Cellular Networks Overview - SNYPER-LTE Graphyte

Background

Cellular communications are a constantly evolving technology. It all started in 1973 when Motorola made the first prototype mobile phone and made the first mobile phone call. But it took a further 10 years to set up the first network and for the first mobile phones to go on sale in the USA (the Motorola DynaTAC 8000X at $4000). This was all analogue technology which has since been obsoleted. Although not named in this way at the time, this can be considered the 1G network (first Generation).

Then digital arrived in 1991 as a replacement for the analogue network, with the first country to use it being Finland. This is what is called the GSM or 2G network. GSM initially stood for 'Groupe Spécial Mobile', but later was given the more international name 'Global System for Mobile Communications'. Initially this was a voice only network but evolved to also carry packet data using GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution).

UMTS (Universal Mobile Telecommunications System) is the third generation (3G) cellular network, with the first network launched in Japan in 2001. It shares many core concepts with the way that GSM works, but the implementation uses the wireless bandwidth much more efficiently. This increases the available bandwidth allowing more simultaneous calls to share the wireless spectrum and increases data transfer speed. There are several ways that UMTS carries packet data. Initially WCDMA was used, then this progressed to Evolved HSPA (HSPA+), but now most have been upgraded to carry packet data using HSDPA (High Speed Downlink Packet Access), also known as 3.5G. With each new implementation of packet data transfer, the data rates achievable improved.

LTE (Long Term Evolution) is the fourth generation (4G) cellular network. The first networks were launched in Norway and Sweden at the end of 2009. In operation, LTE is very different to the technologies that proceeded it. Previous generations of cellular technology worked on a time division multiplexed system, while LTE is a packetized system right from the outset meaning that when LTE carries voice, it carries it as packetized data (VoLTE). It also allows improved throughput by sending and receiving data on multiple channels by using MIMO antennas and aggregating the channels.

Cellular Network Registration Process

When a mobile device is first turned on, it will initially listen for the Broadcast Control Channel (BCCH) which is transmitted by the cells attached to the base stations that are within reach. There normally 3 or more cells on each base station, each with a different field of view. Each cell has its own BCCH which carries identification information that uniquely identifies the cell and its operational parameters. The mobile device compares this information with data held on its SIM card to determine which network operator(s) that it can attach to, and then proceeds to register with the strongest signal level cell that it can access.

What the SNYPER-LTE Graphyte Graphyte Can Discover...

What the SNYPER-LTE Graphyte does when it conducts a survey, is listen to and collect all the information provided by the BCCH from the surrounding cells. Collected data includes network names, signal strength, frequencies/bands used, base station location and identity codes. The Graphyte listens to the BCCH only (which is only a downlink channel); it will not attempt to register onto any network and so generates no network traffic itself. Therefore, no SIM card is required for the Graphyte to function.

2G/GSM Frequency Bands

The SNYPER-LTE Graphyte (EU) supports surveys on the 900 MHz and 1800 MHz frequency bands. This allows the Graphyte to survey 2G/GSM networks anywhere in the world except North and South America which uses 850 MHz and 1900 MHz. However, it is worth noting that in Central and South America, and in the Caribbean, that there are also some 900 MHz and/or 1800 MHz networks that may be coexisting with 850 MHz and/or 1900 MHz networks. Brazil and Uruguay for instance use all four.

The SNYPER-LTE Graphyte (USA) does not support any 2G/GSM frequency bands.

3G/UMTS Frequency Bands

The SNYPER-LTE Graphyte (EU) supports surveys on the 900 MHz and 2100 MHz frequency bands. 900 MHz is used in Europe, Asia, South Africa, Australia, New Zealand and a small number of Latin American countries. 2100 MHz is used in Europe, Asia, Africa, Oceania and a small number of Latin American countries.

The SNYPER-LTE Graphyte (EU) does not support 850 MHz and 1900 MHz which are the main frequency bands used in the Americas and a few Asian countries, nor 800 MHz and 1700 MHz used by a small number of countries.

The SNYPER-LTE Graphyte (USA) supports surveys on the 850 MHz and 1900 MHz frequency bands. 850 MHz is used in North America, Latin America, Australia, New Zealand and a small number of Asian countries. 1900 MHz is used in North America and Latin America only.

The SNYPER-LTE Graphyte (USA) does not support 900 MHz and 2100 MHz which are the main frequency bands used in the Europe, Asia, Africa, Oceania and a small number of Latin American countries, nor 800 MHz and 1700 MHz used by a very small number of countries.

4G/LTE Frequency bands

The SNYPER-LTE Graphyte (EU) supports surveys on bands B1 (2100 MHz), B3 (1800 MHz), B7 (2600 MHz), B8 (900 MHz) and B20 (800 MHz). The SNYPER-LTE Graphyte (USA) supports surveys on bans B2 (1900 MHz), B4 (1700 MHz), B5 (850 MHz), B12 (700 MHz) and B13 (700 MHz). When considering which networks may be surveyed for 4G/LTE, it is important to consider the band numbers and not the frequencies.

For example, there are 4 frequency bands that are 2100 MHz - band 1 (supported by the Graphyte), and bands 33, 34 and 65 (which are not supported by the Graphyte). These bands differ in frequencies at that they operate at (2100 MHz is the nearest round number that the LTE standard uses) and some operating characteristics. Many of these bands exist in the standards, but have no operators using them. Others may only be used by a small number of operators worldwide. In the case of 2100 MHz, band 1 is the only one of the 4 bands that is currently in use worldwide. So, bands 33, 34 and 65 will be of no interest to anyone.

As a general statement, considering the worldwide deployment of 4G/LTE networks and the many frequency bands used, the SNYPER-LTE Graphyte (EU) provides good coverage of the bands used in Europe and Africa and partial coverage in Asia, Oceania, Latin America and the Caribbean. The SNYPER-LTE Graphyte (USA) provides good coverage in the USA and partial coverage in other areas of the Americas and Caribbean.