Ubiquitous indoor connectivity for advanced communication

The advent of smart devices has unleashed an era of truly massive data usage, and it is no secret that mobile data traffic has grown and will continue to grow at exponential rates globally. Live mobile video streaming, 3D mobile gaming, mobile banking and shopping have become a part of everyday life, and users today expect to be connected ubiquitously. At the same time, we tend to spend most of our lives indoors, whether we are working in the office, studying at school, meeting friends at a restaurant, or relaxing at home. So it is not surprising that most mobile usage takes place insides. In fact, more than 80% of all mobile traffic either originates or terminates indoors[1].

While some may presume the cellular network installed outside may be sufficient to cover such traffic, hotspots with consistently large numbers of people or sparsely covered areas need an additional source of connection. Unfortunately, simply increasing the number of base stations outside would have a limited impact on indoor coverage and make management and operations more difficult. For example, an increased number of cells would mean more interference between the cells and consequently require further effort for interference control. Hence, operators and businesses alike need to consider deploying an 'in-building' network dedicated to indoor traffic. For such a network to be a success, the deployed products need to be inconspicuous and more importantly, easy to install and manage.

Samsung's in-building products have taken these concerns into consideration and are small, light, and easy to deploy while providing reliable traffic management. Since indoor environments can vary dramatically by size, wireless propagation, capacity needs, and many other factors, Samsung offers a variety of in-building products and solutions to mobile carriers and enterprises.

[1]   ABI Research,
     https://www.abiresearch.com/press/abi-research-anticipates-building-mobile-data-traf/

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Indoor Small Cell Solution

Samsung offers an end-to-end (E2E) in-building small cell portfolio, complete with enterprise and home/SOHO cells, management system, and small cell gateway. The full solution empowers an operator to build a fully functional, independent small cell network. This separation from the macro network allows for a flexible and scalable network that is easy to manage and operate.

01   Enterprise Cell

Samsung's enterprise cell can be deployed to achieve high capacity as well as expand coverage, enabling the voice and data solutions that businesses rely on. The enterprise cell is LTE-enabled and ideal for mid-sized locations. It is also effective in hotspots with crowds of people such as shopping malls or coffee shops.

The enterprise cell, which weighs only 2.5kg with a volume under 3.4L, can be placed discreetly almost anywhere. It operates effectively without the need for a noisy fan. The enterprise cell is also designed for a simple and smooth deployment. As such, backhaul and clock synchronization are achieved through one LAN cable, decreasing the deployment complexity; the cell supports both GPS and ieee1588v2, requiring no additional accessories. In terms of performance, Samsung's enterprise cell is able to provide more than 60 simultaneous connections to the LTE network.

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The Samsung solution provides us with an offering for … our business and government clients with a 4G voice and data solution that seamlessly extends the corporate network to deliver mission-critical apps and corporate emails in a high performance environment.

- Senior Vice President of Wireless Enterprise for Verizon **"**

Samsung also provides a management system for the indoor solution, which can be used to optimize the performance of each cell and the network as a whole. The management system is a software solution that can be simply loaded onto a commercial server. A single server is able to connect to tens of thousands of indoor cells simultaneously. The system, during the initial installation stage, supports 'Plug & Play,' where the cells under the management system will immediately begin operating after connecting power and Ethernet. The auto configuration function included in the management system also detects the RF signal of neighboring macro and small cells to remove the need for any manual configuration and dramatically reduce manpower and installation costs.

Even after installation, the enterprise cell supports several features that provide meaningful value to operators and enterprises and are only provided by Samsung. The web graphical user interface (GUI) feature allows operators to easily monitor the status of the small cells automatically. The enhanced-911 (e911) feature improves public safety by identifying the location of a user based on the specific small cell used for voice or data. The small cell is also able to operate in a closed subscriber group (CSG) mode, where only those users of a certain operator are allocated the cell's resources.

Samsung's enterprise cell has already been commercially deployed and has been market proven in the US, one of the biggest markets for indoor coverage solutions. Verizon, the biggest wireless operator in the US, has been satisfied with the fast and seamless connection the enterprise cell provides.

[WiFi Integrated]

Many operators are looking to deploy not just LTE capacity and coverage but also carrier grade Wi-Fi into indoor environments. In such cases, instead of installing individual LTE and WiFi units, an operator may save CAPEX through Samsung's WiFi integrated enterprise cell.

The WiFi integrated model retains the features of the standard enterprise cell while incorporating a WiFi access point. Because a WiFi network is created alongside a LTE network, data offload to the WiFi network is possible and even with a sudden influx of devices and data traffic, there is no worry of congestion or disconnection. In cases where the WiFi and LTE frequencies are very close to each other, the cell automatically eliminates interference between the two for optimal performance.

[LTE-Unlicensed (LTE-U) /License Assisted Access (LAA)]

LTE-U and LAA are newly emerging technologies that utilize the 5 GHz unlicensed spectrum to enhance LTE performance. Samsung's LTE-U solution is designed to leverage and aggregate the unlicensed spectrum with the licensed spectrum to further increase throughput for faster data services. Samsung has evolved the standard enterprise cell to include such technology for operators who wish to increase the speed of LTE services. Furthermore, the current LTE-U technology can be migrated to the 3GPP LAA standard with a simple software upgrade.

One of the biggest worries the industry has about LTE-U is that is to be deployed on the same spectrum as the current WiFi technology. As such, there must be a way for both technologies to coexist with each other. In order to address such issues, Samsung's new LTE-U enterprise cell includes an auto channel selection feature that selects the channels within a frequency dynamically so that the LTE and WiFi technologies never select the same channel. Consequently, WiFi and LTE can both receive better throughput even with two different frequency users located at the same location. With carrier aggregation of LTE and LTE-U, the Samsung LTE-U enterprise cell supports a throughput up to 450Mbps. Additionally, Samsung's solution supports 2x2 Multi-input Multi-output (MIMO) on both licensed and unlicensed spectrum bands.

02   Home/SOHO Cell

In many regions of the world, mobile phone penetration rate has already surpassed that of fixed line telephones. With an increasing number of mobile smart devices in the home and customers expecting data service anywhere and anytime, operators are increasingly pressured to consider coverage of mobile users in situations where wide area macrocells are unable to provide adequate coverage - common in low-density suburban neighborhoods and rural towns.

Samsung's home/SOHO cell overcomes the challenges of weak coverage in buildings located in remote areas or built with dense materials. The cell has the equivalent features of the Samsung enterprise cell. Due to the highly compact nature of Samsung's home/SOHO cell offering, it is extremely convenient to carry and can be deployed anywhere in the home and SOHO. The small cell can be deployed either in a standing form or attached to a wall or ceiling. The small cell is designed for a simple 'plug and play' installation, supporting automatic location enforcement and frequency selection.

With the home/SOHO cell, virtually any customer can easily establish voice and data coverage where it is needed. It works like a miniature 4G LTE cell tower in homes or business environments within a 7,500 square foot area. The small cell supports HD Voice coverage (VoLTE) and fast 4G LTE data speeds for up to 7 users; seven channels may be used to connect regular devices with one channel reserved for 911 calls. Samsung's home/SOHO cell continues to evolve in tandem with growing demands; features on the roadmap include increased capacity to support 16 simultaneous users, simple device setup through a smartphone application, and USB ports available for connections to Internet of Things (IoT) dongles.

03   Small Cell Gateway

Enterprise cells are deployed in large numbers in hotspots, with hundreds of cells installed in a given area; Home/SOHO cells may also be deployed in massive numbers. These large quantities of indoor small cells are sometimes connected directly to the macro core network, creating thousands of new connections and increased loading on the already operating Evolved Packet Core (EPC). This can lead to substantial cost and complexity for the operator in the form of EPC capacity growth. In such cases, Samsung's small cell gateway and gateway management system provide more effective and simplified management. With the two products, an operator may coordinate an individual small cell network separate from the macro network.

Instead of connecting the small cells directly to the EPC, the small cell gateway aggregates all of the indoor small cell connections into a single new connection that gets made to the EPC. This approach leads to minimal impact on the overall EPC capacity. At the same time, the small cell network can be controlled more efficiently. For example, when macro and small cells are operated in a unified network and a problem arises in a certain area, it is difficult to determine whether the problem stems from a macro cell or a small cell. On the contrary, with two separately managed networks, it is easier to isolate the problem and quickly recover.

Small Cell Gateway

EPC
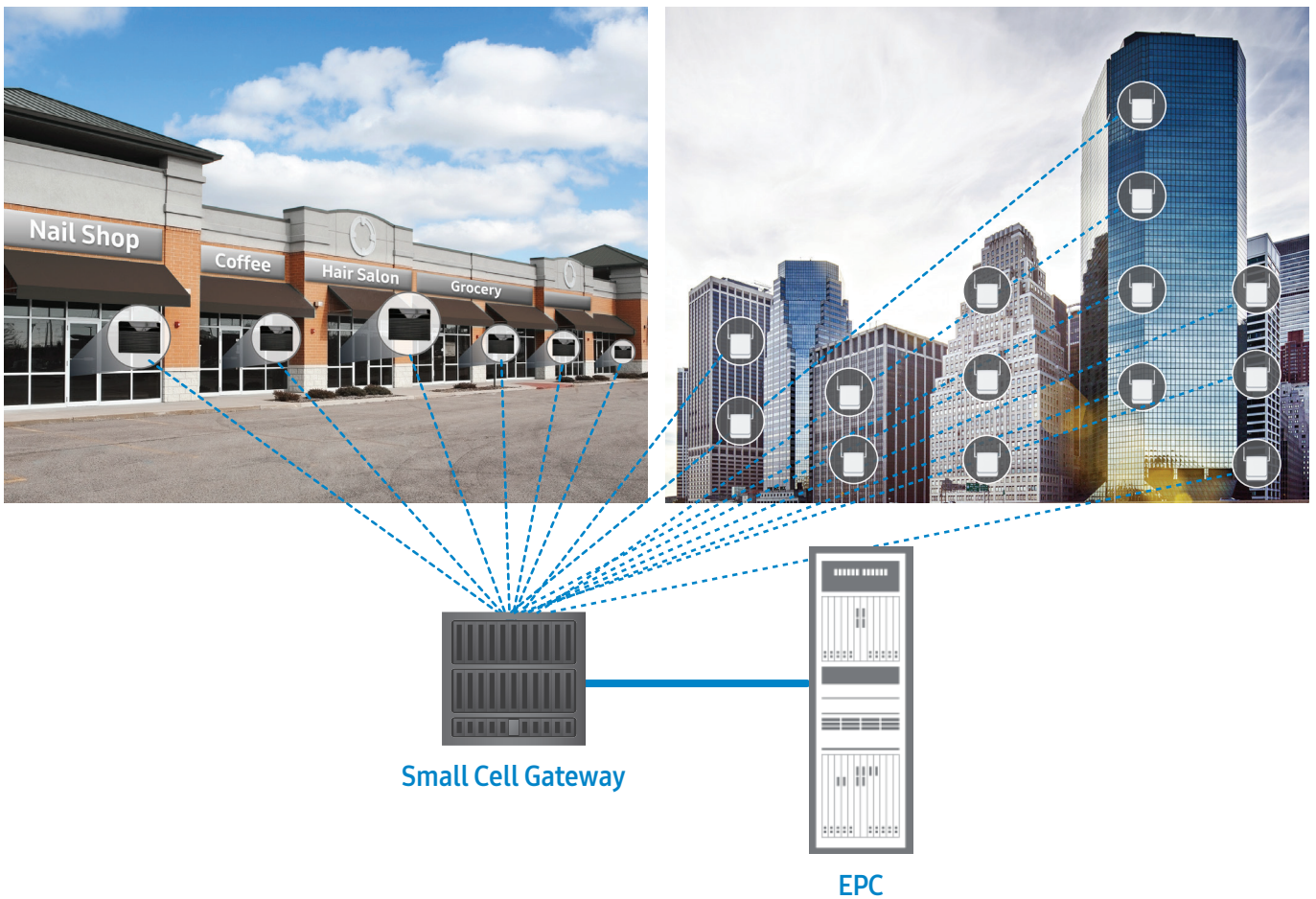
04 Cluster Controller: Interference Mitigation Solution

In large buildings, a single small cell is insufficient to cover each floor and multiple small cells are needed. However, multiple cells on the same floor cause interference and a central management system is necessary to manage such interference. With Samsung's cluster server, group management of cells within a building is made possible. The cluster server is based on a commercial off-the-shelf (COTS) server and is easy to deploy. It is embedded with an IEEE 1588 clock server so that only the cluster server needs to be connected to GPS; enterprise small cells are then connected to the GPS through sync signals sent by the cluster server. One cluster server is able to support up to 100 small cells.

The most significant function of the cluster server is that it acts as an interference controller. The advanced SON technology included in the server examines device distribution for cell size control. With dynamic cell size control, if two cells overlap and cause interference, the server automatically reduces the power of one cell and increases the power of the other cell so that interference is mitigated. With dynamic frequency selection, the frequency of the cells is automatically adjusted so that neighboring cells use different frequency bands for minimal interference.

Furthermore, the cluster server acts as a local G/W and provides local breakout service. Normally, when a small cell receives signal from users' devices, the signal is sent to the operator's core network to be processed. However, with a cluster server, some of the signal received from the device is offloaded directly to the Internet. For operators, this means that the core and backhaul burden is decreased since there is less incoming traffic. For end users, the service quality is enhanced since it takes less time to go straight from the Internet rather than through the operator's core network.

Overall, the cluster server enhances RF performance of indoor small cells through centralized control.
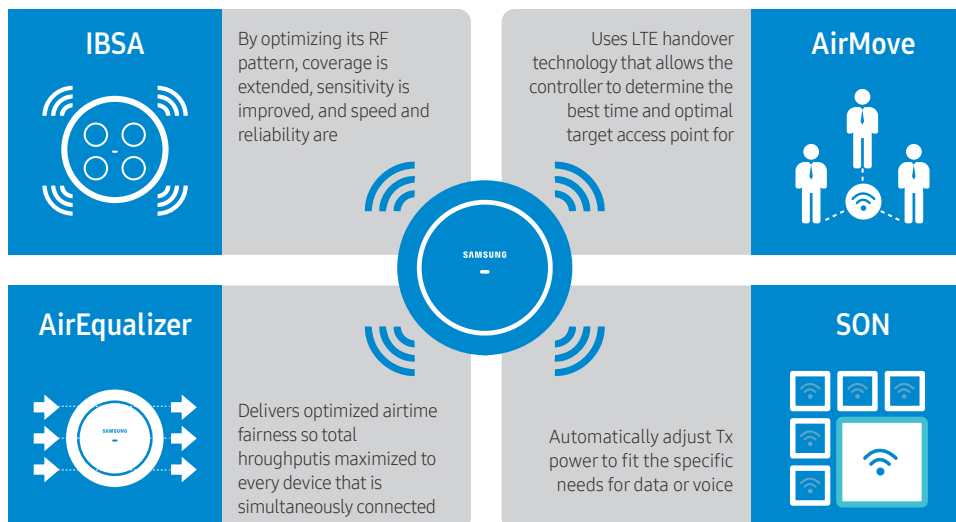
WiFi Access Point (AP)

In some cases, operators or business owners may be satisfied with LTE coverage but need supplementary WiFi coverage. For such occasions, Samsung offers a lineup of WiFi Access Points (AP) for optimal wireless environments. In order to provide carrier-grade WiFi, the AP meets operators' authentication requirements and supports data roaming, in addition to core network interoperability.

The Samsung Wireless Enterprise APs can be installed in diverse locations such as businesses, offices, schools, and hospitals. The high power output, 500mW, enables wide coverage and lowers deployment cost; a single AP can cover a large area.

Several technologies incorporated in the AP contribute to even better performance and faster service speed. The Intelligent Beam Selectable Antenna (IBSA) technology facilitates networks where multiple user require concurrent access. The AP is embedded with multiple physical antennas (up to 15) that enable the radio frequency (RF) pattern to be optimized according to where users are located. Through such enhancements, coverage is extended, sensitivity is improved, and speed and reliability are uncompromised.

The Self-Organizing Network (SON) feature automatically optimizes the cell configuration of the APs in order to extend coverage for voice and other data traffic. At the same time, it dynamically controls the cell size of the APs, decreasing interference.

Designed especially for high density environments, Samsung's AP series is also equipped with the AirEqualizer feature, an integrated traffic scheduling technology which provides smooth and fast service even when a large number of devices are used simultaneously. The equalizer feature offers optimized services and throughput fairness to users when multiple devices concurrently connect to an AP and as a result, seamless handover is also available.

IBSA

By optimizing its RF pattern, coverage is extended, sensitivity is improved, and speed and reliability are

Uses LTE handover technology that allows the controller to determine the best time and optimal target access point for

AirMove

AirEqualizer

Delivers optimized airtime fairness so total hroughputis maximized to every device that is simultaneously connected

Automatically adjust Tx power to fit the specific needs for data or voice

SON

Samsung has virtualized and integrated the AP Controller, P-Gateway and Multi Path TCP-Gateway into a single server for easy deployment; operators and business owners can select which functions they would like to use, and the software is uploaded onto a commercial server. The controller and gateways provide faster speed and central control of the APs.

Apart from the regular APs, Samsung also provides a Security AP which is ideal for business environments that need to protect confidential information. The AP's built-in security monitoring module offers RF monitoring, which helps you avoid the need for additional WiFi security sensors (Wireless Intrusion Prevention System - WIPS)

Conclusion

Enhancing coverage and capacity within buildings not only improves consumer satisfaction and operator economics but also opens up new and advanced services.

The Samsung indoor product portfolio allows operators and enterprises to select the optimal solution depending on the size and complexity of each building. In-building solutions from Samsung cover a wide range from home and SOHO to medium and large buildings, particularly providing solutions that allow easy management of numerous cells and effectively controlling interference within in-building environments.

With Samsung's field-proven and successfully deployed products, operators can provide seamless connectivity wherever people are located.

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Samsung inspires the world and shapes the future with transformative ideas and technologies. The company is redefining the worlds of TVs, smartphones, wearable devices, tablets, digital appliances, network systems, and memory, system LSI, foundry and LED solutions.

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