IN BUILDING SOLUTIONS (IBS) USING DISTRIBUTED ANTENNA SYSTEM

Mr. Akshay Sawant¹, Mr. Yash Shah², Ms. Zarna Parekh³, Mr. Hansal Shah⁴

¹(EXTC, D.J. Sanghvi College Parle (W), Mumbai, Maharashtra, India)
²(EXTC, D.J. Sanghvi College Parle (W), Mumbai, Maharashtra, India)
³(EXTC, D.J. Sanghvi College Parle (W), Mumbai, Maharashtra, India)
⁴(EXTC, D.J. Sanghvi College Parle (W), Mumbai, Maharashtra, India)

ABSTRACT

The world is buzzing with mobile communications. Smart phone usage is booming. We have observed huge demands on the available spectrum as a result of increase in the mobile application and data traffic. 85% data and 70% voice traffic is generated indoor. Poor reception in office buildings, parking garages and airports can lead to missed calls, opportunities, and loss of revenue. In this ever increasing competitive world, organization’s viability, growth and longevity depends on employee productivity and access to key decision makers. Businesses and people need continuous, seamless and robust wireless coverage. Low-quality signals, dropped connections, and lack of coverage decrease productivity and frustrate users. To ensure a workplace with comprehensive wireless coverage, Distributed Antenna System (DAS) can be used. In this paper, we provide a comprehensive review of the DAS and the components used in In Building Solutions (IBS). We also provide an example of IBS with site maps. These In Building Solutions will result in enhanced efficiency, productivity, and employee satisfaction which leads to business gain and revenue growth.

Keywords: Antennas, Couplers, DAS, IBS, Omnidirectional, Panel, Splitters.

1. INTRODUCTION

With the advent of new technologies[1], people using their cellular device expect it to work everywhere. They cannot afford a dead zone where the calls will be dropped. The two main factors for poor network or coverage area are an expanding user base and the raw materials used for building construction. These factors along with few others develop an area where no coverage is possible. A Distributed Antenna System (DAS) alleviates both issues and provide reliable coverage throughout the building.
Wireless device is becoming prevalent in everyday life and hence the ability to have vast service coverage is paramount. When more users access a network, distributed antenna system works to increase the network capacity thus allowing the individuals to continue with their conversation or other work on the cellular device without any interruption. Now-a-days due to the increase in the number of green buildings, DAS has become crucial. In green building the low-E glass blocks the cell signals from reaching its occupants. Thus DAS will enable a flawless cellular coverage transition when walking from outdoors into a building.

In the figure given below[2], a directional Yagi antenna is installed on top of the building to receive the carrier. Since most of the buildings are made from glass which blocks the signals, there is a need for this signal to be passed inside the building. Thus the signal from the Yagi antenna is given to Low loss coaxial cable which is then amplified by Bi-directional amplifier to overcome any loss in the cable. The amplified signal is given to service provider head end followed by fiber distribution hub. The main function of the distributor hub is to split the signals at each and every floor. The signal coming out of the hub is given to various broadband Wi-Fi ceiling antennas which are installed on each floor. Thus this antenna will radiate the signal and allow the cellular user to access their mobile device without any interruptions. In this way the distributed antenna system helps to increase the coverage area efficiently.

**In-Building Distributed Antenna System**

![Diagram of Distributed Antenna System (DAS)](image)

**Figure 1:** Distributed Antenna System (DAS)
2. COMPONENTS USED IN IBS

The components used in IBS are Base Transceiver Station (BTS), Splitters, Couplers, Cables and Antennas.

2.1 Base Transceiver Station (BTS)

A base transceiver station (BTS) is a piece of equipment that facilitates wireless communication between user equipment (UE) and a network. BTS contains the equipment for transmitting and receiving radio signals (transceivers), antennas, and equipment for encrypting and decrypting communications with the base station controller (BSC) [3]. A BTS is controlled by a parent BSC via the ‘Base Station Control Function’ (BCF).

![Base Transceiver Station](image2)

**Figure 2:** Base Transceiver Station

2.1.1 Splitters

RF Power splitters are required to split the Input RF Power into 2 or 3 or 4 equal parts.

2-Way Splitters operate in the frequency range 698-2700 MHz. They have a split loss of 3dB and an insertion loss of less than 0.3dB [4].

![2-Way Splitter](image3)

**Figure 3:** 2-Way Splitter

3-Way Splitters operate in the frequency range 698-2700 MHz. They have a split loss of 4.8dB and an insertion loss of less than 0.4dB [4].

![3-Way Splitter](image4)

**Figure 4:** 3-Way Splitter
4-Way Splitters operate in the frequency range 698-2700 MHz. They have a split loss of 6dB and an insertion loss of less than 0.5dB [4].

![Image of 4-Way Splitter]

**Figure 5: 4-Way Splitter**

### 2.1.2. Directional Couplers

A directional coupler provides coupling of the main signal path to another signal based on the direction of the signal propagation. These devices are used in IBS networks to unequally split the signal flowing in the mainline. Directional couplers operate in the frequency range 698-2700MHz [4].

![Image of Directional Coupler]

**Figure 6: Directional Coupler**

### 2.1.3. Antennas

There are two types of antennas used in IBS – Omnidirectional antennas and Panel antennas.

Omnidirectional antenna is a wireless transmitting or receiving antenna that radiates or intercepts radio frequency electromagnetic fields equally well in all horizontal directions in a flat, two dimensional (2D) geometric plane [5]. The radiated power decreases with elevation angle above or below the plane, dropping to zero on the antenna’s axis. Radiation pattern of omnidirectional antenna is ‘donut’ or ‘torus’ shaped. Omnidirectional antenna has a gain of 2dBi.

![Image of Omnidirectional Antenna]

**Figure 7: Omnidirectional Antenna [6]**

Panel antennas are high performance directional antennas that are designed for point to point and point to multipoint directional wireless applications. Panel antenna has a gain of 7dBi.
3. INSTALLATION PROJECT PHASES AND CHALLENGES

In Building Solutions technology is one of the fastest changes in mobile network rollouts. It has been estimated that 70-90% of all mobile calls are made inside the buildings; therefore to improve the QOS (Quality of Service), operators today have started concentrating more on this aspect of network rollouts [7].

The most efficient way to achieve optimal quality, coverage & capacity result inside the building is to use Microcell with Distributed Antennae System (DAS).

The key essentials for a potential IBS system are:

i. Identification of potential buildings for IBS.
ii. Design Distributed Antenna system using passive & active elements.
iii. Prepare complete diagram with each antenna’s EIRP (Effective Isotropic Radiated Power).
iv. Implementation of IBS solution with best professional way without disturbing aesthetic of building.
v. LOS & Link Planning to connect site.
vi. RF parameter planning, RF walk test and call quality testing.

The following are the challenges that may be faced by the IBS system:

i. Type of environment – Open layout, dense layout or mixed use.
ii. Building’s construction materials (Sheetrock, block, metal or concrete) [8].
iii. RF design goals (required strength of signal).
iv. Special application profiles (hospitals, corporate offices, hospitality, etc.)

4. EXAMPLE OF AN IBS

In the floor plan given below[8], we have mapped the omnidirectional antennas in such a way that all the areas on that particular floor get network coverage.
In the diagram given below [8], we have shown the RF coverage. Red area corresponds to ‘-65dBm’, yellow area corresponds to ‘-75dBm’ and green area corresponds to ‘-85dBm’.

1900 MHz, 4RF Carriers @ 10 dBm/carrier
We take up another example of IBS. We have designed an IBS for a building of 4 floors, with 19 antennas on each floor. The antennas are arranged in an L-shaped pattern. The height of the floors is 20m, and the distance between the two adjacent antennas is 20m. In this paper, we have shown the floor plan of the topmost floor. The power losses for the splitters have been assumed as follows: 3.25dBi for a 2-Way splitter, 5.25dBi for a 3-Way splitter and 6.25dBi for a 4-Way splitter. Cable loss is assumed to be 6dBi/100m. The gains of the antennas are: 2dBi for omnidirectional antenna and 7dBi for panel antenna. The power received by the BTS is 43dBm. In the floor plan, we have used basic geometry and Pythagoras theorem to calculate the distance between the passive elements. The diagram is completed with each antenna’s EIRP (Effective Isotropic Radiated Power).

![Floor Plan Image]

Figure 11: Plan of the topmost floor
5. CONCLUSION

Thus we have provided a comprehensive review of the DAS and the components used in In Building Solutions (IBS). DAS alleviates the issues of poor network or coverage area. DAS works to increase the network capacity thus allowing the individuals to continue with their conversation or other work on the cellular device without any interruption. We have taken up a few examples to prove that DAS is practically possible in IBS.

5.1 Applications

More than ever, executives, clients, patients, and students rely on cellular services to work indoors, as well as they’ve come to expect outdoors. From conducting business more efficiently, to enhancing a patient’s experience or improving customer responsiveness, cellular services need to work everywhere, making the business case for enterprise mobility stronger than ever.

i. Enterprise: The strong five-bar wireless signal enjoyed outside often drops to one or two bars just before entering a building. Building materials such as heavy steel and concrete, as well as low-energy glass used in most structures, absorb or block radio signals, causing such coverage issues. By deploying IBS, enterprises will see coverage enhancements throughout the building regardless of the building materials used, and will also realize unparalleled benefits.

ii. Hospitals: As hospitals continue to adopt life-critical mobile applications to improve patient care, increase caregiver productivity, and maximize operational efficiencies, IBS seek reliable and flexible indoor coverage infrastructures which meet the hospitals existing and future demands.

iii. Hospitality: Delivering a world-class guest experience today means offering innovative amenities and communications capabilities that guests have come to expect when on the go. Whether traveling on business or pleasure, guests use their Smartphones to talk, text, and surf the web, expecting robust cellular coverage throughout the venue. IBS enables long term investment protecting for the future, with ease of deployment today.

iv. Public Venues: Large stadiums, airports, convention centers, and arenas service tens of thousands of visitors every day. But it’s not just visitors and guests who depend on reliable mobile voice and data communications on game day. More and more, cellular coverage can:

- Improve employee productivity
- Enable delivery of premium VIP amenities and mobile applications
- Drive revenues and help guests stay connected
- Ensure security and guest safety

5.2 Advantages

i. Full mobile coverage.
ii. Bolster reliability.
iii. No aesthetic or deployment disruptions to the premises.
v. Improved quality of service (no dropped calls, high speed data connections).
vi. Ubiquitous wireless application access.
6. ACKNOWLEDGEMENT

We hereby take this opportunity to thank all the professors and others who helped in making this paper successfully.

REFERENCES