

## A Review on HetNet in LTE-Advanced

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### ABSTRACT

**Purpose:** Currently, when using a 4G network, there are issues with data speed, interference, and network coverage. Therefore, advancement within the network was required to eliminate this issue. It can be resolved using a heterogeneous network. Connection quality of service and data speed can be improved through heterogeneous network connections. It can be used in LTE Advanced because it is adaptable and inexpensive to deploy. The heterogeneous network has low latency, a larger spectrum, and a high data rate as additional benefits.

**Design/Methodology/Approach:** This paper proposes different techniques used in a heterogeneous network. After going through many research papers, data is collected about differences in Small Cells which is explained in this paper.

**Findings:** A heterogeneous network is a collection of different cell powers that create interference while connecting when used in a network. As a result, there ought to be some methods for getting rid of cell interference.

**Originality/value:** This review paper will play an important role in understanding how can the problem of network coverage and data speed can be improved by using different techniques using HetNet in a 5G network.

**Paper Type:** Theme Based Paper

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## Introduction

Day by day population is increasing rapidly. As the population increases the number of users of the mobile network is also increasing. Therefore, there is a need for lots of work to be done on the mobile network. As the load increases or in other words, the number of users increases in the mobile network, the services of the network are getting poor day by day. A user wants a network that has wide network coverage with a high-speed data rate. By observing this problem 3GPP Release 10 introduce Long Term Evolution (LTE-A). Long Term Evolution is based on a network which is heterogeneous Network. It helps the network to improve the efficiency of spectral per unit area. Due to the increase of users on the network, it becomes hard to provide efficient spectral because it also has some limits. Therefore, there was a need to improve the spectral by increasing in node's density (GPP, 2010).

Before LTE-A all the Macro Base (MB) stations were used for the spectrum. This Macro Base station was used in such a way that they do not cause any interference between the cells. If some interferences occur in the network, then by using different techniques they can be removed from the network by adjusting the bandwidth electronically. For installing Macro Base stations in the area lots of planning must be needed for a network and radiofrequency. But in urban dense areas, the Macro Base station was not able to fulfil the requirement of the user. And also, the signal was not able to reach properly in private premises. It can be solved by using more Macro Base Station in a Network, which is not possible. Because using more Micro Base stations in a network will increase intercell interference in the network and also not seems to be feasible (Wannstrom, 2014). Therefore, there was a need for different approaches to overcome this problem at a low cost.

To overcome these problems low power base stations were used and the problem of coverage area can be solved in the area of the high-power base station. The group of macro and low power Base stations is known as HetNet. HetNet consists of different Power Base stations with varying transmission power.

## HetNet Introduction

A heterogeneous network is a network in which there is a group of different power stations with varying transmission power. In other words, it is a collection of different Power stations with varying transmission power or it is a collection of different small cells. Small cells are used to increase the coverage area of the Macro Base station. Small cells are power station that has transmission power between 10mW to 2 W. While on the other hand, Microcell has transmission power between 5 to 20 W. There are different small cells like Pico, Femto, and Relay Node.

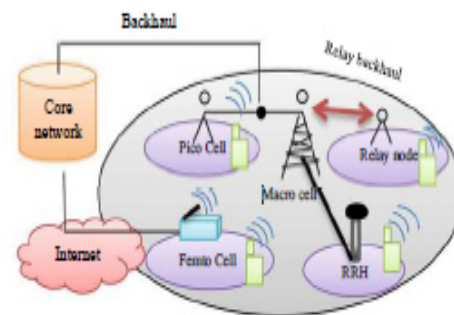


Fig. 1: Architecture of HetNet

Small cells are used to overcome the problem of spectrum coverage area in urban. For increasing the strength of the signal in the basement or where the signal level is very low, Femto or Pico cells are installed to overcome this problem. Hence, small cells are very useful to increase the signal level or strength in an area where the Microcell fails.

Detail information about different Microcells is given below:

**Pico Node:** Pico Node is one of the small cells which is used for increasing the strength of the signal of a network. Pico Node is a small base station that can be used indoors or outdoors as per the requirement of the range coverage. It increases the strength of the signal in the small area where it is installed. Mostly it is used in the basement of offices, buildings, and public places where the signal strength is very low (Vajapeyam, 2011).

**Femto Node:** It is also one of the main small cells which are mainly used indoors only. The main purpose of this small cell is to provide good signal strength in private property according to the demand of the consumer. This type of cell was used for consumer-oriented so it is also called Home eNodeB (Vajapeyam, 2011). It is not like Pico Node which provides indoor and outdoor services but it gave users free access without any charge. While Pico Node is not free for accessing or can be said that Pico Node is a closed subscriber group while Femto Node is an open subscriber group. The Transmission power of Femtocells is not more than 100mW (Wannstrom, 2013).

**Relay Node (RN):** Relay Node is a small cell that works between the user and the Microcell. It is connected to the Microcell which is used to transfer the information from the user to Microcell. There is a relay backhaul link is used between the Base station of the relay node and the Base station of the Micro node, which is used for the transmission of the information using an air interface. It becomes important or useful when the wireline backhaul is not able to work. It is more flexible than the other backhaul (Wannstrom, 2013).

**Features of HetNet:** After 3GPP Release 10 it was found that many features were adopted in the mobile

network. There were a lot of problems in the network in which interference was one of them. And after Release 10 many new features were proposed so that the network can overcome the interference between cells. ICIC technique is used to overcome the problem of interference. Interference occurs when the user Equipment was not able to decide which to connect with which power station. This user cell equipment was at the edge of the cell so this feature helps to decrease the interference of any network.

By using small cells in the network signal strength was increased. Increasing the strength of the signal is also one of the main features of the heterogeneous network. Detail-wise features are discussed in the sections given below.

**Cell Range Increment:** As discussed above small cells play an important role in increasing the coverage area of any Macrocell. But using more small cells in an area can bring some problems in the network. One of the main problems can be interference. When there is more small cell then each cell will try to connect the maximum number of cell phones or equipment. So, when the user equipment is between the range of more than one small cell and Macrocell, user equipment gets confused to connect with which cell. To solve this problem network cell range increment is used (Wannstrom, 2013).

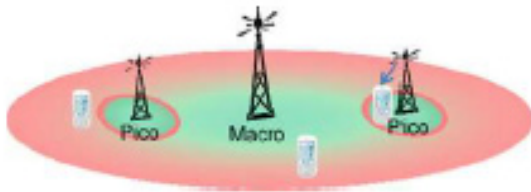


Fig. 2: Interference due to strong Macro signal

Fig. 2 is used to explain how cells faced the problem of selecting a network when it comes between more than one cell coverage or range. As seen in fig. 2 a cell is between two Femtocells and Macrocell. Now the device has to decide to which cell is chosen to connect. To solve this type of problem Path Loss and SINR are checked. The cell with less Pathloss and SINR will be selected for resources. This technique is known as ICIC which is explained below:

**A. Inter-cell Interference Coordination (ICIC)**

In a heterogeneous network, this technique is used to overcome the Interference which comes when user equipment comes between Macro and Small cells. ICIC plays an important role in the heterogeneous network or ICIC is one of the key features of a heterogeneous network. ICIC technique is required when the below condition comes in a network.

- a. Let a user device be connected with a Pico cell and there is high strength of DL signal of Macro Bs. Then there will be interference occurs between the Pico cell and the User device.

- b. Let a user device be connected with a Microcell and it is in the range of closed Femtocell. But user device is not allowed to connect with the Femtocells. In this case, interference will occur even in the DL of the Femtocell is less as compared to the Macrocell.

As explained above two conditions some time Macro base station faced interference due to the Pico Base station. On the other hand, some time Pico base station faced interference due to the Macro base station. To solve this problem resource partitioning took place in the network through cell biasing (Pang, 2012). Partitioning can be done in three different methods which can be time-based, frequency-based or spatial domain-based (Pang, 2012).

All the above are best for the partitioning of resources but mainly time domain is more used for the partitioning of any resource. In time-domain radio, the frame is divided into 10 subframes. Mainly 10 ms radio frames are used for communication with the small cell. Some of the subframes are used for the channel control and the left subframes were used for the Pico cell. While transferring subframes the cell is not able to deliver any data. It is used for controlling the channel which is also shown below in fig. 3 where some of the frames are used for data and others are used for only controlling the channel.

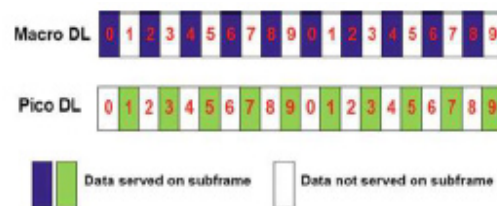


Fig 3. Partition of Macro and Pico Downlink

**B. Advanced Interference cancellation Receiver:**

For decreasing the interference in a network, user equipment checks the cell whether is weak or not. if it is found weak then measure the channel parameters. After all these, it sends feedback to the network core, which is responsible for proper handover. Interference faced by the user equipment is due to channel acquisition and CRS Interference. If any user equipment faces the problem of interference in any cell, it checks that the interference occurs for which reason. If it occurs due to the cell, it will detect the desired cell. If it found the desired cell then it will report to the core of the network, if not then remove the acquisition of signal interference and again check for the interference occurring cell.

If the user equipment found strong CRS interference, then it will decode the data channel. If it is not able to detect the strong CRS interference then it will remove CRS interference and again search for the strong CRS interference.



## Conclusion

For improving the quality of service, data rate and connection between user and cell, HetNet is very necessary for any network. By using HetNet data rate can be increased, services will be provided better and it will also ensure that every user will get proper connectivity with the network. With lots of advantages using HetNet also bring a disadvantage which is interference. This can be decreased by using different techniques used in HetNet which comes in Release 10 of 3GPP. Mainly ICIC is used for reducing the interference which occurs in a network. There is much more work is needed in this area. HetNet will be one of the most important and basic elements for building a 5G network.

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## Annexure 15.2.2

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**Reviewers  
Memorandum**

**Reviewer's Comment 1:** The title of the topic is self-explanatory and provides a satisfactory overview of HetNets in the context of LTE-Advanced. Today while using the 4G network, there are issues with data speed, interference, and network coverage. Since 5G has been enrolled in many cities this topic is very much appropriate. The author has demonstrated a commendable effort in presenting an understanding of the topic and highlighting key aspects of HetNets, however there is room for more research to make this topic more insightful which opens the scope for future research.

**Reviewer's Comment 2:** The Author has done intensive literature review to collect data on small cells. The paper is conceptual in nature and proposes different techniques used in a heterogeneous network. Moreover, Author could have included comparative studies or performance evaluations of different HetNet deployment strategies so that the reader gets to know the strengths and weaknesses of various approaches and make informed decisions when implementing HetNets in real-world scenarios.

**Reviewer's Comment 3:** The findings of the study are valuable in current time, where we are facing network issues like call drop and slow data speed. The author has made significant contributions in terms of content coverage and clarity, providing readers with a valuable resource. Author proposes the use of HetNet for improving the quality of service, data rate and connection between user and cell. The study further leaves the scope for further research.



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**Editorial  
Excerpt**

The article has 06% of plagiarism which is the accepted percentage as per the norms and standards of the journal for publication. As per the editorial board's observations and blind reviewers' remarks the paper had some minor revisions which were communicated on a timely basis to the authors (Vikas, Neeti and Aniket), and accordingly, all the corrections had been incorporated as and when directed and required to do so. The comments related to this manuscript are noticeably related to the theme "**A Review on HetNet in LTE-Advanced**" both subject-wise and research-wise. Paper finds that using HetNet data speed can be increased, and network connectivity problems can be resolved. HetNet will also ensure will that every user will get proper connectivity with the network. The author successfully addresses the various components and technologies involved in HetNets, including small cells, the comprehensive coverage of the terminology provides readers with a holistic understanding of the architecture and functioning of HetNets in LTE-Advanced. Paper also finds that HetNet is the most important and basic element in the 5G network, so there is ample opportunity for future research in this area. Lastly, the organization and structure of the paper are generally sound, but there is room for improvement in terms of the flow of ideas. Ensuring a smooth transition between sections. Overall, it is a commendable paper that provides a comprehensive overview of HetNets and their application in LTE-Advanced networks. After comprehensive reviews and the editorial board's remarks, the manuscript has been categorized and decided to publish under "**Theme Based Paper**" category.

**Acknowledgement**

The acknowledgment section is an essential part of all academic research papers. It provides appropriate recognition to all contributors for their hard work and effort taken while writing a paper. The data presented and analyzed in this paper by (Vikas, Neeti and Aniket) were collected first headedly, and wherever it has been taken the proper acknowledgment and endorsement depicts. The authors are highly indebted to others who facilitated accomplishing the research. Last but not least, endorse all reviewers and editors of GJEIS in publishing in the present issue.

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