CONNECTED AND EFFICIENT BUILDINGS

COMMSCOPE®

INSIGHTS INTO NEW TECHNOLOGIES IN THE WORKPLACE: *BEST PRACTICES*

TABLE OF CONTENTS

AUTHORS

David Beihoff

Michael German

Richard Mei

Masood Shariff

TC Tan

Mike Williamson

Morne Erasmus

Sean Kerr

Matias Peluffo

Philip Sorrells

Dave Tanis

THE CONNECTED AND EFFICIENT BUILDING

INTRODUCTION

THE TERM "INTELLIGENT BUILDING" HAS BEEN IN USE SINCE THE EARLY 1980s.

Over the years, several organizations have attempted to establish a universal definition of an intelligent building. As a result, there are a multitude of definitions with different levels of detail and varying degrees of emphasis on several aspects of building intelligence. One thing most of these definitions have in common, however, is the essential fact that intelligent buildings are Connected and Efficient buildings.

A connected building boasts an integrated communications infrastructure that supports wired and wireless networks and applications. It also facilitates person-to-person, person-to-machine and machine-to-machine communications within the building and with the outside world using a state-of-the-art, intelligent, flexible, wired and wireless platform. The platform supports wired LAN, Wi-Fi, in-building wireless, audio/visual, sensors, lighting and building management applications. These buildings are also becoming cloud connected as an essential part of smart grids and smart cities.

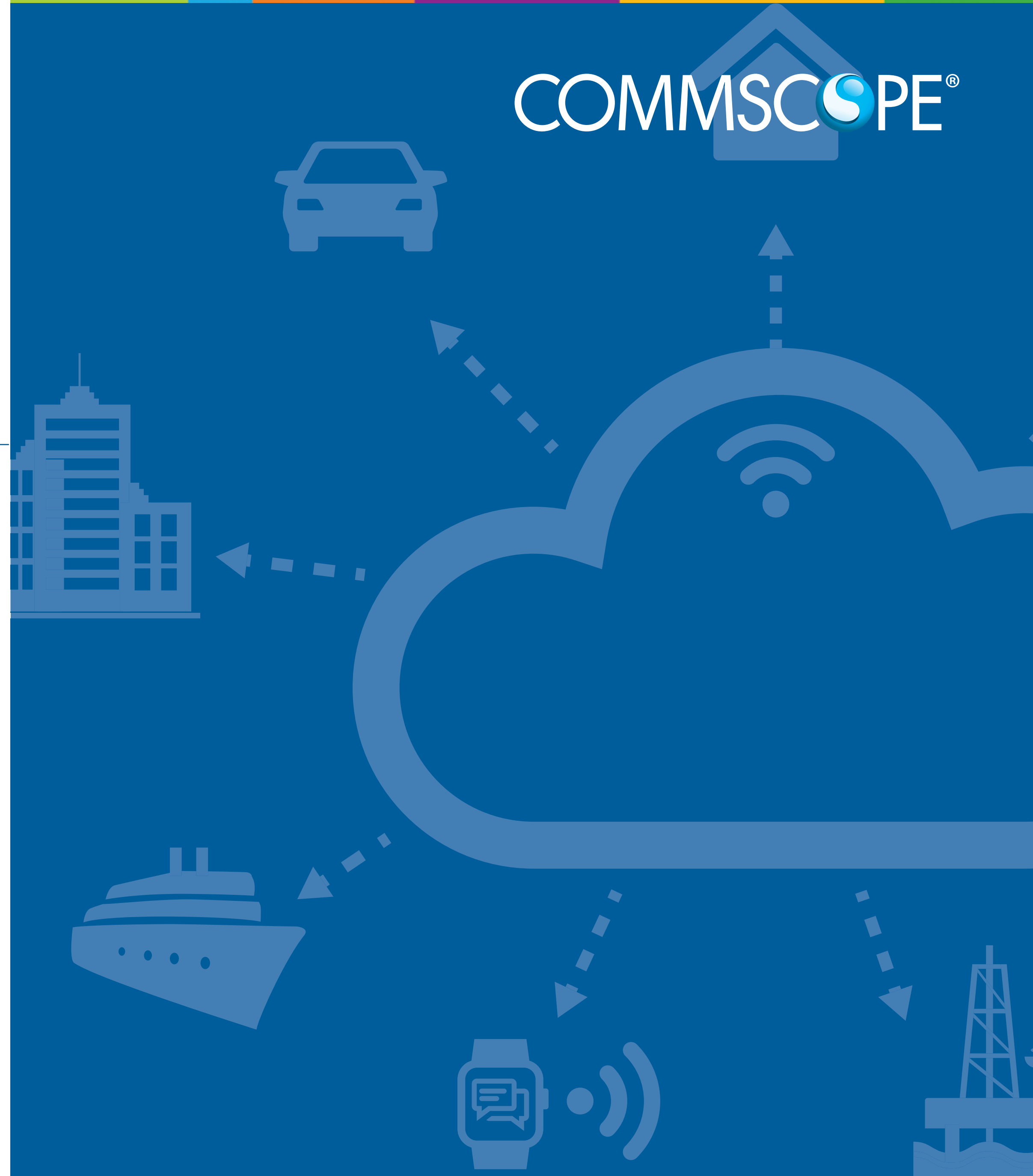
An efficient building leverages a state-of-the-art connectivity platform to address corporate real estate, facilities and IT challenges to improve energy efficiency, space utilization and occupant satisfaction. In an efficient building, the intelligent connectivity platform is easily adaptable to changes in workplace design and communications technologies. Similarly, a high-density sensor network integrates with other building systems to provide fine-grained occupancy-based control for optimal energy use and occupant comfort while providing a real-time and historical view of occupancy patterns.

The evolution to Connected and Efficient buildings has introduced a growing number of technologies, solutions and deployment methods to the enterprise. Navigating this complexity can be challenging, which is why CommScope is eager to share our experience around Connected and Efficient building best practices.

These guidelines are built upon decades of experience in the field and innovation in the lab. They include tips, answers, and insight to help demystify the technology, untangle the complexity, and accelerate time to market to help you spot the challenges—and opportunities—in your Connected and Efficient building.

BEST PRACTICE

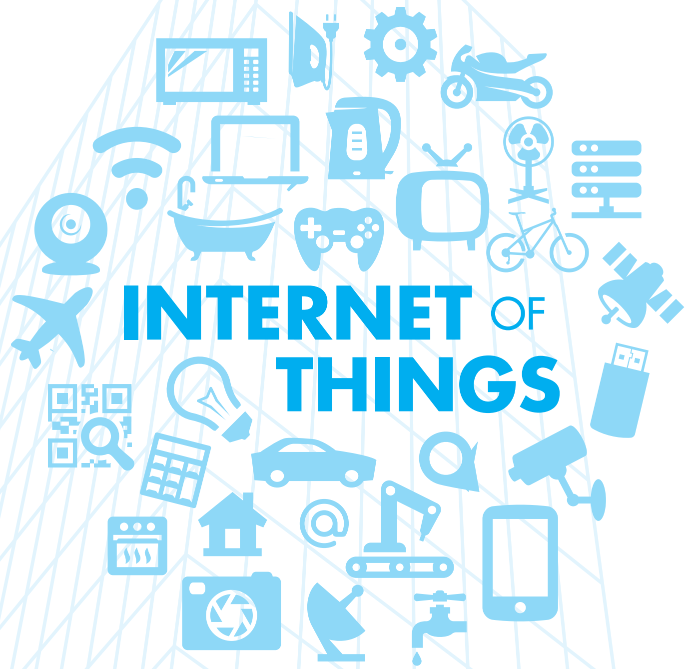
#1 THE INTERNET OF THINGS



BUILDING AN INTELLIGENT WORLD, ONE DEVICE AT A TIME

THE INTERNET OF THINGS (IoT) IS CHANGING THE WAY WE WORK, TRAVEL AND LIVE.

Smart buildings, which adjust their services based on occupancy, are becoming significantly more efficient. Driverless cars may reduce accidents. And smart home technology allows the management of HVAC, lighting and security with a smart phone. Basically, anything that can benefit from network connectivity is a potential connection point.



What is…

The Internet of Things (IoT)?

The addition of sensors, electronics and network connectivity to various discrete devices to enable remote management and data acquisition, improving efficiency.

CONNECTIVITY IS KEY

MANY ENTERPRISE AND COMMERCIAL SPACES ALREADY EMPLOY IOT ON A LIMITED BASIS, INTEGRATING HVAC, LIGHTING AND OTHER BUILDING SYSTEMS.

However, only one percent of the devices in buildings are actually connected to the network.

To fully realize the potential of the IoT, the challenge is to connect the remaining devices via Ethernet, cellular, Bluetooth® Low Energy, Zigbee, Wi-Fi or other protocols, depending on the application.

We will explore the means of providing this connectivity throughout this book. For example, in the next chapter, we will discuss how the deployment of a universal connectivity grid (UCG) can be used to support wireless protocols that exchange limited range for improved battery life in low-power remote sensors.

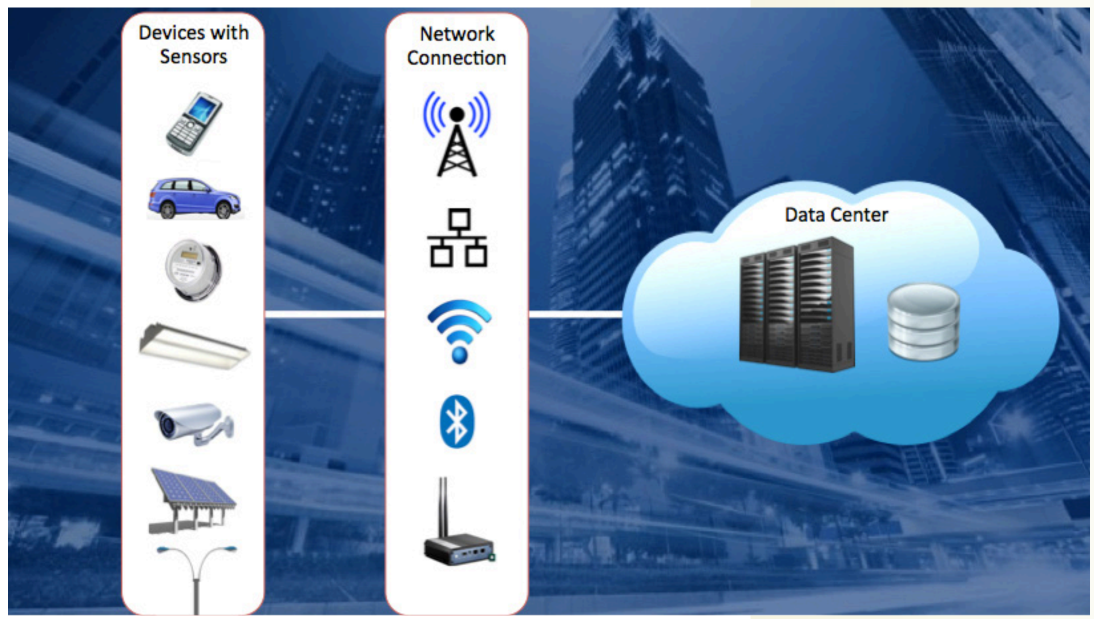
As shown in Figure 3, the network provides the critical function of connecting sensors to the data center, where sensor data is processed, analyzed and stored.

[1] *The Internet of Things in Smart Buildings 2014 to 2020, Memoori, Q4 2014*

How big will IoT become?

There is virtually no limit to the potential applications possible with IoT. Estimates point to a big impact:

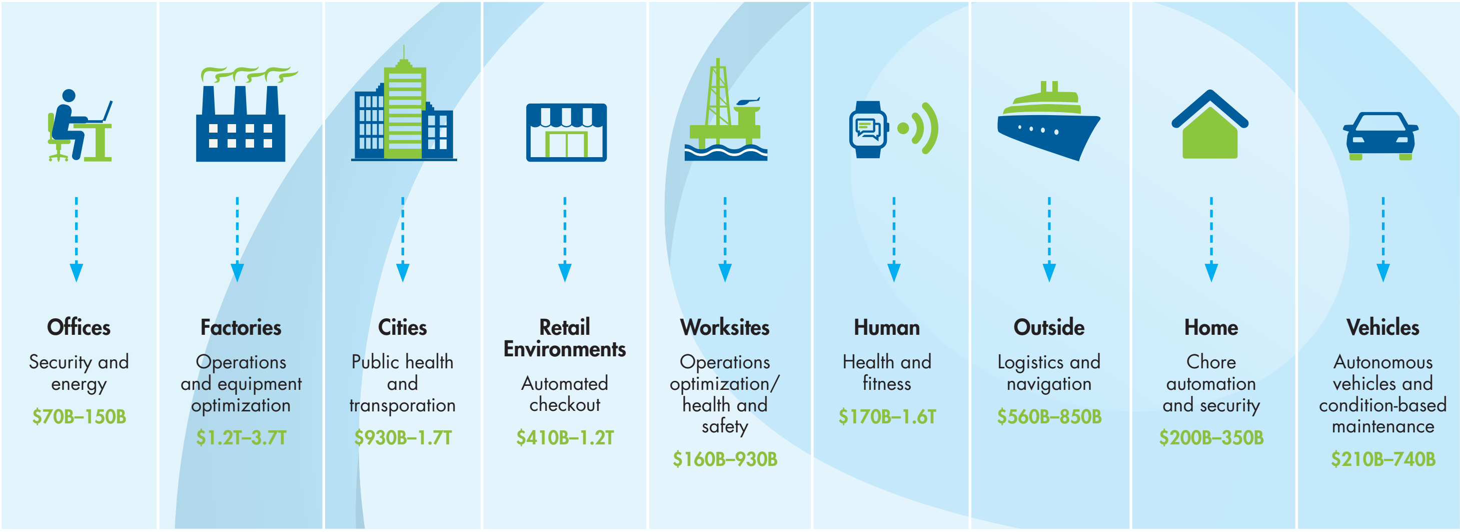
- **1 billion** wireless devices connected in 2015
- **4.9 billion** total devices connected in 2015
- **50 billion** total devices connected by 2020



The IoT and Connectivity

IOT IN THE ENTERPRISE AND COMMERCIAL SPACE

McKinsey's estimate below represents the total potential impact of the IoT ***per year*** in 2025.



Potential impact of the IoT per year in 2025 (McKinsey)

The majority of IoT applications are expected to arise in the construction of smart cities, factories and transportation systems.

Enterprise and commercial space will represent a significant part of that.

Buildings will see the greatest IoT benefit in the increased efficiency of their various systems.

These include security, fire detection, lighting, HVAC, elevators and other connected systems.

Office space will represent an important part of the overall enterprise/commercial segment.

Larger components include retail, healthcare, worksites and industrial spaces.

Additional resources:

Blog: 2016 Trends for Intelligent Buildings by Ispran Kandasamy, Ph.D.

Report: McKinsey IoT Report 2015

BEST PRACTICE

#2 COMMON INFRASTRUCTURE FOR BUILDING APPLICATIONS

THE DISTINCTIONS ARE BLURRING

NETWORKING APPLICATIONS AND TECHNOLOGIES SUCH AS 2.5G/5G/10G ETHERNET, POE, AND HDBASET ARE CONTINUOUSLY EVOLVING.

As they do, there emerge new opportunities to integrate real estate, IT and facilities applications into a single, simplified network infrastructure running on twisted-pair copper cabling. Among others, these applications include:

- Wi-Fi
- In-building wireless (IBW)
- Intelligent LED lighting
- A/V systems
- Security and access control
- Building automation
- Data collection

We will explore these various applications and technologies in detail throughout this book, but one thing is immediately clear: an optimized enterprise environment is one that integrates them all over a common infrastructure.

What is…

Common infrastructure?

Common infrastructure offers a cost-effective means of supporting many diverse applications. It is also ready to accommodate new and emerging wired and wireless applications.

THE ADVANTAGES: COST, RELIABILITY, AGILITY

From an operational standpoint, this integration is a highly preferable alternative to a collection of various wired and wireless topologies—each requiring separate management. By aligning these diverse needs into a single, intelligent "pipeline" that can handle all on-site data traffic and management needs, a common infrastructure can reduce installation costs by up to 50 percent as well as cut ongoing operational expenses.

The reduced number of separate networks helps ensure greater reliability and increased uptime. Since the framework is also flexible and adaptive, it is a simple and inexpensive matter to change or expand the systems it supports as business needs dictate.

In our fast-evolving workplace, these three benefits can deliver the connectivity and efficiency that help an enterprise run smoothly, cost-effectively and—most importantly—competitively.

IMPLEMENTATION RECOMMENDATIONS

Twisted-pair cabling provides a common foundation for evolving applications in the building. Category 6A cabling opens up new possibilities for current and future applications. Optimize the benefits of your deployment with the following tips:

Know your convergent systems

Recent advances are adding more and more applications to the network, such as:

- Voice and data
- In-building cellular coverage
- Access control and surveillance
- Building automation
- Audio and video services
- LED lighting and control
- Occupancy and environmental sensors

Horizontal and backbone cabling

A common infrastructure needs a wide pipe to move data from diverse systems and support future bandwidth requirements.

To meet this demand and provide capacity for future expansion, horizontal cabling (that is, cabling to the end devices) should be Category 6A. Backbone cabling, which connects all the IDFs to the MDF, should be composed of OM4 fiber-optic cable.

Follow the standards

While the infrastructure is common, the applications and devices it supports are not.

Applications standards typically drive cabling standards. As such, it's important to observe all applicable standards as published by ISO, TIA, IEEE and other relevant standards organizations.

See Chapter 12 for more information on standards.

Additional resources:

White paper: Connected and Efficient Building

White paper: Fiber Backbone Cabling in Buildings

BEST PRACTICE

#3 UNIVERSAL CONNECTIVITY GRID

CONNECTING FLOOR TO CEILING AND END TO END

DEPLOYING A COMMON INFRASTRUCTURE FOR REAL ESTATE, FACILITIES AND IT REQUIRES AN ARCHITECTURE THAT SUPPORTS DEVICES FROM THE WORK AREA TO REMOTE LOCATIONS WITHIN THE CEILING, WHILE PROVIDING THE AGILITY TO KEEP PACE WITH THE EVOLVING NEEDS OF THE BUSINESS.

Zone cabling enables the building operator and/or occupant to focus on spaces and applications rather than specific users, devices or work stations—facilitating a forward-thinking, flexible and scalable infrastructure to stay ahead of tomorrow's connectivity demands.

The Universal Connectivity Grid (UCG) takes this idea a step further by mapping the facility into a grid with evenly-sized service areas, each containing a consolidation point (CP) that connects the area back to the core network.

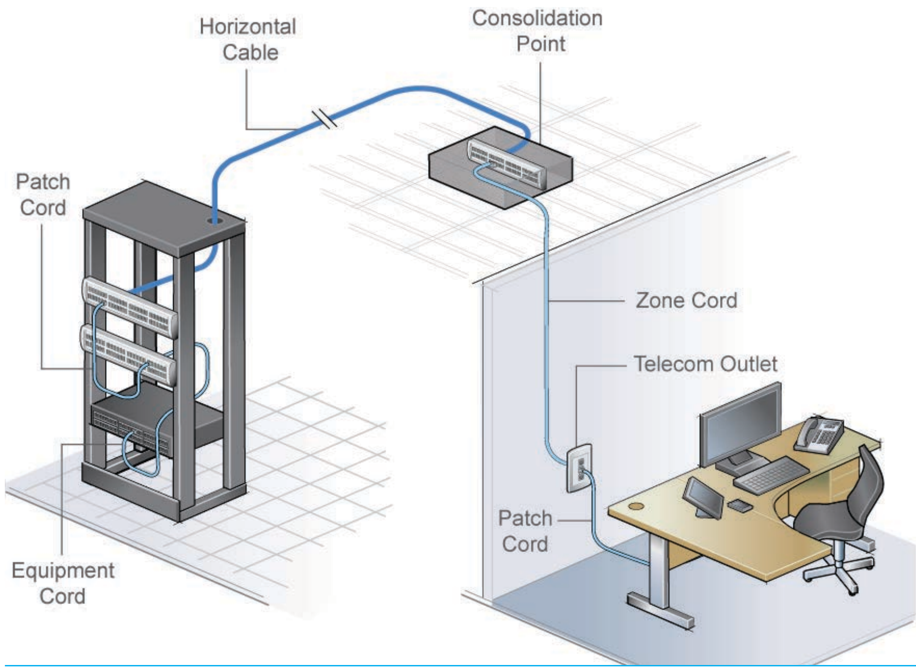
What is…
Zone cabling?

It's an approach to horizontal cabling based on coverage zones rather than end points or specific devices. It enhances flexibility and reduces total cost of ownership over its lifecycle.

THE FREEDOM TO MOVE, ADD AND CHANGE

Whether built into new construction or installed in a retrofit application, UCG's uniform approach to infrastructure means that moving, adding or changing connection points is simple and straightforward. Modifications can be made without extensive material or labor costs while minimizing productivity-reducing disruptions.

From TR to CP to TO



Zone cabling relies on a hierarchy of infrastructure to connect the telecommunications room (TR) to each zone's consolidation point (CP), which acts as an intermediary between the core network and the telecommunications outlet (TO).

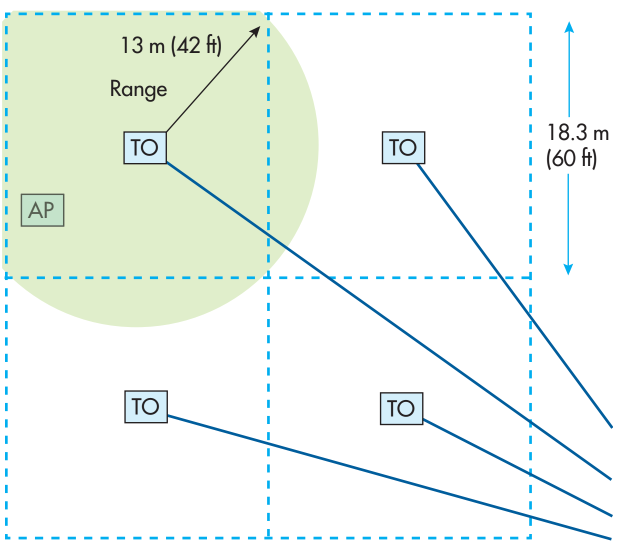
IMPLEMENTATION RECOMMENDATIONS

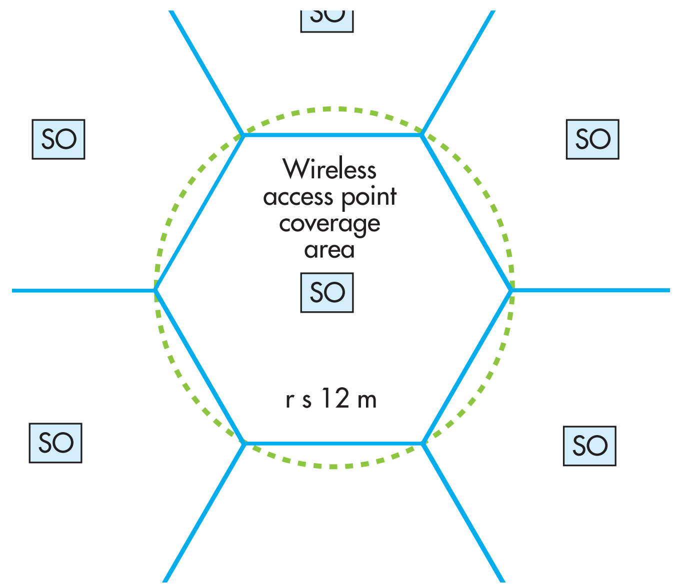
To ensure the UCG provides both connectivity and efficiency, consider several important design and deployment guidelines.

Maximum cell size

TIA-162-A grid recommendations specify cells no larger than 60 feet by 60 feet (18.3 meters by 18.3 meters).

ISO/IEC TR 24704 provides similar dimensions for hexagonal cells, specifying a radius of 12 meters or less.





IMPLEMENTATION RECOMMENDATIONS

Spacing and connection counts

Cells should be evenly spaced to support easy deployment of connected devices.

The number of cable drops in each cell depends on the applications supported and the size of the cell.

Applications	Ports Per Endpoint	Notes/Additional Considerations	Ports Per Cell
Work Station	Two ports per desk	Assumes 36 workstations per 60 foot x 60 foot cell	72 ports
Wi-Fi	Two ports per WAP	Plan for two access points per cell to accommodate future capacity increases	Four ports
In-building wireless	Two ports per AP	Plan one spare port to accommodate future needs	Two ports
Paging and sound masking	One to four ports per system	System architectures vary. Reference manufacturer's requirements	One to four ports
Low-voltage lighting with integrated occupancy sensors	One port per fixture and wall switch	Assumes 9.5 foot ceiling height with connections for wall switches or sensors in common areas	40-48 ports
Occupancy sensors	One port per sensor	Plan one sensor per desk, with additional sensors in hallways and other common areas spaced roughly 10 feet to 15 feet apart	36-48 ports

IMPLEMENTATION RECOMMENDATIONS

Cabling choice

While several kinds of cable may support current applications and demand, Category 6A cable is recommended to ensure ongoing support for evolving bandwidth and power requirements.

Additional resources:

Guide: The CommScope UCG Design Guide

Brochure: CommScope Universal Connectivity Grid

BEST PRACTICE

#4 AUTOMATED INFRASTRUCTURE MANAGEMENT

AUTOMATING FOR EFFICIENCY

THE EMERGENCE OF INTELLIGENT BUILDING SYSTEMS MEANS MORE DEVICES AND APPLICATIONS ARE INTEGRATED WITHIN THE SAME ENTERPRISE NETWORK.

Automated Infrastructure Management (AIM) is a combined hardware/software solution that manages and enhances operational efficiency for each system it touches.

What is…

Automated Infrastructure Management (AIM)?

An integrated hardware and software system that automatically detects the insertion or removal of cords. It also documents the cabling infrastructure, including connected equipment, enabling infrastructure management and data exchange with other systems.

KEEPING TRACK OF EVERY MOVE, CHANGE AND ALERT

AIM systems are particularly useful in keeping track of what's going on across the environment. AIM monitors and records changes to device connections and automatically generates alarms to alert staff to any unauthorized or problematic events—usually by sending an email or text message to the appropriate personnel.

ANSWERING THE HELP DESK CALL

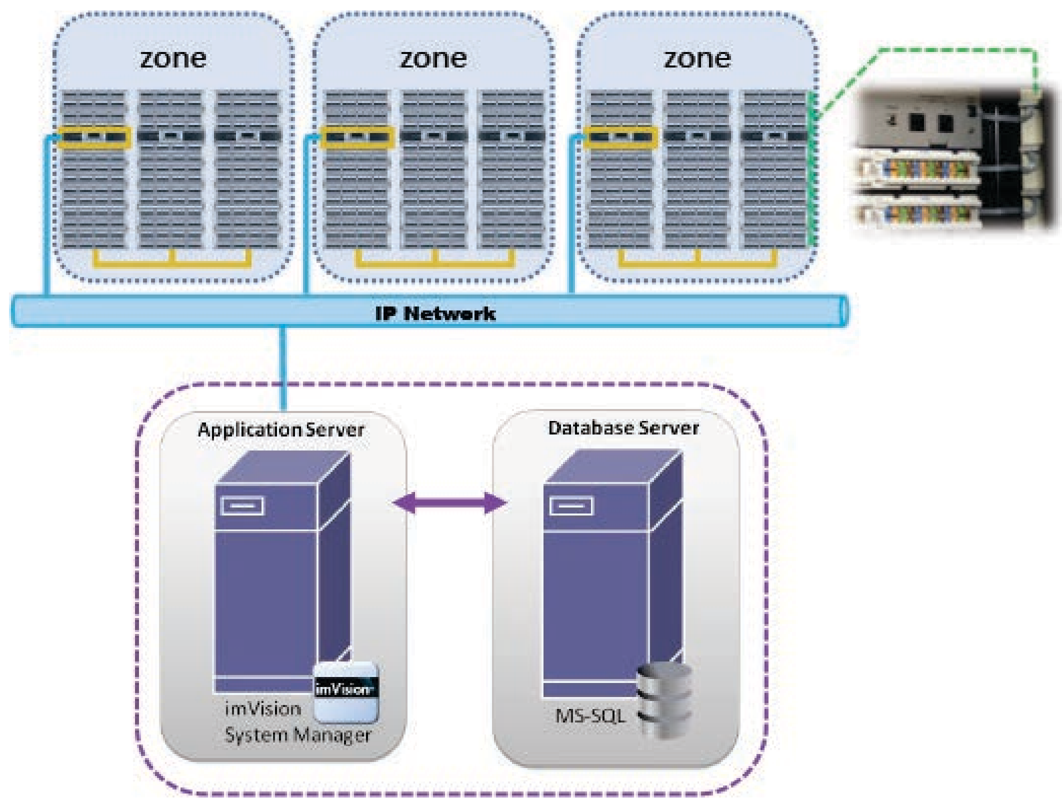
AIM is vital in "help desk" applications that handle user incidents:

- AIM tracks the request process cycle from the opening of a trouble ticket to its resolution
- It also provides critical physical connectivity information to assist in troubleshooting

CONTROLLING CAPEX

In addition to reducing operational expenses, deferring capital expenditures (CapEx) for as long as possible is a top priority for every enterprise. Because AIM identifies and tracks the physical location of each networked device, it can also reveal underutilized resources that may have otherwise been missed—preventing unnecessary investment in additional resources.

Solution Architecture



AIM Architecture

IMPLEMENTATION RECOMMENDATIONS

The realization of AIM benefits depends on understanding the systems to be managed. To ensure proper implementation, it is necessary to work with an AIM-accredited partner who follows these practices:

Design and specification

Define the business, operational and system requirements:

- List of features to be enabled
- Naming conventions
- Define system backup and failover mechanisms
- Reports to be configured
- Requirements for integration with external applications (if any)
- AIM hardware configuration, including recommendation for using cross-connect topology

Installation

- Configure AIM software with customer-specific information
- Activate AIM hardware by powering and synchronizing it with AIM software
- Implement patch connections after activation of AIM hardware
- Conduct user acceptance tests

Operation

The AIM system shall be configured, tested and operational on the day the customer takes ownership.

- Identify user groups and provide training based on each user role
- Integrate AIM system into the existing operational work flow
- Get an official sign-off form that acknowledges system's handover to the customer

Additional resources:

Standards: ISO/IEC AIM Document (18598/DIS draft)

Standards: TIA 606-B standard

Standards: ISO/IEC 14763-2

BEST PRACTICE

#5 POWER OVER ETHERNET

MAKING POWERFUL CONNECTIONS

THE EVOLUTION OF POWER OVER ETHERNET (POE) TRACKS CLOSELY WITH THE EVOLUTION OF THE DEVICES REQUIRING IT.

In 2003, PoE-compliant switches delivered just over 15 watts of power—enough for VoIP phones or security cameras. The newest standard will provide up to 90 watts of power—intelligently detecting and automatically scaling to meet the device's demand.

Clearly, 90 watts is enough to power a great number of different devices. The ability to connect those devices without separate electrical power cable runs—and the expensive licensed electricians those require—is a boon to enterprise environments, removing many obstacles to optimal device placement and reducing deployment costs by as much as 50 percent.

What is…

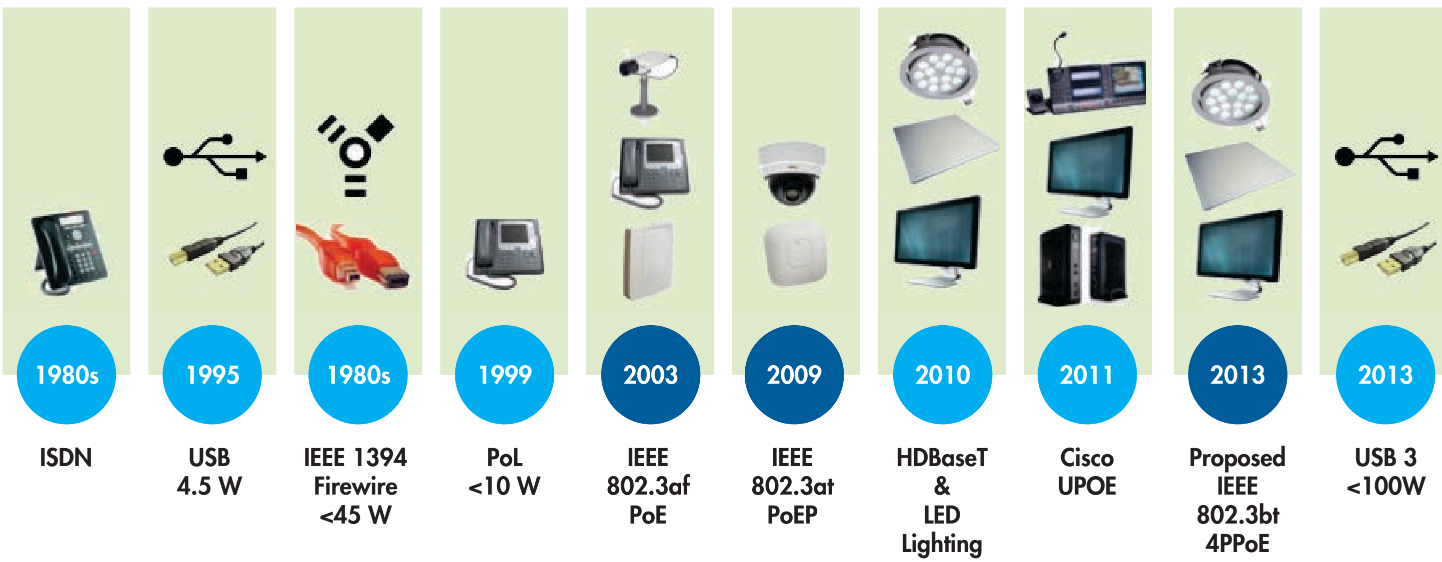
Power over Ethernet (PoE)?

PoE is the ability to provide both low-voltage electrical power and Ethernet connectivity to remote devices over a single cable.

FOUR-PAIR POE (4PPOE)

The current draft standard's designation is IEEE P802.3bt DTE Power via MDI over 4-pair, but we refer to it more simply as four-pair PoE (4PPoE). This indicates the number of wire pairs in the cable used for power delivery.

4PPoE operation depends on specific structured cabling types and installation to function. It also supports power scaling between switches and powered devices, but requires high-quality cabling to do so. Power scaling—including the ability to regulate and completely shut down power to inactive devices—optimizes power delivery and is environmentally friendly because it reduces total power consumption.



The Evolution of Remote Powering

PoE devices: More power, more possibilities

As the capacity for power transmission grows, so does the list of devices and applications PoE supports:

- VoIP phones
- Security cameras
- Wi-Fi access points
- Work stations
- Teleconferencing
- Retail POS terminals
- Industrial sensors
- Digital signage

IMPLEMENTATION RECOMMENDATIONS

PoE offers incredible potential, but also presents certain restrictions that impact how a network is designed and deployed.

Thermal loading and bundling

More current means more heat—and that limits the number of cable runs allowed in a single bundle.

Based on extensive modeling and measurement work done during the development of CENELEC TR 50174-99-01 and TIA TSB 184-A, the recommended bundle size is 24 cables.

Build for future demand

To stay ahead of PoE device demand, it's recommended that Category 6A cabling be used.

To ensure both capacity and reliability, it's also recommended that two Category 6A cable runs be installed per connected device, ensuring it will be connected to two zone distributors instead of one.

Automate the intelligence

As we explored in Chapter 4, automatic infrastructure management (AIM) is vital to an intelligently-managed system like PoE.

By enforcing policies like how many cables in a bundle are powered, an AIM solution can reduce operational costs and ensure optimal PoE performance.

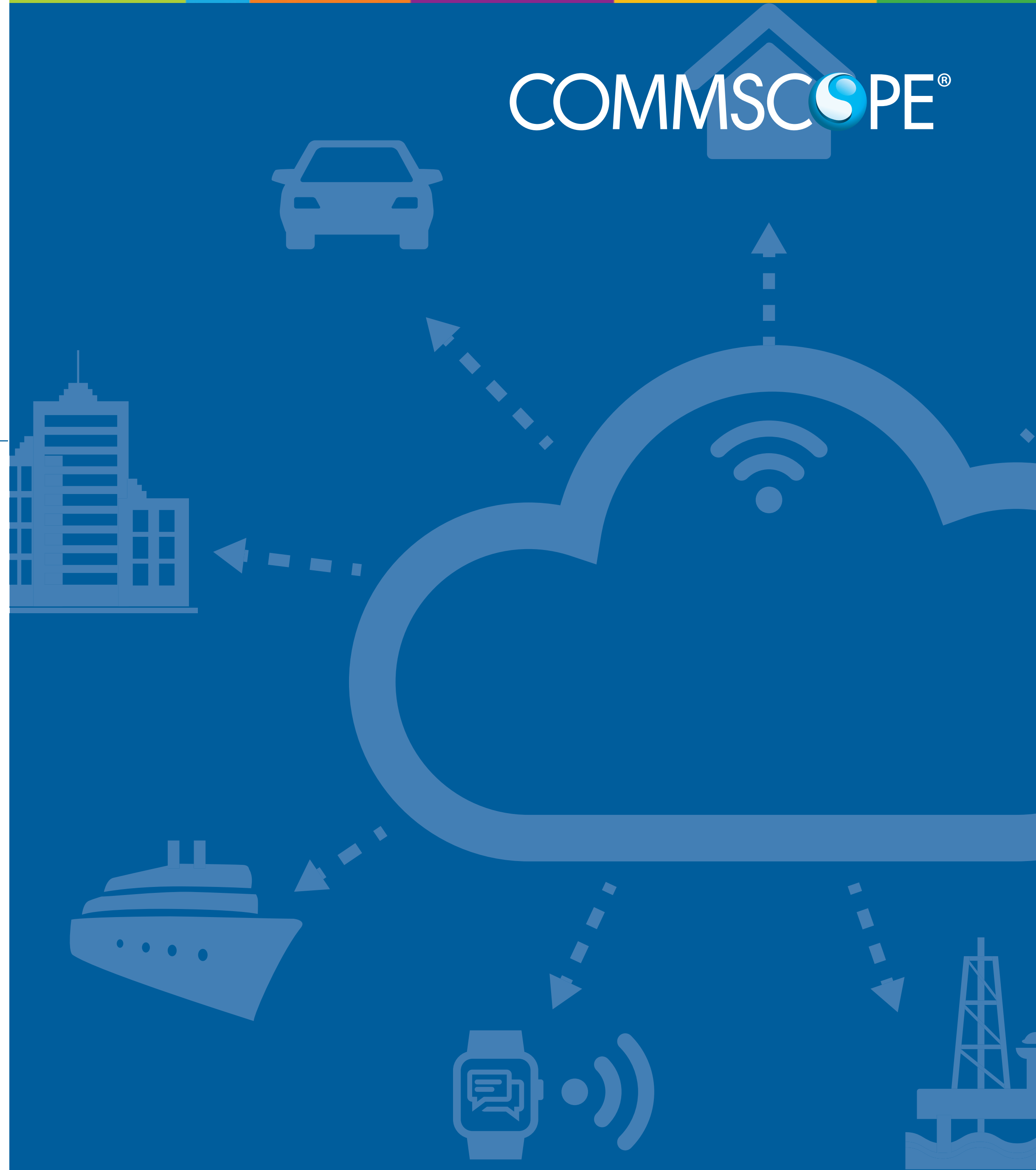
Additional resources:

Blog: Power over Ethernet: A New Strategy for Connected Devices, by Masood Shariff

White paper: Laying the Groundwork for a New Level of Power over Ethernet

BEST PRACTICE

#6 AUDIO/VISUAL AND HDBASET



EXTENDING THE REACH OF AUDIO/VISUAL DEVICES

HIGH-DEFINITION VIDEO SCREENS ARE BECOMING MORE AND MORE COMMONPLACE IN ENTERPRISE AND COMMERCIAL ENVIRONMENTS.

You see them everywhere: in transportation hubs, retail stores, malls, hotels, conference centers and elsewhere. They're a great way to communicate important information, provide an interactive context, and enhance employee productivity and comfort.

One might assume these screens are getting their signals via HDMI or other ordinary A/V cables like a home screen typically does, but the fact is that reliable HDMI connectivity is limited to just 12 or 15 meters of cable length. HDBaseT, on the other hand, can carry high-definition audio and video over a 100-meter structured cabling channel.

What is…

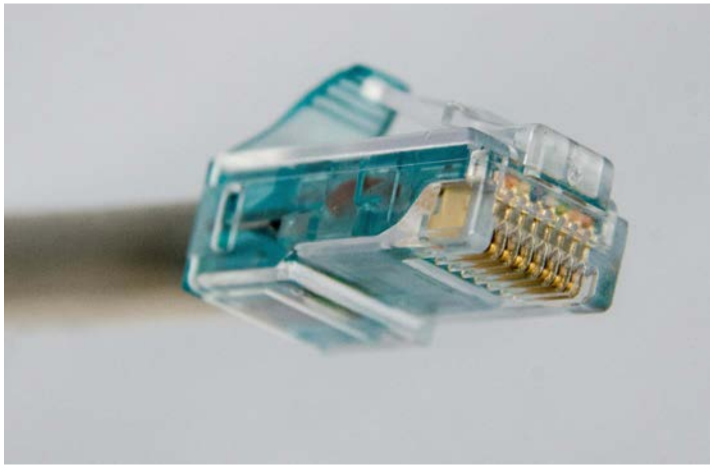
HDBaseT?

It's a point-to-point connection protocol used to distribute high-definition A/V signals, control signals, and power over standard Category 6 or 6A structured cabling through the ubiquitous RJ45 network connector.

A UNIVERSAL INTERFACE

HDBaseT is also gaining popularity for its connection interface. Because it runs on IT infrastructure with the trusted, universal RJ45 connector, HDBaseT doesn't require expensive legacy cables with proprietary connectors, such as HDMI, DVI, VGA, coaxial, RCA or other conventional A/V cables have.

The flexibility and bandwidth available with HDBaseT is the reason it is being standardized by the IEEE under IEEE 1911, which will only accelerate its adoption in the market.



The single-cable solution

HDBaseT allows one Category 6A cable to support transmission of:

- Uncompressed ultra-HD video and audio, including 4K
- 100BASE-TX Ethernet
- Device control
- Power over HDBaseT (PoH), up to 100 watts of dc power

IMPLEMENTATION RECOMMENDATIONS

Flexible and powerful, HDBaseT offers incredible simplicity and functionality for an efficient and connected enterprise or commercial space. Nevertheless, optimizing your HDBaseT solution depends in large part on solution selection and installation practices.

Choose Category 6A

HDBaseT is sensitive to alien crosstalk. While HDBaseT can theoretically run on lesser cabling standards—even Category 5—Category 6A exhibits the alien crosstalk performance specified in TIA and ISO standards.

This means it can support bundling and cable tray installation practices typical in commercial buildings—making it the recommended choice.

Watch the thermal loading

HDBaseT can deliver up to 100 watts by powering all four pairs within the cable.

While this supports connectivity and power over the same cable, it comes with the additional thermal loads described in Chapter 5.

Cabling choice

For optimal performance, use cables certified by the HDBaseT Alliance.

It's also important to know which vendors support only the use of shielded cabling with their equipment, since that will impact other purchasing decisions.

Additional resources:
White paper: Implementation Considerations for HDBaseT Networks

BEST PRACTICE

#7 WIRELESS AS THE NEXT UTILITY

THE WIRELESS EXPECTATION

THESE DAYS, WIRELESS CONNECTIVITY IS A UNIVERSAL EXPECTATION.

Workers don't care whether their wireless connection is via the Wi-Fi network or a cellular network—they just want connectivity and performance.

Since most enterprises need to provide both types of wireless technologies, their infrastructure must accommodate both.

What is…

Wireless as the next utility?

It is the seamless availability of wireless connectivity throughout a building—making it as ubiquitous and reliable as other established utilities.

WI-FI

Wi-Fi cabling infrastructure has established guidelines (TIA TSB 162-A and ISO/IEC TR 24704) defining a grid network to place outlets for potential Wi-Fi access points, as shown in Chapter 3. As Wi-Fi standards evolve to higher throughputs, the cabling that connects Wi-Fi access points to switches must support higher backbone speeds, including 2.5 Gbps, 5 Gbps and, ultimately, 10 Gbps.

IN BUILDING WIRELESS (IBW)

Unlike Wi-Fi, IBW uses licensed frequency bands, so great care must be taken to ensure the system will support all wireless operators used by the facility's occupants.

IBW systems may also support different wireless technologies and virtually any frequency bands—including vital public safety bands. In some jurisdictions, supporting public safety bands is a prerequisite to obtaining an occupancy license.

CONNECTING IBW TO IT CONVERGENCE

Recent innovations have yielded IBW solutions that employ ordinary Category 6A cable instead of expensive coaxial cable. This greatly streamlines installations and increases its possible applications—as well as simplifying expansion as needed. Likewise, its headend operates like a conventional IT server and switch. For all these reasons, this evolution is called IT convergence.

Why include IBW?

It all comes down to the numbers.

- 80 percent of mobile calls terminate indoors
- 2 percent of commercial spaces have IBW solutions
- 75 percent of callers have had to hunt for good reception

IMPLEMENTATION RECOMMENDATIONS

While there are multiple ways to deploy a wireless infrastructure in buildings, the global trend is tilting toward an IT-convergent infrastructure that accommodates Wi-Fi and IBW. Here's how you can ensure peak performance:

Plan ahead with UCG

A pre-cabled grid such as the UCG discussed in Chapter 3 helps simplify wireless deployment, additions and expansions as needs change.

- Define a grid layout based on TIA-162-A or ISO/IEC24707
- Install two Category 6A cables per cell for Wi-Fi
- Install two additional Category 6A cables per cell for IBW and a spare

Cover all the bases

A modern IBW solution should be technology-agnostic; that is, it should operate with all operators, all networks and all frequencies—including public safety frequencies.

This prevents the need to overlay multiple operator-specific networks because of changing needs or circumstances.

Cabling choice

Category 6A is recommended for horizontal runs because of its ease of installation and support for 10G backhaul.

An OM4 backbone capable of migrating to 40G and 100G is recommended for vertical cable runs to aggregate 10 Gbps horizontal links.

Additional resources:

Infographic: Wireless in the office

White paper: Laying the groundwork for a new level of wireless access performance

BEST PRACTICE

#8 LOW-VOLTAGE LIGHTING CONTROL

EFFICIENT NEW OPTIONS COME TO THE FOREFRONT

LIGHTING CONTROL SYSTEMS AVAILABLE TODAY ARE TYPICALLY OVERLAY SYSTEMS; THAT IS, THEY ENHANCE RATHER THAN REPLACE EXISTING ENTERPRISE AC ELECTRICAL INFRASTRUCTURE.

While they can deliver lower energy costs, they are limited by the standard voltage of ac line power.

Low-voltage lighting control systems, on the other hand, use low-voltage dc current to power networks of LED lights. It is comparatively much less expensive to install and operate than conventional line-voltage lighting options. In addition, its network connectivity allows the integration of several other important features.

What is…

Low-voltage lighting?

High-efficiency LED lighting designed to operate on low-voltage dc current instead of conventional ac line voltage.

GAINING ENLIGHTENMENT FROM THE LIGHTS

These LED fixtures can also provide building intelligence because networked sensors can be integrated to measure occupancy, temperature, humidity or other factors an intelligent building needs to know in order to operate efficiently.

It's this added intelligence that allows the LED lights to deliver more granular, responsive, real-time control over lighting levels—all without the expense and disruption of a licensed electrician running line voltage throughout the enterprise space.

Lighting Controls System	Topology	Attributes
Wireless Overlay	Wireless control network manually connected to independent ac line volatge power infrastructure	• Required licensed electrician • Costs more to install/recommission than low-voltage wired system • Subject to radio interference, latency and bandwidth contention • Minimal install bas limited to smaller scale deployments
Wired Overlay	Wired control network manually connected to independent ac line volatge power infrastructure	• Required licensed electrician • Costs more to install/recommission than low-voltage wired system • No radio interference, latency or bandwidth contention
Low-Voltage Wired	Wired control network integrated with low-voltage dc power infrastructure	• Enables simple, low-cost install using low-cost wiring • No radio intereference, latency or bandwidth contention • Scalable for mission-critical performance across enterprise • Measured energy savings • Centralized driver enables improved thermal management • Average energy savings of 75 percent compared to flourescent options

IMPLEMENTATION RECOMMENDATIONS

Low-voltage lighting is all about efficiency and cost reduction. To help it deliver its full potential, consider how you plan your infrastructure.

Significant energy savings

Moving from traditional lighting to an LED lighting system running on low-voltage cabling can significantly reduce energy costs. Case studies have shown savings of 75 percent or more over traditional methods.

Combine control and power

One wired infrastructure can carry control and power, and eliminate the many hassles associated with wireless controller deployments, such as:

- Interference and bandwidth competition from other equipment and signals in the area
- Maintenance costs resulting from battery replacements
- Reduced reliability due to control signals becoming corrupted and instructions not understood

Use real-time data to cut costs

Because LED lighting fixtures can be fitted with any number of sensors, they can automatically detect occupancy and light levels in real time and respond accordingly.

Rules can be set establishing how long a room must be empty before the lighting adjusts.

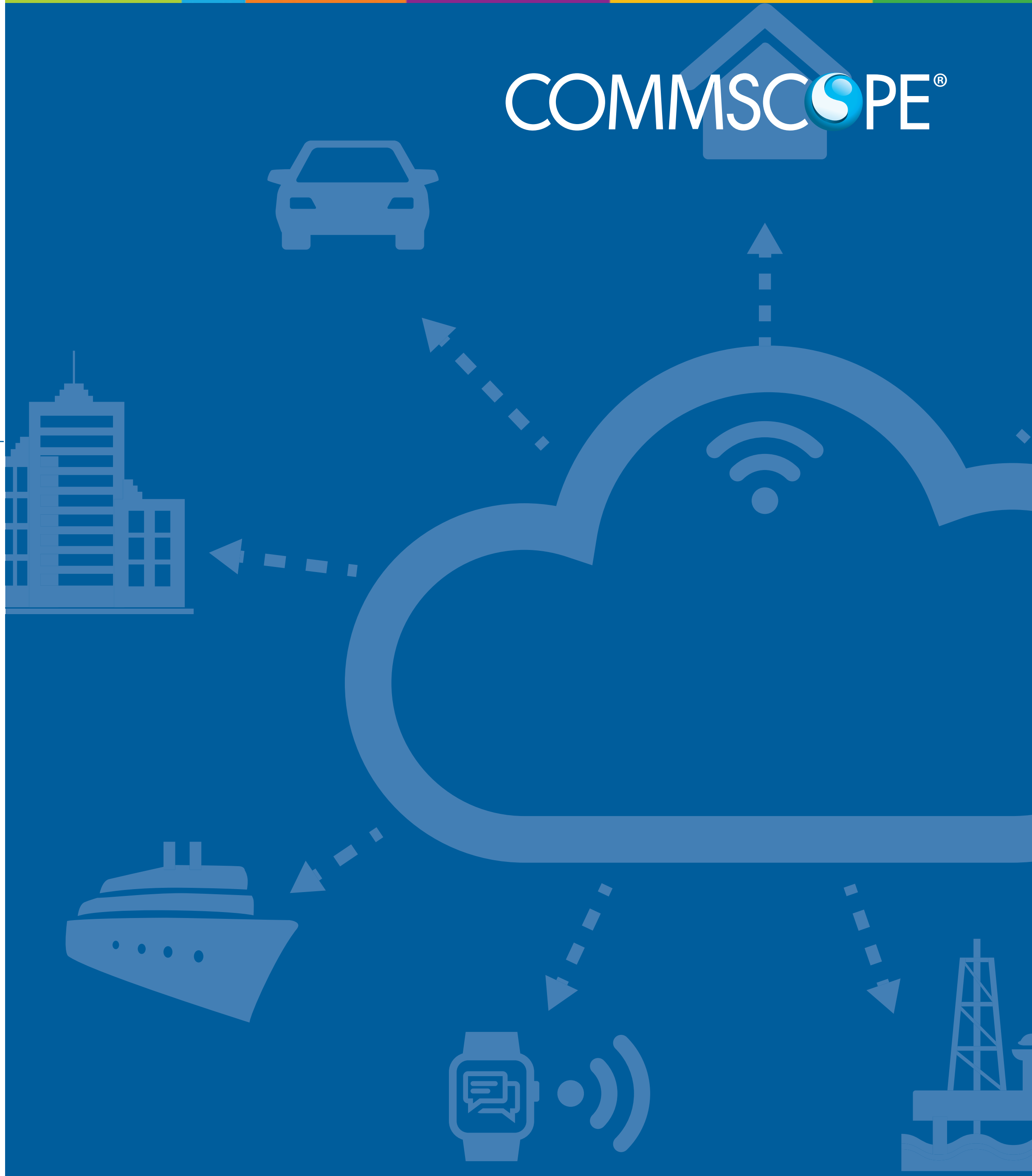
CommScope studies reveal that LED deployments can reduce energy used for lighting by as much as 75 percent.

Additional resources:

White paper: Enhancing building performance with an intelligent lighting network solution

BEST PRACTICE

#9 SPACE UTILIZATION



KEEPING TRACK OF A MOBILE WORKFORCE

THE FULL COST OF A WORKSPACE IN MAJOR METROPOLITAN AREAS SUCH AS LONDON AND SINGAPORE CAN EXCEED $15,000 PER YEAR.

This cost makes it vital that each workspace is fully utilized—but the problem lies in measuring that utilization.

Workspaces are evolving. Wireless technology makes it almost effortless for employees to work from anywhere in the building—or even far outside of it. How can space utilization be measured, both historically and in real time? The answer is a high-density sensor network

What is…

Space utilization?

Employing a high-density, ubiquitous sensor network to inform building systems of where and how people work—so those systems can operate efficiently and effectively.

UBIQUITOUS SENSORS AND AMBIGUOUS DETAIL

The ability to deploy a ubiquitous network of sensors throughout a building makes it possible to collect information about occupancy, light levels, temperature, humidity or other key measurements that can inform a more efficient operational strategy. The building learns and adjusts to accommodate exhibited behavior. To gain that insight, collected information can be extremely detailed and granular; yet, it can also be nonpersonal so as not to invade individual privacy.

A sensor network should offer integration capabilities with an open API. As open APIs allow for greater and greater integration of building systems, the boundaries between IT, building facilities and corporate real estate begin to blur. Enterprise environments gain deeper insights into their own operation and can therefore enhance system efficiency, improve space utilization, and decrease maintenance costs.

Open APIs offer better connectivity

Application Program Interfaces (APIs) are the mechanisms by which different devices communicate with each other.

Open APIs offer the best interoperability, since proprietary APIs may restrict deployments to a specific vendor's products—not a very efficient way to go.

IMPLEMENTATION RECOMMENDATIONS

There's immense variety in how occupancy data can be captured and how it can be used. Depending on the specific application, here are some factors to consider.

Powering the sensor network

Low-voltage power allows for data and power connectivity in a single network cable. There are several advantages to this capability:

- Improved scalability and flexibility in sensor placement
- Reduced maintenance costs due to the lack of ballasts and batteries
- Battery-powered sensors economize by using less power; cabled sensors can operate at higher power levels

Coverage and placement

The type and location of sensor placement will depend on what is being measured.

A single sensor network can include "coarse grain" sensors that measure entire areas as well as "fine-grain" options that collect data from a specific desk.

The real-time acquisition of this data can yield more efficient operation than schedule- or policies-based automation.

Scaling to the environment

How levels are measured will depend in large part on the size and typical use of that specific area.

Ensure that the sensors can scale to meet expected purposes regarding the size of the area being monitored, as well as to the building functions that will be affected by different occupancy levels.

BEST PRACTICE

#10 BUILDING INFORMATION MODELING

COMMSCOPE®

PLANNING A SMARTER BUILDING FROM THE GROUND UP

THE CONSTRUCTION OF ANY NEW COMMERCIAL STRUCTURE IS A COMPLICATED UNDERTAKING.

More than ever, the systems and controls of various building functions and applications are intertwined. At the same time, there are significant financial and regulatory pressures to create the most efficient building possible, with the smallest carbon footprint.

Enter building information modeling (BIM). BIM's unified, three-dimensional model of the completed building can simulate its entire lifecycle. BIM is estimated to reduce construction costs by 20 percent and total costs by up to 33 percent over the life of the building.

What is…

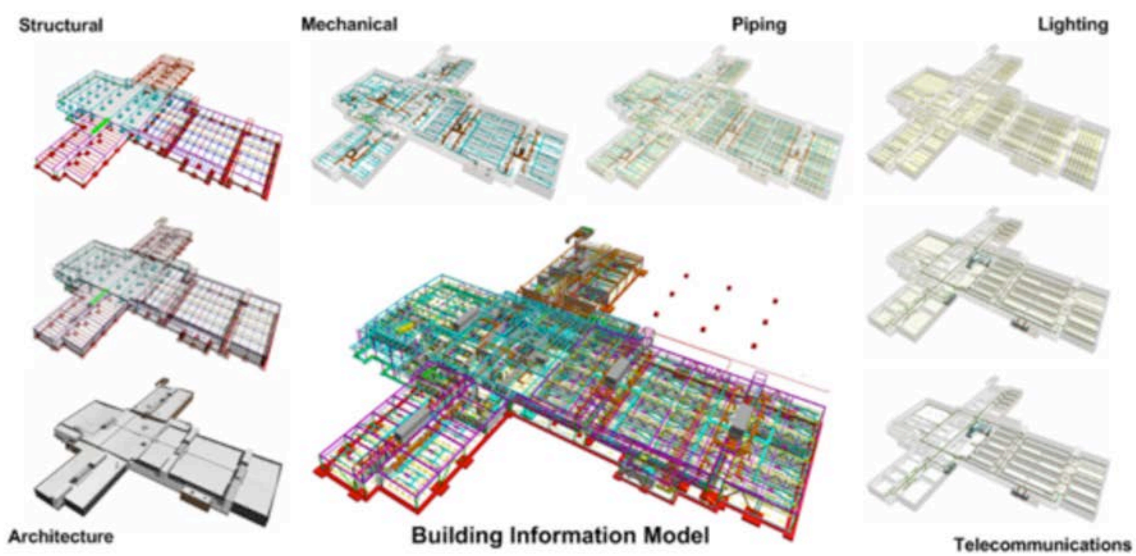
Building information modeling (BIM)?

A business process for generating, leveraging and managing building data to design, construct and operate the building during its lifecycle in order to optimize efficiency and sustainability.

A COMPLETE PICTURE

Typically, BIM software models five main systems: architectural, structural, mechanical, electrical and plumbing. Unlike a simple 3D CAD drawing of overlaid systems, BIM also integrates time and cost, overlaying construction schedules and deployment/operation costs.

What is often missing from these models is the network infrastructure. As more and more building services are connected via network cabling, it becomes more important to figure the network infrastructure into BIM models.



Building Information Model

COBie: how information is shared

Construction Operations Building Information Exchange (COBie) is a specification defining how BIM data is stored and shared between the many parties involved in the construction and operation of the building. COBie is also a checking tool to ensure that efficiency and carbon targets are met.

The current specification, COBie-UK-2012, is part of British Standard BS 1192-4 and may be adopted as an ISO standard as well.

IMPLEMENTATION RECOMMENDATIONS

A useful and powerful tool, BIM is rapidly becoming a mandatory requirement in the United Kingdom, United States and other regions of the world. We strongly recommend that you become familiar with it.

Get to the next level

BIM model complexity is defined by levels ranging from 0 to 3.

Level 0: Simple CAD drawings—now considered obsolete

Level 1: 2D and 3D drawings—currently the most common approach

Level 2: Modeling includes time and cost factors—rapidly becoming the new standard

Level 3: Integrated BIM allows modeling against carbon targets—expected to be implemented in the UK by 2025

IT matters

Intelligent buildings consolidate many key functions into standard network infrastructure, so inclusion in BIM models is becoming essential.

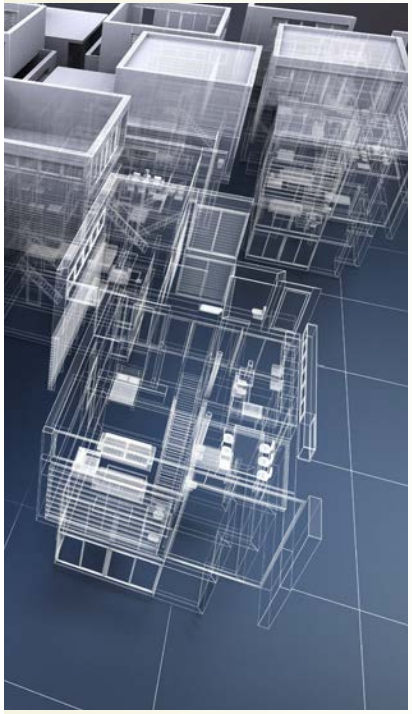
- New PoE standards introduce more stringent thermal loading standards governing space and number of cables per bundle
- Universal sensor networks that coordinate with intelligent building functions (lights, HVAC and so forth) must have ubiquitous access
- Ideally, UCG should be planned into the construction phase to reduce cost and avoid disruption

Sharing and securing BIM data

To remain accessible to the many parties involved in construction, BIM data is often stored in the cloud, introducing security concerns.

Security depends on the energetic applications of cyber-security policies and awareness efforts, along with robust technical processes to resolve any perceived threat.

The UK Institution of Engineering and Technology (IET) publishes guidelines on security of BIM data and the UK British Standard Institute is developing a standard for BMI security under BS 1192-5.



Additional resources:

Video: BIM video

White paper: BIM Whitepaper

BEST PRACTICE

#11 SAFETY AND SECURITY

THE IMPORTANCE OF A SAFE BUILDING

SAFETY AND SECURITY ARE TWO VITAL BENEFITS OF A CONNECTED AND EFFICIENT BUILDING.

Proper planning can help designers ensure against worst-case safety scenarios and help emergency services personnel do their jobs more effectively in case of an emergency that threatens occupant safety. As such, in-building wireless systems must be able to support emergency service frequency bands. Similarly, local building codes around the placement of fire alarms, emergency lighting, and fire performance of cabling infrastructure must be obeyed.

A secondary consideration is the asset value of a modern intelligent building. Such a construction may require the expenditure of millions—or even billions—of dollars; thus, any measures that can reduce the risk or extent of damage are certainly worth serious consideration.

SECURING THE NETWORK AS WELL AS THE BUILDING

Protecting a building against disaster is one thing, but there are more deliberate threats to the security of the building's networks. These fall into two broad categories:

- **Unauthorized access by an unauthorized person.** This can be prevented via physical security, including IP cameras, access controls and occupancy sensors. For remote intrusions, firewalls can provide protection against unauthorized access.
- **Unauthorized access by an authorized person.** This can be more difficult to combat, as physical security is less effective against an employee with bad intent. Here, AIM is an invaluable tool as it allows immediate and automatic detection of any newly-added rogue access points or unauthorized devices, including their physical location.

AIM: a network's watchful automatic eye

Unauthorized network access can lead to loss or theft of valuable information. AIM systems provide constant monitoring of the physical layer and provide alerts in the event of an unscheduled change.

IMPLEMENTATION RECOMMENDATIONS

Effective safety and security are products of smart decisions made elsewhere in the process of designing, constructing and managing a connected and efficient building. For this reason, it touches many of the topics covered in this book.

In-building wireless

An intelligent in-building wireless solution carries cellular network traffic, including frequencies reserved for use by emergency services personnel like TETRA, which is used by fire, police and paramedics in parts of the world.

Unfettered access to clear communications while inside the building can help these personnel save lives—and protect their own.

Security monitoring and sensors

The ubiquitous sensor networks and PoE-driven IP security cameras present in intelligent buildings are a critical defense against intruders.

At the same time, occupancy sensors can help emergency services personnel locate trapped or endangered workers inside the building, and IP-powered paging can help direct occupants to safety.

Fire safety

Selection of cable with suitable flammability ratings and the deployment of emergency lighting can also minimize the likelihood or consequences of fire.

Standards

The draft standard ANSI/TIA 5017 Physical Network Security Standard addresses physical infrastructure security as well as providing an integrated approach to security

Additional resources:
Blog: The Three S's to Planning a Smart Building, by Philip Sorrells

BEST PRACTICE

#12 STANDARDS

KEEPING YOUR OPTIONS (AND YOUR ARCHITECTURE) OPEN

A CONNECTED AND EFFICIENT BUILDING IS ONE WHERE ALL SYSTEMS COMMUNICATE FREELY, ACCURATELY AND SECURELY ON A UNIFIED NETWORK INFRASTRUCTURE.

Published industry standards make possible an open architecture that does not limit the enterprise manager to working with specific vendors or technologies, as proprietary specifications often do.

What is…

The reason for standards?

Standards define minimum requirements for the conception, development, installation, testing and operation of advanced networking solutions in buildings.

COMBINING SYSTEMS SOMETIMES MEANS COMBINING RULEBOOKS

Standards are important not merely because they directly inform specific solutions, but also because they influence broader technologies, solutions and standards.

For instance, ISO/IEC standards for channel performance are written to dovetail with IEC standards governing the components used in those channels. If these two sets of specifications were not coordinated, the solution may not perform to expectations—or, indeed, at all. More importantly, channel performance specifications are written in collaboration with applications standards groups such as IEEE. This ensures that the overall system performance is maximized, while supporting legacy and future applications and reducing total cost of ownership.

Seamless handoffs between technologies and specializations are only possible by adopting and adhering to published standards.

Standards change constantly.

How can you stay up to date?

Standards organizations are independent groups comprising some of the industry's best minds, including key experts from leading manufacturers such as CommScope.

These manufacturers regularly update published standards on their websites as an industry service. For instance, CommScope publishes quarterly updates reflecting recent changes.

WHO ARE THE BIG NAMES IN STANDARDS?

Here are some of the most prominent and widely-respected examples, along with links to their online resources.

ISO:

International Organization for Standardization, an independent organization promoting industrial, commercial and technological standards worldwide.

IEEE:

Institute of Electrical and Electronics Engineers, a global organization drafting electronic and telecommunication standards.

TIA:

Telecommunications Industry Association, operating 12 committees publishing guidelines for RF, cellular and satellite communications and data centers, VoIP and smart building networks.

IEC:

International Electrotechnical Commission, publishing electrical and electronic standards for fiber optics, telecommunications and other fields.

INCITS:

InterNational Committee for Information Technology Standards, writing standards for many fields—from communications to cloud computing to transportation.

CENELEC:

European Committee for Electrotechnical Standardization, an organization publishing standards for wired and wireless interconnection and network technologies.

Additional resources:
Standards: Enterprise industry standards summary

CONCLUSION

COMMERCIAL BUILDINGS PLAY A CRITICAL ROLE IN OUR LIVES. THE INCREASING INTEGRATION OF INTELLIGENCE IN THOSE BUILDINGS IS DRIVING A REVOLUTION IN CONNECTIVITY AND EFFICIENCY BENEFITTING OWNERS AND OCCUPANTS.

In this book, we have covered best practices the Connected and Efficient approach to intelligent buildings. Beyond the sheer diversity of applications, systems and technologies involved, the Connected and Efficient building is constantly evolving, bringing new benefits, efficiencies and potential to life.

Because of the number of solutions and the agility with which they must be deployed, it's no surprise that commercial buildings all over the world have built networks that run on CommScope. As an industry leader with decades of expertise and ongoing innovation, we design and build the solutions that power intelligent building networks and much more—always with an eye on collaborative development, competitive cost structures, and the ever-growing demand for capacity.

We invite you to contact your CommScope representative to see how collaboration can help you build a more Connected and Efficient building.

THE CONNECTED AND EFFICIENT BUILDING

APPENDIX A: OVERVIEW OF CURRENT AND EMERGING TECHNOLOGIES

- *2.5 and 5GBASE-T*

Developments in wireless technologies are pushing horizontal bandwidth beyond 1 Gbps. The broad adoption of these technologies will have a significant impact on the adoption of faster speeds elsewhere in the horizontal and backbone network. As a result, the IEEE is currently in the process of defining 2.5 and 5 Gbps Ethernet interfaces to provide faster data rates over existing Category 5e or Category 6 infrastructure already deployed in many commercial buildings.

- *Automated Infrastructure Management (AIM)*

Integrated hardware (patch panels and controllers) and software system that automatically detects the insertion or removal of cords and also documents the cabling infrastructure, including connected equipment.

- *Power over Ethernet (PoE)*

A system to safely transmit electrical power—along with data—to remote devices over standard Category 3, 5, 5e, 6 and Category 6A cabling. PoE is designed so Ethernet data and power signals do not interfere with each other, thereby enabling simultaneous transmission without signal disruption.

- *HDBaseT*

HDBaseT is a connectivity standard for the distribution of uncompressed ultra-high-definition multimedia content, 100BaseT Ethernet, USB 2.0, up to 100 watts of power over cable, and various control signals through a single LAN cable for up to 100 meters (328 feet).

- *802.11ac*

IEEE 802.11ac is an evolution of the 802.11n wireless local area network (WLAN) standard that supports increased performance and capacity through use of frequencies in the 5 GHz band and more sophisticated modulation techniques.

- *In-Building Wireless (IBW)*

A solution that brings wireless coverage and capacity to an indoor space the macro network can't reach effectively.

CommScope (NASDAQ: COMM) helps companies around the world design, build and manage their wired and wireless networks. Our network infrastructure solutions help customers increase bandwidth; maximize existing capacity; improve network performance and availability; increase energy efficiency; and simplify technology migration. You will find our solutions in the largest buildings, venues and outdoor spaces; in data centers and buildings of all shapes, sizes and complexity; at wireless cell sites and in cable headends; and in airports, trains, and tunnels. Vital networks around the world run on CommScope solutions.

www.commscope.com

Visit our website or contact your local CommScope representative for more information.

CO-109520.1-EN (03/16)