

LTE spectrum and Deployment Choices for Operators

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1. Global spectrum availability for LTE

The initial deployment in LTE is expected in 700 MHz for the US, 2.1 GHz for Japan and 2.6 GHz in Europe. The 2.3/2.5 GHz TDD band for deployment is available in China, India. The new LTE systems will support existing bands of GSM/W-CDMA/HSPA, as most of the devices will support multiband operation, and it will allow operators to smoothly introduce LTE services in dense markets and gradually proliferate for a national coverage. A brief update of spectrum availability for LTE is presented below.

United States: Federal Communications Commission (FCC) in April 2008 auctioned 62 megahertz of spectrum in the 700 MHz band for LTE services. The band is highly prized because the low frequency, as it allows signals to travel farther and provide better in-building coverage than higher frequencies such as 1900 MHz. As a result, operators need fewer base stations to cover an area, which translates into lower overhead costs—a major asset for any operator looking to be aggressive on the pricing front.

Verizon Wireless was the biggest winner in the 700 MHz auction. The other big winner of the spectrum was AT&T. AT&T bid for fewer licenses than Verizon, having won much of the spectrum it wanted in FCC auctions held in 2002 and 2003.

Europe: Norway, Finland and Sweden auctioned their spectrum in 2007, 2008 and 2009 respectively. This year the Netherlands and Denmark have concluded their 2.6GHz auctions, the auction in Germany is completed and some point during 2010 (France, Spain, Poland, Portugal, Switzerland and Belgium are all expected to hold auctions this year).

Germany: A total of 41 spectrum blocks was sold in the auction, in the 800MHz, 1.8GHz, 2GHz and 2.6GHz bands. The three largest mobile operators, O2, Vodafone and Deutsche Telekom's T-Mobile, each won two paired 5MHz chunks of spectrum in the 800MHz band, considered key for rural coverage of mobile broadband.

China and India: 2.3 GHz TDD frequency is recently allocated to 3 operators in India. In china 2.3/2.5 GHz spectrum is available for LTE deployments. Both the spectrum in India and China is TDD type.

Japan: In Japan, 2.1 GHz and 1.5 GHz spectrum is available for LTE Deployments.

Figure 1 : Global LTE spectrum status

Spectrum	Awarded today	2009	2010	2011	2012+	
2.6 GHz	New Zealand Norway Sweden HK		Austria UK France Germany Spain	Portugal Italy NL Spain Denmark	Czech Republic India Canada	Estonia Latvia
2.3 GHz	China (TDD)					
2.1 GHz	EMEA, Japan					
AWS	NAR					
1900 MHz	NAR				Refarming	
1800 MHz	APAC & EMEA	Finland HK			Refarming	
1500 MHz	Japan					
900 MHz	EMEA				Refarming	
850 MHz	NAR				Refarming	
800 MHz	Sweden Finland Germany NL Belgium (Flemish)	Denmark Norway	Spain Estonia Austria	France Czech Republic Slovenia Hungary	Lithuania Portugal Ireland Slovakia Ukraine Poland Russia	
700 MHz	US					
700 MHz D block			US To be confirmed			

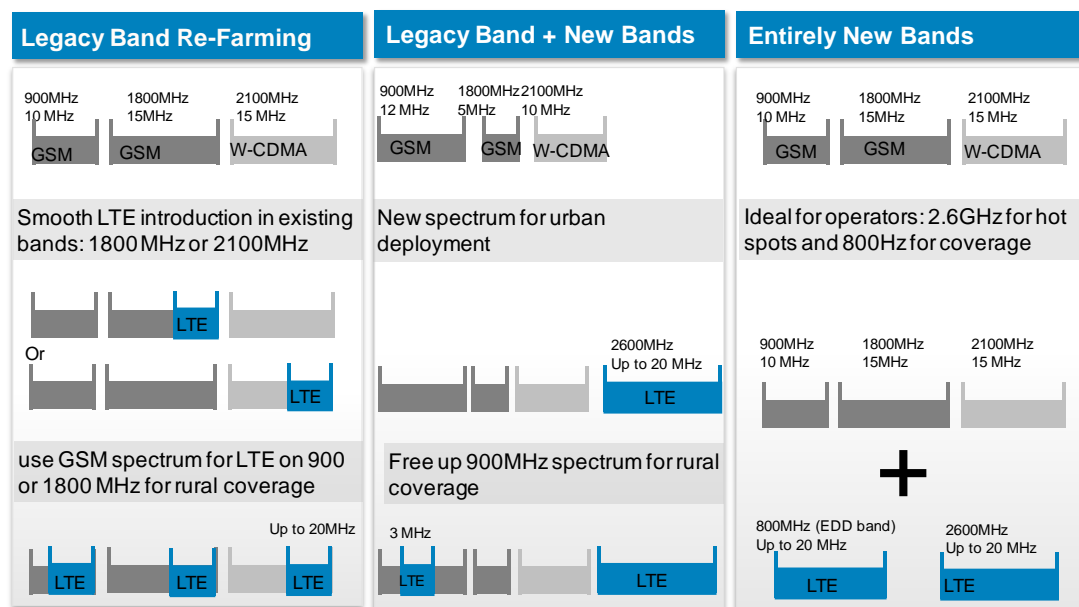
2. Deployment Strategies with LTE spectrum

2.1 3GPP FDD Operators: 3GPP operators have natural evolution and migration aligned towards LTE.

Legacy band Re-Farming: A GSM and W-CDMA operator has the possibility to introduce LTE in their existing bands. The spectrum at 1800 MHz and 2100 MHz can be reused for LTE systems. LTE allows operation in 1.4,3,5,10,15 and 20MHz channel sizes. The flexibility of choosing different channel bandwidths will allow operators to slowly introduce LTE in existing GSM/W-CDMA band and in new spectrum at 900 MHz for rural coverage.

Legacy band and New Bands: A GSM and W-CDMA operator has the possibility to introduce LTE in new spectrum like 2.6 GHz. Teliasonera introduced its LTE services in new spectrum majorly in 2.6 GHz. Teliasonera introduced initial LTE services in urban areas , in the same time reusing their existing 3G networks . Possibility of introducing LTE in lower spectrum like 900 MHz makes excellent case of deployment in rural population.

Figure 2 : LTE spectrum for 3GPP operators



Entirely New Bands: A GSM and W-CDMA operator has the possibility to introduce LTE in entirely new spectrum like 2.6, 2.3 or .8 GHz's. New spectrum will allow operators to use larger bandwidths and leapfrog in mobile broadband networks. The performance of LTE system can reach up to 140 Mbps in 20 MHz of spectrum under suitable Radio condition. Service continuity with operator's 3G or 2G networks will be supported as most of the LTE chipset will support GSM/GPRS/EGDE/W-CDMA/HSPA+/LTE

Figure 3 : Common LTE supported bands and peak data rates

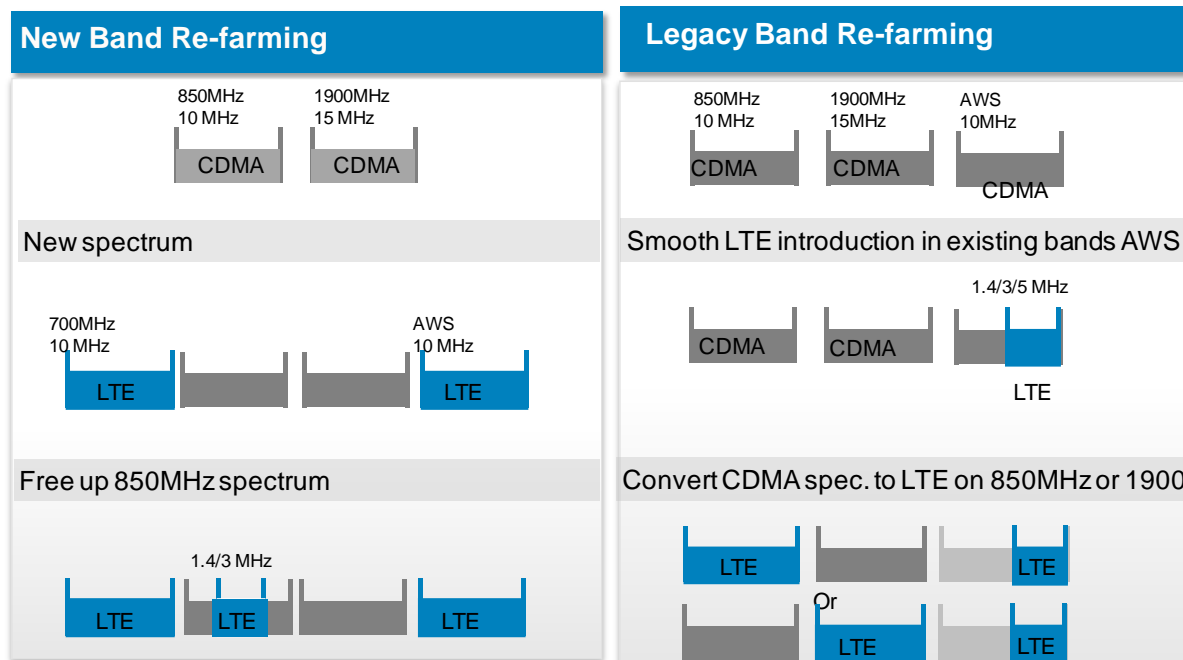
	Supported Bands						Peak Data Rate
LTE	700	850	900	1800	2100	2600	LTE - 100 Mbps DL/50 Mbps UL
WCDMA/HSPA	850	900	1900	2100	NA	NA	HSPA - 42 Mbps DL/11 Mbps UL WCDMA - 384 Kbps
GSM/GPRS/EDGE	850	900	1800	1900	NA	NA	GPRS - 48Kbps(DL/UL) EDGE- 384 Kbps @ MCS9(UL/DL)

2.2 3GPP2 Operators

3GPP2 operators have the option to deploy LTE in new spectrum possibly in 700 MHz or AWS band. Regulators can also free up more spectrums in 850 MHz for accelerating LTE deployments. This is very similar to deployment strategy adopted by Verizon Wireless in US. The operator has CDMA/Ev-DO commercial operation in 850 MHz and 1900 MHz. In the recent auction by US regulator, Verizon wireless secured nationwide wireless spectrum which it will utilize for new LTE deployment. LTE networks can support interworking with CDMA/Ev-DO technologies.

Alternatively operators have the choice to introduce LTE in the existing AWS bands or CDMA bands co-existing with legacy bands. One of the noteworthy advantages of LTE is its ability to support smaller as well as bigger channel bandwidths. Operators can deploy LTE networks in as little as 1.4 MHz or support channels up to 20 MHz's.

Figure 4 : LTE Spectrum for 3GPP2 operators



2.3 For 3GPP TDD Operators

The TDD spectrum indentified by 3GPP group for LTE deployment is listed below. Recently 2.3 to 2.4 GHz band was allocated for TDD deployment and since it is new spectrum, possibilities of using bigger channel bandwidths is expected.

33	1900 MHz	-	1920 MHz	1900 MHz	-	1920 MHz	TDD
34	2010 MHz	-	2025 MHz	2010 MHz	-	2025 MHz	TDD
35	1850 MHz	-	1910 MHz	1850 MHz	-	1910 MHz	TDD
36	1930 MHz	-	1990 MHz	1930 MHz	-	1990 MHz	TDD
37	1910 MHz	-	1930 MHz	1910 MHz	-	1930 MHz	TDD
38	2570 MHz	-	2620 MHz	2570 MHz	-	2620 MHz	TDD
39	1880 MHz	-	1920 MHz	1880 MHz	-	1920 MHz	TDD
40	2300 MHz	-	2400 MHz	2300 MHz	-	2400 MHz	TDD

Figure5 : Global TDD Spectrum

New 2.3 GHz spectrum is allocated in China, India, Korea, Malaysia and other countries especially in Asia.

A small amount of spectrum is available in 1900-1920 MHz and 2010- 2025 MHz for TDD application. This spectrum is mostly unused by operators and may become interesting spectrum for TDD LTE deployment. In China 1880-1900 and 2010-2025 MHz is used for TD-SCDMA application. Chinese operator may introduce LTE in this spectrum or consider new deployment in 2.3/2.6 GHz TDD bands.

Figure 6: LTE spectrum for TDD Operators

