WHITE PAPER

IBW Wireless Networks Decision Baseline

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EXECUTIVE **SUMMARY**

Today's commercial buildings are not designed or built to allow radio signals to penetrate into the building – this means that the cellular experience in an office or hospital, for example, is often very poor or non-existent. This means that using a cellular network in a commercial building to provide critical communications or access to corporate applications is problematic at best and usually impossible.

The answer is to deploy an in-building wireless network (IBW) - the radio signal is now transmitting inside the building and hence providing connectivity throughout the office or hospital. Different technologies can be used to support an in-building wireless network: commercial Wi-Fi; a Distributed Antenna System; or private 5G/LTE using CBRS. These solutions provide the ability to reliably make phone calls, connect to critical communications (such as between nurses and doctors in a hospital), video conferences, and access corporate applications.

Note that an IBW does not have to be cellular OR Wi-Fi - due to the many needs for coverage and capacity inside a building and the need to support different devices and applications, buildings usually take a technology-agnostic approach to deploying IBW. It is common to have both Wi-Fi and cellular systems installed in a building. Note that cellular integration with the Wi-Fi network is possible to provide multi-carrier access inside the building.

This is especially true of buildings with good LEED (Leadership in Energy and Environmental Design) scores – low-e glass does an especially good job of blocking radio signals. Wi-Fi and cellular signals are also blocked by steel and since most commercial buildings use steel in the construction, the walls and fabric of the building will block signals coming from outside the building and signals moving between rooms or floors inside the building.

When a building owner or tenant is selecting an IBW solution provider, it is therefore important to look for a vendor that is technology-agnostic and can provide complete range of solutions: cellular; Wi-Fi; and wired. With IBW, one size does not fit all needs – networks need to be designed to make the most of the building layout and construction, and to fit the specific needs of the users and applications.

AN INTRODUCTION TO
IN-BUILDING WIRELESS NETWORKS

Simply put, an in-building wireless (IBW) network provides cellular or Wi-Fi coverage inside a building. Because radio signals do not travel well through walls or glass, the cellular or Wi-Fi service available inside a building is usually poor. So, while a person may enjoy a good cellular connection outside a building, as soon as they walk inside the lobby, the number of bars (declines significantly. Move further inside the building and you will likely lose the cellular connection completely.

Why is a wireless network needed in offices and hospitals?

The solution is to deploy an in-building wireless network - the radio signal is now transmitting inside the building and hence the outside walls and windows of the building are not a problem.

IBW therefore allows tenants or guests inside the building to access Wi-Fi or cellular as needed and enjoy a higher quality connection. This means the ability to reliably make phone calls, connect to critical communications (such as between nurses and doctors in a hospital), video conferences, and access corporate applications.

An IBW does not have to be cellular OR Wi-Fi - due to the many needs for coverage and capacity inside a building and the need to support different devices and applications, buildings usually take a technology-agnostic approach to deploying IBW. It is common to have both Wi-Fi and cellular systems installed in a building.

Who typically pays for the IBW?

Historically, the mobile operators (AT&T, Verizon, T-Mobile, etc) paid for the installation of the first IBW networks inside stadiums and large venues where the cellular signal was poor. But as the requirement for IBW increased (due to more people using their smartphones and devices for work, etc), the operators were unwilling to fund all the necessary builds. Today, a cellular IBW network is usually funded by the building owner or the tenant, or a combination of both.

The importance of sustainability

Sustainability and energy conservation are obviously very important considerations for any commercial building - buildings today are built to minimize their environmental impact as much as possible, with the goal of obtaining a high LEED (Leadership in Energy and Environmental Design) score.

Unfortunately, a good LEED score in a building usually means that radio signals will transmit poorly through, and inside, the building. For the building owner or tenant wishing to install IBW, therefore, it is very important to select a vendor that has experience working in new buildings with high LEED scores to maximize the design of the network and ensure that the targets for coverage and capacity are met.

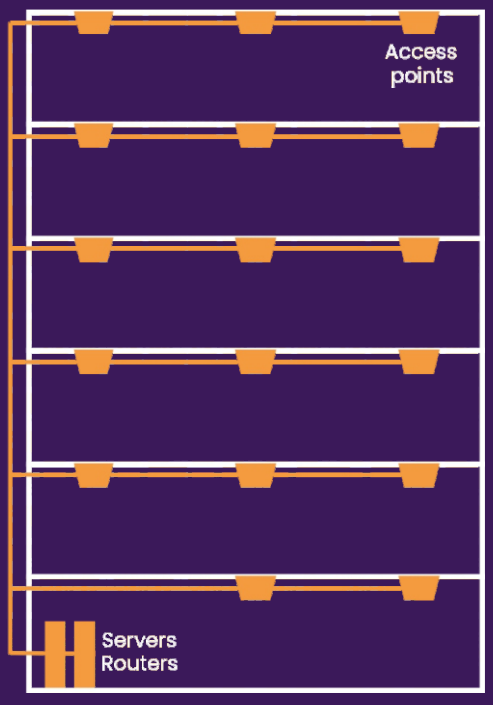
IBW NETWORK OPTIONS

For commercial IBW networks, there are essentially three choices: commercial Wi-Fi, a cellular DAS (distributed antenna system) or a private 5G/LTE network using CBRS. This section discusses the strengths and weaknesses of each technology, as well as the approximate costs to deploy and operate the network.

COMMERCIAL WI-FI

Wi-Fi is of course widely available in commercial and residential environments – in fact, Wi-Fi started out as a business networking solution before migrating to the residential market. Figure 1 below shows a typical configuration for commercial Wi-Fi in a six-story building: access points are spread throughout the building, connected to the Wi-Fi router and associated services in a basement, closet or building data center.

Figure 1: Typical Wi-Fi configuration



Source: iGR, 2022

Wi-Fi is typically used to provide general wireless connectivity throughout a building. Wi-Fi offers relatively high bandwidths and since a wide range of devices are available, everything from a thermostat to a laptop can be connected.

If there are a few users in a given area, the Wi-Fi experience is generally good. Problems arise as the number of user or devices on the network increases – the Wi-Fi protocol's weakness is in dealing with large numbers of devices. Overall network management and policy enforcement is poor.

But since Wi-Fi is relatively low cost and easy to install, it has found applications in commercial environments from coffee shops to offices, hospitals and airports.

Note that cellular integration with the Wi-Fi network is possible to provide multi-carrier access inside the building.

WI-FI

1

BENEFITS

Relatively low cost and easy to install

Well-established technology with a wide and varied device ecosystem

Relatively easy to manage and maintain

Ability to connect multiple devices at one time

Cellular integration possible

2

DRAWBACKS

Many access points required to cover an area compared to alternatives and adding capacity usually means adding equipment

Poor upgradeability between versions – usually requires new equipment when a new version is released

Poor policy and management capabilities – not able to differentiate traffic between users/devices

Security questioned by many

As more users and devices are added, becomes congested due to poor traffic management

3

TYPICAL COSTS

$0.45 - $0.60 per square foot for an enterprise-grade network

4

SPACE REQUIRED IN BUILDING

● LOW ○ MEDIUM ○ HIGH

5

POWER CONSUMPTION REQUIREMENT

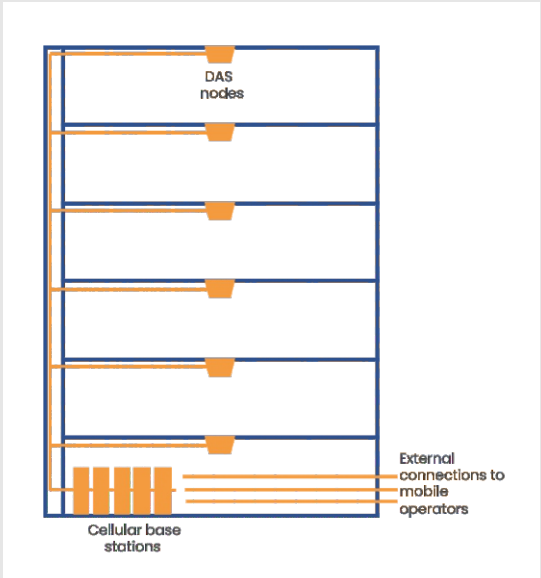
● LOW ○ MEDIUM ○ HIGH

DAS
DISTRIBUTED ANTENNA SYSTEM

A distributed antenna system, as the name suggests, takes a cellular signal and spreads it throughout a building. Essentially, a cellular signal is taken from outside the building and then rebroadcast inside, allowing devices inside the building to connect to the public cellular networks – to the mobile device, the DAS looks and feels just like a cell tower outside of the building. A DAS can also support multiple carriers inside the same building.

The main issue with most DAS deployments is the need to get a connection to the outside cellular network - a cellular base station is deployed inside the building which connects to the cellular provider's network and is managed just as any other cell site would be. The need to get this 'signal source' in a DAS adds both time and cost to the deployment – cellular operators have been known to take up to 12 months to provision the base station. And the additional cost can be $30,000 to $50,000, depending on the size of the installation.

Figure 2: Typical Active DAS configuration



Source: iGR, 2022

But the advantage of a DAS is that the user experience inside the building is comparable to a cellular experience outside – for most users, the experience will be seamless. This is ideal in hospitals, for example where guests and patients want to communicate, but also nurses and doctors need critical communications capabilities.

Figure 2 shows a typical active DAS deployment in a six-story building – note that fewer nodes are needed than with Wi-Fi. But the cellular base station needed for the DAS can take up considerable space inside the building, and also consumes significant power. An external link, usually via high-quality fiber, is required to each mobile operator's network that requires provisioning inside the building – this again adds cost.

DAS

1

BENEFITS

Well-established technology that can be provisioned as active or passive

Wide device ecosystem – all cellular devices can be used

Ability to connect multiple devices at one time and ability to scale as the number of devices increases

Multi-carrier support

Upgradeability is through the base station and usually not by the need to change the nodes

Policy and management capabilities of parent cellular system

Inherent security of cellular network

Relatively few nodes (antennas) required to cover a given area compared to Wi-Fi

2

DRAWBACKS

Cost

Need to secure signal source (active) from a mobile operator

Significant amount of equipment to house in building and maintain, including significant power requirements

Does not support private network connections

3

TYPICAL COSTS

$1.20 - $1.80 per square foot but can be higher depending on building construction

Passive systems can be under $1.00 per square foot

4

SPACE REQUIRED IN BUILDING

○ LOW ○ MEDIUM ● HIGH

5

POWER CONSUMPTION REQUIREMENT

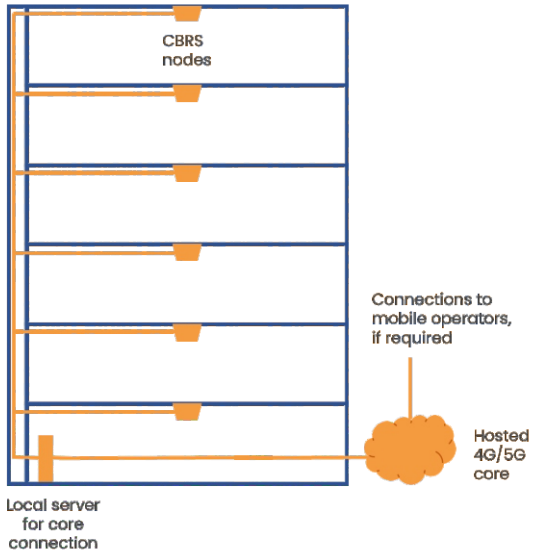
○ LOW ○ MEDIUM ● HIGH

CBRS PRIVATE 5G/LTE NETWORK

Building owners and tenants also have the option of deploying their own private cellular network in-building, using LTE and/or 5G. A private cellular network uses the same technology as the large cellular operators but deployed at a much smaller scale. To support private wireless networks, in April 2015, the U.S. Federal Communications Commission (FCC) established the Citizens Broadband Radio Service (CBRS) for shared wireless broadband use of the 3.5 GHz spectrum band. This allows enterprises to build, deploy and operate their own cellular network, independent of the mobile network operators.

Figure 3 shows a typical CBRS network deployment in a six-story building – note that there are fewer CBRS nodes than used in Wi-Fi. The core is essentially a simplified version of the same 4G or 5G core used by the mobile network operators – a small server is housed in the building to connect the nodes to the core, which is hosted in the public or private cloud. This simplifies the deployment and reduces the amount of equipment needed on-site, as well as cost. If connectivity to the mobile network operators is required (to provide roaming inside the building, for example), this can be accomplished through the hosted core.

Figure 2: Typical CBRS configuration



Source: iGR, 2022

Since CBRS network uses the same LTE and 5G technology as the major mobile network operators, high bandwidth/low latency services can be provided. CBRS has been used for augmented and virtual reality applications, remote control and monitoring of augmented vehicles or machine tools, connectivity to HD video cameras, and critical communications, including push-to-talk.

5G/LTE Private Network using
CBRS

1

BENEFITS

Ability to deploy a private cellular network without the mobile network operators, supporting high bandwidth/low latency services

Wi-Fi and CBRS can both use the same building wiring infrastructure

Can use 4G or 5G technology

Rapidly developing ecosystem of network equipment, devices and vendors

Tools to deploy the 4G/5G core in the cloud and manage remotely

Ability to scale number of nodes and devices supported by adding spectrum

Ability to use dedicated CBRS spectrum if needed (Priority Access License)

Security, policy enforcement and network management tools are the same as for a cellular network, allowing policy to be defined per-device

2

DRAWBACKS

Requires managed services provider or resource to manage network

Limited CBRS devices are available, but ecosystem is growing quickly

3

TYPICAL COSTS

$0.55 - $0.85 per square foot for a private network, not connected to a public mobile network operator

4

SPACE REQUIRED IN BUILDING

● LOW ○ MEDIUM ○ HIGH

5

POWER CONSUMPTION REQUIREMENT

○ LOW ● MEDIUM ○ HIGH

WHEN TO USE
EACH IBW OPTION

The following decision matrix provides a basic guide to selecting the 'best' network technology for an IBW, based on the needs of the application and type of connection. This should be used as a guide – when a building owner or tenant is selecting an IBW solution provider, it is therefore important to look for a vendor that is technology-agnostic and can provide complete range of solutions: cellular; Wi-Fi; and wired. With IBW, one size does not fit all needs – networks need to be designed to make the most of the building layout and construction, and to fit the specific needs of the users and applications.

There are obviously many factors that go into the decision as to which technology to use for an in-building wireless network: Wi-Fi, DAS or private 5G/LTE with CBRS. While a building is unlikely to use a single network for all devices and applications, each network technology has benefits and drawbacks.

	Applicable Venue Size (S SMALL, M MEDIUM, L LARGE)	System Cost (HIGH, MEDIUM, LOW)	Approximate Cost (square foot)	Installation Complexity (HIGH, MEDIUM, LOW)	Energy Use & Expense (Low/Med/High)	Network Security	Network Speed (200MB - 1GB speeds)	Cellular Connectivity (Voice, Data, SMS)	Outdoor Venues or Parking Garages	Hybrid Deployment network of mixed technologies	Venue Examples
WiFi Network	S M L	Green	$0.35 - $0.55	Green	Green	Yellow	Yellow	Enabled using "Passpoint" for cellular interconnect	Yellow	Green	*CRM, Multi-Family, Clinics, Nursing Homes, Hospital seeking a network for patient and guests connectivity*
DAS Network	M L	Red	$1.20 - $1.80	Yellow	Yellow	Green	Green	Carrier interconnect required	Yellow	Green	*Manufacturing, Industrial, Stadiums, Airports, Convention Centers. Any venue serving 50K-100K users simultaneously*
Private Network *(Neutral Host CBRS)*	S M L	Yellow	$1.00 - $3.00	Green	Green	Green	Green	Carrier interconnect required	Green	Green	*CRM, Multi-Family, Clinics, Hospitals in need of a network for patients and guests*
Private Network *(Private Only)*	S M L	Yellow	$0.55 - $0.85	Yellow	Green	Green	Green	A Private network is a Closed Network	Green	Red	*Manufacturing, Industrial sites where M2M connectivity for IoT or machinery*
Private Network *(Carrier Grade)*	S M L	Red	$5.00+	Red	Yellow	Green	Green	Private + Carrier interconnect required	Red	Red	*Manufacturing, Industrial, Stadiums, Airports, Convention Centers. Any venue serving 50K-100K users simultaneously*

ABOUT iGR

iGR is a market strategy consultancy focused on the wireless and mobile communications and digital infrastructure industries. Founded in 2000 by Iain Gillott, one of the industry's leading analysts, iGR researches and analyzes the impact new wireless, mobile and digital infrastructure technologies will have on industries, the competitive landscape and on a company's strategic business plan.

A more complete profile of the company can be found at http://www.iGR -inc.com/.

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