APT 700MHz

Best Choice for nationwide coverage

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1 Overview

The Global mobile Suppliers Association (GSA) has re-affirmed its view that Long Term Evolution (LTE) is the fastest developing mobile system technology ever[1]. This view can be quantified by the technology commitments strategically made by Mobile Operators worldwide – the GSA reported that at the end of 2012 there were 144 operating commercial LTE networks; this number is expected to increase to 234 by the end of 2013. These early adopter commercial LTE networks are predominantly based on the 1800MHz spectrum, and if an operator were to do a economic comparison with an equivalent contiguous network coverage provided on 700MHz spectrum, the 1800MHz roll-out cost will be a factor of two higher. As a general rule, access networks operating on lower frequencies, such as 700MHz, provide better cellular penetration (i.e. in-building reception) and coverage with fewer deployed cell sites – this topic is discussed in detail in section 3. Verizon Wireless (USA) has stated that from operational analysis of their system "that its 4G LTE network, which operates in the 700MHz band, is five times more efficient than its 3G network"[2]. Section 3 provides an analysis of the technical benefits of operating LTE technology on the 700MHz band.

Despite the inherent benefits of the 700MHz band for LTE technology, the need for other paired LTE spectrums, such as 1800MHz, 2600MHz, 2100MHz or 900MHz, is still required. The fragmented spectrum allocation available around the world for mobile operator usage has evolved in such a way that requires harmonization of their frequency assets in order to deliver seamless mobile customer experiences. Today, the challenge for technology suppliers is to create evolutionary solutions that not only complement the use of available spectrum assets, but delivers technology innovations that leverage the inherent strengths of each spectrum band. ZTE will continue its endeavors into delivering technology and innovations which will aid operators utilising its technology to capitalize their invested spectral bands. Section 4 provides insight into ZTE's approach to support the 700MHz spectrum and capitalizing on its inherent strengths, but also the approach of co-existence with other spectrum bands.

To provide a baseline of the 700MHz band, this paper will begin with an overview of the APT 700MHz spectrum in section 2. Summary and conclusive statements can be found in section 5.

[1] Global mobile Suppliers Association (GSA) "Evolution to LTE Report – Market/Technology Update", dated March 19th 2013.

[2] Source: "Asia's APT700 band plan leads the way to large-scale 4G LTE growth", Mobile World Live, Joss Gillet, 31st May 2013.

2 APT 700MHz

The Asia Pacific Telecommunity (APT) has defined the 700MHz band for the two LTE variants of FDD (Frequency Division Duplexing) and TDD (Time Division Duplexing), hence APT 700MHz[3]. The 3GPP (3rd Generation Partnership Project) and the ITU (International Telecommunications Union) have standardized the spectral band plans for the APT segmentation of the 700MHz band summarized in Table 2-1 below.

3GPP Band	Duplex	Uplink Frequency	Downlink Frequency
28[4]	FDD	703 – 748 MHz	758MHz – 803MHz
44[5]	TDD	703 – 803MHz	703 – 803MHz

Table 2-1 3GPP Standardized Band Plans for APT Segmentation of 700MHz Band

Since its inception, the popularity of the APT 700MHz band plan has grown and has been accepted by many countries in the Asia-Pacific, South America and the Middle-East as shown in Table 2-2.

Country	Region	Adopted?	Population
Australia	Asia-Pacific / Oceania	Yes	23.0 million
Argentina	South America	Yes	40.1 million
Brazil	South America	In development	194.0 million
Chile	South America	Yes	16.6 million
China	Asia-Pacific	Yes – TDD	1,354.0 million
Colombia	South America	Yes	47.1 million
Costa Rica	South America	Yes	4.3 million
Ecuador	South America	Yes	14.7 million
Japan	Asia-Pacific	Yes	127.8 million
India	Asia-Pacific	Yes	1,210.5 million
Mexico	South America	Yes	112.3 million
New Zealand	Oceania	Yes	4.4 million
Panama	South America	Yes	3.6 million
Papua New Guinea	Asia-Pacific	Yes	7.1 million
South Korea	Asia-Pacific	Yes	49.8 million
Taiwan	Asia-Pacific	Yes	23.3 million
Tonga	Oceania	Yes	0.1 million
United Arab Emirates	Middle-East	Yes	7.9 million

Table 2-2 Countries that have adopted the APT 700MHz segmentation

[3] This is not to be confused with the North American AWS (Advanced Wireless Servcies) 700MHz band plan for LTE.

[4] Band 28 is separated by a 10MHz Center Gap to avoid interference between the Uplink and Downlink transmissions

[5] Band 44 provides for 100MHz of continuous spectrum.

As shown above in Table 2-2, the current world population coverage provided for the APT 700MHz band plan is approximately 3.24 billion people. This coverage is expected rise over the next few years. The significance of this collective worldwide adoption is undoubtedly a positive factor for driving economies of scale into LTE technology and end user devices available within the APT 700MHz band plan. This will inevitably drive lower unit costs into the business for equipment and devices whilst encouraging technology vendors to provide a more diverse array of mobile handsets and devices.

3 Performance Analysis of 700MHz Band

There are various LTE operating spectrums distributed from 700MHz to 2.6GHz, with considerations for even higher bands for some services. Fundamentally, the propagation loss attributed to different bands and the spectral coverage distances differ, even when using the same MAPL (Maximum Allowed Path Loss). Given these differences, link performance and equipment configurations also vary between the different spectrum bands. Therefore, the selected operating band will have a significant effect on the coverage distance and customer experience. To save costs and construct a nationwide network, operators must select a band which affords them the largest coverage and the highest penetrative capability for their investment.

3.1 Propagation Loss

The propagation loss of radio waves increases with the frequency. High frequency bands have a larger propagation loss. The Hata model is usually adopted in macro cell link budgets. The Hata model is divided into the Okumura-Hata model and the Cost231-Hata model according to the operating frequency band. The Okumura-Hata model is suitable for spectrum between 150MHz ~ 1500MHz. The Cost231-Hata model is suitable for spectrum above 1500MHz.

The comparison between different frequency propagation losses can be calculated using the propagation model. In the dense urban environment and with antenna height of 30metres, propagation loss and propagation distance curves in the 2.6GHz, 2.1GHz, 1.8GHz, 900MHz and 700MHz bands are shown in Figure 3-1.

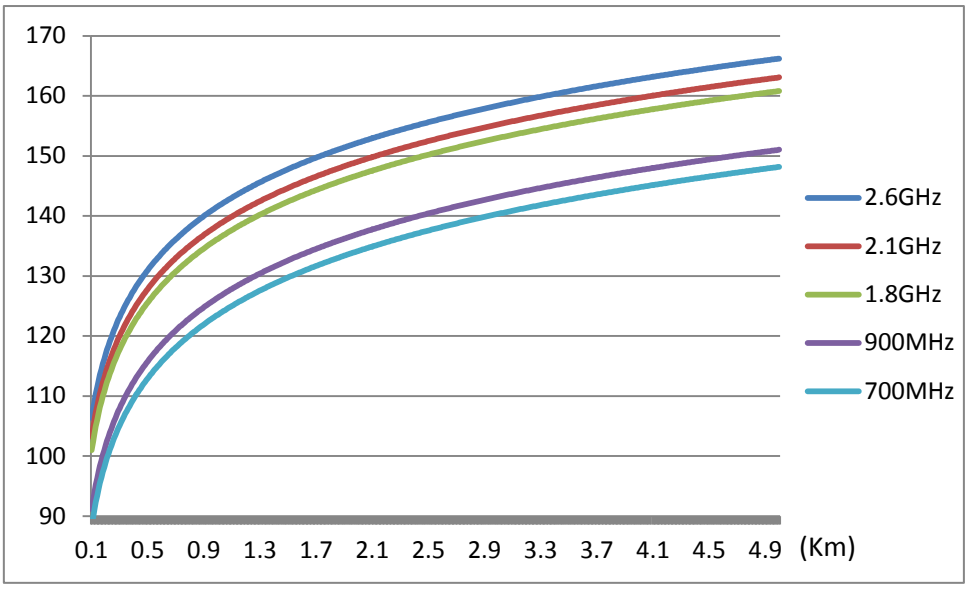


Figure 3-1 Propagation Loss & Propagation Distance Curve Comparison in Dense Urban Areas

For example, from the results the propagation loss of 2.6GHz at 500m is about 18dB larger than 700MHz. As another example, for the same propagation loss at 130dB, the propagation distance for 2.6GHz is about 500m, while the propagation distance for 700MHz is about 1.6Km

3.2 Link Performance

Link performance is usually characterized by SINR with guaranteed BLER. Frequency effects on the link performance are mainly manifested in the Doppler shift disparity with a certain moving speed and, eventually, effects on SINR. However, taking into account the typical network deployment scenarios (e.g. dense urban, urban, suburban, rural, etc.), the terminal speed is slow. The Link Simulation results show that in slow moving conditions, the SINR of each band is very similar. Figure 3-2 shows the link performance simulation conditions of the SEM channel model with comparisons between 800MHz, 2.3GHz and 2.6GHz with 3km/h movement speed.

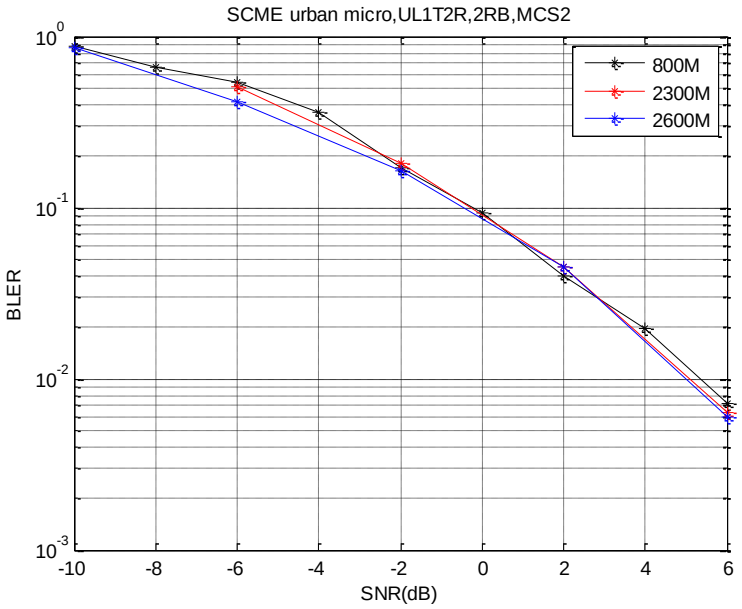


Figure 3-2 Link Performance Curves of 800MHz, 2.3GHz, 2.6GHz

Based on the simulation results, the SINR performance impact between the frequency bands is very limited. Therefore, we will adopt the same link performance parameters in the current network planning and link budget.

3.3 Coverage Analysis of Different Frequency Bands

With typical link budget parameters and configuration, uplink coverage is limited. A comparison based on the uplink edge rate from dense urban to rural environments and the coverage radius of a single site utilizing 700MHz, 800MHz, 1.8GHz, 1.9GHz, 2.1GHz, and 2.6GHz is shown in Table 3-1.

Morph		Dense Urban	Urban	Suburban	Rural
Cell Edge User Throughput	kbps	512	256	128	64
700MHz					
UL Cell Range	km	0.70	1.21	3.37	8.48
Coverage Area	Km2	0.95	2.84	22.16	140.37
800MHz					
UL Cell Range	km	0.63	1.09	3.04	7.65
Coverage Area	Km2	0.78	2.33	18.06	114.22
1.8GHz					
UL Cell Range	km	0.38	0.64	1.67	4.40
Coverage Area	Km2	0.27	0.80	5.42	37.71
1.9GHz					
UL Cell Range	km	0.36	0.61	1.58	4.17
Coverage Area	Km2	0.25	0.72	4.87	33.84
2.1GHz					
UL Cell Range	km	0.32	0.55	1.43	3.77
Coverage Area	Km2	0.21	0.60	4.00	27.69
2.3GHz					
UL Cell Range	km	0.30	0.51	1.31	3.44
Coverage Area	Km2	0.17	0.50	3.35	23.08
2.6GHz					
UL Cell Range	km	0.27	0.45	1.16	3.04
Coverage Area	Km2	0.14	0.40	2.63	18.06

Table 3-1 Uplink Coverage Comparison of Typical Scenarios

From the results, a single site coverage area using the 700MHz band in various scenarios is the equivalent of 7 to 8 times that of the 2.6GHz band. In the other words, to cover the same area, the number of sites used for 2.6GHz will be 7 to 8 times what is used for 700MHz.

If the operator will be utilising multiple bands for the network deployment, there is no doubt that 700MHz is the best choice for nationwide coverage to save network deployment costs and to speed up deployment.

4 ZTE's APT 700MHz LTE Access Solution

To date, ZTE has concluded 45 LTE commercial contracts (CSL, TeliaSonera, Telenor, Hutchison, SoftBank, Bharti) and nearly 110 trial networks with leading operators. ZTE has entered into 68% of countries that have invested in LTE networks.

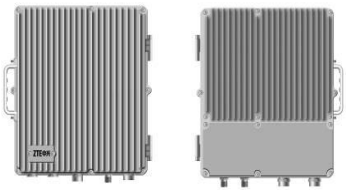
In the context of long term multi-system coexistence, the rise of the mobile broadband era accelerates the pace of network upgrades and evolution. How to efficiently protect the investment and fulfill requirements of new technologies and high data services are the challenges operators need to address. ZTE's SDR-based Uni-RAN solution provides an industry leading solution that meets all foreseeable primary needs while also cutting-down the total cost of ownership and protecting the customer's investment for future technologies.

ZTE fully supports the APT 700MHz band and has planned a series of products to meet various deployment scenarios. The network hierarchy includes different kinds of products that employ diverse output power and form (i.e. Marco, Micro, Pico, Femto, AAS, C-RAN) with the aim of providing capacity and coverage while achieving higher spectrum utilization and improved user experience.

4.1 Macro Basestation

As a result of the growth of its commercial LTE business, ZTE expanded the range of performance support parameters for its base stations to 900Mbps (DL) and 450Mbps (UL) on commercial networks. This solution uses a mature commercial DSP chip for more flexible and stable performance than the ASIC chip which is widely-used throughout the industry. The new solutions are capable of providing a higher level of support for upcoming LTE-A systems.

ZTE SDR BBU



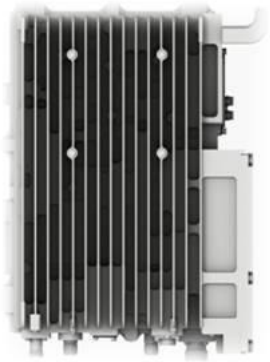
ZTE RRU

4.2 Small Cells – Micro, Pico, Femto

Small cells are low-powered radio access nodes used to provide in-building and outdoor wireless service. While struggling to support the growth in mobile data traffic, mobile operators use small cells to extend their service coverage and increase network capacity. With small cells, mobile operators can offload as much as 80% of traffic during peak times. Therefore, small cells can help service providers discover new revenue opportunities.

Small cells encompass femtocells, picocells, and microcells. As a leading comprehensive provider of telecommunication equipment and network solutions, ZTE has launched an LTE small cell series for hot spot and indoor coverages and is dedicated to improving operators' competitiveness.

ZTE's LTE small cell product portfolio consists of micro (BS8912), indoor Pico (BS8102), outdoor Pico (BS8202) and femto (BS8002) products to suit various power and application scenarios.



Micro BS8912

Indoor Pico BS8102

Outdoor Pico BS8202

Femto BS8002

4.3 ZTE’s Advanced AAS Solution

Additional frequency bands and system modes make antenna installation complicated; site rental also becomes more difficult and expensive for operators, especially in hotspot areas of large cities. Operators are urgently working to introduce an overlay network to achieve the evolution to LTE without influencing their ongoing 2G/3G services. To solve this problem, ZTE has launched the LTE BeamHop AAS. This solution is designed to meet an operator’s new requirements and includes features such as multi-mode, highly compact, low power consumption and high performance.

The LTE BeamHop AAS Solution also consists of both active and passive antennae. Since the LTE radio unit is integrated into the existing antenna, the new LTE network can be deployed without purchasing additional antenna site space, reducing the installation costs by leveraging existing resources. This product is especially beneficial to operators competing in developed markets in which the cost of renting antenna space is high.

ZTE's BeamHop AAS Solution

5 Summary

Mobile service providers today need to harmonize the benefits of all spectrum bands in their network. As we can see, 700MHz spectrum is the best solution for operators looking for nationwide and in-building coverage. The asset deployment is reduced in relation to the spectral efficiencies attributed to selected band. The higher the spectral band, the higher the number of cells required to provide the desired user experience and coverage. Conversely, the lower the spectral band used, the better the coverage and penetration, and therefore, and by association the lower the cost and the higher the quality of service. Specifically, the APT 700MHz allocation is being taken up and widely utilized worldwide to help lower TCO and provide massive quantities of scale.