

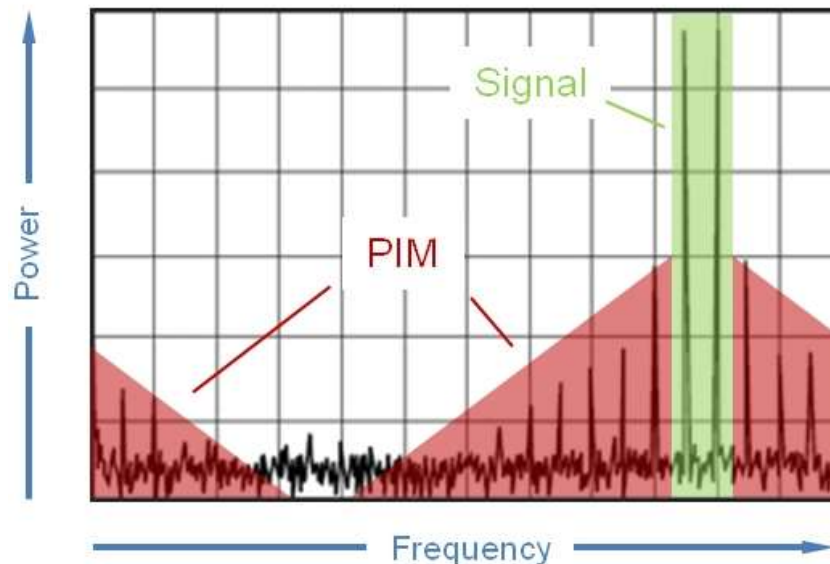
PIM – Passive Inter Modulation

Definition: When there are two or more passive components with two or more high power input signals, it results in intermodulation distortion (Distortion formed by sum/difference of amplitudes), referred to as Passive Inter Modulation.

Explanation:

PIM is very common in cellular installation where the same antennae is utilized for multiband operation utilizing high RF transmission power. This can occur even when there are non-active components present in the system. Mostly this is caused due to vulnerable components such as coaxial connectors to cables, rusty bolts or any joint where dissimilar metals occur. In a city environment like in NYC, where there are space constraints and service needs to be provided for millions of people, it is for sure not practical to have separate antennae for different bands of operations. Hence it is very critical and essential to eliminate Passive intermodulation. With the city progressing towards a hundred percent broadband reach and IOT enabled sensors for monitoring every other activity, more and more antennae would be installed in the city and hence the problem of PIM should be overcome. Several companies have come out with solutions to overcome this issue. PIM can be removed by filtering of the signals and by proper maintenance of the active and passive components connected to the transmitting and the receiving device.

Network Disturbance by
Passive Intermodulation (PIM)



Glossary:

Amplitude Modulation: When the Amplitude of the wave is varied in proportion to waveform being transmitted, it is referred to as Amplitude Modulation.

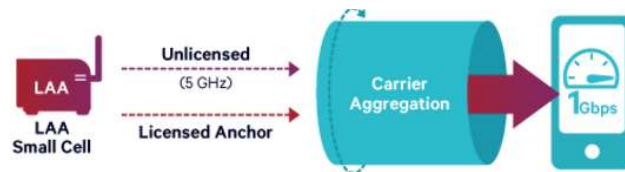
Intermodulation Distortion: Intermodulation distortion (IMD) is the amplitude modulation of signals containing two or more different frequencies, caused by nonlinearities in a system.

LAA – License Assisted Access

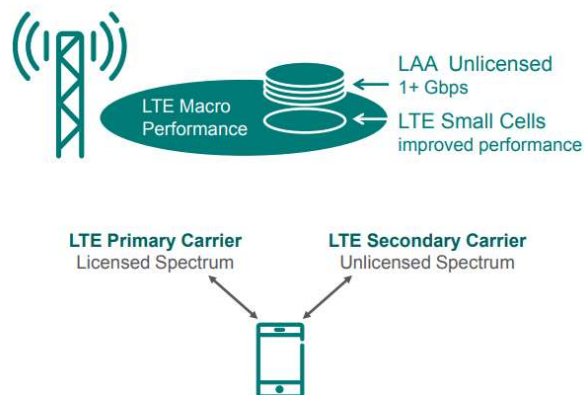
Definition: License Assisted Access is a technology which enables the usage of the free 5GHz. spectrum band to boost the network signal.

Explanation:

Since there is very limited wireless spectrum availability and the number of users or sensors in the network have increased demanding higher speed and bandwidth, it is best optimized combining the licensed spectrum with the unlicensed band to provide better service. With the communication technology evolving continuously and cities following the pace to catching up, 5G technology is not too far away from the books. In 5G Technology, MIMO – multiple antennae and receivers will be used to boost speeds by sending multiple streams of data at the same time and is expected to have a much higher speed and lower range as compared to that of 4G. This could mean installation of a lot more “Small Cells” and other Antennae to provide signal range. The installation of high end infrastructure would trigger companies to setup more sensors and other IOT enabled devices that would require higher bandwidths. So, to cope up with this increase in the number of devices, LAA would become the most feasible and economical solution providing better bandwidth utilizing the free spectrum.



Using LTE Advanced Technology to Aggregate Licensed & Unlicensed Spectrum



Glossary:

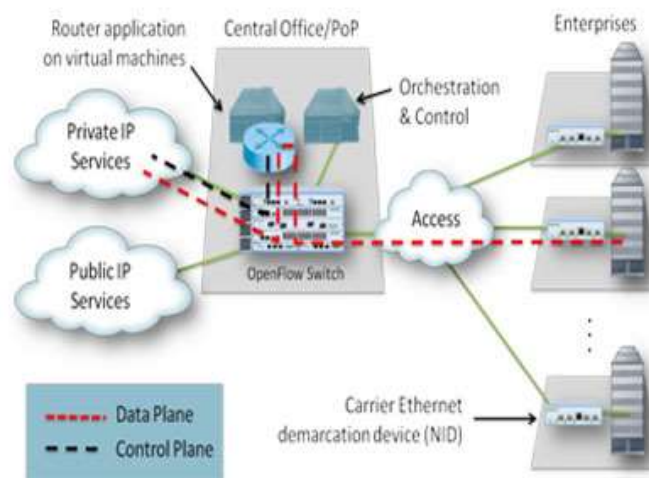
5G: 5G is the coming fifth-generation wireless broadband technology based on the IEEE 802.11ac standard. 5G will provide better speeds and coverage than the current 4G. 5G operates with a 5Ghz signal and is set to offer speeds of up to 1 Gb/s for tens of connections or tens of Mb/s for tens of thousands of connections.

MIMO: Multiple input, Multiple output is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed.

NFV – Network Function virtualization

Definition: Network functions virtualization is a network architecture concept that uses the technologies of IT virtualization to virtualize entire classes of network node functions into building blocks that may connect, or chain together, to create communication services.

Explanation: By utilizing Network functions virtualization we can virtualize most of the networking functions. That is all the networking functions such as network address translation (NAT), firewalling, intrusion detection, domain name service (DNS), and caching are removed from the actual physical hardware and run as a software. With huge amount of data flowing in from several sensors in the city, it would be best suited to go for a cloud based infrastructure, and NFV further reduces the cost of physical hardware and can accelerate deployment. It is also a very reliable and flexible methodology as all that needs to be modified can be done through software, reducing the effort and operational costs.



Glossary:

Network Address Translation: NAT is a method of remapping one IP address space into another by modifying network address information in Internet Protocol (IP) datagram packet headers while they are in transit across a traffic routing device.

Firewalling: It is a network security system that monitors and controls the incoming and outgoing network traffic based on predetermined security rules.

Domain Name Service: It is a hierarchical decentralized naming system for computers, services, or other resources connected to the Internet or a private network.

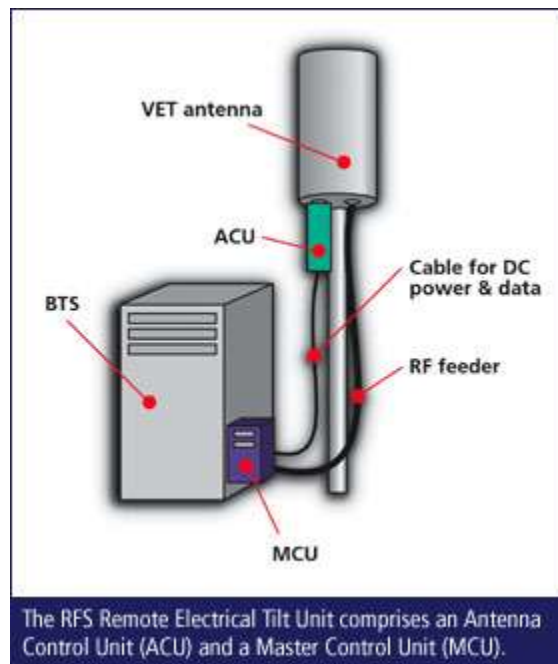
Cache: It is a hardware or software component that stores data so future requests for that data can be served faster

RET – Remote Electrical Tilt

Definition: Remote Electric tilt is an electronic device that is used to remotely adjust the tilt of an antennae. This allows accurate control of antenna tilt eliminating site-access requirement.

Explanation:

It is a motor controlled device that is powered by a microprocessor and a communication port. This device communicates over an open AISG protocol (Antenna Interface Standard Group) that is standard for such devices. This would be very useful in providing backhaul connectivity support for a Smart City. Imagine a situation where the antennae Line of Sight can be controlled based on the network traffic by an Artificial Intelligence Algorithm. This would be a best way to optimize antennae locations and providing the best effort bandwidth and service levels. These devices would hence play a major role in providing infrastructure support for a smart city while acting as sensors that help to analyze the network traffic and user reach.



Glossary:

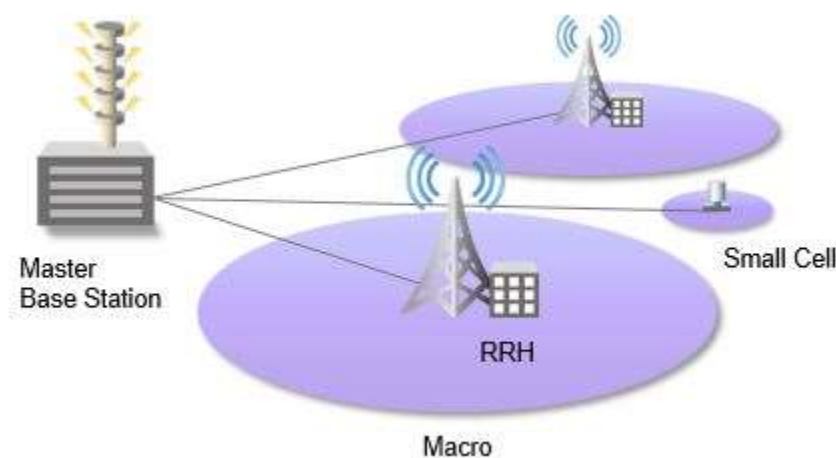
AISG protocol: AISG is based on RS485 communication bus, which is a multi-device bus. They have created open specifications for the control interface for a variety of Antenna Line Devices.

Antenna Control Unit (ACU): It facilitates monitoring and control of tracking systems in remote locations.

CRAN – Centralized Radio Access Networks

Definition: C-RAN is a centralized, cloud computing-based architecture for radio access networks that supports 2G, 3G, 4G and future wireless communication standard.

Explanation: It is a proposed architecture for future cellular networks introduced by China Mobile Research Institute. It uses low cost Coarse or Dense Wavelength Division Multiplexing technology, and mm Wave to allow transmission of baseband signal over long distance thus achieving large scale centralized base station deployment. It applies recent Data Centre Network technology to allow a low cost, high reliability, low latency and high bandwidth interconnect network in the BBU pool. It utilizes open platforms and real-time virtualization technology rooted in cloud computing to achieve dynamic shared resource allocation and support of multi-vendor, multi-technology environments. With the densely-cluttered infrastructure in the city it would not be feasible solution to introduce several BTS to further support the bandwidth and increase the coverage. A cloud based Radio Access network would be a possible solution that might provide a reliable centralized network reducing the installations of BTS.



Glossary:

CWDM: Coarse wavelength division multiplexing is a method of combining multiple signals on laser beams at various wavelengths for transmission along fiber optic cables, such that the number of channels is fewer than in dense wavelength division multiplexing (DWDM) but more than in standard wavelength division multiplexing (SDWM).

BBU: A baseband unit (BBU) is a unit that processes baseband in telecom systems. A typical wireless telecom station consists of the baseband processing unit and the RF processing unit.

mmWave: Millimeter wave (also millimeter band) is the band of spectrum between 30 Ghz and 300 Ghz. Researchers are testing 5G wireless broadband technology on mm wave spectrum.

BTS: A base transceiver station (BTS) is a piece of equipment that facilitates wireless communication between user equipment and a network.