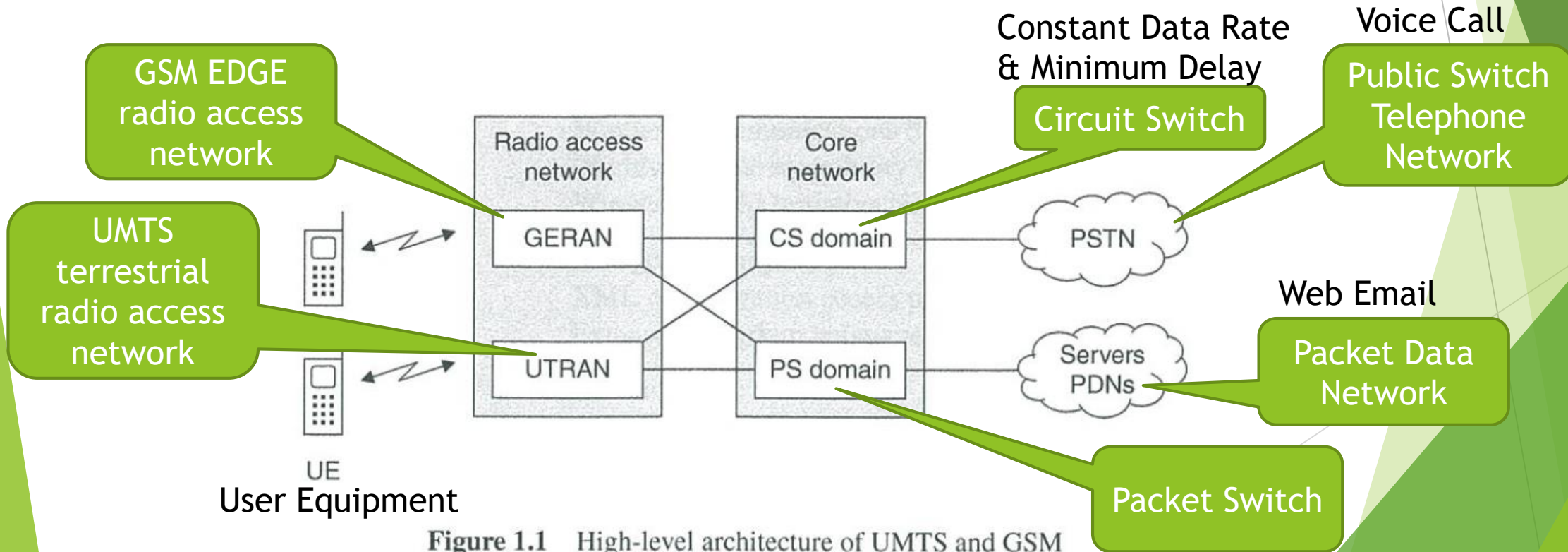
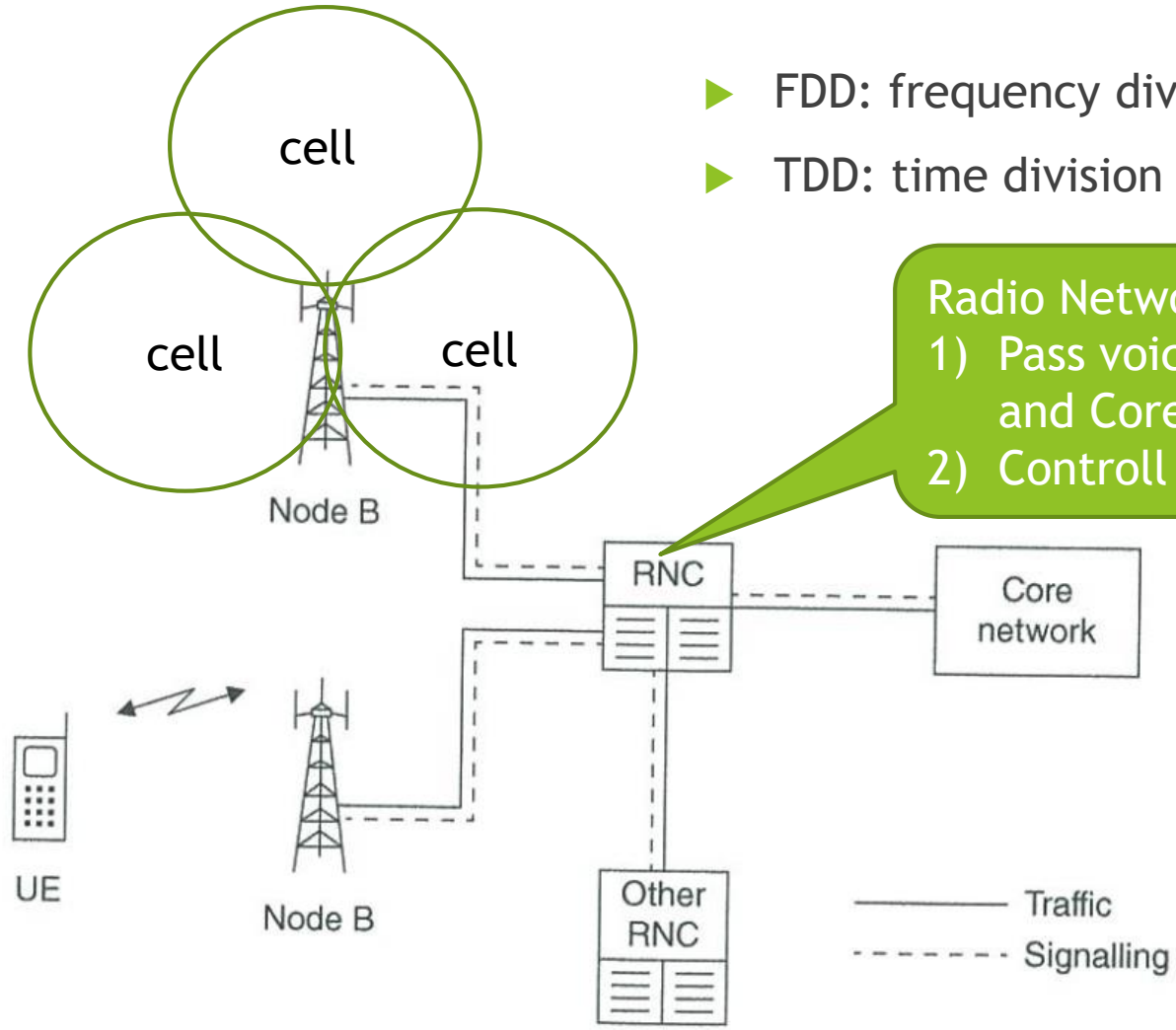


Figure 1.1 High-level architecture of UMTS and GSM

# Detail of Air Interface (UMTS)



- ▶ FDD: frequency division duplex
- ▶ TDD: time division duplex

**Radio Network Controller**  
1) Pass voice and packet among Node Bs and Core network  
2) Control mobiles by signals

Figure 1.2 Architecture of the UMTS terrestrial radio access network

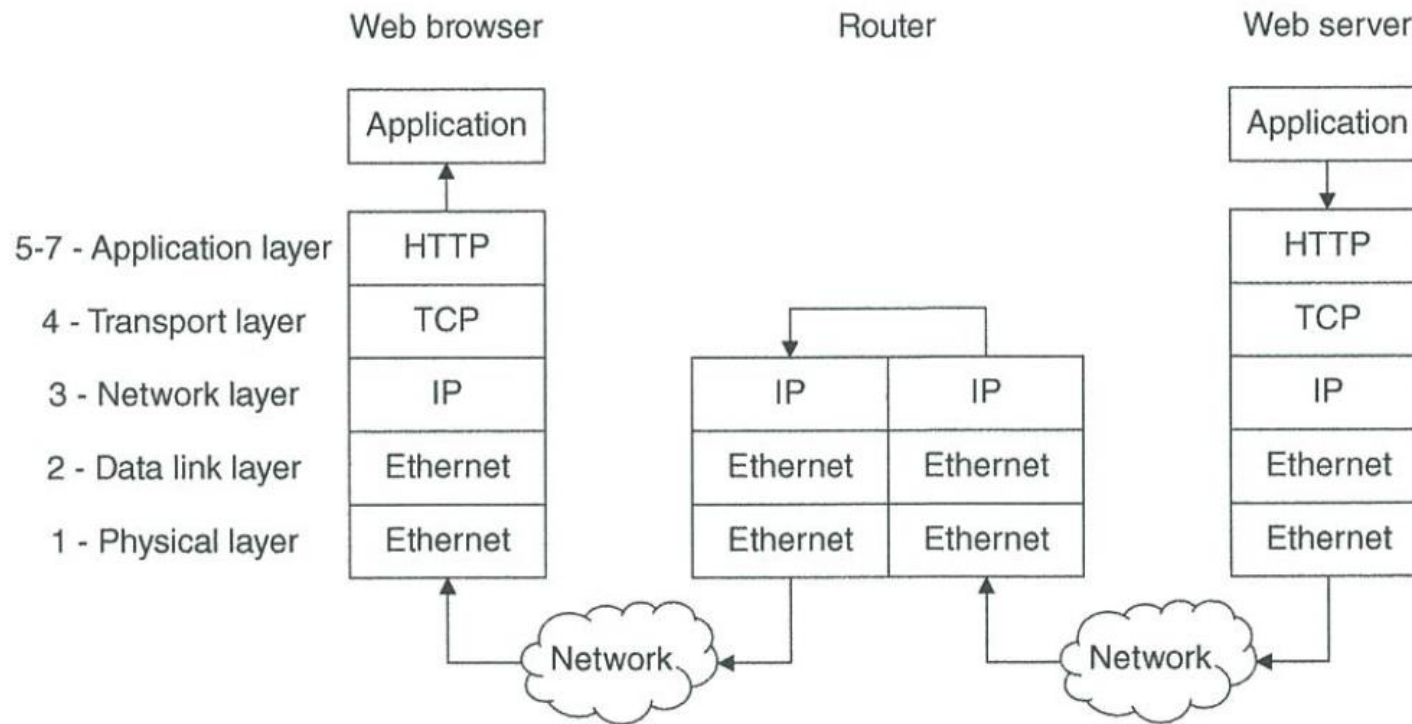
# Review of OSI model

## ▶ TRANSPORT LAYER

- ▶ TCP(transmission control protocol): does re-transmit.
  - ▶ Web, email etc.
- ▶ UDP(user datagram protocol): no re-transmit
  - ▶ Real time voice and video

## ▶ NETWORK LAYER

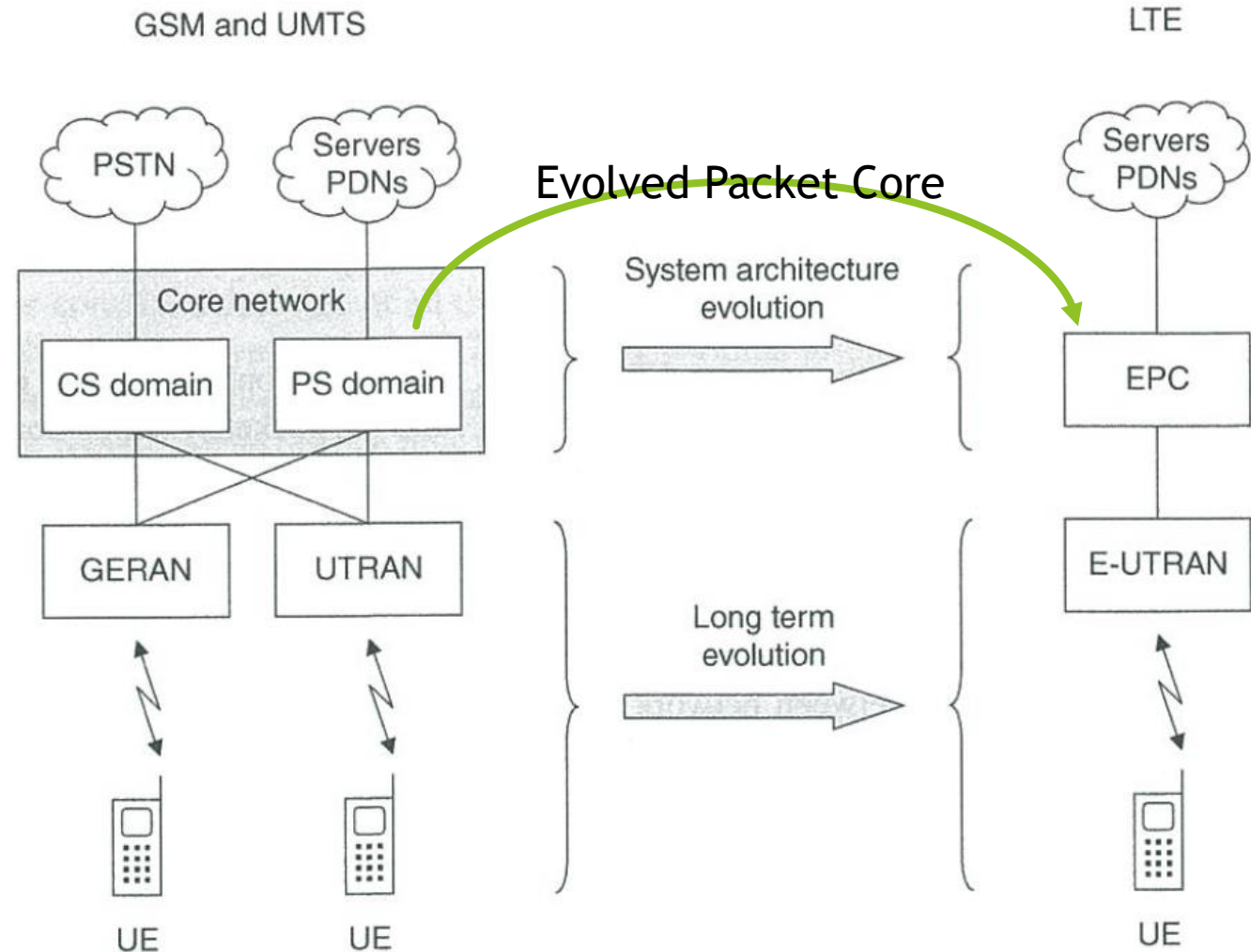
- ▶ IP(internet protocol): send packet using IP address.



**Figure 1.4** Examples of the communication protocols used by the internet, showing their mapping onto the layers of the OSI model

# LTE is much simpler : data main

- ▶ No circuit switch in LTE
- ▶ IP multimedia subsystem (IMS) supports voice over IP call.



**Figure 1.8** Evolution of the system architecture from GSM and UMTS to LTE

# Key features of air interface

**Table 1.1** Key features of the air interfaces of WCDMA and LTE

Feature	WCDMA	LTE	Chapter
Multiple access scheme	WCDMA	OFDMA and SC-FDMA	4
Frequency re-use	100%	Flexible	4
Use of MIMO antennas	From Release 7	Yes	5
Bandwidth	5 MHz	1.4, 3, 5, 10, 15 or 20 MHz	6
Frame duration	10 ms	10 ms	6
Transmission time interval	2 or 10 ms	1 ms	6
Modes of operation	FDD and TDD	FDD and TDD	6
Uplink timing advance	Not required	Required	6
Transport channels	Dedicated and shared	Shared	6
Uplink power control	Fast	Slow	8

# Key features

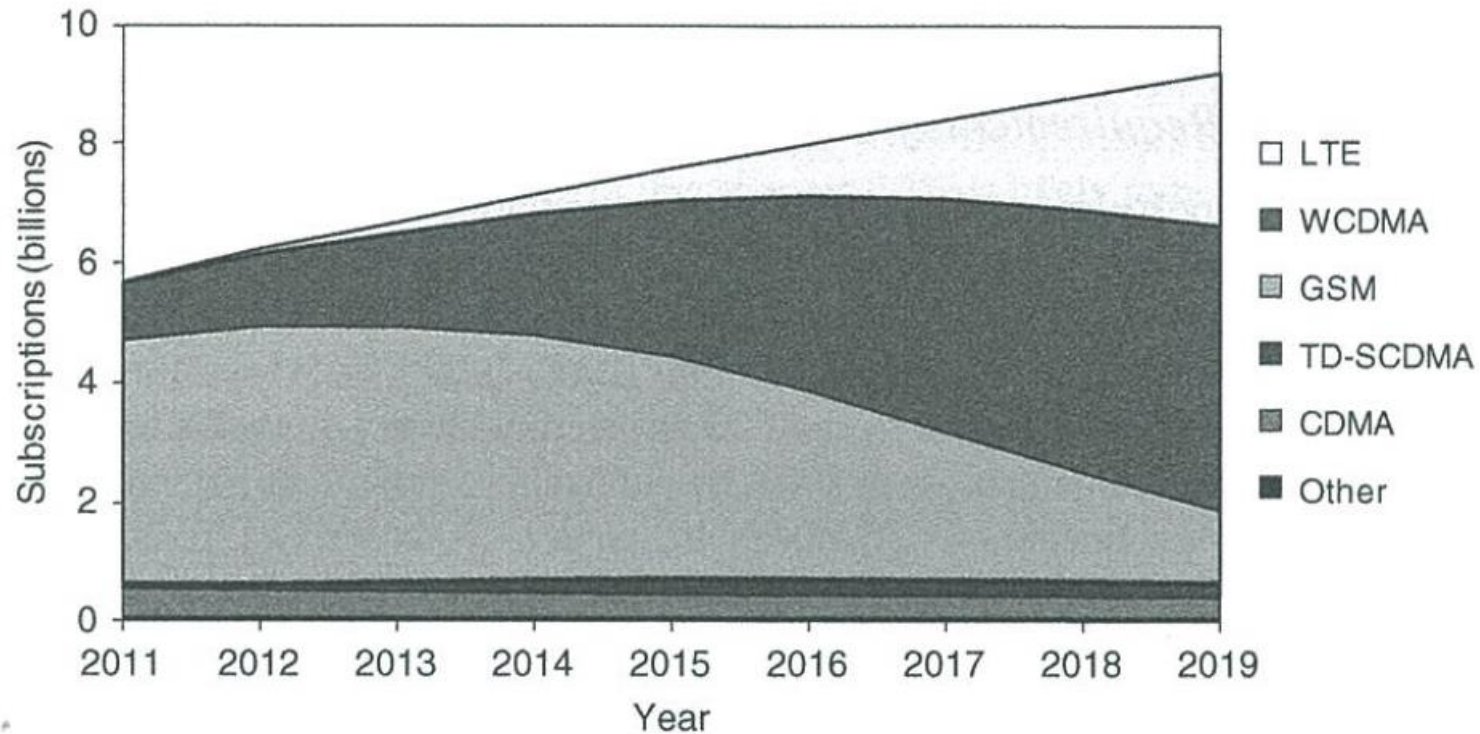
**Table 1.2** Key features of the radio access networks of UMTS and LTE

Feature	UMTS	LTE	Chapter
Radio access network components	Node B, RNC	eNB	2
RRC protocol states	CELL_DCH, CELL_FACH, CELL_PCH, URA_PCH, RRC_IDLE	RRC_CONNECTED, RRC_IDLE	2
Handovers	Soft and hard	Hard	14
Neighbour lists	Always required	Not required	14

**Table 1.3** Key features of the core networks of UMTS and LTE

Feature	UMTS	LTE	Chapter
IP version support	IPv4 and IPv6	IPv4 and IPv6	2
USIM version support	Release 99 USIM onwards	Release 99 USIM onwards	2
Transport mechanisms	Circuit & packet switching	Packet switching	2
CS domain components	MSC server, MGW	n/a	2
PS domain components	SGSN, GGSN	MME, S-GW, P-GW	2
IP connectivity	After registration	During registration	11
Voice and SMS applications	Included	External	21, 22

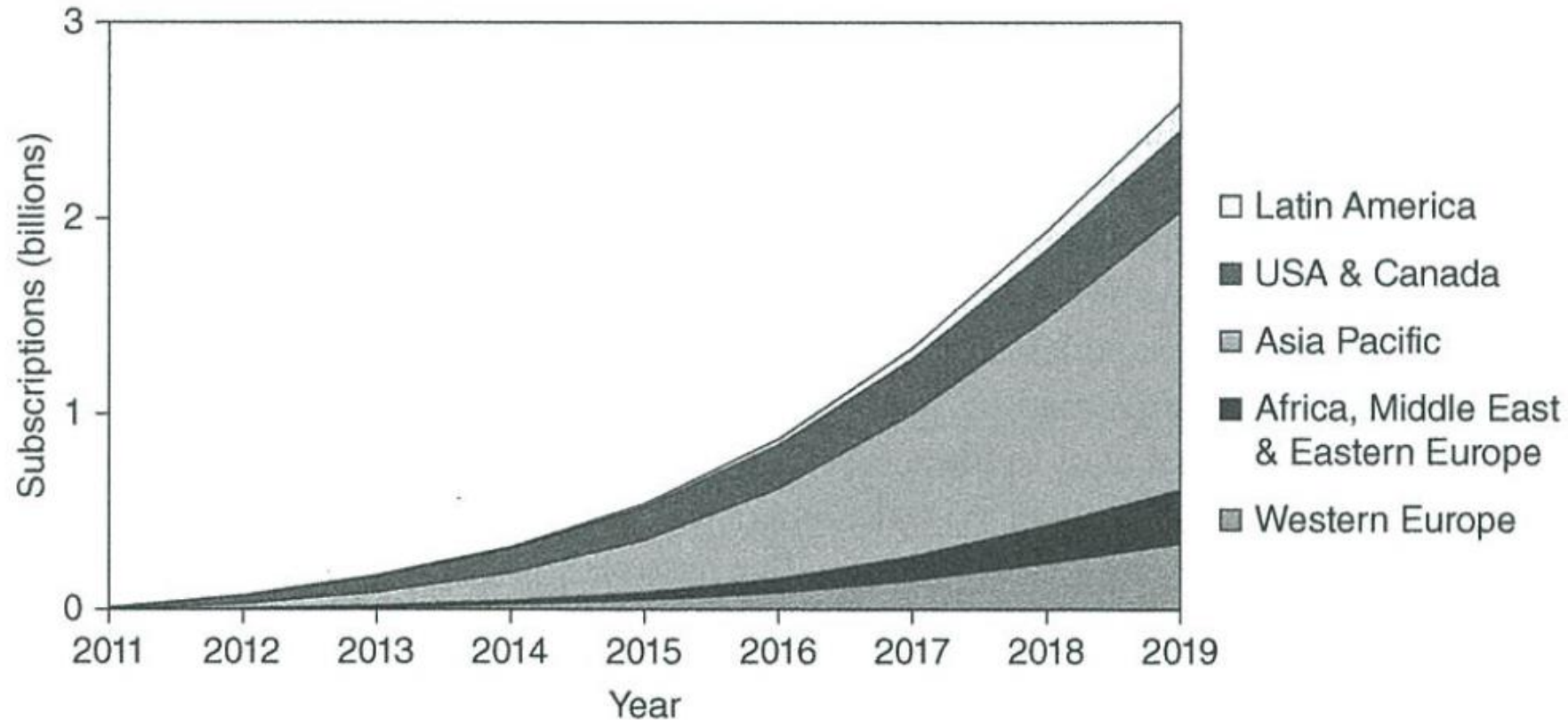
# Number of all subscriptions



**Figure 1.9** Numbers of subscriptions to different mobile communication technologies, with historical data up to 2013 and forecasts thereafter. Source: [www.ericsson.com/TET](http://www.ericsson.com/TET)



# LTE subscriptions



**Figure 1.10** Number of subscriptions to LTE in different regions of the world, with historical data up to 2013 and forecasts thereafter. Source: [www.ericsson.com/TET](http://www.ericsson.com/TET)

# 3GPP specs

**Table 1.4** 3GPP specification releases for UMTS and LTE

Release	Date frozen	New features
R99	March 2000	WCDMA air interface
R4	March 2001	TD-SCDMA air interface
R5	June 2002	HSDPA, IP multimedia subsystem
R6	March 2005	HSUPA
R7	December 2007	Enhancements to HSPA
R8	December 2008	LTE, SAE
R9	December 2009	Enhancements to LTE and SAE
R10	June 2011	LTE-Advanced
R11	June 2013	Enhancements to LTE-Advanced
R12	September 2014	Enhancements to LTE-Advanced

# FDD frequency

Table 2.3 FDD frequency bands

Band	Release	Uplink band (MHz)	Downlink band (MHz)	Main regions	Common name	Notes
1	R99	1920–1980	2110–2170	1, 3	2100	WCDMA
2	R99	1850–1910	1930–1990	2	1900	PCS
3	R5	1710–1785	1805–1880	1, 3	1800	GSM 1800
4	R6	1710–1755	2110–2155	2	1700/2100	AWS
5	R6	824–849	869–894	2, 3	850	GSM 850
6	–	–	–			Not used by LTE
7	R7	2500–2570	2620–2690	1, 2, 3	2600	
8	R7	880–915	925–960	1, 3	900	GSM 900
9	R7	1749.9–1784.9	1844.9–1879.9	Japan		
10	R7	1710–1770	2110–2170	2		AWS extension
11	R8	1427.9–1447.9	1475.9–1495.9	Japan	1500	
12	R8	699–716	729–746	USA	700	Lower band A, B, C
13	R8	777–787	746–756	USA	700	Upper band C
14	R8	788–798	758–768	USA	700	Upper D, public safety
15	–	–	–			Not used by 3GPP
16	–	–	–			Not used by 3GPP
17	R8	704–716	734–746	USA	700	Lower band B, C
18	R9	815–830	860–875	Japan		
19	R9	830–845	875–890	Japan		
20	R9	832–862	791–821	Europe	800	Digital dividend
21	R9	1447.9–1462.9	1495.9–1510.9	Japan	1500	
22	R10	3410–3490	3510–3590	1, 2, 3		
23	R10	2000–2020	2180–2200	USA		S band
24	R10	1626.5–1660.5	1525–1559	USA		L band
25	R10	1850–1915	1930–1995	2	1900	PCS extension
26	R11	814–849	859–894	2, 3		Bands 5, 18, 19
27	R11	807–824	852–869	2		
28	R11	703–748	758–803	3	700	Digital dividend
29	R11	–	717–728	USA		Carrier aggregation <sup>11</sup>
30	R12	2305–2315	2350–2360	USA		WCS
31	R12	452.5–457.5	462.5–467.5	1, 2, 3	450	

Source: TS 36.101 and TS 36.104. Reproduced by permission of ETSI.

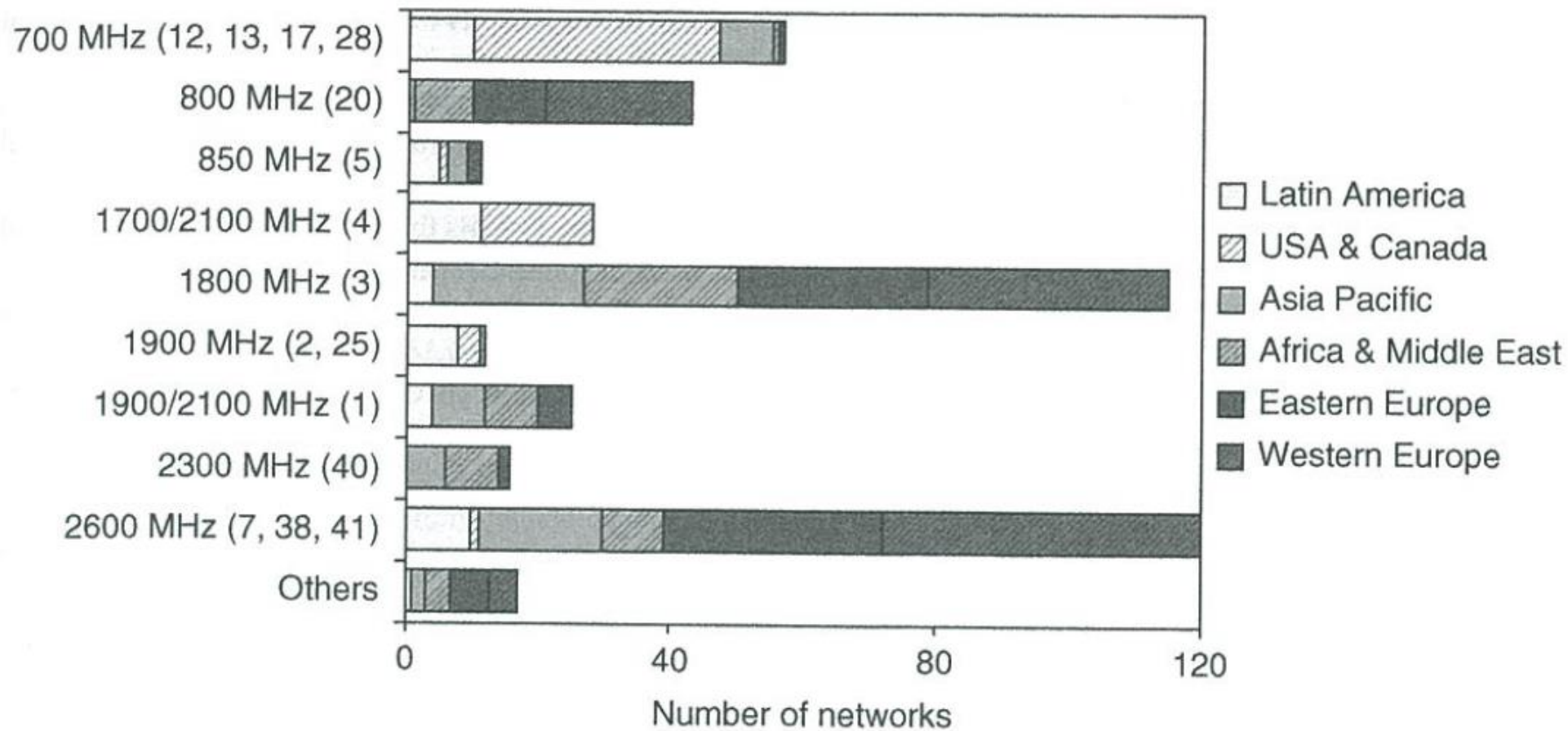
# TDD frequency

**Table 2.4** TDD frequency bands

Band	Release	Frequency band (MHz)	Main regions	Common name	Notes
33	R99	1900–1920	1, 3		
34	R99	2010–2025	3		
35	R99	1850–1910	2		PCS
36	R99	1930–1990	2		PCS
37	R99	1910–1930	2		PCS
38	R7	2570–2620	1, 2, 3	2600	
39	R8	1880–1920	China		
40	R8	2300–2400	3	2300	
41	R10	2496–2690	USA	2600	
42	R10	3400–3600	1, 2, 3		
43	R10	3600–3800	1, 2, 3		
44	R11	703–803	3		

Source: TS 36.101 and TS 36.104. Reproduced by permission of ETSI.

# Freq used by LTE (2013)



**Figure 2.26** Frequency bands used by operational and planned LTE networks in November 2013. Source: <http://www.4gamericas.org>. Reproduced by permission of 4G Americas