# Alternative Frequency Selection of Long Term Evolution (LTE) Technology in Indonesia

**Uke Kurniawan Usman, Galuh Prihatmoko**
Faculty of Electrical Engineering and Communication
Telkom Institute of Technology
Jl. Telecommunications No.1 Bojongsoang Bandung 40257
e-mail: uku@ittelkom.ac.id, galuh@mobilecommlab.or.id

***Abstract***

*Frequency is a limited resource that is indispensable for cellular telecommunications. Frequency allocation needs to be done from the beginning that there was no interference between cellular technology. Frequency allocation policy is one factor inhibiting adoption of Long Term Evolution technology in Indonesia. Based on standard ITU-R, 3GPP, APAC conference, as well as the frequency of the condition in Indonesia. There are several candidate frequency can be allocated to LTE technology, namely: 700MHz,2.1GHz,2.3 GHz and 2.6GHz frecuency. After review of the analysis result produced a recommendation for LTE frequency allocation in Indonesia, is 700MHz frecuency. However, if the use of 700 MHz frequency has 700MHz frecuency constraint is currently still used for TV broadcast frecuency. So using 700MHz frequency can be implemented for LTE technology is carried out after the TV broadcast frequency has been re-farming to digital TV.*

***Keywords****: LTE, Frequency, 3GPP.*

## 1. Introduction

LTE technology is designed to separate downlink and uplink spectrum in two different pipes. Downlink speeds can be more than 300 Mbps, while the uplink speeds over 80 Mbps. Its uplink based on a technology called SC-FDMA or Single Carrier Frequency Division Multiple Access. While the downlink OFDM-based (Orthogonal Frequency Division Multiplexing).With this technology, the handset battery will last longer even be used for data connections.

LTE, together with a SAE (service architecture evolution), is the core work of 3GPP Release 8. The essence or core LTE called EPC (evolved packet core). EPC is an all-IP (all IP, and IP only), and easy interconnection with other IP network, including WiFi, WiMAX, and xDSL. LTE is also expected to support personal broadband network, by integrating mobile and fixed services. Users do not have to wait for a more stable network, for example, to upload a video file. LTE should be ready in a technical (and economic) to accommodate dynamic traffic from Web 2.0, cloud computing, to a wide range of gadgets. ABI Research projects that devices such as cameras, MP3 players, video, etc. equipped with network capability will be close to number half a billion units in 2012. High traffic and dynamic that requires replacement of return transmission system. From TDMA in 2G and 3G CDMA, 4G technologies will use OFDMA, which again will increase the efficiency of spectrum. Average speed ranges at 15 Mbps with 15 ms delay, although the maximum value expected to reach over 200 Mbps in 20MHz bandwidth. LTE can operate at 1.4 to 20 MHz bandwidth. Access will be based on the use of radio channels together at 300 Mbps on the way down and 75 Mbps on the rise. If the 2G/3G, the radio access will be connected to the circuit-switched domain, the E-UTRAN LTE will only be connected to the EPC.

SAE, unlike the previous system, only two nodes in the user plane: base station (called eNodeB) and gateways. The number and type of signaling is minimized. RNC (radio network controller) is included as a function in the eNodeB, which makes the handover process is managed entirely by eNodeB - similar to the 3G UTRAN.

## 2. Research Method

This research was using literature study method. First of all, policies of ITU-R studies serve as first step and then refer to 3GPP standard that Indonesian celuler technology used. APAC conference also considered the results to support this research. From all of ITU-R studies, 3GPP, and APAC, were concluded several frequencies candidate. The candidates were analyzed and matched with the condition of existing frequencies in Indonesia.

The analysis covers the advantages and disadvantages of implementing a particular frequency. Results of the analysis has been got a strong candidate for the implementation of LTE in Indonesia. This will be used as a recommendation to the government to quickly determine the frequency policy for LTE deployment in Indonesia.

## 3. History LTE

Radio Access Network of 3GPP LTE or also called Evolved-UTRAN (E-UTRAN) began to be discussed at RAN Evolution Workshop November 2004. At the workshop have identification some outline requirements (high level requirement) from LTE, namely:

- Reducing the cost per bit.
- Improving the provision of services (service provisioning) - more and more services with a small cost and a better user experience.
- Flexibility in frequency band new operator and existing.
- Simplifying the architecture, open interface
- Power consumption at a reasonable terminal.

Feasibility study on E-UTRA and E-UTRAN began in December 2004 with the main objective is to build a framework as the evolution of the 3GPP radio access technology to obtain high data-rate, low-latency and optimization of radio access technology for packet-switched domain. Details of the needs of the E-UTRAN formulated in the Technical Report (TR) 25 913 "Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN)" which includes among others:

- Peak data rate of 100 Mbps for the downlink with a 20 MHz downlink spectrum allocation (5bps/Hz) and 50 Mbps (2.5 bps / Hz) for the uplink.
- Reduced latency in the Control-plane and user-Plane.
- Data throughput increased by 3 to 4 times to down link of HSDPA Rel-6 and 2 to 3 times for the uplink from Rel-6 HSUPA.
- Eficiency spectrum with a fixed transmitter can use a location that has been used in the UTRAN / GERAN.
- Use a flexible spectrum.
- The ability of a user mobility that still get service with high performance at speeds up to 350 km / hour.
- Coverage area (coverage) with a radius of up to 5 km in order to achieve the above mentioned performance and maximum range of 100 km.
- Enhanced MBMS (Multimedia Broadcast / Multicast Service).
- Maintain 3GPP RAT (Radio Access Technology) which already exist and supports interworking with him.
- Single packet-based architecture, interface minimization and simplification.
- Reduction of complexity.

At a meeting in June 2005, 3GGP RAN WG1 begin to evaluate the several new technologies of water-interface that will be used as E-UTRA physical layer. 6 types of physical layer based on WCDMA, SCDMA and OFDMA are evaluated and the results can be seen in the TR 25 814 "Physical layer aspect for evolved UTRA." In 2005 the 3GPP RAN WG2 also responsible for the specification of Radio Access Layer 2 and Layer 3 discusses the requirements / agreements for water-interface protocol based on several assumptions for defining the protocol is highly dependent on air-interface technology that is used. Until the end of the meeting, finally give a conclusion about the specification capabilities / requirements of LTE technology which is comprised of 3GPP.

**4. LTE Specification**

LTE, together with a SAE (service architecture evolution), is the core work of 3GPP Release 8. The essence or core LTE called EPC (evolved packet core). EPC is an all-IP (all IP, and IP only), and easy interconnection with other IP network, including WiFi, WiMAX, and xDSL. LTE is also expected to support personal broadband network, by integrating mobile and fixed services. Users do not have to wait for a more stable network, for example, to upload a video file. LTE should be ready in a technical (and economic) to accommodate dynamic traffic from Web 2.0, cloud computing, to a wide range of gadgets. ABI Research projects that devices such as cameras, MP3 players, video, etc. equipped with network capability will be close to number half a billion units in 2012. High traffic and dynamic that requires replacement of return transmission system. From TDMA in 2G and 3G CDMA, 4G technologies will use OFDMA, which again will increase the efficiency of spectrum. Average speed ranges at 15 Mbps with 15 ms delay, although the maximum value expected to reach over 200 Mbps in 20MHz bandwidth. LTE can operate at 1.4 to 20 MHz bandwidth. Access will be based on the use of radio channels together at 300 Mbps on the way down and 75 Mbps on the rise. If the 2G/3G, the radio access will be connected to the circuit-switched domain, the E-UTRAN LTE will only be connected to the EPC. Optimal using radio access for IP traffic.

SAE, unlike the previous system, only two nodes in the user plane: base station (called eNodeB) and gateways. The number and type of signaling is minimized. RNC (radio network controller) is included as a function in the eNodeB, which makes the handover process is managed entirely by eNodeB - similar to the 3G UTRAN. LTE will be deployed on a wide band spectrum. It is expected that the new 2.6 GHz band can be used, because of its capacity allows for the provision of the band up to 20MHz. But LTE could also be held in the former band GSM at 900MHz and 1800MHz. 3GPP LTE standards for frequency 3GPP working group [7] to formulate some frequency bandwidth for each channel on LTE technology.

**5. Frequency Spectrum Usage in Indonesia**.

On the frequency of 450 MHz to 467 MHz, currently used for cellular communications which are fixed wireless, by the operator Ceria. As for the 478-978 MHz frequency, used for broadcast TV. At frequency 800 MHz to 960 MHz, has been solid occupied by several operators, both GSM and CDMA operators.

While in the 1700-1880 MHz frequency, has been inhabited by GSM operators, namely SingTel, Indosat, Excelcomindo, and Hutchinson (Tri). For 3G networks, some operators using the frequency spectrum 1900 MHz to 2100 MHz. One of the opportunities for LTE technology implementation in the frequency of 2500 MHz to 2670 MHz, which has been used to channel Indovision.

**6. Results and Analysis**

LTE will be deployed on a wide band spectrum. It is expected that the new 2.6 GHz band can be used, because of its capacity allows for the provision of the band up to 20MHz. But LTE could also be held in the former band GSM at 900MHz and 1800MHz. 3GPP LTE standards for frequency 3GPP working group [7] to formulate some frequency bandwidth for each channel on LTE technology. Here are the details:

Table 1. 1,4 MHz and 3 MHz

| Uplink (UL) operating band | Downlink (DL) operating band | Duplex Mode |
|---|---|---|
| BS receive | BS transmit | |
| $F_{UL\_low}$ – $F_{UL\_high}$ | $F_{DL\_low}$ – $F_{DL\_high}$ | |
| 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| 1710 MHz – 1755 MHz | 2110 MHz – 2155 MHz | FDD |
| 824 MHz – 849 MHz | 869 MHz – 894MHz | FDD |

| | | |
|---|---|---|
| 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| 698 MHz – 716 MHz | 728 MHz – 746 MHz | FDD |
| 1850 MHz – 1910 MHz | 1850 MHz – 1910 MHz | TDD |
| 1930 MHz – 1990 MHz | 1930 MHz – 1990 MHz | TDD |

Table 2. 5 MHz and 10 MHz

| Uplink (UL) operating band | Downlink (DL) operating band | Duplex Mode |
|---|---|---|
| BS receive | BS transmit | |
| UE transmit | UE receive | |
| $F_{UL\_low}$ – $F_{UL\_high}$ | $F_{DL\_low}$ – $F_{DL\_high}$ | |
| 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| 1710 MHz – 1755 MHz | 2110 MHz – 2155 MHz | FDD |
| 824 MHz – 849 MHz | 869 MHz – 894MHz | FDD |
| 830 MHz – 840 MHz | 875 MHz – 885 MHz | FDD |
| 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| 1749.9 MHz – 1784.9 MHz | 1844.9 MHz – 1879.9 MHz | FDD |
| 1710 MHz – 1770 MHz | 2110 MHz – 2170 MHz | FDD |
| 1427.9 MHz – 1447.9 MHz | 1475.9 MHz – 1495.9 MHz | FDD |
| 698 MHz – 716 MHz | 728 MHz – 746 MHz | FDD |
| 777 MHz – 787 MHz | 746 MHz – 756 MHz | FDD |
| 788 MHz – 798 MHz | 758 MHz – 768 MHz | FDD |
| 704 MHz – 716 MHz | 734 MHz – 746 MHz | FDD |
| 815 MHz – 830 MHz | 860 MHz – 875 MHz | FDD |
| 830 MHz – 845 MHz | 875 MHz – 890 MHz | FDD |
| 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| 1447.9 MHz – 1462.9 MHz | 1495.9 MHz – 1510.9 MHz | FDD |
| 1900 MHz – 1920 MHz | 1900 MHz – 1920 MHz | TDD |
| 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |
| 1850 MHz – 1910 MHz | 1850 MHz – 1910 MHz | TDD |
| 1930 MHz – 1990 MHz | 1930 MHz – 1990 MHz | TDD |
| 1910 MHz – 1930 MHz | 1910 MHz – 1930 MHz | TDD |
| 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |

Table 3. 15 MHz

| Uplink (UL) operating band | Downlink (DL) operating band | Duplex Mode |
|---|---|---|
| BS receive | BS transmit | |
| UE transmit | UE receive | |
| $F_{UL\_low}$ – $F_{UL\_high}$ | $F_{DL\_low}$ – $F_{DL\_high}$ | |
| 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| 1850 MHz - 1910 MHz | 1930 MHz – 1990 MHz | FDD |

| | | |
|---|---|---|
| 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| 1710 MHz – 1755 MHz | 2110 MHz – 2155 MHz | FDD |
| 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| 1749.9 MHz – 1784.9 MHz | 1844.9 MHz – 1879.9 MHz | FDD |
| 1710 MHz - 1770 MHz | 2110 MHz - 2170 MHz | FDD |
| 815 MHz - 830 MHz | 860 MHz – 875 MHz | FDD |
| 830 MHz – 845 MHz | 875 MHz – 890 MHz | FDD |
| 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| 1447.9 MHz – 1462.9 MHz | 1495.9 MHz – 1510.9 MHz | FDD |
| 1900 MHz – 1920 MHz | 1900 MHz – 1920 MHz | TDD |
| 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |
| 1850 MHz – 1910 MHz | 1850 MHz - 1910 MHz | TDD |
| 1930 MHz – 1990 MHz | 1930 MHz – 1990 MHz | TDD |
| 1910 MHz – 1930 MHz | 1910 MHz – 1930 MHz | TDD |
| 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |

Table 4. 20 MHz

| Uplink (UL) operating band | Downlink (DL) operating band | Duplex Mode |
|---|---|---|
| BS receive | BS transmit | |
| UE transmit | UE receive | |
| $F_{UL\_low}$ – $F_{UL\_high}$ | $F_{DL\_low}$ – $F_{DL\_high}$ | |
| 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| 1710 MHz – 1755 MHz | 2110 MHz – 2155 MHz | FDD |
| 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| 1749.9 MHz – 1784.9 MHz | 1844.9 MHz – 1879.9 MHz | FDD |
| 1710 MHz – 1770 MHz | 2110 MHz – 2170 MHz | FDD |
| 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| 1900 MHz – 1920 MHz | 1900 MHz – 1920 MHz | TDD |
| 1850 MHz – 1910 MHz | 1850 MHz – 1910 MHz | TDD |
| 1930 MHz – 1990 MHz | 1930 MHz – 1990 MHz | TDD |
| 1910 MHz – 1930 MHz | 1910 MHz – 1930 MHz | TDD |
| 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |

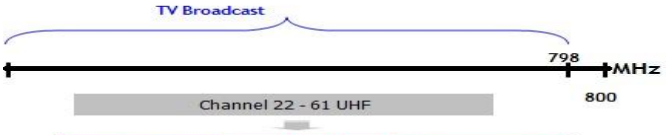
Table 5. 3GPP LTE Frequency Standards

FDD (left) and TDD (right) frequency bands defined in the 3GPP (May 2009)

| Operating band | 3GPP name | Total spectrum | Uplink [MHz] | Downlink [MHz] |
|---|---|---|---|---|
| Band 1 | 2100 | 2x60 MHz | 1920-1980 | 2110-2170 |
| Band 2 | 1900 | 2x60 MHz | 1850-1910 | 1930-1990 |
| Band 3 | 1800 | 2x75 MHz | 1710-1785 | 1805-1880 |
| Band 4 | 1700/2100 | 2x45 MHz | 1710-1755 | 2110-2155 |
| Band 5 | 850 | 2x25 MHz | 824-849 | 869-894 |
| Band 6 | 800 | 2x10 MHz | 830-840 | 875-885 |
| Band 7 | 2600 | 2x70 MHz | 2500-2570 | 2620-2690 |
| Band 8 | 900 | 2x35 MHz | 880-915 | 925-960 |
| Band 9 | 1700 | 2x35 MHz | 1750-1785 | 1845-1880 |
| Band 10 | 1700/2100 | 2x60 MHz | 1710-1770 | 2110-2170 |
| Band 11 | 1500 | 2x25 MHz | 1427.9-1452.9 | 1475.9-1500.9 |
| Band 12 | US700 | 2x18 MHz | 698-716 | 728-746 |
| Band 13 | US700 | 2x10 MHz | 777-787 | 746-756 |
| Band 14 | US700 | 2x10 MHz | 788-798 | 758-768 |
| Band 17 | US700 | 2x10 MHz | 704-716 | 734-746 |
| Band 18 | Japan800 | 2x30 MHz | 815-830 | 860-875 |
| Band 19 | Japan800 | 2x30 MHz | 830-845 | 875-890 |

| Operating band | 3GPP name | Total spectrum | Uplink and downlink [MHz] |
|---|---|---|---|
| Band 33 | UMTS TDD1 | 1x20 MHz | 1900-1920 |
| Band 34 | UMTS TDD2 | 1x15 MHz | 2010-2025 |
| Band 35 | US1900 UL | 1x60 MHz | 1850-1910 |
| Band 36 | US1900 DL | 1x60 MHz | 1930-1990 |
| Band 37 | US1900 | 1x20 MHz | 1910-1930 |
| Band 38 | 2600 | 1x50 MHz | 2570-2620 |
| Band 39 | UMTS TDD | 1x40 MHz | 1880-1920 |
| Band 40 | 2300 | 1x50 MHz | 2300-2400 |

### 6.1 Alternative 1 using Spectrum Frequncy on 700 MHz [8]




| Station | Channel | Frequency |
|---|---|---|
| (blank) | 23 UHF | 486 MHz - 494 MHz |
| (blank) | 25 UHF | 502 MHz - 510 MHz |
| Space Toon | 27 UHF | 518 MHz - 526 MHz |
| Trans | 29 UHF | 534 MHz - 542 MHz |
| TVRI | 31 UHF | 550 MHz - 558 MHz |
| O Channel | 33 UHF | 566 MHz - 574 MHz |
| ElshinTa | 35 UHF | 582 MHz - 590 MHz |
| TPI | 37 UHF | 598 MHz - 606 MHz |
| (blank) | 39 UHF | 614 MHz - 622 MHz |
| Indosiar | 41 UHF | 630 MHz - 638 MHz |
| RCTI | 43 UHF | 646 MHz - 654 MHz |
| SCTV | 45 UHF | 662 MHz - 670 MHz |
| anTV | 47 UHF | 678 MHz - 686 MHz |
| Trans7 | 49 UHF | 694 MHz - 702 MHz |
| GlobalTV | 51 UHF | 710 MHz - 718 MHz |
| TVOne | 53 UHF | 726 MHz - 734 MHz |
| JakTV | 55 UHF | 742 MHz - 750 MHz |
| MetroTV | 57 UHF | 758 MHz - 766 MHz |
| DAAI TV | 59 UHF | 774 MHz - 782 MHz |
| (blank) | 61 UHF | 790 MHz - 798 MHz |

For the frequency of 700 MHz, currently used for TV broadcast service. The service is great demand by users in Indonesia.

But on the other hand, in many countries, a broadcast TV service is becoming obsolete, even for developed countries, are not allowed anymore to broadcast the service. They have begun to enter the era of digital TV, which in transmission using packet data network. Surely the technology in our country will soon adopt digital TV. The impact of the use of digital TV technology, one of which is no longer used 700 MHz frequency spectrum.

Along with the development of Indonesian telecommunication, digital TV era is estimated to be entered when the LTE began to be implemented. This frequency can be used to implement LTE in the future. For the working frequency is 700 MHz, suitable for implementation of LTE in suburban and rural areas, due to low frequency, coverage will be wider when compared with the use of high frequency.

The ability to cover large areas is very suitable for suburban and rural areas, where the number of users are still rare.

### 6.2 Alternative 2 using Spectrum Frequncy on 1800 MHz [8]

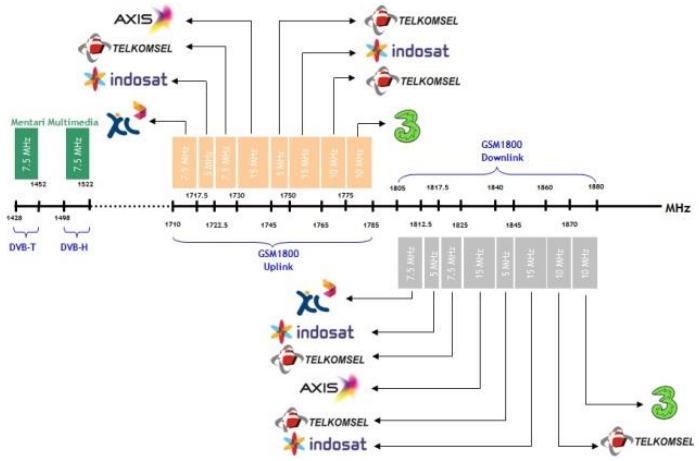



Figure 2. Spectrum Frequency on 1800 MHz

1800 MHz frequency spectrum usage right now is for the GSM technology. Appropriate standards 3GPP, LTE may work on this frequency band, thus become candidates for the implementation of LTE technology.

However, its use can only be started if the GSM will be direfarming to another frequency, or reduced the amount of bandwidth usage frequency.

### 6.3 Alternative 3 using Spectrum Frequncy on 2,3 GHz [8]

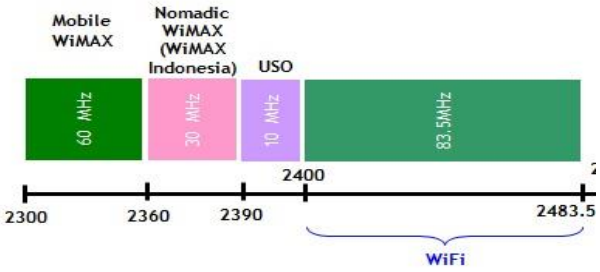



Figure 3. Spectrum Frequency on 2,3 GHz

Scenario usage frequency is 2.3 GHz for mobile WiMAX, but the presence of this technology in Indonesia will still doubt, will be even less with the mobility that is owned by the LTE. This makes the frequency of became the candidate of the LTE technology implementation.

### 6.4 Alternative 1 using Spectrum Frequncy on 2,6 GHz [8]

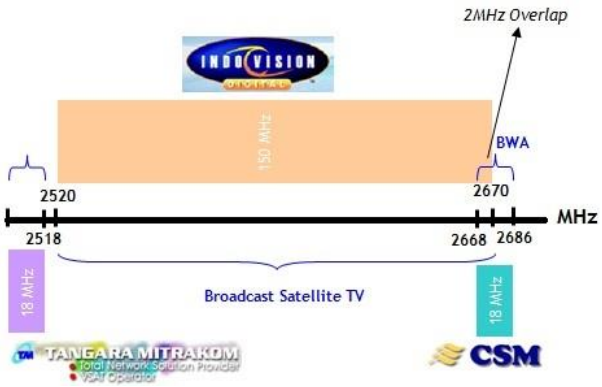



Figure 4. Spectrum Frequency on 2,6 GHz

At 2.6 Ghz frequency, it is still used for Indovision channel. But in the future, this frequency will be used for the deployment of LTE at high frequencies.

LTE network performance at these frequencies is very good. The negative impact of the use of high frequency is higher the damping value to be gained during the communication process, so the coverage area will be more narrow.

Use of these frequencies for LTE deployment is suitable for urban areas or what we call urban and dense urban.

## 7. Conclusion

From the above, can disumpulkan that the strongest candidates for frequency allocations for LTE is on the 700 MHz frequency band. However, its implementation should be started when the new television channel in Indonesia have been digitized. For that, there needs to be comprehensive migration from broadcast TV to the digital TV. So the chances of implementation of LTE at this frequency will be realized when the migration to digital TV has been fulfilled.

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