Femto Cells Connecting Fixed and Mobile

How does an existing cellular system work? And how will the emerging femto cells enable improved indoor coverage and fixed-mobile convergence? Find out

Picochip PC302 residential femtocell enables better communication indoors

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In cellular systems, one primary objective is to use the spectrum efficiently. In order to use the limited radio spectrum efficiently, the same frequencies are reused in non-adjacent cells.

Cellular radio systems were implemented for the first time in the advanced mobile phone system (AMPS) in the USA. In AMPS, the concept of frequency reuse was introduced to support more users. AMPS is an analogue system known as the first-generation cellular radio system.

Current cellular radio systems are known as the second-generation (2G) systems. These are digital. In the USA, two standards are used for 2G systems: IS-95 (CDMA) and IS-136 (D-AMPS). Europe and Asia implemented a system called the global system for mobile communications (GSM). Japan uses a system called personal digital cellular (PDC).

GSM is used in more than a hundred countries by over 215 operators inside and outside of Europe. The Japanese PDC system is the second largest digital cellular system, followed by the IS-54/136 and IS-95 systems used in North America.

The third generation of cellular systems (3G systems) will allow different systems to interoperate in order to attain global roaming across different cellular radio networks with full man and machine mobility and unique single identification number (UTN: universal telecommunication number) globally.

The International Telecommunication Union (ITU) has been doing research on 3G systems since the mid 1980s and a version of a 3G system is called International Mobile Telecommunications - 2000 (IMT-2000).

3G systems have the following major objectives:

1. Use of common global frequencies for all cellular networks
2. Worldwide roaming—anywhere, anytime communication
3. Standardisation of radio interfaces
4. High data transmission rates for both circuit- and packet-switched data
5. Efficient spectrum utilisation schemes
6. Full man and machine mobility
7. Personal communication network (PCN) with UTN

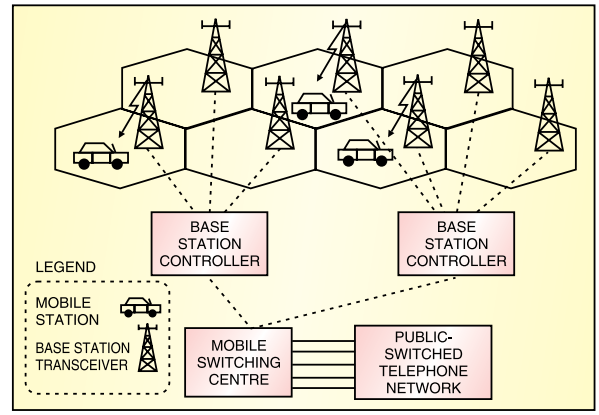
Cellular system architecture

A cellular radio network consists of:

1. ***Mobile station.*** A device used to communicate over the cellular network
2. ***Base station transceiver.*** A transmitter/receiver used to transmit/receive signals over the radio interface section of the network
3. ***Mobile switching centre.*** The heart of the network which sets up and maintains calls made over the network
4. ***Base station controller.*** Controls communication between a group of base station transceivers and a single mobile switching centre
5. ***Public-switched telephone network.*** Land-based section of the network

The base station transceivers and base station controller are often collectively known as the base station sub-system.

Cells—the basic geographic unit. A geographic region is divided into cells. Each cell has a base station transceiver that transmits data via a radio link to mobile stations within the cell. A group of base station transceivers is connected to a base station controller. A group of base station controllers is, in turn, connected to a mobile switching center via microwave links or telephone lines. The mobile switching centre connects to the public-switched telephone network, which switches calls to other mobile stations or land-based telephones.



A cellular system

Coverage areas of different cells

Based on the geographic coverage area, cells in a cellular radio network are classified as macro cells, micro cells, pico cells and femto cells.

Macro. A macro cell provides the largest coverage area within a mobile network—perhaps an entire metropolitan area of 80.5 km (50 miles) in diameter. It is larger than a micro cell and much larger than a pico cell.

But, macro cells provide radio coverage over varying distances depending on the frequency used, the number of calls made and the physical terrain. The antennae for macro cells are usually mounted on ground-based masts, rooftops or other existing structures and are positioned at a height that is not obstructed by terrain or buildings.

Typically, macro-cell base stations have a power output in tens of watts. Macro cells are used to cover the widest range of cell sizes. These are found in rural areas or along highways.

Micro. Micro cells are used over a smaller cell area such as in a densely populated urban area. These enable greater frequency reuse by allowing radio frequency propagation to be confined to a small local area.

A micro cell is served by a low-power tower, covering a limited area such as a small colony, mall, hotel or transportation hub. It is larger than a pico cell in both physical size and coverage area, though the distinction is not always clear. Typically, the range of a micro cell is less than 1.6 km (a mile).

Usually, micro cells are used to enhance coverage in a small but important area or to add network capacity in areas with very dense phone usage, such as train stations.

Pico. Pico cells are used in areas smaller than micro cells, such as part of a building, a street corner or an airplane cabin. The pico cell is the smallest of the cells in a cellular personal communications system (PCS) or PCN. It is most commonly used in connection with 3G systems.

A cellular base station designed to serve a relatively small area, such as a single building or a city block, is the basic motive of pico cells. Usually, pico cells are used to extend coverage to indoor areas where outdoor signals do not reach well or to add network capacity in areas with very dense phone usage, such as train stations**.** Pico cells may combine the electronic equipment and antenna in one integrated unit.

Femto. Currently, the smallest area of coverage that is proposed to be implemented is with a femto cell. Femto cells are proposed to be used in homes or small offices. These are perhaps the most exciting products and challenging technology emerging in the communications market today. According to Dr Alastair Brydon of Analysys, "Femto cells have the potential to transform the telecom industry."

Originally, femto cells were conceived as low-cost consumer products, but today it is becoming clear that these cells will be deployed in a diverse range of communications infrastructure applications. Many researchers believe that femto cells will be a fundamental technology enabler in the deployment of 3G network infrastructure technologies such as UMTS.

"Femto cells are an essential part of operator strategy going forward. pico-

Chip is the leading provider of femto cell chips, and once more demonstrates this position of leadership with its software-defined architecture," says Stuart Carlaw, ABI Research.

Femto cells are tiny, low-power 3G radio systems that plug into a residential broadband connection to provide a mobile signal directly in the home. A femto cell is smaller than a picocell and used to describe a very small radio cell associated with a cellular radio base station located in a home or small office.

Femto cells: Ideal for indoor coverage

Cellular radio is the fastest growing segment of the communications industry. Cellular companies reported a subscription base of more than 200 million people in 1997. This figure grows by an average of 150,000 new subscribers every day. With about 30 per cent of mobile calls made at home, operators with coverage holes in residential areas have the potential to boost their revenues significantly by deploying femto cells.

A survey in June 2008 predicted that 50 per cent of phone calls and 70 per cent of data calls would take place indoors in coming years. Therefore indoor coverage with high QoS (quality of services) will be in demand. Since other cells' coverage for such huge demands of indoor access will be expensive, the judicious choice will be to provide the service with femto cells.

Low-powered base stations in femto cells will provide desired solutions for indoor coverage. These will change the way operators build their networks and grow capacity and coverage.

The use of femto cells will benefit both users and operators in several aspects:

1. Communication with large capabilities and throughputs
2. Better signal quality due to proximity between the transmitter and the receiver in the smallest cell
3. Power savings
4. Reduced electromagnetic interference
5. Faster data speed
6. Low-cost service
7. Improved indoor coverage of both voice and data services

The transmit power of the femto base station, to be placed in individual homes, will be low. The femto cell connects to the service provider's network over the household's existing broadband link such as conventional digital subscriber line (DSL) or cable broadband access; current designs typically support two to four active mobile phones in a residential setting.

Femto cells allow service providers to extend service coverage indoors, especially where access would otherwise be limited or unavailable. Cost saving is a primary drive for femto services for users. The cost savings can be passed on to customers; for example, via femtozone tariffs, making broadband-bundled mobile price plans competitive not only with the fixed-line telephone but also with the TV and PC for entertainment and information services in the home.

Femto cells help in two ways:

- Removing indoor data sessions from the macro network reduces the number of users each macro cell needs to support.
- Because of the way CDMA works, if indoor users are served via femto cells instead of the macro cell, the capacity of the macro network increases in proportion to the number of users who have been removed from the cell.

Fixed-mobile convergence possible

Over the years, we have seen users ignoring landline in favour of mobiles. Clearly, there is a need to hybrid the fixed line with mobile.

Femto cells are an alternative way to deliver the benefits of fixed and mobile convergence. A femto cell-based deployment will work with existing handsets but requires installation of a new access point that uses licenced spectrum.

Femto cells provide a solution to a hybrid cellular and broadband network by using an existing broadband link to connect securely to wireless and then send and receive cellular signals throughout a home or office. ●

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