Personal Radio Device Connectivity

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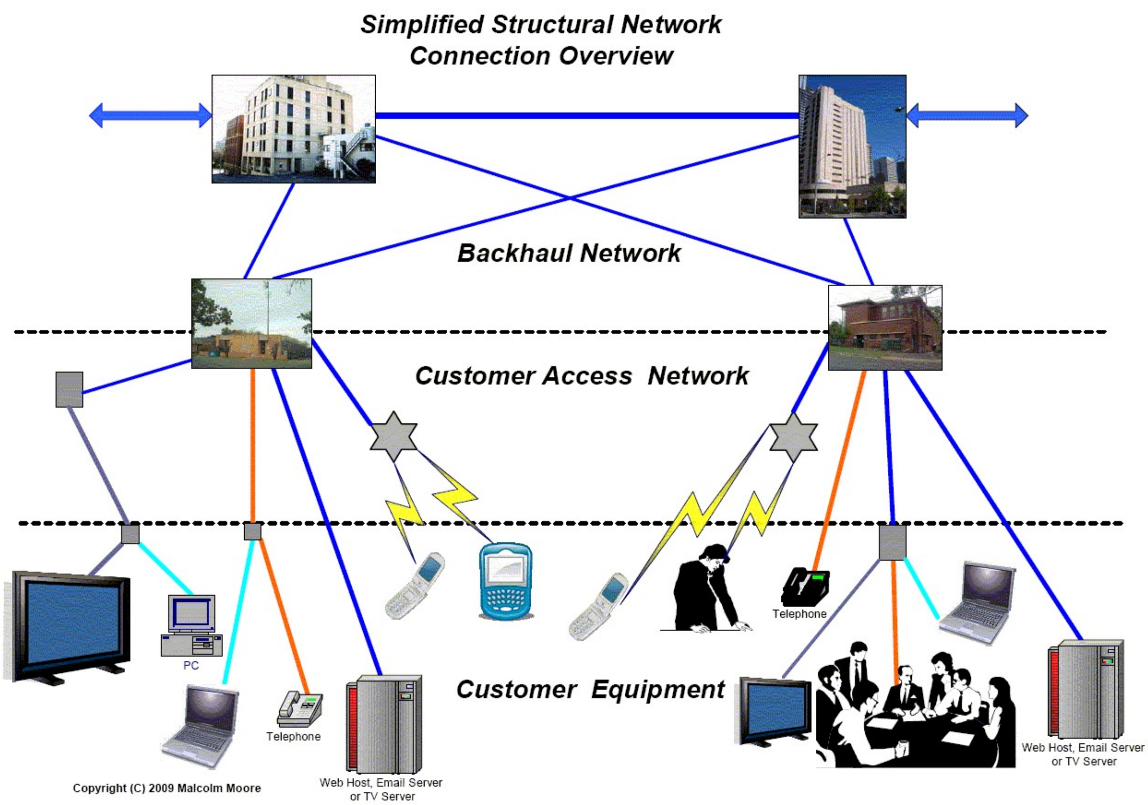
Connecting Personal Mobile Devices

The picture below shows the mobile personal devices as part of the Customer Equipment and connected via Radio (the yellow zips) to radio base stations that are back connected to the Local / District exchange sites, usually with Optical Fibre cables. From here the connection is through the Backhaul Network to the distant end, where it again goes through the Customer Access network to a range of customer equipment.



Mobile Cellular CAN

With Mobile Cellular Radio, the CAN structure is very similar to ISDN and Frame Relay etc. Because of the intensive signalling required by Mobiles/Laptops etc (Personal Communication Devices), these devices also connect at the Node/District Switch via a Radio Base Station that is back connected with and optical fibre ring to the District (Node) Switch site.

The Mobile Cellular CAN consists of three parts - the Optical Fibre transmission system - or point-to-point radio transmission system from the Node switch to the Mobile Base Station (MBS), the radio transceiver equipment at the MBS - including the antennae and tower, and the radio link from the transceiver/antennae to the Personal Communication Device.

The demarcation point between the IEN and CAN in this case is the Equipment / Switch side of the IDF. The Line/Drop side of the IDF connects to the CAN based

Optical Fibre or Radio transmission system. The demarcation point between the CAN and the Personal Communication Device is the Antenna - Space interface on the mobile phone/Personal Communication Device.

Wireless Broadband CAN

Wireless Broadband Internet also fits this structure in a very similar manner to Mobile Cellular. The MBS transceiver is essentially identical and instead of the voice circuits being connected as 64 kb/s PCM through the telephony network (IEN / IDN), Broadband Internet is already in packets and in IP form and this very comfortably converges into Node based routers to the main Core IP network (IPN).

The demarcation point between the CAN and the IPN / Core Network is at the Router side of the IDF feeding towards the Optical Fibre/Radio Transmission Equipment that connects to the Mobile Base Station. The demarcation point between the CAN and the Wireless Broadband is the Antenna - Space interface on the Broadband Modem / Personal Internet Device.

General Structure of the Mobile CAN

In using a mobile phone, there is a Customer Access Network (CAN) link from the mobile phone (antenna) to the Inter-Exchange Network (IEN). This infrastructure can appear to be complex to comprehend, as there are a few different connection scenarios.

At the phone, there is a bi-directional radio link to antennae on mobile radio towers – usually within line of sight because of the nature of the part of the radio spectrum used for mobile phones.

The antenna connects with a radio transceiver (transmitter / receiver) which then has a multiple of E1 (2 Mb/s MegaLinks) in pair shielded copper or coax cable, or STM-1 (155 Mb/s) in coax cable or optical fibre, back to the Node (District) Switch, and the DDF (Digital Distribution Frame) or ODF (Optical Distribution Frame) associated with the switch is the CAN-IEN demarcation point as already been spelt out in a preceding document, Telecommunications 101.

More recently (2012), point-to-point radio links capable of 100 Mb/s are being used instead of optical fibre to keep the connectivity costs down. *(This point-to-point radio strategy would never be necessary in a non-competitive infrastructure build as optical fibre is by far the first choice for bandwidth and reliability!)*

When radio base stations for mobile networks are initially set up the base stations are usually located on the highest points to get the biggest coverage with the least capital outlay. Where possible, most mobile base stations were co-located at the district or local exchange sites. Otherwise put on the top of the tallest available building or hill.

As it became more obvious that there were 'black spots' where networks would drop out because of very low field strength of radio coverage, local antennae with lower power transceivers were remotely located to near the centres of these black spots so that the personal devices could “hand-over” to a stronger field strength and keep the call from dropping out.

In metropolitan areas, the radio base station network structure thinking has since reversed to put radio base stations in the “saucers” (valleys) of these areas and keep these mobile devices connected such that they switch over control to other radio base stations as they move between valleys. This network strategy really minimises the computing overhead necessary to keep the personal devices connected and minimise network congestion.

To help clarify the situation here are a few Mobile CAN scenarios with pictures:

In this case the IEN / Backhaul interface point from the district switch in the same building is the DDF (shown on the left) in the Node (District) exchange with white sheathed coax cables feeding to the (co-located in this case) radio base station transceivers, (shown on the right hand picture).

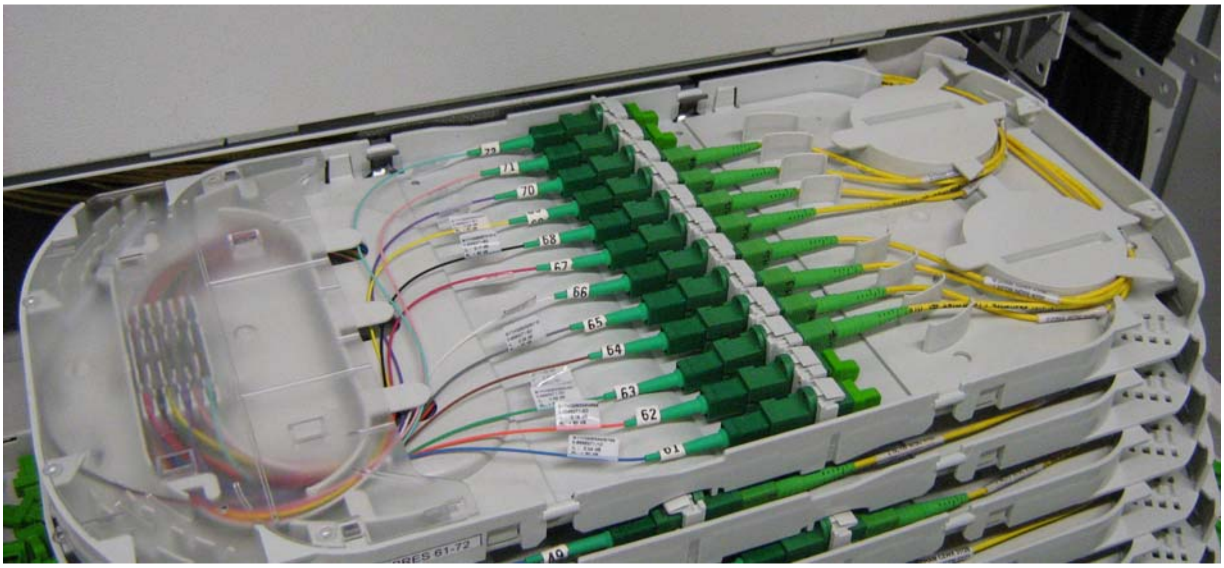
The radio base station transceivers as shown in the right hand picture above then connect with antenna through thick black coax cables – as shown above right (top of the picture).

This thick black coax cable feeding (up the towers in the right hand side picture) then connects to the Base Station antennae. These antennae are the vertical 'poles' mounted on the top of the tower). From there radio waves connect with personal mobile devices - making a wireless connection.

The above case shows a co-sites arrangement where the node / district switch is co-sited with the radio base station. Another common situation is where the radio base station is remote to the exchange site and the connection is via a pair of single mode optical fibre (SMOF) strands in a cable.

In this case the node switch in the edge of the Backhaul Network, usually has pair of single mode optical fibre (SMOF) connections through a GigaBit Interface Connectors (GBIC) as shown on the right hand side. Two fibres per GBIC.

The GBIC plugs into the switch and connects directly into a SMOF patch lead (usually a pair with yellow sheaths) and the optical patch cords then connect into an Optical Distribution Frame (ODF).



The picture above is an Optical Distribution Frame (ODF), where the optical patch leads on the right hand side connect to an optical cable on the left hand side through optical splices held in the far left plastic ribs. This optical cable would then be run underground to the distant site (as far as 90 km away) and then connect with the radio base station equipment like the mini-transceivers shown in the picture below.

In the left hand picture below, on the top of these mini-transceivers, thick black coaxial cables then runs up the tower as shown above right and into the vertically mounted antennae where radio waves then connect with the personal mobile devices. In this case the tower also has several point-to-point antennae on it. These are parabolic dishes, with hoods or drums in front of them to keep birds from nesting there and to keep birds out of the line of fire of the radio beams.

Note that this tower also has point-to-point parabolic antennas dishes (these look like short cylindrical drums) that connect radio transmission systems.

These systems could be radio repeaters to receive - amplify and re-transmit the radio signal to another location, or they could be part of a transmission system to connect with some of the Mobile Base Station antenna on the same tower.

In this case on the right, the IEN interface point is the ODF with Optical Fibre connecting from the Node exchange site to a CAN Optical Fibre cable feeding underground in trenches under the footpaths to the remote radio transceivers, and then coax feeding to the Base Station antennae - which connects to the mobile phones/modems etc.. This would be a typical CAN Optical Fibre with 12 fibres per sheath (not 120, 240 or 312 fibres per sheath like those used in the IEN).

The Mobile Base Station is a small one mounted on a Power Pole beside an arterial road - in a 'black spot' where normally without this base station, the mobile radio signal strength would fade out and the call would drop out.

The mobile network senses that the user is in the weak radio strength area, and when they move nearer this base station, the CCS7 (signalling) automatically switches the call to connect from this base station and not the former one - and in most cases the connection does not drop out.

All mobile phone base stations have this general access structure, and there is a signalling arbitration process so the base station with the strongest reception from the mobile phone connects to the call and the other sit ready to take over to automatically switch the access path as the mobile phone changes locations. All base stations are powered from the local mains and have large on-site battery back up to keep the system functional during power blackouts.

With G3 mobiles, (third generation) the radio bandwidth is considerable wider (as they use spread spectrum to minimise drop-outs), and the associated transmission link that connects to the IEN has to have a much larger bandwidth too – to account for broadband to the mobile phones.

For these advanced switching capabilities, Mobile phone networks connect in at the 'Node' level (a bit deeper in the IEN) and not the Local/Terminal exchange level, mainly due to the network switching complexity involving mobile number location, call roaming, and automatically switching between Base Stations etc issues.

Radio Base Stations (with their towers and antennas) are usually located in line-of-sight with the mobiles being used, and that means usually on the highest vantage points. In urban areas the power from these towers is quite low on purpose to cover small cell radii and provide high user density. In less populated areas the power is slightly greater and the number of base stations / antennae substantially less, and in rural areas typically only the major roads are covered.

So connecting to a mobile phone includes the radio spectrum – limited by geography, the antennae, mobile base station and transmission feed, back to the Core Network / Backhaul Network / Inter-Exchange Network.

The picture above shows a typical Mobile Base Station fitted into a curb-side cabinet.

In this case the Mobile Base Station connects to the Node exchange equipment via a point-to-point radio system, but in most cases it is usual to connect with a pair of underground optical fibres in a cable. All of this equipment and the transmission equipment at the Node site and Node “Edge Switch” are part of the Customer Access Network.

With competition, there are now at least four mobile networks all covering the same or very similar geographic footprints in metropolitan areas. There are also three different technology networks GSM, CDMA, and WCDMA (G3), and G4 is on the way too with an even wider bandwidth per user.

This makes a total of about 10 overlayed mobile networks - and that has to be about the most inefficient communications scenario possible - and it ably demonstrates that competition of infrastructure is extremely ineffective, very expensive, systematically under-utilised and very inappropriate.

There has to be a rationalisation, and the catalyst for this rationalisation will be technology advances - not competition!

With advances in Broadband Internet, GSM has already proven that it is not capable of good data rates, and it has a bad habit of dropping out - so GSM1 will be removed. CDMA is the predecessor for WCDMA, so CDMA base stations will be replaced by WCDMA, and the infrastructure for WCDMA (G3) will be come the national standard - but there are at least four carriers vying for service providing.

With some common sense, competitive businesses will call a truce and start to share infrastructures and this will lead to one common infrastructure used by multiple carriers - with all calls 'tagged' and passed through 'Gateway' switches before being switched by the various carriers. This is an area for the 'Core' Network discussion!

Connection by Satellite

This CAN infrastructure is very similar to connection for mobile personal devices in that the Local Network switch sits on the edge of the Backhaul or Core Network and an optical fibre cable connects the Local Network Switch to the Satellite Earth Station which has a good point-to-point radio connection with the satellite (while the weather is good).

The satellite is usually geostationary with respect to the earth rotating and therefore the satellite’s antenna is focussed on a particular part of earth (say inland and northern Australia), acting as a radio transceiver, transmitting a wideband signal to Australia.

At the premises, the premises satellite receiving station communicates with the satellite using a parabolic reflecting dish antenna about 600 mm in diameter that is aimed at the satellite that is about 240,000 km above earth. This special parabolic dish has a pencil thin beam that has a very high “gain” with respect to a monopole reference antenna. The premises’ receiving side picks up the signal from a transmitting earth station (located at Belrose or Oxford Falls in NSW).

The most common purpose for satellite reception is Pay TV where HFC cannot connect. Pay TV Satellite is a diverse solution where all that is required is a local (roof mounted) dish, a power source and a TV Set-top box. This solution provides Pay TV - but the earlier version was rather easy to 'crack' and a large percentage of customers had Pay TV for free for several years. The second version of Set Top Box had a greatly improved security system that (as far as I am aware) is synchronised by a phone call and the Set Top Box then translates TV signal to the TV.

If the renter fails to pay then that code is cut from the Earth Station Transmitter and the Set Top Box software excludes the suer from viewing the picture.

Another pseudo CAN solution using Satellite technology is for the reception of Broadband Internet, and uses a land based phone line connection as the upstream connection.

This may work in remote areas, but the overall Broadband bandwidth is limited making this a rather awkward and temporary solution before using Fibre to the Premises (FTTP) or 3G radio-based Broadband Internet.

Satellite maintenance is extremely expensive (and all foreign debit), and satellites have a relatively short life of five to seven years before they have to be pulled out of orbit and refuelled (by the Space Shuttle) and then put back into orbit again - which I believe is about 240,000 km from earth.

The other big problem with satellite transmission is the uplink – which requires considerable power and this is expensive equipment, and the reliability is also limited by weather and solar conditions at both sides of the satellite link.

If anybody really did the maths then they would find out that it is far cheaper (and involved almost no foreign debit) to connect with FTTP to the most outback places!

Comments and Corrections are welcome