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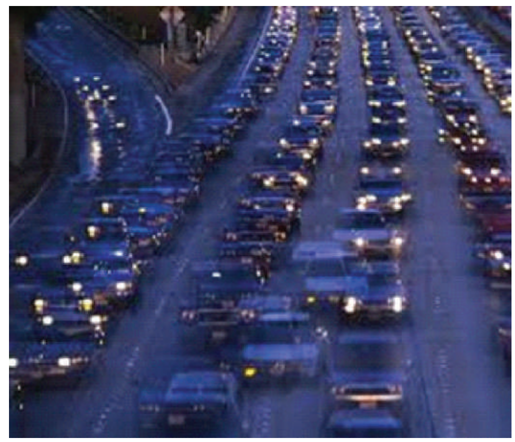
Mobile Data Offloading

The proliferation of mobile broadband devices such as smart phones, tablets, wireless dongles, and demand for new data-intensive applications along with the unlimited data plans from the operators have fueled the increase in mobile data usage. According to a recent report by Cisco, mobile data traffic worldwide will grow 18-fold by 2016, reaching an annual rate of 130 exabytes. In India specifically, mobile data traffic is expected to increase 114-fold by 2015. In 2015, users from India are estimated to generate data that will be equivalent to 15 times the volume of the entire Indian Internet in 2005.



Increase in mobile data usage puts a lot of pressure on the capacity of the existing networks. The availability of additional radio spectrum resources and deployment of higher performance technologies, such as LTE, may enhance existing network capacity. This capacity development, while significant, falls well short of what is needed to meet future mobile broadband demands. This will lead to network congestion and deterioration of network quality, which consequently leads to poor quality of experience for customers. Moreover, adding capacity to the wireless network is a significant investment and thus operators are looking at alternate approaches to deliver more capacity in a cost effective manner.

Further, Spectrum is a finite precious natural resource. The wireless segment is witnessing unprecedented growth. As the demand for wireless connections continues to grow, the service providers need to efficiently utilise available spectrum and data offloading techniques may play a substantial role here.

To address this issue, service providers are embracing “Mobile Data Offloading”, which allows operators to alleviate network congestion quickly as it is flexible in its deployment options and is applicable to both LTE and 3G wireless networks. Traffic Offload refers to the ability to move mobile data traffic from one network to another in a way that is transparent to the subscriber. It can be done either by an end-user (mobile subscriber) or an operator.

The main drivers for adopting offloading techniques are summarized as follows:

- **Efficient utilisation of Radio Spectrum :** Radio spectrum is finite, therefore with the increase in the number of connected devices, operators will need to plan the effective utilization of their radio resources by offloading data between licensed and unlicensed spectrum. Thus offloading can help operators reduce the traffic on their licensed radio spectrum.
- **Minimize overburden on Core Network :** Appropriate offloading solutions can facilitate service providers to effectively manage their network resources. Routing traffic directly to the internet before it reaches core network elements (such as the SGSN, the GGSN, etc), offloads traffic from these elements which reduces backhaul costs.
- **Flexibility :** Data offload solutions can provide telecom service providers with the flexibility to control data flow across the network based on traffic patterns, customer requirements, enabling a better quality of service. In addition, users can also have the flexibility to control the data traffic that they wish to offload based on the type of applications, their location or service type, helping them manage their data expenses better.

- **Reduced costs :** Data offloading results in reduced costs for the service providers as it results in better utilisation of available resources. It may also lead to reduced costs for the consumers as data is offloaded to alternate networks.

Traffic Offload forecast

Data off-loading solutions such as femtocells and Wi-Fi, etc (which are discussed in the subsequent paragraphs) facilitate in alleviating network congestion problem. According to Juniper Research, the amount of data traffic that is being off-loaded from operator networks to other complimentary networks will increase from 43.1 percent in 2010 to 63.2 percent by the end of 2015.As per the forecast the developed markets including North America and western Europe are expected to witness the highest offload factor (%) throughout the forecast period, reaching 76% and 74% respectively by the end of the forecast period. It is expected that the developing markets will witness higher growth over the forecast period of 2010-2015 with Indian Sub Continent at 137.8% CAGR, Latin America and Africa & Middle East at 126% CAGR. By 2015, the annual mobile data traffic off-loaded from operators' networks via Wi-Fi and small cells will reach 9,000 petabytes. [9].

Options for Offloading

Various options for offloading are as below :

Wi-Fi

Wi-Fi is an easy to install solution that can help operators to manage data traffic growth at reduced costs. The key advantage of Wi-Fi is that they operate over unlicensed spectrum. However, Wi-Fi traditionally lacks security, guaranteed quality of service and seamless coverage. As the coverage of a Wi-Fi is limited, its effectiveness depends upon the duration for which the user remains in the coverage area. Three strategies for Wi-Fi traffic offloading are discussed below [2]:

Network Bypass

In this strategy (Figure 1) the mobile user is able to access the internet through WiFi for data traffic, consequently offloading the operator's core network. The mobile device identifies when entering the Wi-Fi area and authenticates the mobile device via a login and logout settings. This strategy only requires the Wi-Fi access points. There are some limitations of this strategy such as operator loses visibility and control of their subscribers while they are in the Wi-Fi area, thus they are unable to maintain the desired billing structure of the users.

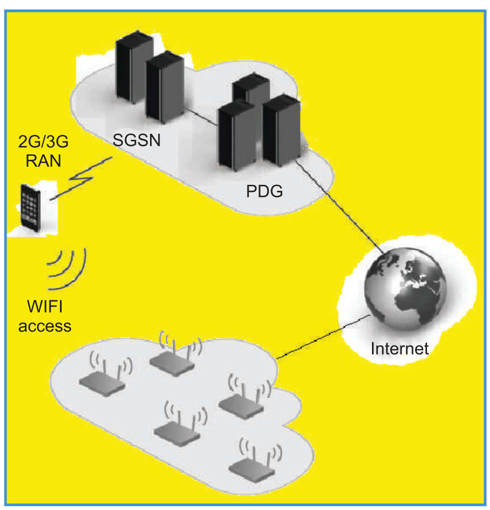


Figure 1 : Network Bypass

Managed Network Bypass

This strategy (Figure 2) is implemented when the service providers want to provide a secured connection to the subscriber. It enables the service providers to add additional features such as parental control and visibility of the subscriber's Wi-Fi data usage. Here limitation is that it still prevents the service provider from fully managing the network as it is not integrated with the core mobile network. In addition, it does not generally facilitate carrier subscribed content.

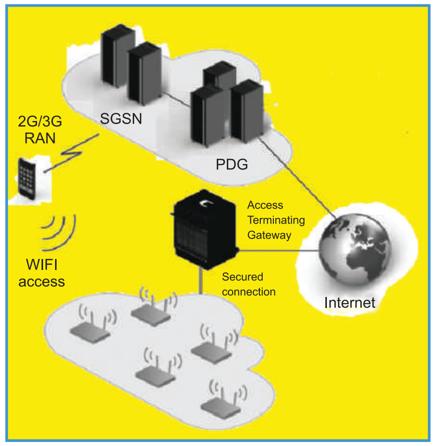


Figure 2: Managed Network Bypass

Integrated data offloading

In this case the Wi-Fi data offloading strategy is fully integrated with the operator's core network through Packet Data Gateway (PDG) which facilitates subscriber to move seamlessly between the core network and the Wi-Fi network. The network authentication is carried out autonomously by device without need of user intervention. The service providers can promote carrier subscribed content to the subscriber independently if they are in the core network or Wi-Fi network. It secures the subscribers and the core network preventing hacking attempts and tampering. The ability to integrate the Wi-Fi solution in the core network provides the full management capability to the operator and full visibility to the billing process and facilitates provision of more content based services. This solution also enables the operator to provide Lawful Intercept solutions (LI) as law enforcement policies are also subject for the Wi-Fi network in many countries.

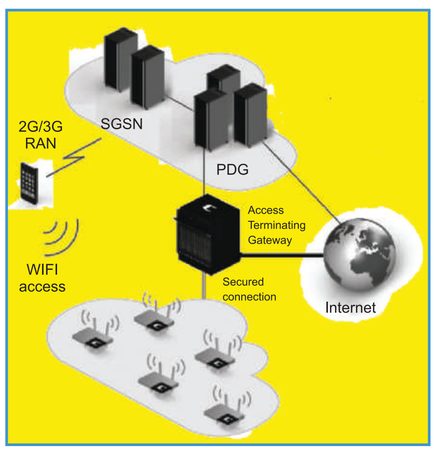


Figure 3 : Integrated Data Offloading

Femtocell

Femtocells, also known as Home NodeBs, are low powered small cells that are deployed in homes and offices to provide better coverage and capacity. In recent years, different types of femtocells have been designed and developed based on various air interface technologies, services, standards, and access control strategies. For example, 3G femtocells use Wideband Code-Division Multiple Access (WCDMA)-based air interface of Universal Mobile Telecommunication System (UMTS), which is also known as UMTS Terrestrial Radio Access (UTRA). The 3rd Generation Partnership Project (3GPP) refers to these 3G femtocells as Home Node Bs (HNBs). On the other hand, WiMAX (Worldwide Interoperability for Microwave Access) and Long Term Evolution (LTE) femtocells use Orthogonal Frequency-Division Multiple Access (OFDMA). The LTE femtocells are referred to as Home evolved Node Bs (HeNBs).

In this case the operator provides a femto access point that operates in licensed spectrum and provide mobile coverage and capacity over internet-grade backhaul. They utilize customer'sbroadband Digital Subscriber Line (DSL) or cable or fiber to the home (FTTH) broadband Internet connections for backhaul to the operator's core network. When a subscriber enters his home or office the device automatically associates with the femtocell. Traffic that would have flowed between the macro-cellular site and the subscriber's phone, laptop, etc flows instead through the femtocell and the subscriber's broadband connection (figure 4).

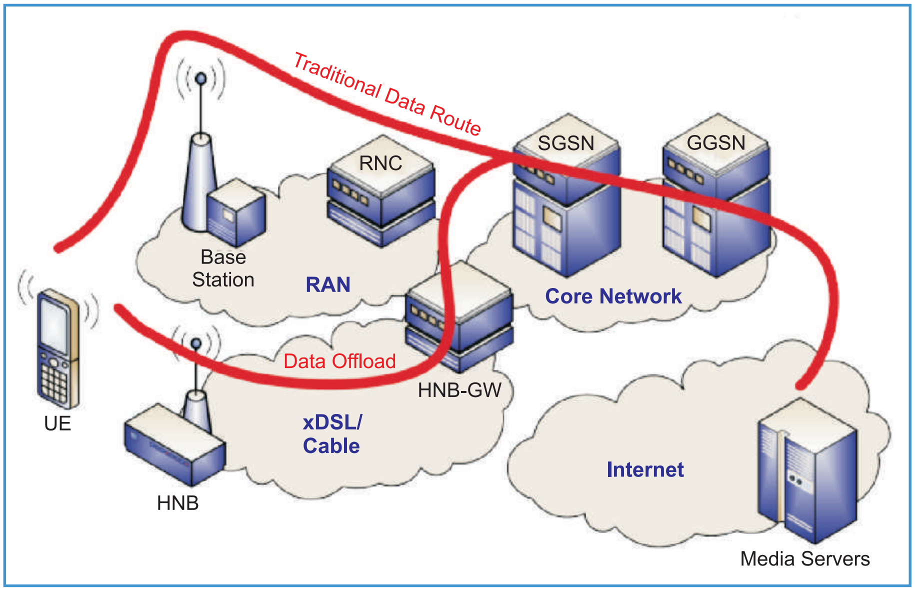


Figure 4 : Femtocell

Within 3GPP there are two recent initiatives in Release 10, each centered around the Home(e)NodeB, that allows traffic offload in the access network: Local IP access (LIPA) and Selected IP Traffic Offload (SIPTO) [1].

Local IP Access (LIPA)

LIPA (Figure 5) is a 3GPP initiative that allows the subscriber to access a residential or corporate subnet via the Home (e) Node B. The terminal while connected to the mobile operator's core network will also have simultaneous access to devices on the local IP subnet.

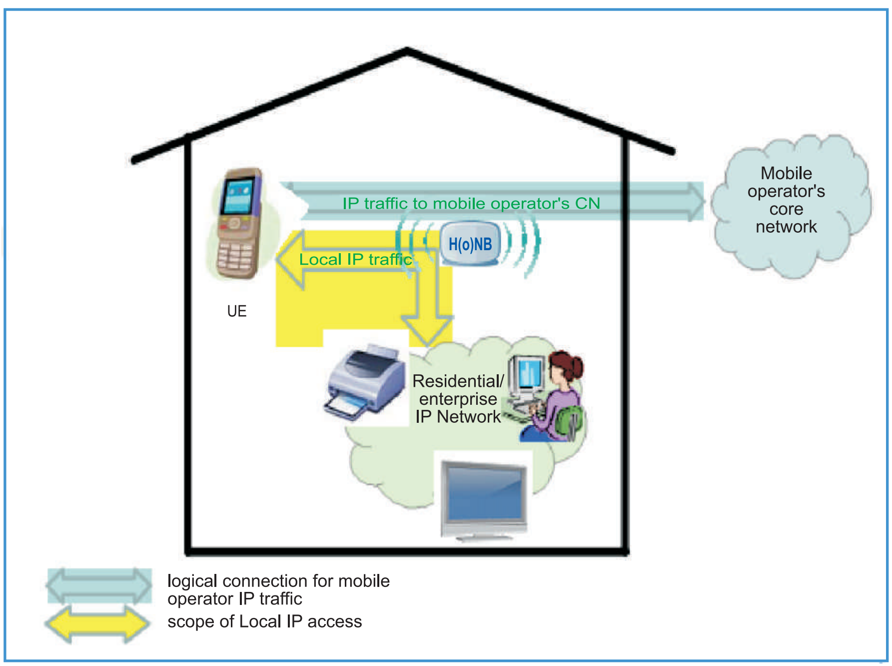


Figure 5 : Local IP Access (LIPA)

Selected IP Traffic Offload (SIPTO)

SIPTO (figure 6) refers to the ability to selectively route different types of traffic, originating from the terminal, to different destinations, dependent on some predefined operator policy. Traffic can be routed directly to the Internet therefore bypassing (offloading) the operator's core network.

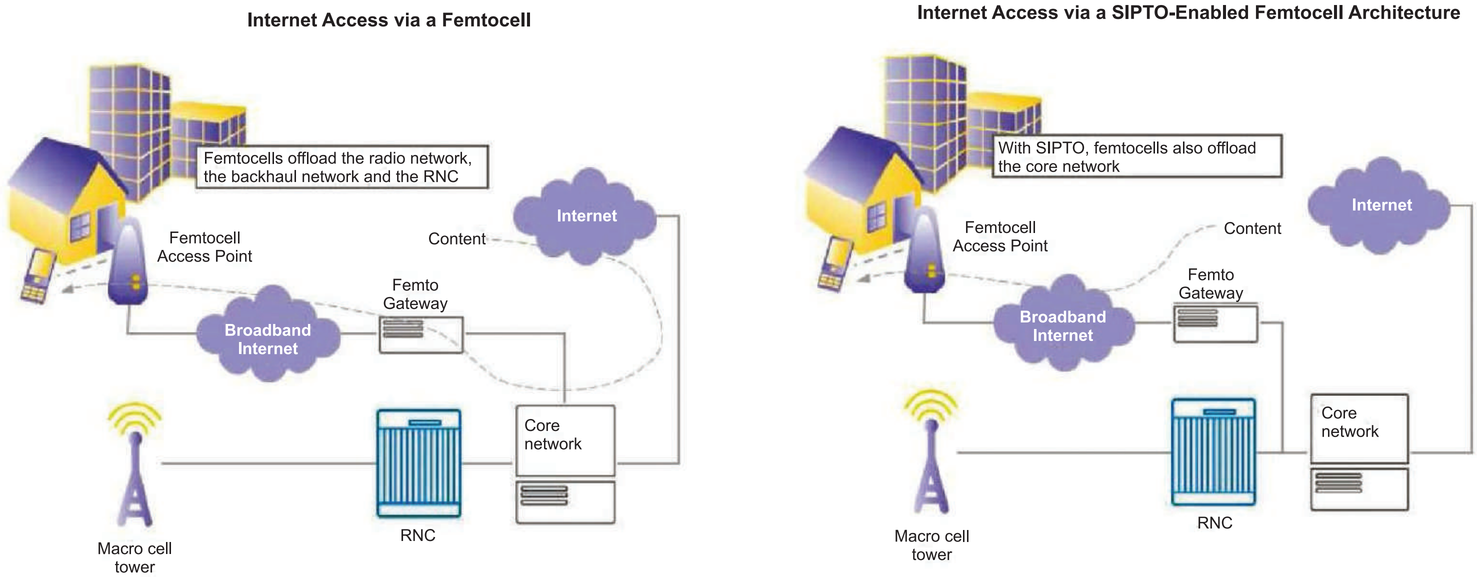


Figure 6 : Selected IP Traffic Offload (SIPTO)

Whereas LIPA is beneficial to the end user, SIPTO is for the benefit of the operator and is transparent to the end user.

IP Flow Mobility and Seamless Offload(IFOM)

Whereas LIPA or SIPTO are dependent on upstream network nodes to provide the optimization of routing different types of traffic, IFOM relies on the handset to achieve this functionality. It explicitly calls for the use of simultaneous connections to both macro network, e.g., LTE, HSPA and non-3GPP access network such as WiFi [3]. IFOM uses an Internet Engineering Task Force (IETF) Request for Comments (RFC), Dual Stack Mobile IPv6 (DSMIPv6) (RFC-5555). DSM IPv6 is an extension of Mobile IPv6 to support mobility of devices irrespective of IPv4 and IPv6 network.Mobile IPv6 (MIPv6) is a protocol developed as a subset of Internet Protocol version 6 (IPv6) to support mobile connections.MIPv6 allows a mobile node to transparently maintain connections while moving from one subnet to another[7].

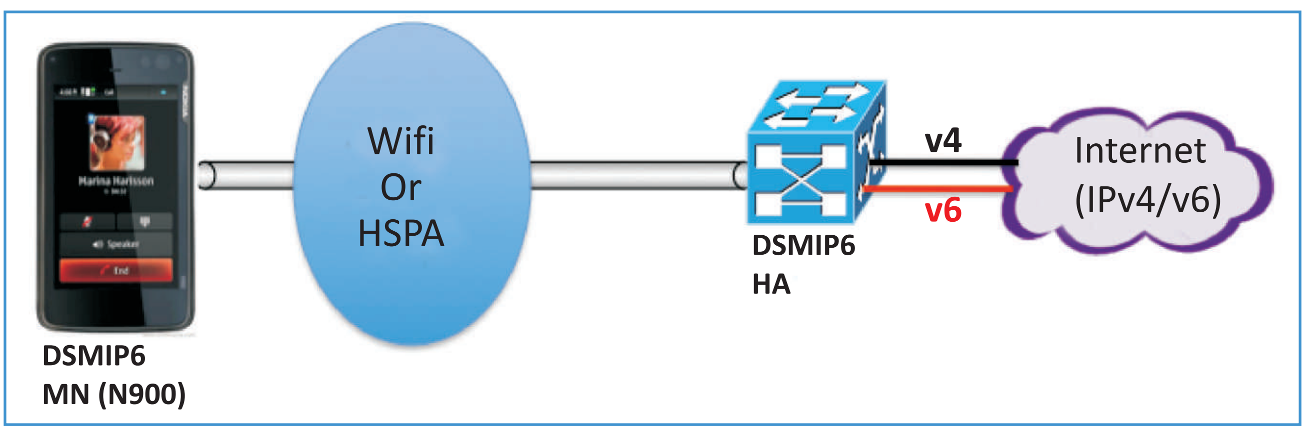


Figure 7 : IP Flow Mobility and Seamless Offload (IFOM)

Since IFOM is based on DSMIPv6, it is independent of the macro network. It can be used for a green-field LTE deployment as well as a legacy GPRS packet core.Using IFOM, it will be possible for user equipment (UE) to bind one of two different tunnels between the user equipment (UE) and the DSMIPv6 Home Agent (HA) that can be implemented within a Packet Gateway(P-GW) or Gateway GPRS Support Node (GGSN). DSMIPv6 requires a dual-stack (IPv4 or IPv6) capable UE. It is independent of the access network that can be IPv4 or IPv6 [3].

Packet-Switch Core Offload

Packet-switch (PS) core offload (Figure 8) comprises deployment of Internet offload gateways behind Radio Network Controller (RNC), or group of RNCs, to split out traffic bound for the Internet (the majority of traffic by volume) from traffic bound for the operator's core network (which includes signalling). This is also known as "Iu-PS offload." It is expected to save operators money by reducing the incremental investment in GGSNs and SGSNs needed to support broadband traffic growth; and the potential to use lower cost transport and distributed Internet peering.[6]

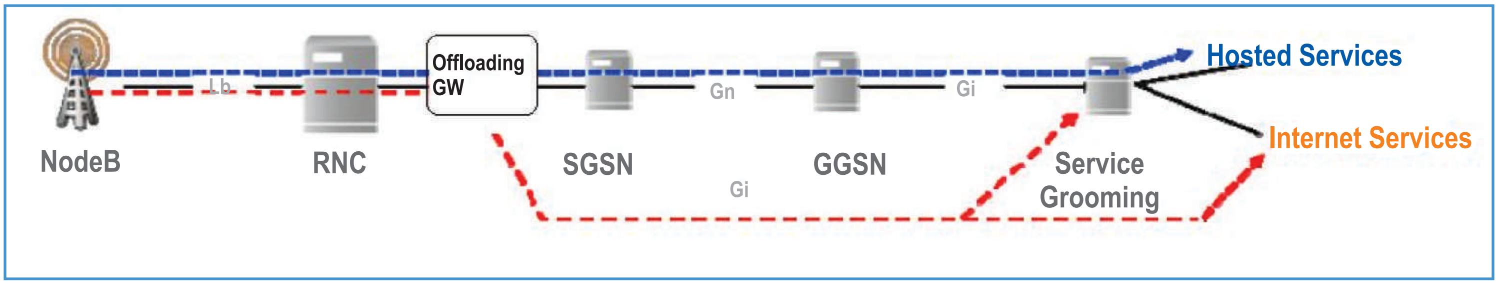


Figure 8 : Offload Gateway at RNC site

Conclusion

As radio spectrum is limited, network congestion and deterioration of network quality will become inevitable for operators due to unprecedented growth of data traffic in future. Deployments like LTE-advanced and Wireless MAN-Advanced, although having better spectral efficiency may not be able to handle network data capacity commensurate to future mobile broadband demands. In such circumstances offloading of data traffic will be viable solution as it provides not only relief from increased growth rate of data traffic but will also help operators reduce costs.

Various options have been discussed above, to offload data from the mobile network either at the access or the core network level. These options are not mutually exclusive and the operator has the flexibility to choose the best option depending upon the status of existing infrastructure, current & expected traffic trends, user density, ease of deployment, costs involved, etc.

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