

# Bandwidth Expansion Mode Under Component Carrier based scheme in LTE Networks



N. Prabakaran, P. Sravanthi

**Abstract:** This paper reflects the bandwidth expansion using component carrier scheme in LTE networks by using different OFDM's i.e. bandwidth allocation algorithm and resource allocation algorithm are observed. Wireless cellular networks are an underlying for mobile phones, personal communication systems etc. There is a dramatic growth of wireless cellular networks in number of mobile phones. As a result, there is a significant increase in base station power consumption and data requirements. In competitive cellular industry, the power consumption in the base station has therefore become a major challenge to the vendors. Through component carrier based scheme the energy efficient LTE networks can be realized and energy efficiency can be improved to some extent through component carrier based scheme.

**Index Terms:** Component carriers, Bandwidth allocation, resource allocation, OFDM.

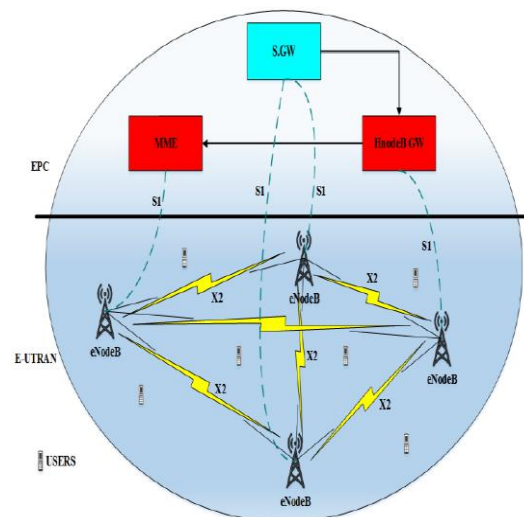
## I. INTRODUCTION

The evolution of wireless technology has brought much advancement with its effective features. In modern world it has become the basic provision required. In the last few decades wireless communication system has seen a massive growth from two individuals to majority of users [2], [3]. More improvements in the radio communication were observed by introducing cellular system in digital oriented through which a revolution passes called generations. As seen before an enhanced performance through the usage of 1G,2G,3G and 4G in the standards of communication which resulted in the enhanced performance before. Now the key achievements are aimed towards short transmission time, bandwidth allocation, security and less latency. All of these systems consists of base stations(BS), which are used to monitor and connected to the core networks for better functioning. By employing Orthogonal Frequency Division Multiplexing Access(OFDMA) the increase in data rate in LTE networks can be improved to some extent. In this OFDMA technique, it has low latency and high data rate which helps the LTE networks to enhance and improve the energy efficiency. The current bandwidth specifications are likely: 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, and 20MHz.

This increase in data rate can be achieved by Orthogonal Frequency Division Multiplexing Access(OFDMA).

## II. ARCHITECTURE OF LTE NETWORK

The systems in LTE networks usually has low latency, pocket optimized radio access and high data rate. It also provides compatibility and with legacy networks it provides international roaming which are used in 4G systems. These schemes have flexible bandwidths to support. From the fig (1) The architecture of LTE is based upon Evolved Packet Core(EPC), Universal Terrestrial Radio Access (UTRA), and Universal Terrestrial Radio Access Network (UTRAN), each of which communicates with radio access networks and core networks air interfaces.



There are some perspective communication challenges in LTE networks though LTE is a complex network. Those challenges are:

They are:

- Signaling system
- Backward compatibility
- Base station efficiency

### A. Signaling system

In LTE networks, signaling overhead and signal overlapping is the major issue to avoid or reduce in the control system of the network. More no. of connections between nodes and networks fragmentation causes speed increase in signaling traffic. Any failure in signaling system will drag operators towards increased system latency and results in low of revenues If there's any increase in signalling traffic then that leads to increased energy consumption.

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**B. Backward compatibility**

With all the other relevant major standards LTE is considered as compatible network. The end-to-end functionality testing and interoperability testing are complicated by the combination of devices, combination of networks and other standard equipment to support.

**C. Base station efficiency**

Due the employment of OFDM, the LTE signals have high amplitude variability which is called as peak-to-peak average power. This PAPR reduces the transmitter efficiency. At cost of high dynamic transmission power, the base station provides high data rate.

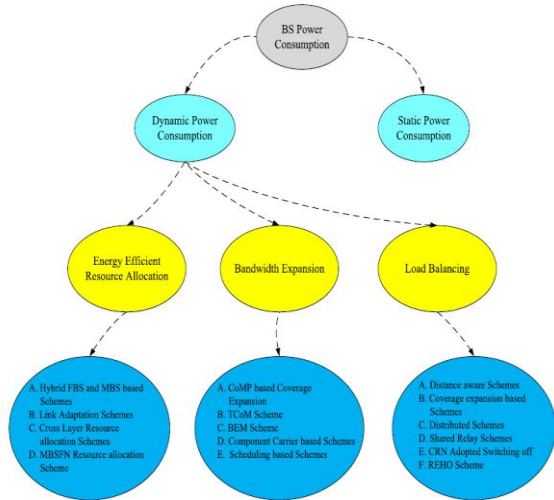


Fig 2, Classification of energy efficient schemes.

There are many energy saving schemes for more energy efficiency in LTE networks as shown in the fig (2). This paper presents about the amount of work which can be considered on component carrier based scheme.

**III. BANDWIDTH EXPANSION SCHEME**

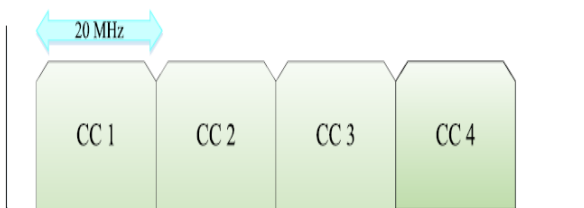
There are nearly five schemes by which the bandwidth in the LTE networks can be managed for more energy efficient LTE networks. This paper reflects about component carrier base scheme in carrier aggregation technology has the effective use of bandwidth.

**3.1 Component carrier based scheme:**

Component carrier is nothing but each aggregated carrier. For a component carrier bandwidth ranges from 1,4,3,5,10,15 or 20MHz

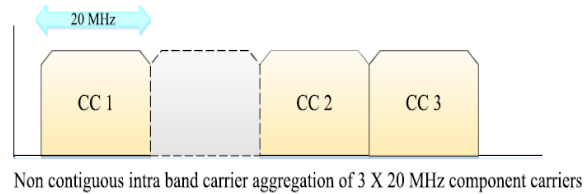
There are three methods to obtain carrier aggregation. They are

3.1.1 **Intra band contiguous**, It operates at same frequency band with contiguous carrier aggregation.



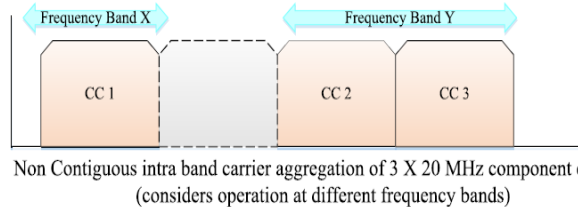
Contiguous intra band carrier aggregation of 4 X 20 MHz component carriers

3.1.2 **Intra band carrier aggregation in non-contiguous**, in this the component carrier operates with have at same frequency band.



Non contiguous intra band carrier aggregation of 3 X 20 MHz component carriers

3.1.3 **Inter band carrier aggregation in non-contiguous**, In this carrier operates at different frequency bands. To obtain energy efficiency in the LTE networks, more no. of CC's can be used utilized jointly in a BS's for enhanced energy saving opportunities.



Non Contiguous intra band carrier aggregation of 3 X 20 MHz component carriers (considers operation at different frequency bands)

**IV. OFDM COMPONENT CARRIERS**

Based on the OFDMA there two component carrier techniques through which the energy efficiency can be improved. This scheme consists of 2 component carriers.

- **Primary component carrier (PCC):** Uses normal transmission data.
- **Secondary component carrier (SCC):** It is used only under high traffic conditions.

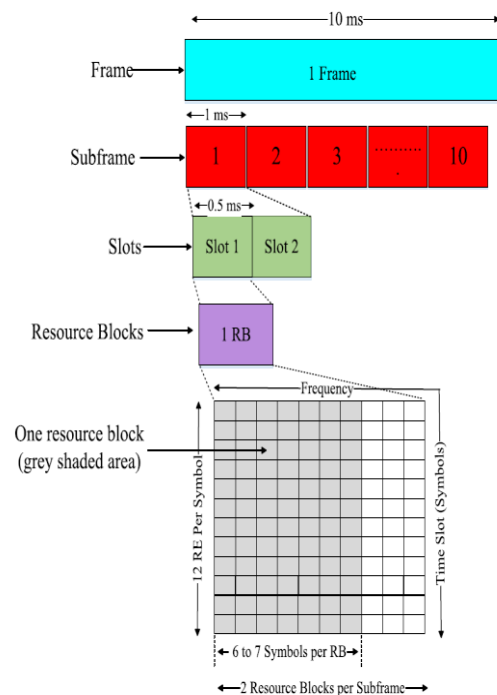


Fig 3 OFDM FRAME STRUCTURE

In fig (3) resource block allocation for each sub frame is explained. Each sub frame consists of two slots. In each slot one resource clock is allotted. Each slot consists of 0.5ms width, each sub frame ha 1ms, each frame has 10ms and each resource consists of atleast 6-7 symbols per block.



The data packets wait for the transmission. It is transmitted in queue which is to be provided by the energy saving scheme. This ES scheme has of two algorithms. They are:

- Bandwidth allocation algorithm
- Resource allocation algorithm

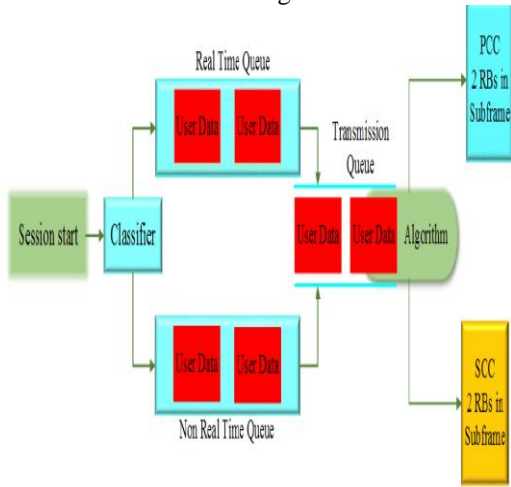


Fig 4 OFDM procedure

From the fig 4, the procedure for processing the algorithms to obtain primary component carrier(PCC) and secondary component carrier(SCC) in which it consists of two resource blocks in a sub frame. It is classified into real time queue and non-real time queue. Whereas PCC uses normal transmission data and SCC is used only under high traffic conditions.

## V. RESULTS

### A. Bandwidth channel allocation

As shown in the fig 5, Using matlab after processing bandwidth allocation in OFDM. The generalized bandwidth channel allocation has three offsets as shown in the fig,5 within the f-1 offset it has low offset at the edge of the channel and at the end of the bandwidth channel it has high frequency offset. Used parameters are mentioned below.

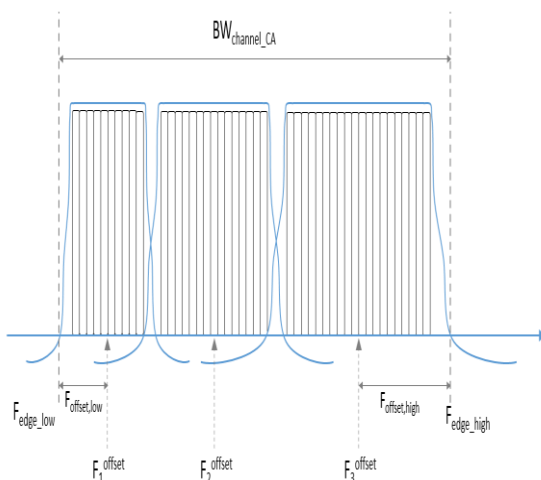


Fig 5 Bandwidth channel CA

### Bandwidth allocation parameters:

BW channel CA: 45.6000 MHz  
F offset low: 3.5000 MHz

F offset high: 9.0000 MHz  
F edge low: -21.3000 MHz  
F edge high: 21.3000 MHz

### B. Carrier aggregation waveform

As shown in the fig 6, Since the carrier based scheme has different methods to operate at the same frequency band. To obtain a carrier aggregation waveform three component carrier are compared with different frequency components. The parameters are mentioned below.

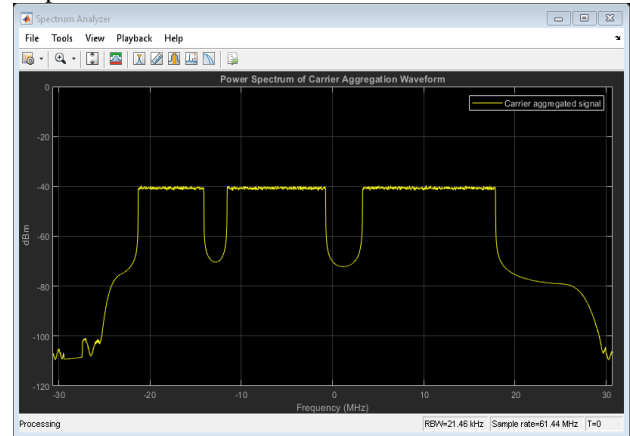


Fig 6 Carrier Aggregation Waveform

### Carrier Aggregation Parameters Calculation:

Component Carrier 1:  
Fc: -14.6000 MHz  
Component Carrier 2:  
Fc: -3.4000 MHz  
Component Carrier 3:  
Fc: 10.3000 MHz

### C. Spectrum analyzer

As shown in the fig 7, carrier aggregation signal and filtered signal are measured through which spectrum is analyzed. It is a power spectrum of demodulated and filtered waveform. Therefore, the allocation of the channel is estimated after comparing the signal with the filtered signal and demodulated waveforms of the power spectrum.

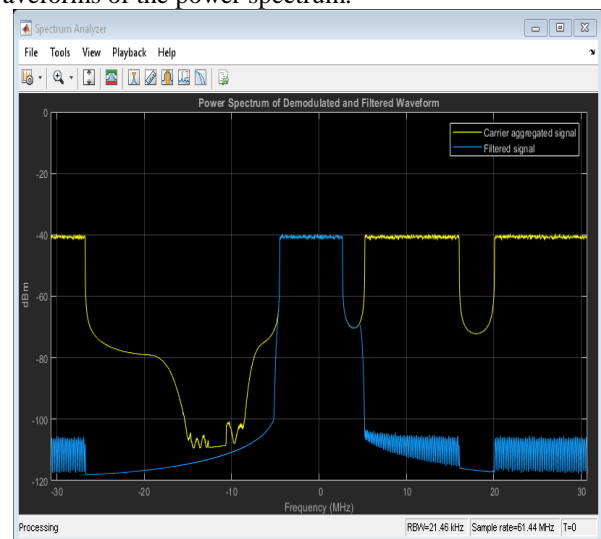
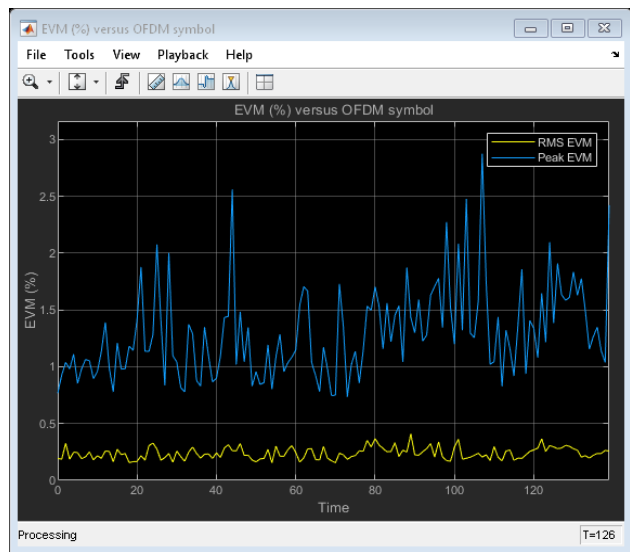


Fig 7 Spectrum Analyzer

**D. OFDM symbol**

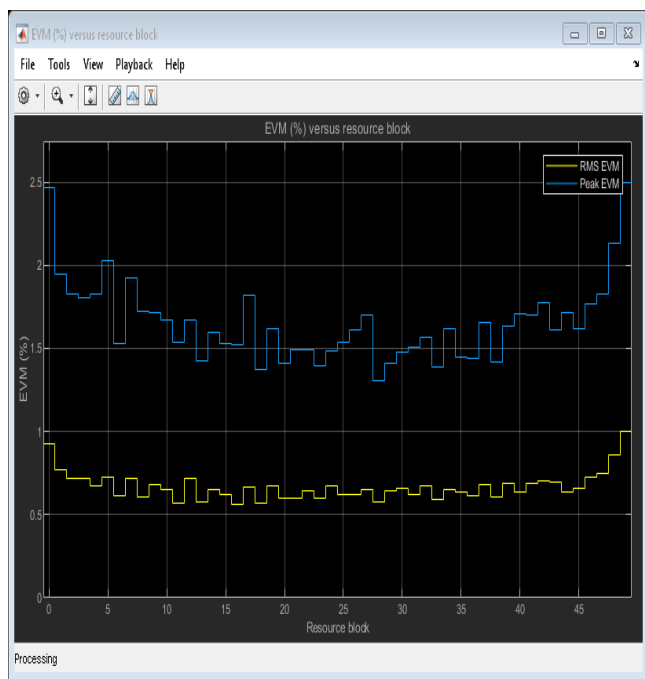
As shown in fig 8, the OFDM symbol is observed in which error vector magnitude and OFDM symbol are observed, here the RMS EVM and PEAK EVM are measured. whereas EVM is measured in percentages (%).



**Fig 8 OFDM Symbol**

**E. Resource block**

As shown in fig 9, the resource block range is estimated using resource allocation algorithm with the help of primary and secondary component carriers through the OFDM.



**Fig 9 Resource Block**

**VI. ADVANTAGES**

- It can save upto 40% of power.
- It is more effective for lightly loaded networks.

**VII. DISADVANTAGES**

- It can reduce bandwidth or actual capacity.
- As the traffic load increases the bandwidth decreases.

**VIII. CONCLUSION**

The bandwidth allocation algorithm and resource allocation algorithm are performed based on the parameters used for OFDM uplink and downlink channels. Further enhancement can be made by changing the required parameters to some extent. In this research work has proven that the base stations in LTE networks consume more dynamic power during idle state, which can be saved by the appropriate energy saving schemes. The power consumption which is reduced improves the performance of LTE networks by cutting down the carbon emission and OPEX.

**IX. FUTURE WORK**

Further enhancement can be made by offering energy saving scheme during peak load hours and also can implement other resource allocation algorithm by modifying some of its parameters. Load balancing technique can also be performed by using bandwidth allocation algorithm and resource allocation algorithms. Energy efficient base station reduced provisions can be increased by another dynamic energy saving schemes based on the enhanced energy efficient systems.

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