

Indoor Coverage in 3G and the Benefits of Pico Base Stations

a report by

Kevab

There is a greater need for indoor coverage solutions in 3G when compared with Global System for Mobile communications (GSM)TM.

Pico base stations are an effective solution for providing the required network quality and to reduce infrastructure investments and running costs. Whether in stand-alone operation or together with antenna distribution systems, pico base stations are cost-effective for small to large buildings.

One of the most important challenges facing the wireless industry today is providing seamless coverage for wireless communications. Due to growing competition between wireless service providers and rising customer expectations for 'seamless coverage', broad coverage of large geographic areas is no longer sufficient. Customers expect their mobile phones to work everywhere, including in buildings, malls, airports and tunnels. The next generation of telephony products must provide improved coverage to these important areas.

This article discusses the drivers for indoor solutions, provides some information about Kevab's pico base station, OneBASETM, and presents some indoor solutions based around it.

The Importance of In-building Coverage for UMTS Networks

A 3G service needs to offer great improvements in terms of both coverage and capacity compared with a 2G service. Meeting these expectations will require a solid network design, relying on a rugged macro network in combination with a powerful portfolio of specialised solutions such as dedicated indoor solutions. This section highlights some of the reasons that indoor solutions are seen as fundamental and mandatory for any 3G operator.

The indoor solution market for 3G is expected to be more important and also start earlier than for 2G, mainly for the following reasons:

- **Insufficient coverage** from macro sites since most 3G operators are forced to rely on the reuse of existing 2G sites.
- **Higher traffic** resulting from the use of new services such as e-mail, Internet, multimedia messaging and video, which significantly increases the traffic demand per user.
- **Network quality** – a single hot spot of users could jeopardise the network quality in a large part of the network if not dealt with.
- **Reduced investments** – dedicated indoor solutions are the most cost-effective method for providing the coverage and capacity needed to support a corporate client.

Insufficient Coverage from Macro Sites

Most 3G operators are today struggling with finding the best sites for their 3G service. In many cases, new sites are not allowed and operators are forced to reuse whatever sites they may already have for GSM. Other possibilities are to reuse sites owned by another operator. Such co-siting of macro base stations, although attractive from the city council's point of view, leave most operators with far from optimal site locations and, as a consequence, far from satisfactory network quality. Also, from a cost perspective, finding new macro sites is proving more difficult. Landlords and real-estate owners have realised the value of attractive rooftops for telecoms and have started to charge accordingly.¹

The New End-user Behaviour

Although, initially, 3G revenues will mostly come from the traditional voice service, there is a constantly growing demand for data services such as e-mail, video telephony and access to the Internet and intranets. A study made by the Universal Mobile Telecommunications System (UMTS) Forum predicts that, between 2005 and 2007, revenues from

1. "The Importance of Indoor Solutions in 3G", Kevab White Paper, January 2002.



Figure 1: In a 3G Network, the cell size varies depending on the traffic load.



Figure 2: The oneBASE™ is a complete eG Node B, easily mounted on a wall.



entertainment and information services will match those from traditional voice services.

Network Quality

It is not common knowledge that 3G differs from 2G (GSM) in one important aspect – the interdependence of network quality. In 2G, high traffic caused by a hot spot (many users in one location) could introduce poor quality in the particular cell covering the hot spot. In 3G however, the hot spot also generates interference and bad quality in surrounding cells. This phenomenon is called ‘cell breathing’, and is caused by the Wideband Code Division Multiple Access (w-CDMA) technology’s interdependence between capacity and coverage, which causes the cell size to vary depending on the traffic load carried by the cell (see Figure 1).

As a consequence, even a system planned for proper

indoor coverage from macro sites could run into coverage problems during unforeseen traffic peaks caused by, for instance, bandwidth-heavy services or hot spots. Operators need to keep a constant watch on permanent as well as occasional hot spots, wherever they occur, that could potentially jeopardise the entire network quality and an operator’s reputation.^{1,2}

Reduced Investments and Quicker Pay-back

3G operators are faced with some major financial investments. In addition to the licence fees, handset subsidies and marketing expenses, the investment in network infrastructure is a major concern in both the short and long term.

An economic comparison of different solutions for providing indoor coverage reveals that pico base stations, combined with a Distributed Antenna System (DAS), can be an excellent solution not only from a technical standpoint, but also from an economical perspective.³

The High-rise Building Problem

When a large number of equally strong pilot signals is present, there is difficulty for mobiles to distinguish to which of the pilots to connect and, moving a short distance to another pilot can become dominating. This makes handovers difficult since it increases the frequency of handovers and the number of users in soft handover. It also increases the interference in the system. The situation is termed ‘pilot pollution’ and causes large problems, especially in high-rise buildings that have a line-of-sight to many macro sites. Both pico systems and DASs remove the pilot power pollution while repeaters only mitigate the problem.⁴

Using Picos to Solve Indoor Coverage

The OneBASE™ is intended for use in indoor environments to enhance coverage and increase capacity. It is a low-power, high-capacity pico base station optimised for indoor use, i.e. small size, low weight and possibilities of mounting the base station on a wall or in a ceiling. Optional cover panels are available to ensure that the base station blends into the environment in which it is installed. The base

2. H Andersson, R S Karlsson, P Larsson and P Wikström, “Improving System Performance in a WCDMA FDD Network Using Indoor Pico Base Stations”, Institute of Electrical and Electronics Engineers, Inc. (IEEE) Vehicular Technology Conference (VTC), Fall 2002.

3. “Indoor Solutions for UTRAN and their Effect on the 3G Operator’s Economy”, Kevab White Paper, October 2001.

4. F Sapienza and S-L Kim, “Dominant Pilot Recovery in IS-95 CDMA Systems Using Repeaters”, Institute of Electronics, Information and Communication Engineers (IEICE) Trans. Fundamentals, No. 1, Jan. 1999.

station is noise-free since it uses self-convection cooling instead of fans.

Kevab's pico base station is excellent for the following:

- coverage enhancements, i.e. to cover white spots (an area where no coverage is supported by the macro bases);
- adding capacity in local indoor hot spots, e.g. in airport terminals, shopping malls, offices, train and underground stations;
- providing localised coverage and capacity in office environments for both voice and high-speed data service; and
- improving overall quality in the radio network by off-loading the macro network.

The OneBASE™ pico base station is a complete 3G Partnership Project (3GPP)™ Node B in a single unit. The base station includes transmission, baseband processing, radio frequency and control parts. It connects to the radio network controller using the I_{ub} interface according to 3GPP specifications. The pico base station supports one carrier and one sector with soft handover together with other Node Bs in the radio network.

Single and Cluster Configurations

With a single OneBASE™, up to 80 simultaneous speech users can be supported. The built-in antenna will suffice for up to a few floors of office space. For more complex structures, a passive DAS can be used, where external antennas distribute the signals throughout one or several floors. For locations with high-capacity demand, several pico units can be co-located or spread out.

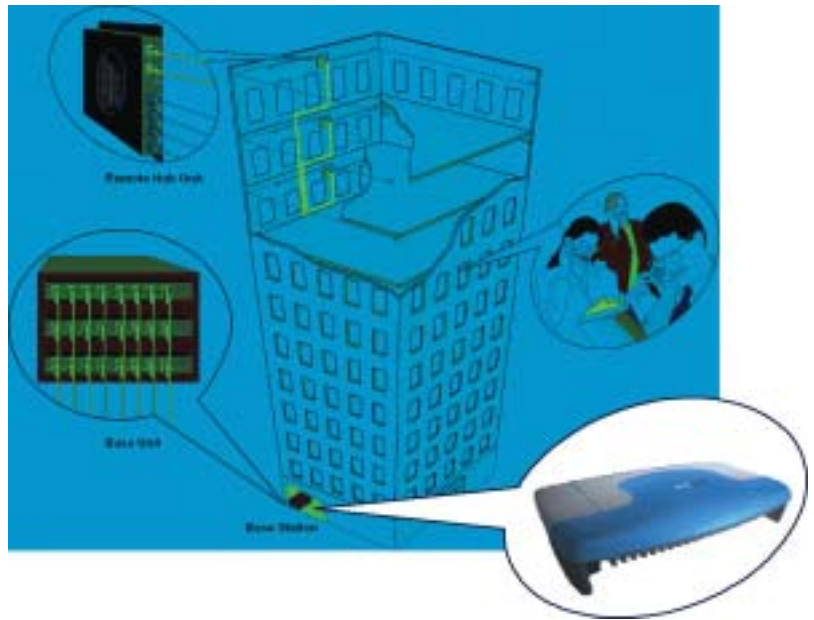
Due to its low cost and simple installation, operators can expect quicker pay-back compared with other solutions. Only 18 subscribers per pico base station are needed to achieve pay-back within one year.

Combining Picos with Active DAS

An active DAS is a system that is composed of many small amplifiers and antennas deployed throughout a building (shopping mall, business centre, etc.) connected by fibre-optic cables to a centralised distributor. The distributor may be connected to a co-located base station, such as a pico base station (also known as Node B).

This section shows how a fibre-based DAS can be combined with Kevab's pico base stations to create a powerful and cost-effective indoor solution.

Figure 3: The OneBASE™ combined with a distributed antenna solution



The OneBASE™ is used to feed a DAS, which usually consists of the following components: the base unit (BU); remote hub unit (RHU); and antenna elements.

The BU interfaces between the Node B and the RHUs via a single-mode fibre-optic cable. The RHUs are distributed throughout the building and connect to a number of antenna elements.

Transmission Flexibility

With pico base stations, transmission efficiency is an important factor. By using a conventional twisted pair interface, OneBASE™ allows the use of local-area network cables, which are readily available in most buildings. By supporting fractional E1's, operators can keep the transmission costs at a minimum at all times.

Easy Installation

Ease of installation is becoming increasingly important when time-to-customer diminishes. A pico base station like OneBASE™ requires a minimum of preparation; once the operator has ensured that a standard alternating-current power outlet and a twisted-pair E1 socket is present, installation of the unit can be done in a matter of hours by a single technician.

Service and Repair

With a minimum of components in the base station, fault location is easy and repair simplified. Complete unit replacement allows the operator to minimise the training for the service staff and as well as their time

in the field. This has a positive effect on both service costs and customer satisfaction. ■

Kevab is developing indoor solutions for 3G, including a pico base station suitable for applications such as those mentioned in this article. With a small physical size and an adaptable design it is the quickest and most cost-effective way to solve 3G operators' indoor needs. Kevab was established in 2000 and is located in Stockholm, Sweden. The OneBASE™ pico base station is available through several major system suppliers or directly from Kevab.

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