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Cellular / Mobile Backhaul

- basics of mobile or cellular backhaul detailing methods, technologies and techniques for providing effective links to base stations.

Cellular / Mobile Telecommunications Basics Includes:

What is cellular communications Concept of cellular system Radio access network, RAN Base station antenna technology Multiple access techniques Duplex techniques What's inside a cellphone SIM cards Handover Backhaul

In any telecommunications network, the backhaul portion of the network is formed of the links between the core network and the small outlying sub-networks at the edge.

Typically for a mobile network the backhaul elements are used to transfer data from the base stations or Node Bs or eNode Bs into the central areas of the overall network.

As networks carry more data, the mobile backhaul or cellular backhaul elements form an increasingly important part of the overall cellular system.

Mobile network basics

Although cellular networks topologies are developing as the networks move from 2G to 3G and then 4G, there are certain elements that remain the same. These show how the mobile backhaul elements fit into the overall network.

When looking at network infrastructures, it is best to start with a GSM network as this builds the picture and shows how the backhaul elements have developed over the years.

The basic GSM network consists of a variety of base station transceivers, BTS, connected to a base station controller, BSC which might be located remotely with a centrally located BTS, or even within the mobile switching centre, MSC. Initially the GSM system only carried voice, but with the introduction of GPRS and EDGE, data services were also carried. Voice was circuit switched, but data was packet switched.

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Quote: *It is a miracle that curiosity survives formal education.* Albert Einstein

Special interfaces were developed to link as part of the GSM standard to link these elements. The BTS / BSC link was the Abis, and the BSC / MSC interface (voice) was termed the A and the BSC / SGSN (data) was termed the Gb interface.

When UMTS arrived different interfaces were introduced to cater for the new system. The BTS was remained as a Node B, and the equivalent of a BSC was the Radio Network Controller, RNC. The link from the Node B to the RNC was termed the Iub, and from the RNC to the MSC, was the Iu-CS and from the RNC to the SGSN for data was the Iu-PS.

In terms of the areas where mobile backhaul technologies are applicable, all the Abis, A, Gb, and Iu links can be included under the mobile backhaul banner.

Backhaul types

There are several different technologies that can be used to provide mobile backhaul. The choice for any operator will depend upon the performance required and the accessibility of the site for various forms of backhaul.

The various technologies used for mobile backhaul include:

- **E1/T1:** The E1/T1 systems were widely used in telecommunications when 2G technologies including GSM were being rolled out and deployed. These circuits could be run in parallel to provide additional capacity, thereby enabling the requirements for a variety of backhaul situations to be met. Nowadays, other forms of backhaul are used to enable much higher data rates to be carried, although many of these circuits still remain in use.
- **Carrier Ethernet:** Carrier Ethernet is an ideal format for mobile backhaul and it is being widely used in this application. It provides a significant bandwidth with an industry standard interface / protocol. It can be carried over copper, fibre or microwave.
- **DSL:** Technologies like DSL, ADSL, etc are being used increasingly for backhaul offload techniques. For example many mobiles will switch to Wi-Fi when they are within range of a hotspot, and many of these are connected back via a form of DSL link. In addition to this an increasing number of femtocells are being deployed in homes, where again ADSL, etc are widely used forms of data link that form the mobile backhaul connection.

There are also a number of media over which the data can be carried.

- **Copper:** Copper is one of the traditional methods for carrying data. Speeds are not as high as those that can be achieved with fibre. Technologies including E1/T1 and DSL, etc widely use copper for the medium over which the data is transmitted.
- **Fibre:** Fibre links are being installed and used increasingly. They are reliable and have a much higher bandwidth than copper.
- **Microwave backhaul:** Microwave is particularly useful for situations where it is not possible to run a copper or fibre link. Remote locations where it is not viable to run a physical link, or even where small cells are mounted on street furniture are ideal opportunities for using microwave backhaul.

Fact: There are several billion mobile phone subscribers around the world now. It only took 25 years to reach the first billion after the launch of the first commercial systems. It took over 100 years for land lines to reach this figure.

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There are many techniques, technologies and flavours of providing mobile or cellular backhaul. With increasing bandwidths and a greater number of base stations being used, an increasing variety of options must be considered to provide the cellular backhaul.

Backhaul capacity

One of the key elements of any cellular backhaul system is its capacity.

The cellular backhaul capacity needs to meet the expected needs for the base station or other link that it serves, otherwise the data that needs to be transported will either be delayed or lost.

The backhaul capacity requirements pay a large part in determining the overall solution. As the investment in backhaul of a complete network is large, and also the cost of adding further capacity is large, it is essential to install the required capacity at the beginning.

One of the major factors that governs the type of mobile backhaul capability needed is the capacity expectations. When deciding upon the backhaul solution, it is necessary to estimate the maximum traffic that will be carried by the cell. Similar but different calculations are needed for the backhaul system between the BSC or RNC and the core network.

To estimate the capacity required for the mobile backhaul solution, it is necessary to look at the capacity for the radio access network, i.e. the radio interface with the mobile phones, seeing what the maximum capacity and likely usage is.

Backhaul capacity requirements for various systems

As cellular systems have developed from their early 2G GSM technologies, the requirements for data backhaul have rapidly increased as data usage and radio access network capacity and capability has increased. Using the basic system details it is possible to estimate the maximum backhaul requirements.

The cellular network capacity is dependent upon a variety of factors:

- Bandwidth available.
- Spectral efficiency of the cellular system.
- Number of sectors being served by the base station.
- In some cases whether voice or data is being carried.

Knowing the system of system, its bandwidth and other factors it is possible to estimate the typical capacity of the radio access network and hence the cellular backhaul capacity required.

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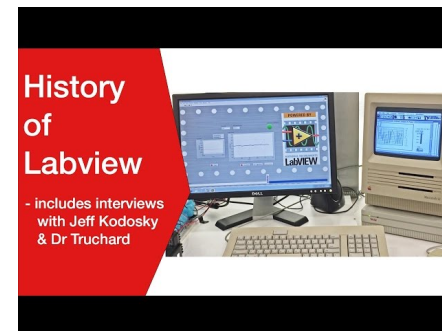
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APPROXIMATIONS FOR CELLULAR BACKHAUL CAPACITY REQUIREMENTS

CELLULAR SYSTEM	VOICE SPECTRUM (MHZ)	DATA SPECTRUM (MHZ)	VOICE SPECTRAL EFFICIENCY (BITS/HZ)	DATA SPECTRAL EFFICIENCY (BITS/HZ)	BANDWIDTH REQUIRED (MBPS)
GSM	1.2	N/A	0.52	N/A	1.3
EDGE	1.2	2.3	0.52	1	6,1
HSPA	N/A	5	N/A	2	21.0
LTE (5MHz)	N/A	5	N/A	3.8	39.9
LTE (10MHz)	N/A	10	N/A	3.8	79.8
CAPACITY ASSUMES 70% PEAK USAGE, & THREE SECTORS PER BASE STATION					

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