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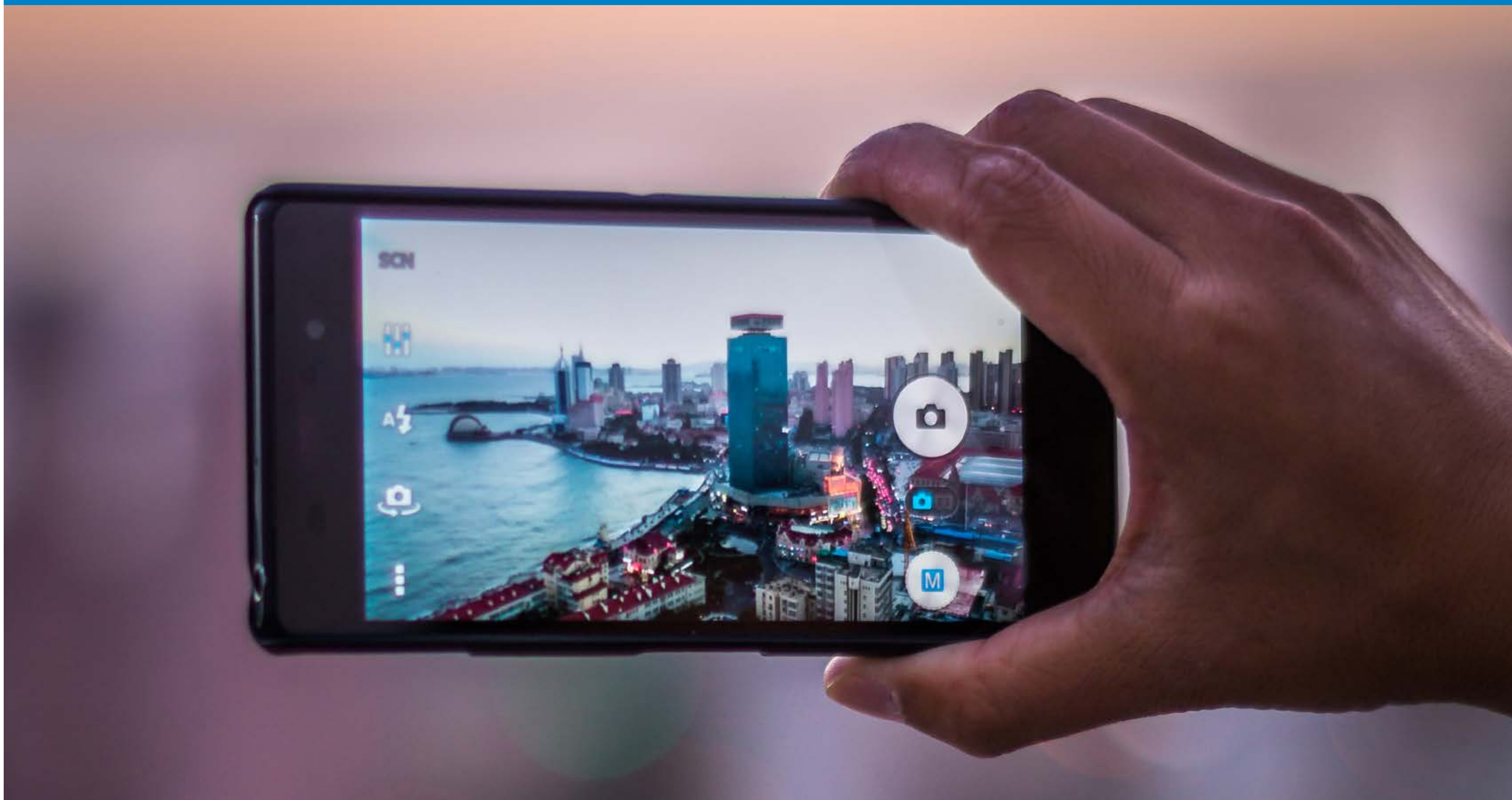
LTE BEST PRACTICES

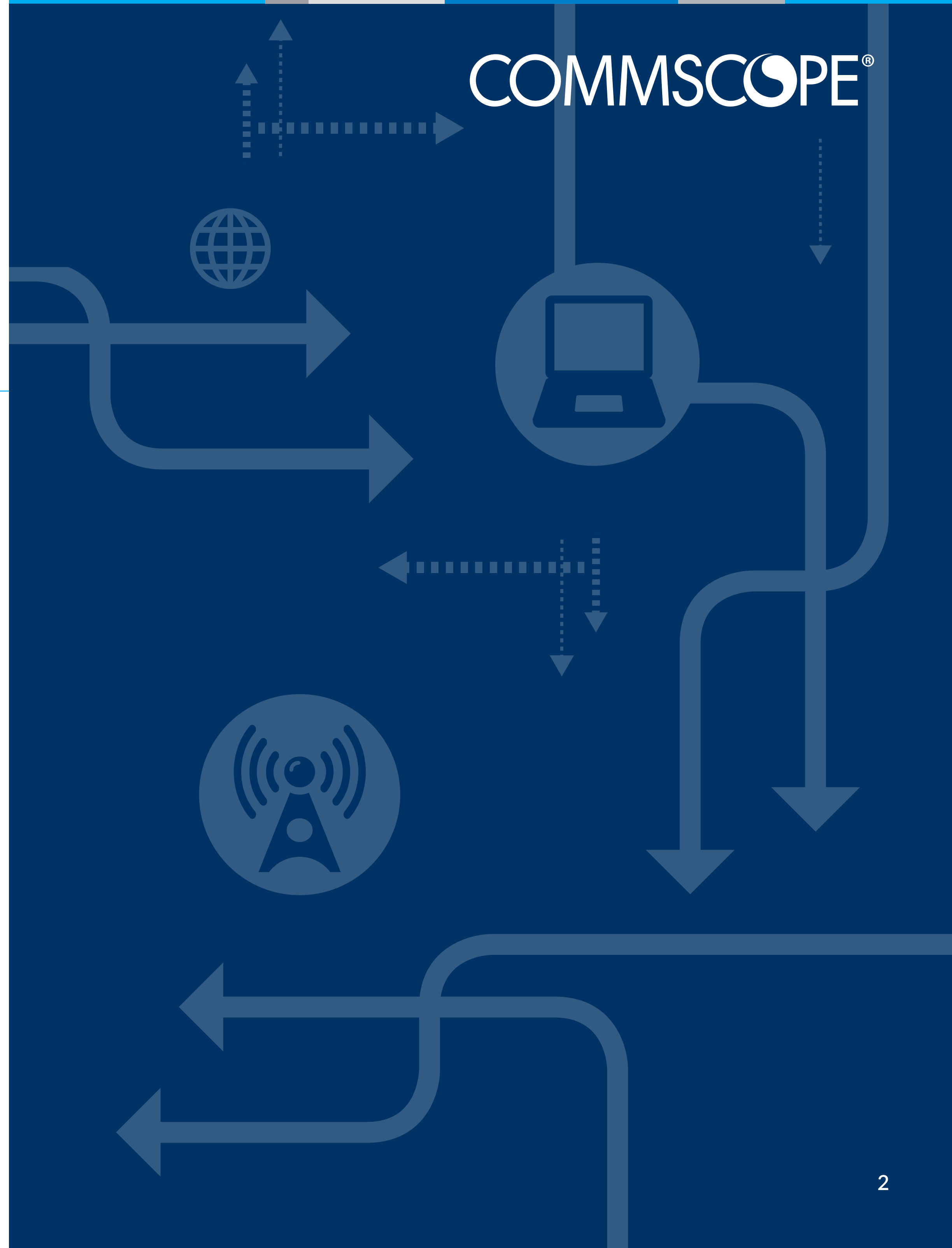


Insights to navigate the technology maze

LTE BEST PRACTICES:

Insights to navigate the technology maze

Table of Contents



LTE best practices: Authors

Click the bubble next to the author to read their bios and blogs.

Introduction: About LTE
Morgan Kurk

Noise mitigation
Erik Lilieholm

Interference mitigation
Ray Butler

Co-Siting existing technology
Rob Cameron

How to avoid PIM
Lou Meyer

FTTA implementation
Chris Stockman

Implementing DAS
Luigi Tarlazzi

Outdoor site construction
Mike Fabbri

Selecting and deploying antenna technology
Mike Wolfe

Voice over LTE (VoLTE)
Erik Lilieholm

Microwave backhaul
Donald Gardner

Fiber backhaul
Wes Oxlee

C-RAN
Pat Thompson

Indoor small cells
Joshua Adelson

Metro cell applications
Philip Sorrells

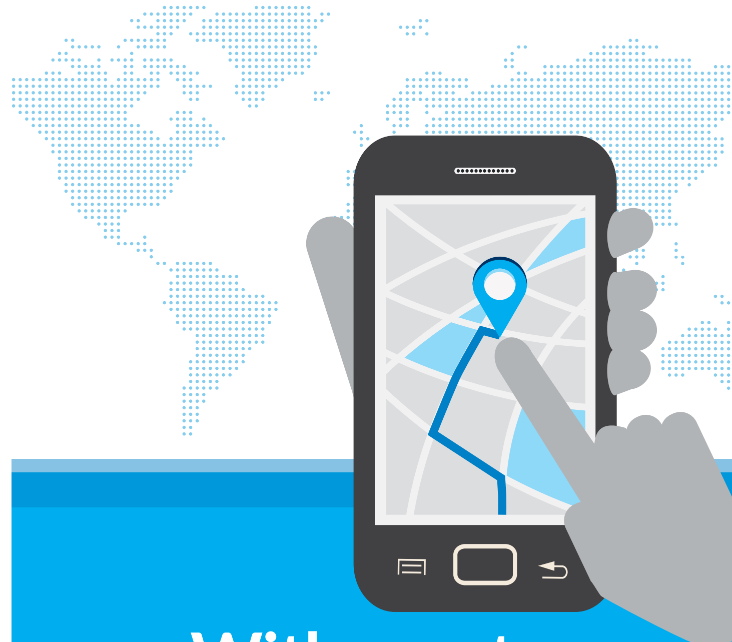
MIMO implementation
Ray Butler

LTE continues

to gain relevance—and share—in the modern wireless world

While many in Europe and North America have made LTE wireless connectivity part of their daily lives, it is surprising to see how much more potential exists for LTE in the rest of the world, and how much more potential it could have in those parts of the world where it is already an established technology.

It's anticipated that 65 percent of the world will be covered by LTE by the year 2019, and, as performance increases, so do user expectations of ubiquitous coverage and sufficient capacity. This endless demand is fueling not only the global expansion of LTE into new markets, but also the ongoing evolution of what LTE can deliver.



With great capacity comes great challenges

LTE performance far outstrips anything possible from 2G and 3G networks. However, it comes with a new—or at least more prominent—vulnerability to the effects of interference. Network complexity, tower load, and speed of deployment also have an enormous impact on LTE rollouts. For these reasons, wireless operators must take extreme care in their deployments to ensure that LTE delivers on its promise. That's what these best practices are all about.

Interference and noise

One issue that will arise in many ways in this book is that of interference. Because LTE networks (and their associated schemes LTE-A and LTE Pro) employ high-order modulation schemes, the effect of any interference is magnified and even a small amount can have performance-crippling effects. This interference may be external, in the form of neighboring sectors or channels, or even weather radar; or it may be internal, in the form of passive intermodulation (PIM) caused by moisture, improper connections or damaged cable.

Interference has been an issue since the dawn of radio frequency (RF) technology. However, as the complexity of the network increases, so does the effect of interference and noise. Levels that may be perfectly acceptable in a 3G network can bring an LTE network to a grinding halt. This is why LTE planning and execution must take extra care in every stage of deployment.

Wireless data traffic has increased by a factor of

400 MILLION

since the year 2000.

(Cisco VNI Mobile forecast, February 2017)

Crowded tower tops

Increased complexity also takes the form of more crowded tower tops. To increase network performance and electrical efficiency, remote radio units (RRUs) are moving functionality from the shelter or cabinet at the base to the top of the tower. In addition, the process of moving ever-greater amounts of data on the LTE network necessitates more advanced backhaul solutions, which are the means of getting a cell site's traffic on and off the operator's core network. Often, this increased backhaul takes the form of large point-to-point microwave antennas, also mounted at or near the tower's peak.

These changes have introduced new challenges in the additional weight, wind load and lease costs associated with such a crowded tower top. They also take longer to deploy, slowing down crucial time to market. Because of this, choosing the optimal technology and partners is critical.

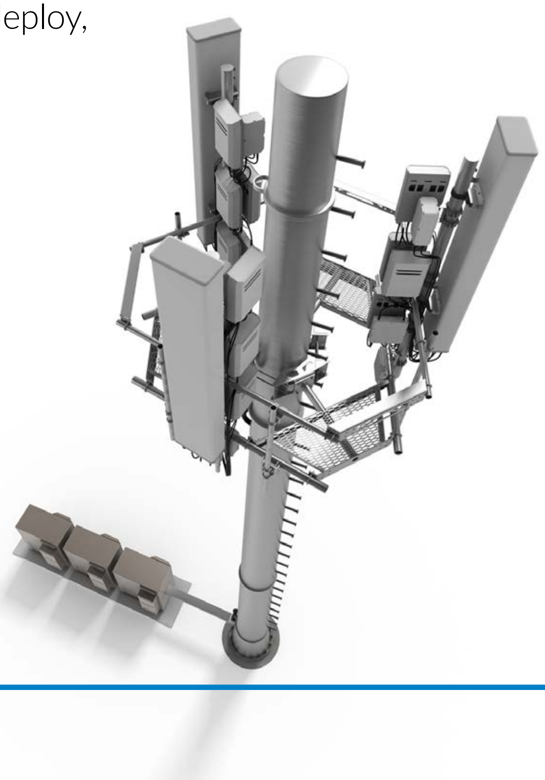
In 2015, LTE carried more traffic worldwide than 3G for the first time.

(Cisco VNI Mobile forecast, February 2017)

What you need to know about modernizing to LTE

You've probably heard about the eventual arrival of 5G, but the fact is that, as of the beginning of 2017, 5G's standards remain uncertain and a formal definition remains in the indeterminate future. While it is expected to start gaining traction in the market by 2020, there remains a vast amount of untapped potential in LTE that continues to be revealed, innovation by innovation, over time.

We will see more improvements in LTE before 5G is ready for prime time, and, for this reason, CommScope is delighted to share these best practices designed to help you deploy, grow and improve your LTE network.



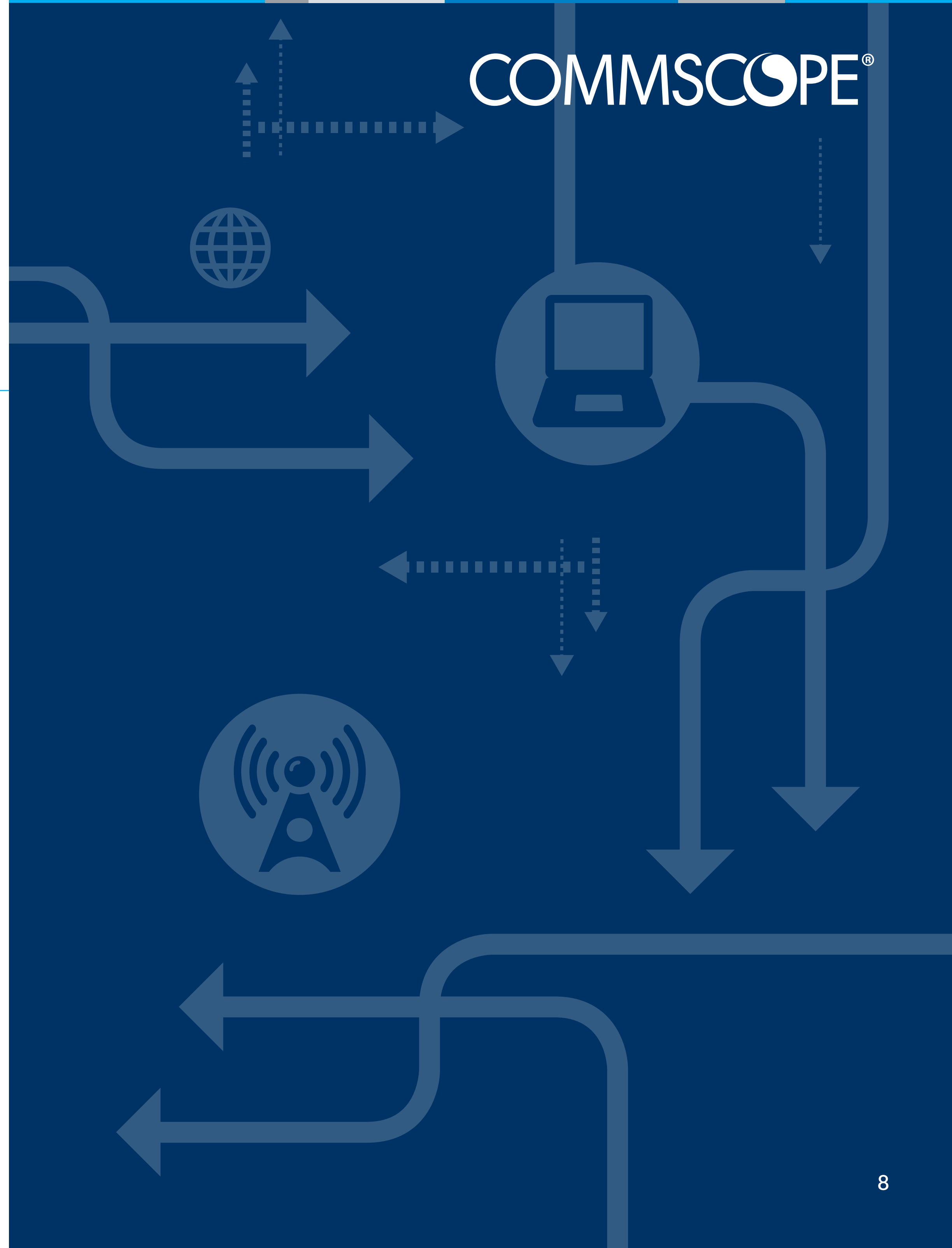
Did you know?

Wireless traffic growth is expected to increase six-fold by the year 2021.

(Ericsson Mobility report, June 2016)

BEST PRACTICE

#1 Noise mitigation



#1 best practice: Noise mitigation

Why is noise an LTE challenge?

LTE's growth is rooted in the ever-growing demand for data speed and throughput. To meet this demand, LTE technology uses a number of methods and practices that can boost capacity—but leave it susceptible to stray interference.

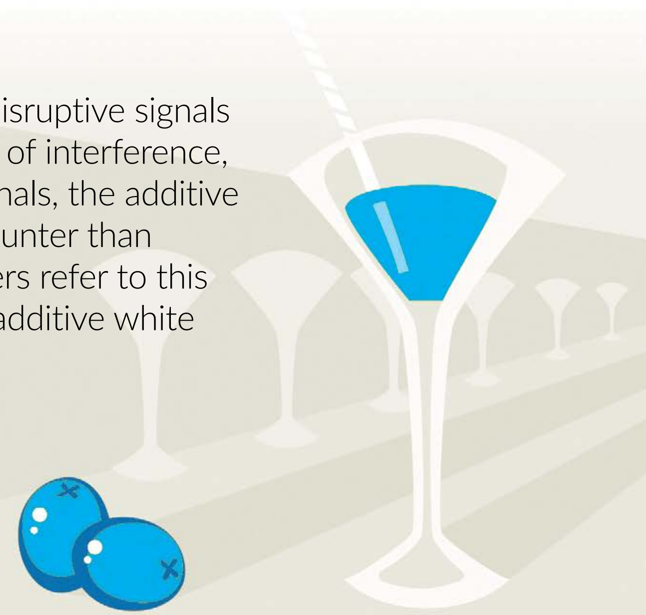
Because optimal LTE performance requires a higher signal-to-noise ratio (SNR) than any previous technology, noise can present a major obstacle to the smooth, efficient and profitable operation of an LTE network.

What causes noise?

As a rule, noise has a wide array of sources. Noise emissions are generated by nearby electrical machinery, radio equipment, or electrical discharges caused by poorly-connected RF components. Even in properly-connected and maintained site infrastructure, base stations will pick up noise from adjacent sectors. Indeed, noise is present in the active RF circuit's thermal noise floor—the wide-spectrum white noise emitted by every electrical conductor.

What is noise?

Noise is a general term describing disruptive signals within the radio channel. It is a kind of interference, but, because it consists of many signals, the additive sum total is harder to isolate and counter than single interference sources. Engineers refer to this combined signal "cocktail party" as additive white Gaussian noise (AWGN).



Fast facts

In 2017, there are 581 commercial networks operating in 186 countries.

(LTE–GSA: Evolution to LTE Report, January 2017)

#1 best practice: Noise mitigation

Equipment selection

- Choose antennas with radiation pattern envelopes (RPEs) that minimize sector overlap and suppress coverage where it's not desired, such as the upper floors of tall buildings.
- Tower-mounted amplifiers offer a simple, efficient way to improve SNR by offsetting feeder loss and reducing the uplink noise floor.
- Install interference mitigation filters (IMFs) on nearby transmitters to suppress out-of-band emissions that can cause noise.
- Always select equipment rated to the specified operating conditions.

Environmental practices

- Regulate equipment temperature by allowing maximum air circulation, and installing sun shields where needed, such as in hot climates.
- Identify likely noise sources (such as electric motors, power converters and other nearby electrical devices) and make sure they are grounded and shielded where possible.
- Carefully evaluate spurious emissions from co-located and adjacent transmitter sites, then place and point antennas to maximize isolation from those noise sources.

Installation practices

- Ensure that all coaxial connections are tightened to their specified torque in order to reduce the chance of noise-generating electrical discharge.
- Follow all practices for proper equipment grounding.
- Do not exceed transmit power ratings of any component in the RF path.
- Make sure installers correctly handle components labeled as electrostatic sensitive.
- Secure and protect cabling to prevent strain, vibration or environmental damage.

Additional resources

Training

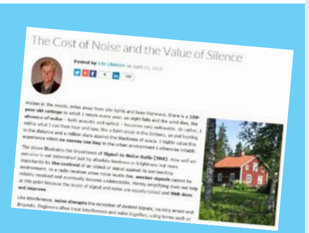
SP6000

Understanding the RF path

Learn more

Blog

The cost of noise and the value of silence


The Cost of Noise and the Value of Silence

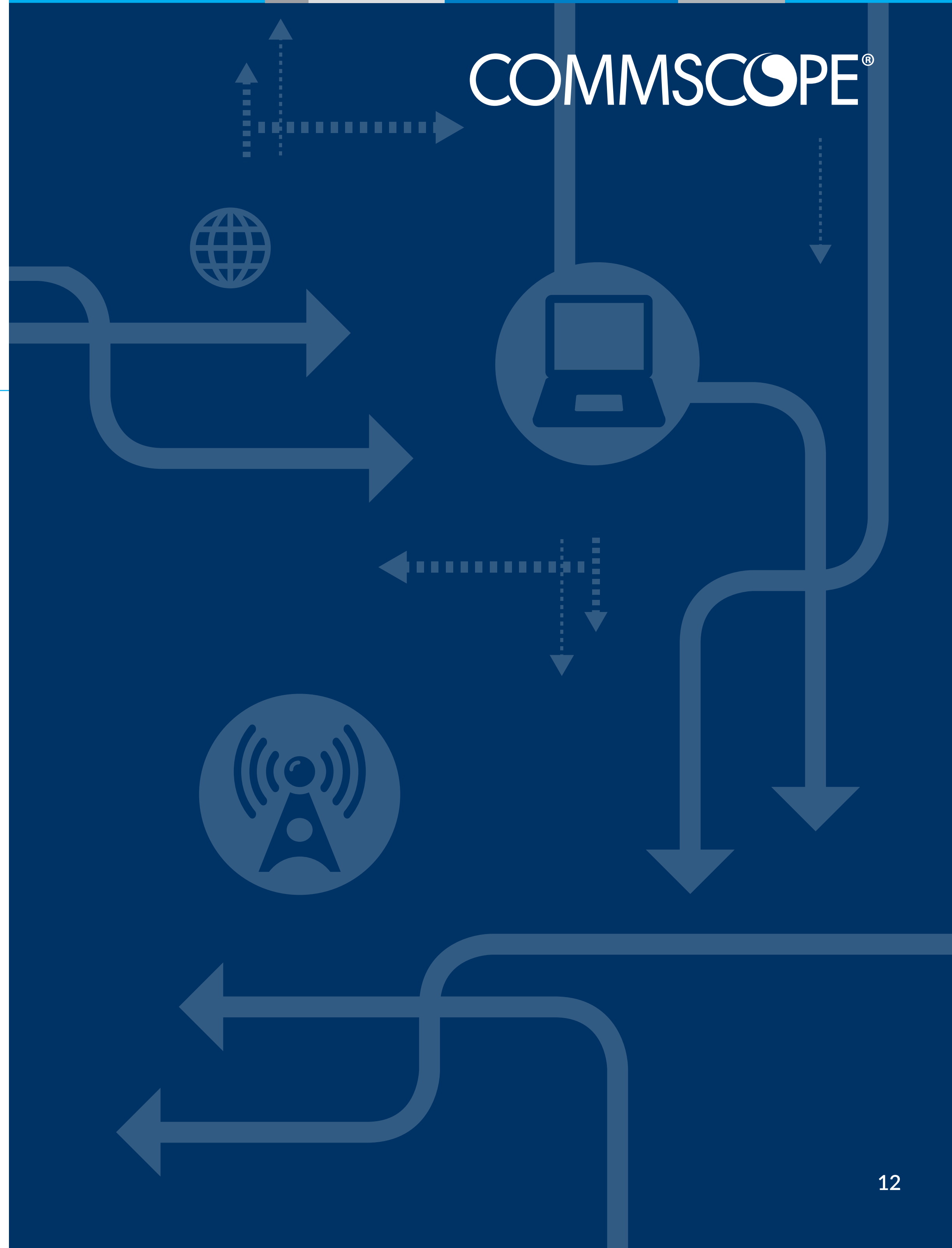
Learn more

Did you know?

Optimum LTE performance demands a signal-to-noise ratio (SNR) as high as 20 dB.

BEST PRACTICE

#2 Interference mitigation



#2 best practice: Interference mitigation

Why is interference an LTE challenge?

Distinct from the broadband disruption of noise, interference is a discrete issue more prevalent in urban and suburban areas where pattern-controlled antennas are the norm.

Because LTE performance is so significantly impacted by any kind of interference, the network's noise-plus-interference ratio (SNIR) must be higher than in any previous technology.

What causes interference?

Interference can be caused by nearby electrical equipment or discharges in poorly-installed or low-quality RF components or passive intermodulation (PIM). Due to its prominence as an urban and suburban issue, it can also be caused by improperly isolated antennas, adjacent sector signals, and high multipath interference—that is, reflected signals arriving at different times via multiple paths.

What is interference?

Interference is defined as discrete disruptive signals within a radio channel. Unlike the more generalized nature of noise, these disruptions are called “interference” when singular, identifiable sources are involved. Noise is covered in best practice 1.

Fast facts

It's expected that there will be 4.6 billion LTE subscriptions worldwide by the end of 2022.

(Ericsson Mobility report, June 2016)

#2 best practice: Interference mitigation

Equipment selection

- Antenna patterns should have low sector power ratios to minimize overlap, and high upper sidelobe suppression to minimize coverage in unwanted directions.
- Opt for electrical downtilt instead of mechanical downtilt, which can cause pattern blooming on the horizon.
- Remote electrical tilt (RET) is required for LTE Self Organizing Network (SON) optimization.
- Select only 100 percent PIM-tested equipment that's rated for your intended operating conditions.

Environmental practices

- Plan against potential wind- and ice-loading conditions by choosing sturdy antenna mounts.
- Identify likely noise sources (such as electric motors, power converters and other nearby electrical devices) and make sure they are grounded and shielded where possible.
- Carefully evaluate signal levels from co-located and adjacent transmitter sites, then place and point antennas to maximize isolation from those interference sources.
- Install interference mitigation filters (IMFs) on receivers to suppress strong signals in adjacent frequency bands.

Installation practices

- Use a level for antenna elevation alignment and GPS for azimuth alignment—compasses are unreliable around so much steel.
- In rooftop installations, ensure the elevation beam clears the parapet, particularly when the antennas are set back from the edge.
- To minimize PIM sources, tighten coaxial connections to specified torque and ensure proper grounding of all equipment.
- Do not exceed transmit power ratings of any equipment in the RF path.
- Protect cabling from strain, vibration and environmental damage by securing and shielding it appropriately.

Additional resources

Training

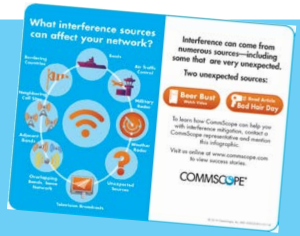
COMMSCOPE®
INFRASTRUCTURE ACADEMY

SP6000
Understanding the RF path

Learn more

Infographic

What interference sources can affect your network?



Learn more

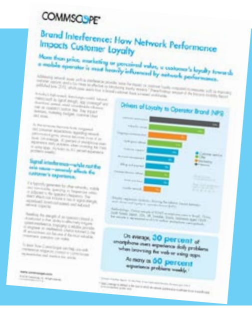
Blog

The cost of noise and the value of silence

Learn more

Industry survey

Are your callers getting the service they deserve?



Learn more

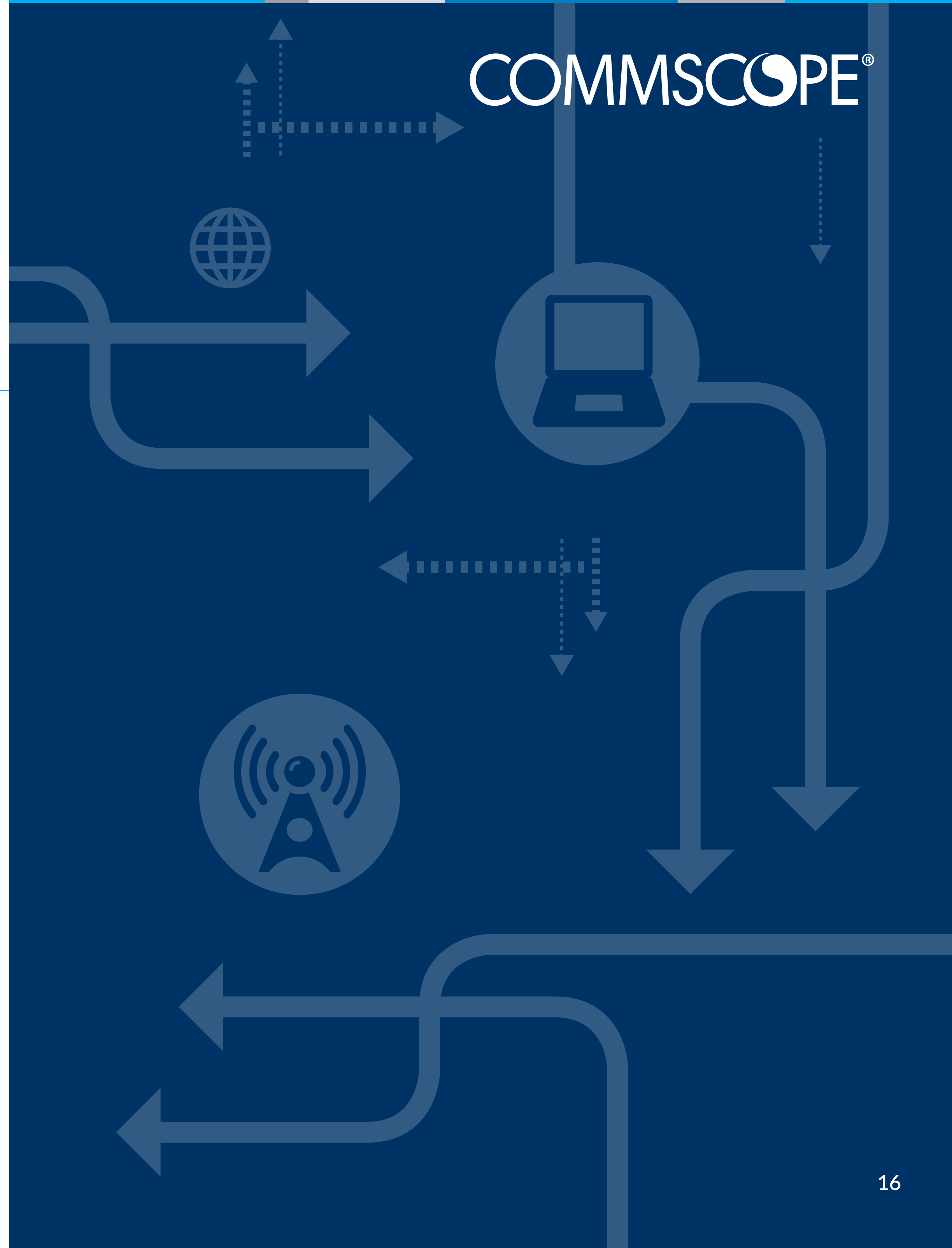
Did you know?

Monthly GLOBAL wireless data traffic will reach 30.6 exabytes by the year 2020

(Cisco VNI Mobile forecast, February 2017)

BEST PRACTICE

#3 Co-siting existing technology



#3 best practice: Co-siting existing technology

What is co-siting?

Co-siting, also called co-location, is the practice of sharing site resources between base station radios. On a practical level this generally means multiple technologies, radios and/or channel elements sharing space on a single tower. In some cases, it even includes multiple operators sharing the same radio equipment and RF path, separating services at the baseband unit (BBU) or switch.

Why is co-siting an LTE challenge?

LTE deployments must co-exist with existing technologies, meaning equipment will necessarily have to co-site with older network infrastructure. While this offers some advantages, such as the ability to leverage a site's existing backhaul capacity, it can also introduce additional time and cost as tower space becomes limited. Plus, additional technologies introduce the possibility of interference.

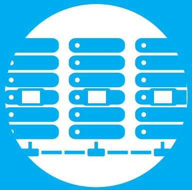
What co-siting options exist?

Options are limited and dictated by circumstances. First and foremost, the site must have tower space and load capacity. After that, options are determined by other factors, such as whether LTE frequencies and technologies can be combined with existing network infrastructure and how extensive the sharing should be—from sharing a tower to sharing an entire RF path.

Fast facts

The average global mobile connection speed will surpass 3 mbps by 2017.

Cloud storage is expected to grow 28 percent by the year 2021.



(Cisco VNI Mobile forecast, February 2017)

#3 best practice: Co-siting existing technology

Equipment selection

- Choose components designed to minimize passive intermodulation (PIM) and test thoroughly for PIM after installation.
- Install multiband antennas to cover today's needs and plan ahead for tomorrow's additional spectrum.
- To minimize interference resulting from co-sited components, include combining and filtering solutions that prevent adjacent-channel interference.

Environmental practices

- Before deployment, survey the RF landscape to ensure that any interference you are likely to encounter can be adequately mitigated.
- Separate antennas vertically and horizontally to keep them from interfering with one another.
- Orient antennas so they do not encounter physical obstacles near their main beams.
- Isolate antennas from potential sources of external interference such as parapets, support structures, guy wires or other tower equipment.

Installation practices

- Use only certified installation crews that are familiar with co-siting challenges.
- Combine technologies based on frequencies that do not produce harmful PIM products.
- Build arrays of technologies that use the same tilt, of similar antennas that use the same azimuth, and on different antennas that use different azimuths.

Additional resources

Diagram

How is interference impacting your network?

Learn more

Article

How does interference impact your network investment?

Learn more

Video

Interference impacting your network KPIs?

Learn more

White paper

Densifying with grace: The resurgence of RF conditioning devices

Did you know?

BY 2022, there will be 8.9B mobile subscriptions

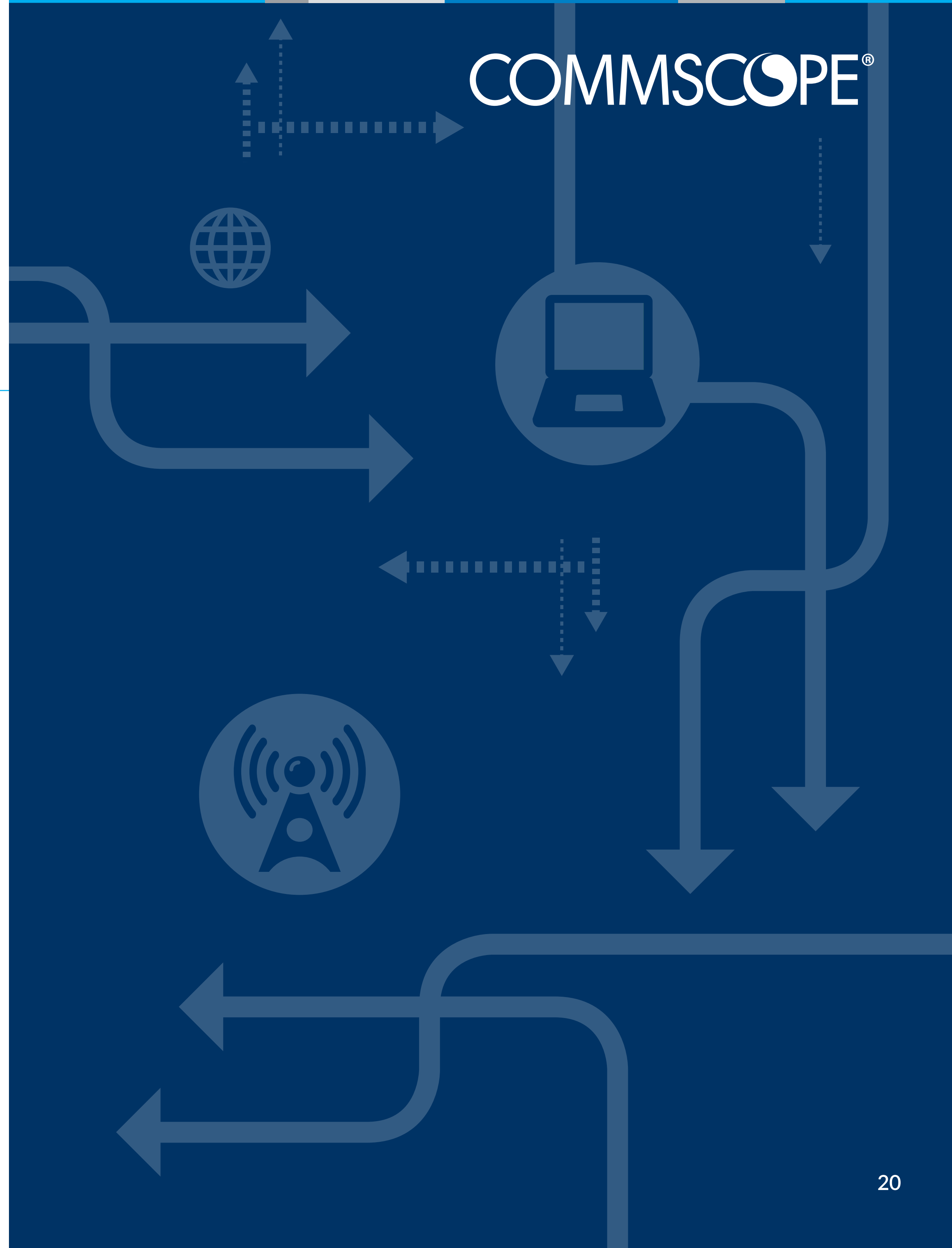
8B mobile broadband subscriptions

and 6.1B unique mobile subscribers.

(Ericsson Mobility report, June 2016)

BEST PRACTICE

#4 How to avoid PIM



#4 best practice: How to avoid PIM

Why is PIM an LTE challenge?

As LTE networks are overlaid on legacy 2G and 3G network infrastructure, interference becomes a real challenge—particularly passive intermodulation, or PIM.

PIM has been a known issue for as long as RF communications have involved more than one component. However, LTE is particularly sensitive to its effects.

What causes PIM?

PIM can be caused by any nonlinearity in the RF path. Possible sources include poor connections, damaged cable or water infiltration. In some cases, PIM can also be caused by objects outside the path, such as light posts, buried conduit, fences or site equipment. In fact, there are so many possible sources, PIM is sometimes known as "the rusty bolt effect."

What is PIM?

PIM is interference resulting from the nonlinear mixing of two or more frequencies in a passive circuit. If the interference coincides with an LTE network's uplink receive frequencies, it can cripple network performance and throughput.

Fast facts

Smartphone usage will increase to comprise **80 percent** of wireless data traffic by the **year 2020.**

(Cisco VNI Mobile forecast, February 2017)

#4 best practice: How to avoid PIM

Equipment selection

- Use pre-tested, PIM-certified cable assemblies. Connector-related PIM is the most common source of interference.
- Many older devices (antennas, diplexers, and so forth) were not designed to today's higher PIM standards. Specify new, PIM-certified devices with weather-resistant connections.
- Verify that your suppliers' testing protocols include environmental stress screening and PIM testing in both static and dynamic conditions. Nothing is static at the top of a tower.

Environmental practices

- Ensure the antenna system is clear and free of obstacles in its pattern direction.
- Be aware of frequency sources in the immediate area of the antenna system such as large machinery, high-voltage power lines and other sources that can create an unexpected frequency experience.
- A comprehensive site audit can identify potential external sources of PIM, such as buried conduit, nearby metallic structures or other issues. Such audits may also include post-installation testing and mitigation.

Installation practices

- Ensure that installation technicians have the right tools to prepare and connect cabling, including the connectors' correct torque specifications.
- Minimize the number of adapters used in the design of the RF path.
- Use frequency sweep PIM testing to reveal problems that fixed-frequency testing does not. If that is not an option, use multiple fixed frequencies to reveal hidden PIM.
- Ensure all installers are trained and certified.

Additional resources

Training

SP6160
PIM/VSWR certification

Learn more

White paper

- PIM testing
- Network modernization: PIM
- PIM in DAS

Learn more

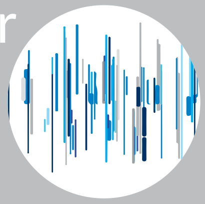
Apps

WebTrak® and cTrak™ certified report system

Learn more

Did you know?

PIM most frequently degrades receiver sensitivity at the cell site.

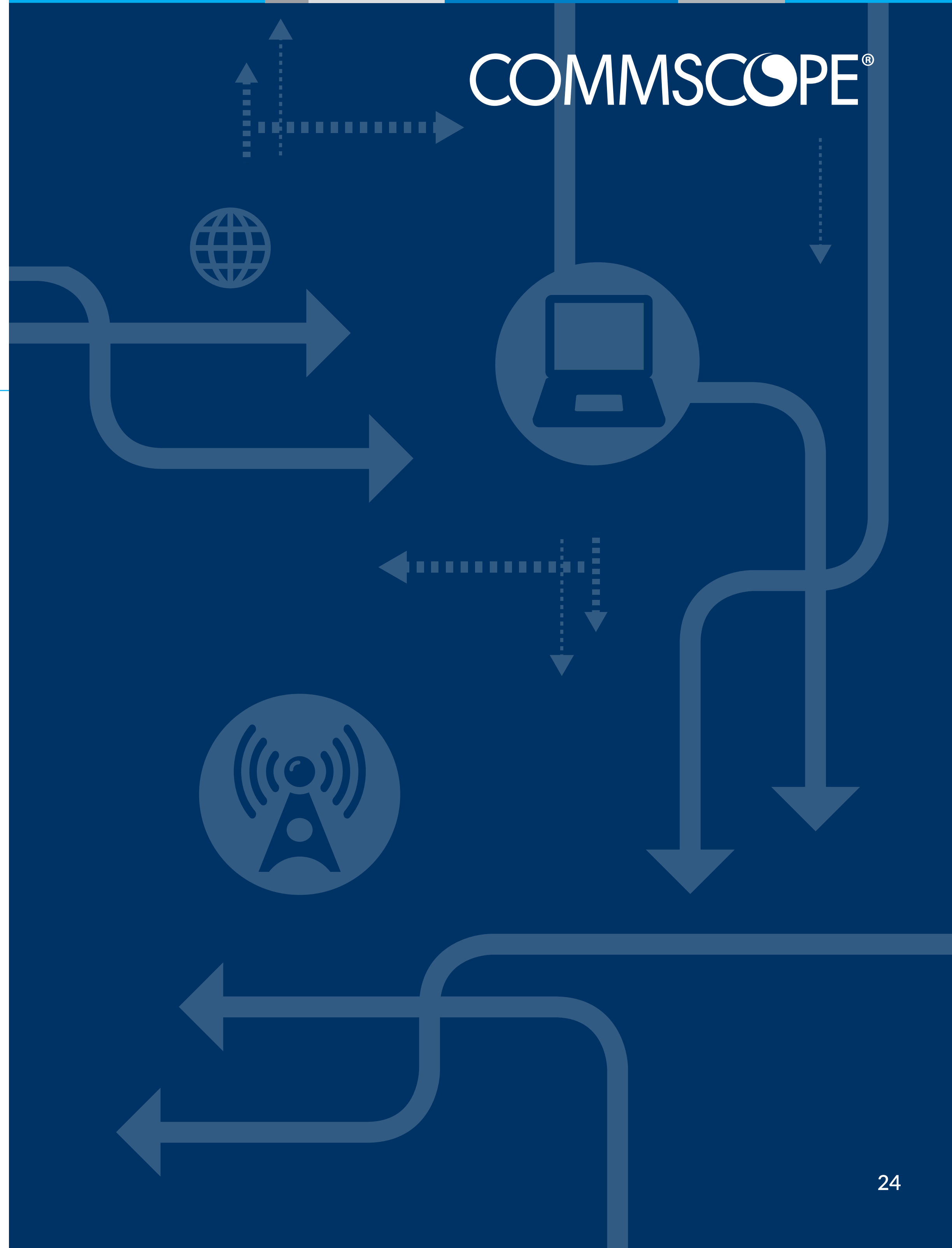


Just **1 dB** lost to PIM can reduce LTE efficiency by **11 percent.**

Read blog, "What is PIM"

BEST PRACTICE

#5 FTTA implementation



#5 best practice: FTTA implementation

What is FTTA, and how does it figure into LTE?

Fiber to the antenna (FTTA) wireless site architecture is characterized by remote radio units (RRUs) and other components located at the top of the tower rather than at the traditional base location. This configuration allows for enhanced energy efficiency, increased bandwidth and improved flexibility—all essential ingredients for a successful LTE network.

What challenges exist in FTTA architecture?

FTTA sites call for both fiber-optic and power cables to connect RRUs at the top of the tower. Running these as separate cables can be complex, time-consuming, and expensive. Additionally, RRUs from different OEMs feature different interfaces, often requiring specific fiber and power connectors.

What strategies exist to overcome the challenges?

Hybrid cable—a combination of fiber and power cable in a single run—can greatly streamline installation and simplify site infrastructure. Since a hybrid cable typically contains many fibers, one run can support multiple RRUs and even include extra fibers for future expansion. There are also new factory-assembled, pretested solutions available that allow installers to hoist all the key components into position as a single unit.

Hybrid connectivity solutions can reduce tower load by 33 percent.

Fast facts

87 percent of respondents have moved to **FTTA**, or plan to in the foreseeable future.

79 percent of respondents say that fiber technology can benefit their brands by improving their service offerings.

(Broadband Outlook report, October 2016)

#5 best practice: FTTA implementation

Equipment selection

- Choose hybrid cable capable of accommodating more RRUs than you are installing now—even if you don't need that many connections now, it will ease future expansion at minimal up-front cost.
- When ordering cable, it's always best to order longer lengths to accommodate for any adjustments needed on-site.
- Select plug-and-play hybrid breakout systems that directly connect RRU and BBU to eliminate the need for additional cable runs or junction boxes that increase tower loads.
- Factory-terminated, factory-tested hybrid cables offer better quality control.

Environmental practices

- Keep the provided dust caps on the ends of the fiber-optic cable until the connection is actually made to ensure dust does not settle on the fiber connector.
- More tower-top components means more connections in an already-crowded location. Hybrid breakout canisters eliminate the need for a tower-mounted junction box and minimize the amount of space required.
- Harsh weather can affect connectors as well as cable, reducing performance. Ensure that you select weatherproofed connectors rated for the environment.

Installation practices

- Always clean and inspect connections before mating to prevent damage, ensure optimal signal performance and reduce the time spent troubleshooting.
- Handle and store hybrid cables according to the manufacturer's specifications.
- Installation and testing of fiber-optic cable should always be performed by skilled technicians.
- All cable must be actively supported to within a distance of no more than 1–2 feet (30–61 cm) of its connection point. As a general rule, hangers should be spaced no more than 3–4 feet (0.9–1.2 m) apart.

Additional resources

Training

SP6170

Fiber to the antenna (FTTA)

Learn more

Video

Fiber to the antenna turnkey solution

Learn more

Apps

WebTrak® and cTrak™ certified report system

Learn more

White paper

Technical keys to network modernization: FTTA

Learn more

Brochure

HELIAX® FiberFeed Direct

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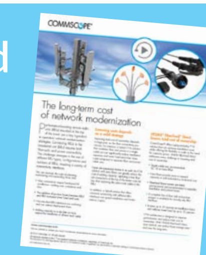
Article

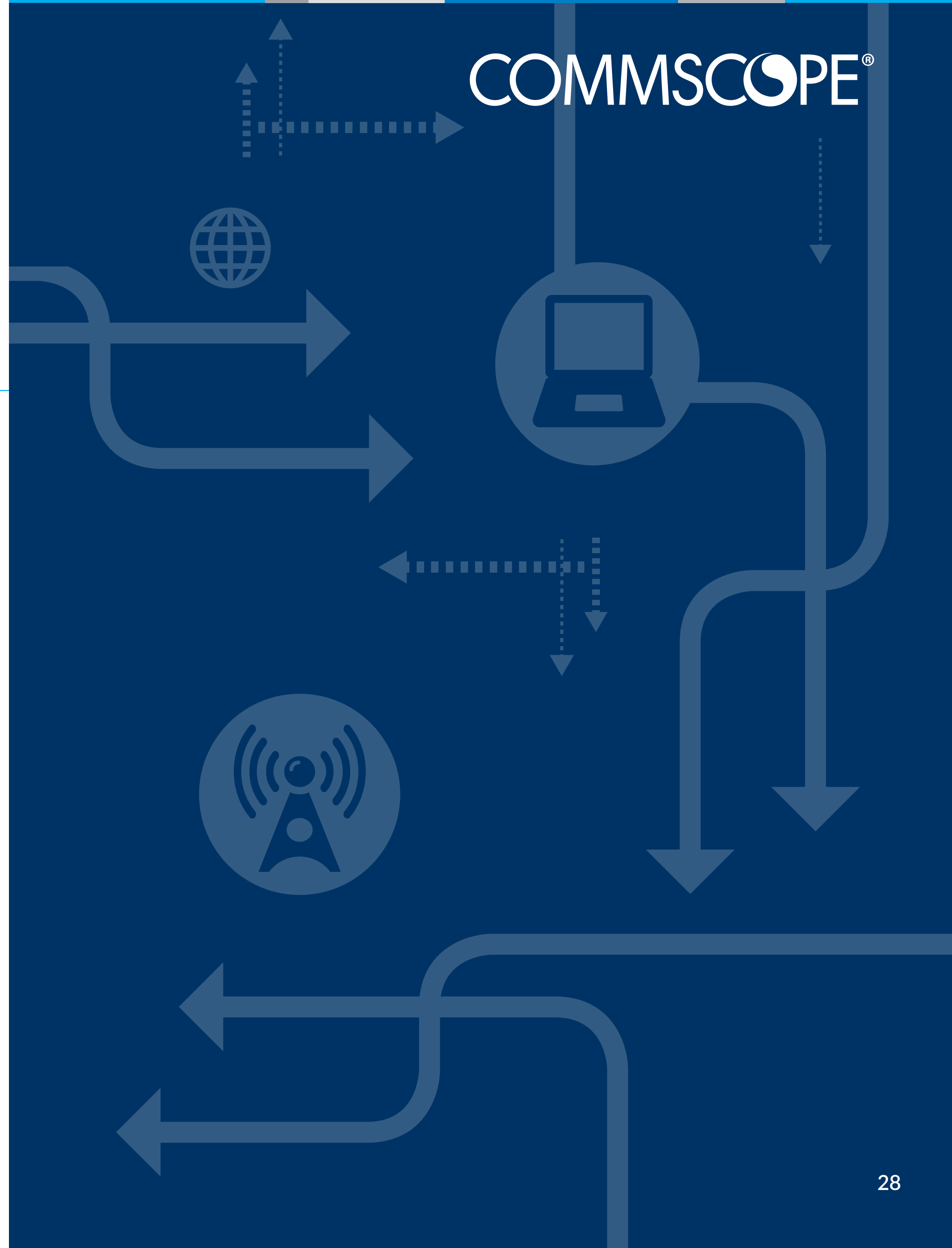
HELIAX FiberFeed Direct Hybrid connectivity solution



Learn more

BEST PRACTICE

#6 Implementing DAS



#6 best practice: Implementing DAS

How does DAS fit into LTE?

Distributed antenna systems (DAS) allow operators to offload wireless traffic from a particularly user-dense environment from the macro network.

DAS is also an effective way of bringing reliable, high-quality LTE data service to hard-to-cover areas, such as large office buildings or hospitals; across sprawling college campuses or airports; around massive sports stadiums; or underground subways or parking garages.

What is DAS?

A DAS is a network of distributed antennas specifically designed to add coverage and capacity to areas of buildings and venues where boosted service is needed. This distributed capacity is connected via vertical fiber backbone to a headend, usually on the premises, which then connects to the carrier equipment and the broader network.

Regarding LTE in particular, DAS allows for the addition of a new capacity layer without building new macro network infrastructure.

Why is DAS important?

In its earliest incarnations, DAS was regarded as a difficult-to-deploy solution suited only to specific installations. With the explosion in LTE demand, however, DAS has evolved into a critical part of the larger network.

An average user spends 85 percent of smart phone time on apps—and 84 percent of that time on just five apps.

(2015 U.S. Mobile App report, September 2015)

Fast facts

- Well suited to high-density user environments
- Built off a network of remote access nodes connected via fiber to the headend
- May be low-power (indoor), high-power (outdoor), or a combination
- DAS popularity has grown with increase in LTE demand

#6 best practice: Implementing DAS

Equipment selection

- Choose a DAS solution with remote units that are capable of multiband support, ideally supporting all main commercial bands.
- DAS solutions can be time- and labor-intensive to install, commission and optimize. Make sure to choose a solution that simplifies and streamlines these processes and one that requires less-specialized labor to deploy.
- Select factory-tested, PIM-rated passive devices between remote units and antennas to maximize performance.

Environmental practices

- When designing your DAS, map DAS zones according to the demand they will have to serve. This will determine the number and sizes of your zones.
- Use single-cell simulcast in large, open areas to reduce the number and size of handover areas.
- Building materials, wall configurations and internal partitions will all affect RF propagation. Know the terrain and composition of the venue your DAS will serve.

Installation practices

- Plan for the future. Allow extra space for future upgrades in telco closets and headend room.
- Clean fiber connectors thoroughly during installation. Even the smallest particles of dust can degrade performance.
- Know and observe the maximum power ratings of all components.

Additional resources

Blog

The value of multiples in DAS

Learn more

Blog

Why permit a preventable weakness in your DAS?

Learn more

White paper

PIM requirements must increase to support evolving DAS systems

Learn more

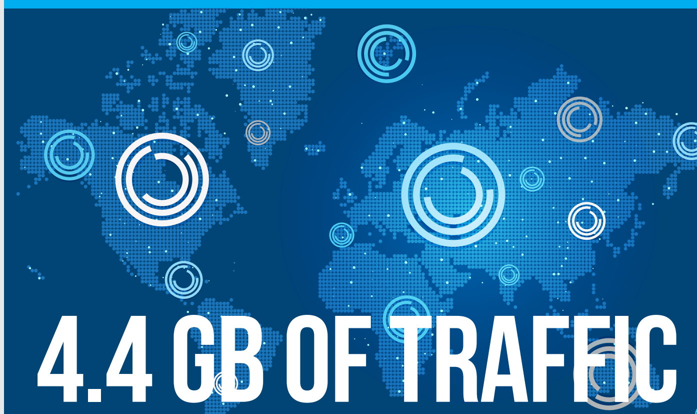
Blog

PIM requirements must increase to support evolving DAS systems

Learn more

Did you know?

The average smartphone will generate



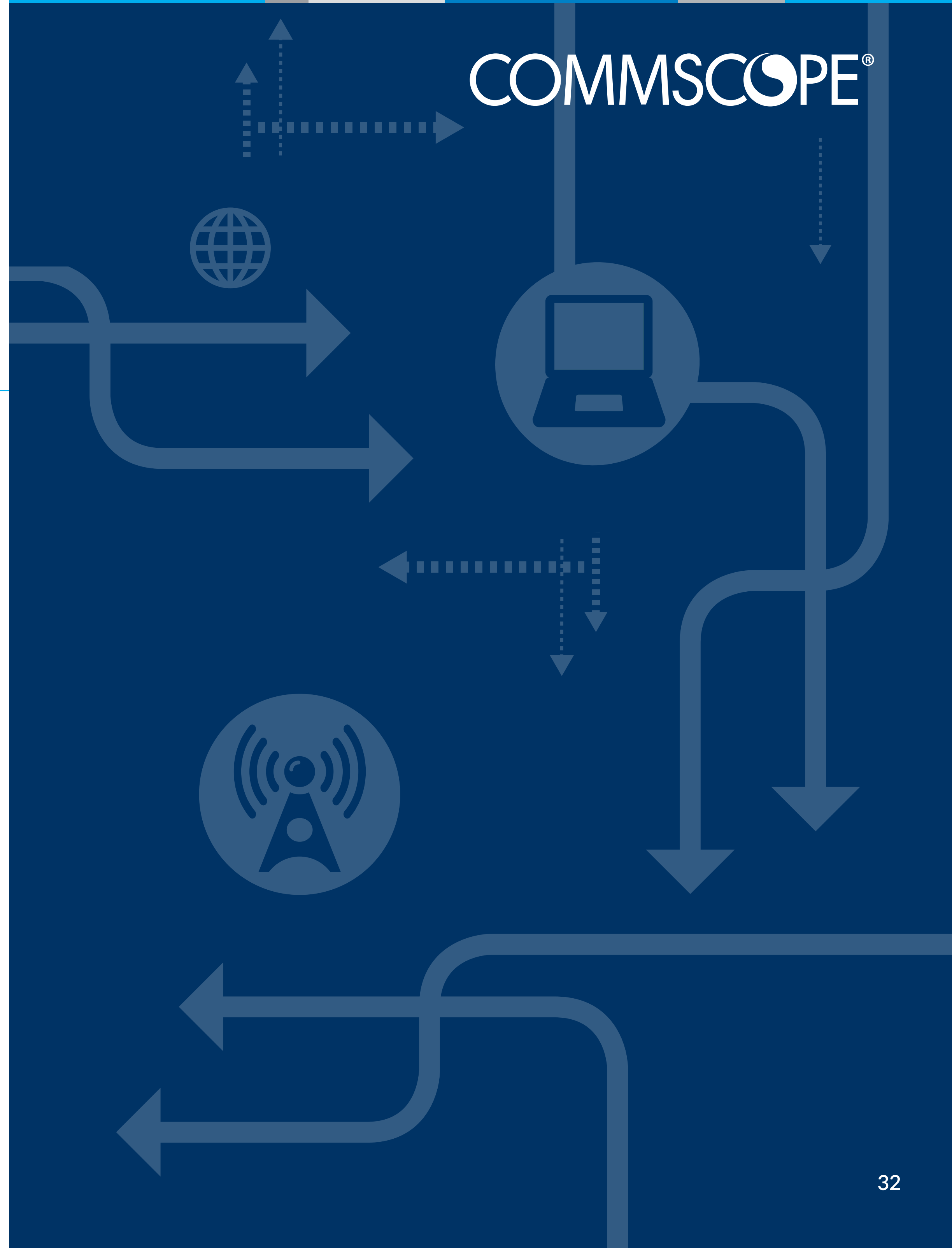
4.4 GB OF TRAFFIC

per month by 2020, a five-fold increase over 2015 levels.

(Cisco VNI Mobile forecast, February 2017)

BEST PRACTICE

#7 Outdoor site construction



#7 best practice: Outdoor site construction

How do site construction practices relate to LTE?

LTE performance depends on having the right infrastructure in the right places. While many LTE deployments involve adding technology to existing macro cell sites alongside 2G and 3G infrastructure, there are still opportunities to construct entirely new sites in areas with growing demand and population density.

How are cell sites built?

Cell site construction involves a great number of partners and stages of development—even more so for LTE deployments that have more exacting specifications. Once the site location has been chosen, surveyed and secured, an operator must choose a service company to erect the physical structure of the site.

Then the operator must identify vendors to supply the infrastructure that will power the LTE site. This includes: cable connectivity, backhaul infrastructure, remote electrical tilt (RET) articulators and other sector-shaping technology, antennas and other active components.

What's on the line with new site construction for LTE?

Construction is a complex process that involves many different priorities and players. There are legal and zoning issues to consider; geographical and topographical factors; risk and liability considerations; and, of course, the matter of providing LTE coverage where you need to have it.

Fast facts

- A complex process involving several specialized partners
- LTE performance depends on specific methods of construction and deployment
- Service companies build the structure of the site
- Vendors provide infrastructure and active components
- Touches on multiple business considerations: legal, strategic, financial and others

#7 best practice: Outdoor site construction

Equipment selection

- As with any LTE deployment, a new site demands precise pairing of components. Consider factory-tested, preterminated coaxial and hybrid connectivity solutions to reduce errors and deployment times.
- Maintain consistency by manufacturer for component types to ensure continuity and quality across the installation of hybrid or coaxial cable.
- Passive intermodulation (PIM) is a constant threat to LTE performance. Always select PIM-tested components for site deployments.
- Ensure that the people constructing your site are reputable, well insured and fully certified in the kind of construction they will perform.

Environmental practices

- Survey the prospective cell site to ensure it is geographically and topographically advantageous, and that all permits and consents can be obtained.
- Ensure that all components feature appropriate weatherproofing for their location and specification. This includes cables, connectors and all outdoor tower-mounted components.
- Proper electrical grounding is essential. A typical site should be grounded at the tower top and base, and just outside the access point of the site's outbuilding, shelter or cabinet.

Installation practices

- Ensure the azimuth is accurate and that both mechanical and electrical tilt are set to match the site's plan.
- New tower-top solutions exist that are pre-assembled, configured and tested in a factory before hoisting it as a single unit to the tower top, saving time and money.
- Observe the cable manufacturer's bend radius specifications and use the manufacturer's hangers and supports to avoid damage during installation.
- Fiber-optic installations are a recent technology, requiring a new generation of highly-trained specialists to handle.

Additional resources

Training

COMMSCOPE® INFRASTRUCTURE ACADEMY

SP6000

Understanding the RF path

Learn more

Blog

How to make a standardized tower top

Learn more

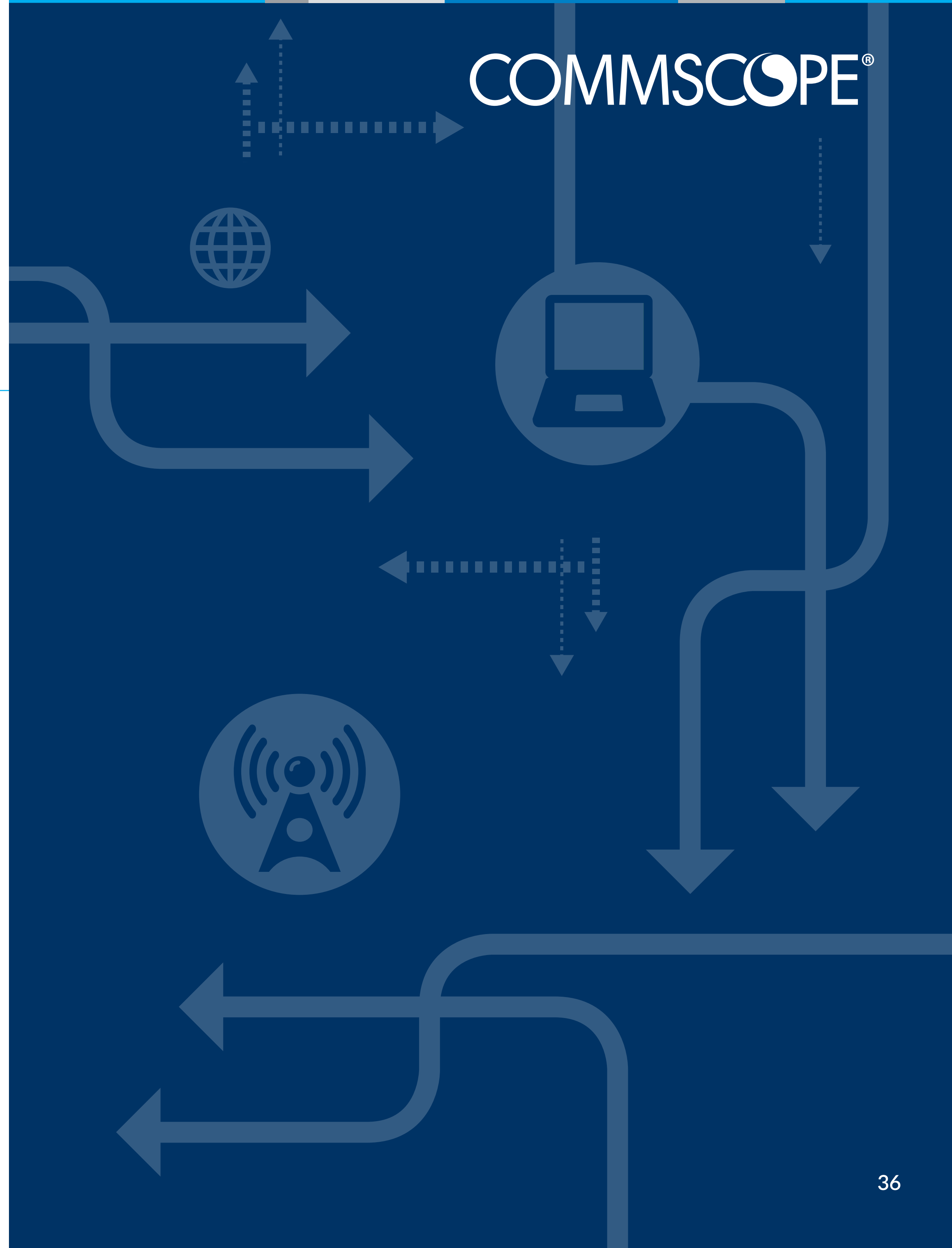
Did you know?

By 2022, the traffic generated by smartphones is expected to grow 10-fold.

(Ericsson Mobility report, June 2016)

BEST PRACTICE

#8 Selecting and deploying antenna technology



#8 best practice:
Selecting and deploying antenna technology

Why does antenna type matter so much in LTE?

In order to provide LTE-level capacity, antennas must support higher modulation schemes than were required by 2G and 3G networks. Modulation compresses data, improving throughput but increasing interference sensitivity.

LTE also requires antennas with optimal RF containment to prevent sector overlap, because it does not support soft handoffs.

How are LTE antennas designed to improve performance?

LTE antennas are built to provide precise sector-by-sector coverage with optimal signal-to-interference-plus-noise ratio (SINR). Their specifications include such key characteristics as:

- Horizontal and vertical beamwidths
- Pattern roll-off characteristics
- Upper sidelobe suppression
- Front-to-back ratio
- Port-to-port isolation
- PIM performance

What factors should go into antenna selection?

There are several strategic considerations involved in your choice. Consider your current—and future—spectrum plans, and ensure your choice supports them all. Look at the antenna's support for migration to advanced technologies to ensure you can scale capacity and coverage as needed. Understand the environment where the antenna will be deployed, and, of course, choose a solution from an experienced, reliable supplier with a solid track record and warranty protection.

Fast facts

Enhanced sector power ratio and upper sidelobe suppression increase LTE capacity

LTE requires clean sector handoffs

LTE antennas improve SINR through tighter radiation pattern controls and PIM management

MIMO, RET and other technologies factor in as well

High-quality LTE antennas are designed to deliver upper sidelobe suppression, focusing more power where it's needed and reducing sector overlap.

#8 best practice: Selecting and deploying antenna technology

Equipment selection

- Choose remote electrical tilt (RET)-capable antennas to quickly optimize your network.
- Ensure that your chosen solution has undergone interoperability testing with your radio platforms.
- During the planning phase, use network planning tools to ensure network KPIs are met in your specific deployment scenario.
- Look for antenna solutions that support multiband capability, 2x4/4x4 MIMO and offer sufficient ports to support local RF plumbing.

Environmental practices

- Towers should be analyzed for structural loading by a professional engineer prior to antenna installation. To ensure structural integrity, use only manufacturer-specified antenna mounts that are properly torqued.
- Observe radiation hazard warnings to ensure that personnel are not exposed to harmful levels of RF exposure.
- When upgrading an existing deployment, remember that replaced antennas should be disposed of in an environmentally responsible manner.

Installation practices

- Follow vendor and network operator procedures for antenna commissioning, such as system sweeps, PIM testing, RET configuration and RF connector torque levels.
- Ensure proper weatherproofing of antenna RF connections, preferably with a weatherproofing solution provided by the antenna manufacturer.
- Do not weatherproof RET connections, but apply silicone grease supplied with the RET cables to the connector pins prior to connecting the cables.

#8 best practice: Selecting and deploying antenna technology

Additional resources

Training

COMMSCOPE®
INFRASTRUCTURE ACADEMY

SP6910
Antenna theory

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Video

Ultra-wideband solutions

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Tip sheet

Top five tips for optimizing network performance

Learn more

White paper

Improving metro cell performance

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Training

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INFRASTRUCTURE ACADEMY

SP6104
RET antenna systems

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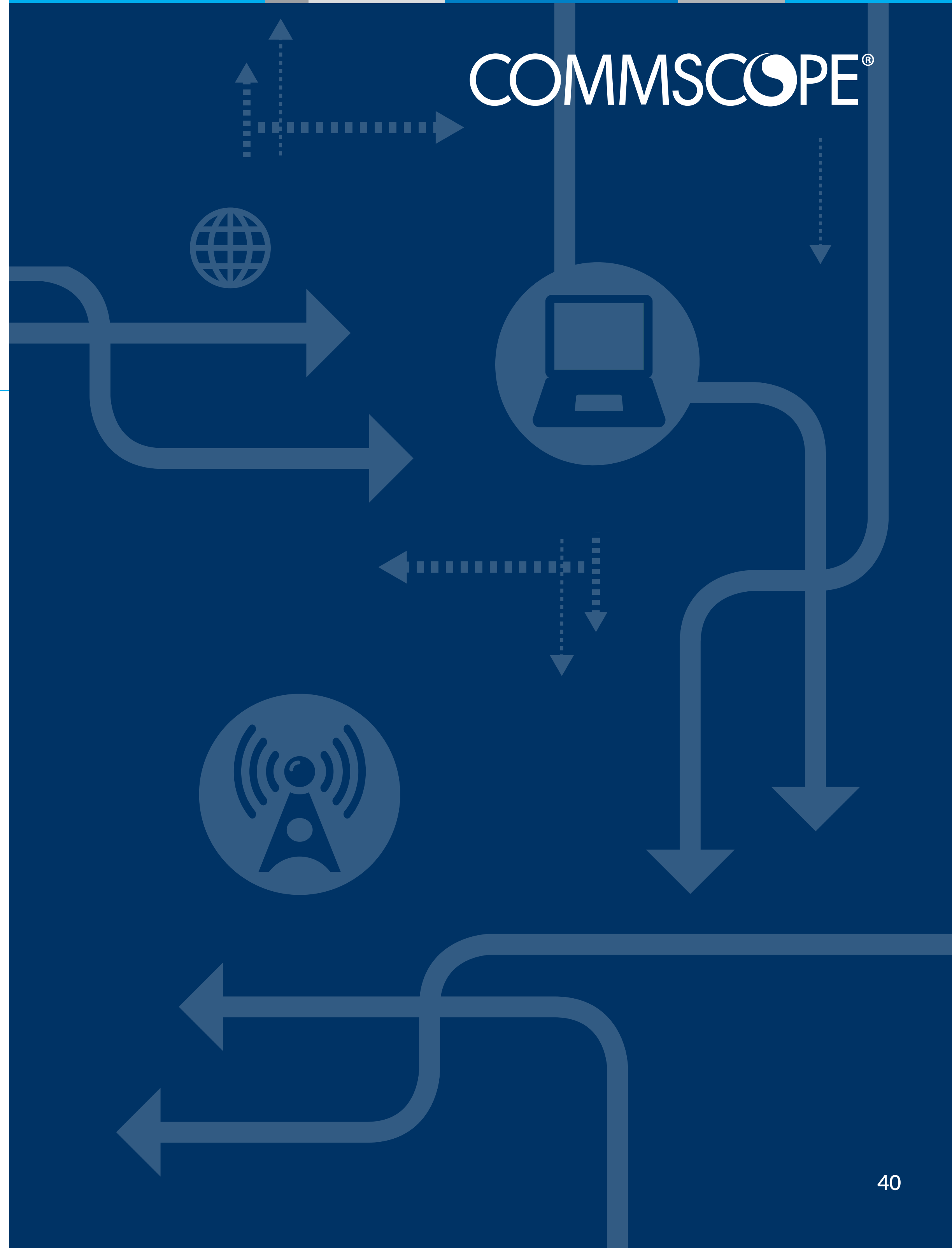
BEST PRACTICE

#9 Voice over LTE (VoLTE)



#9 best practice: Voice over LTE (VoLTE)

What is VoLTE?

Voice over LTE (VoLTE) is the technology that allows voice calls to be carried over LTE networks. It may surprise you to learn that your voice data doesn't necessarily travel on the same LTE network as your other wireless data, but it's true. Cellular voice calls are still often carried on 3G networks running in tandem with LTE.

New technology is changing all that, allowing voice to be carried efficiently on LTE networks, using advanced codecs (encoding/decoding software) in wireless devices, not unlike the way conventional voice over IP (VoIP) negotiates signals between landline phones and the internet to carry voice calls.

The number of worldwide VoLTE subscriptions will reach 3.3 billion by 2022.

(Ericsson Mobility report, June 2016)

What does VoLTE offer to the broader LTE strategy?

For wireless operators and enterprises running their own in-building wireless solutions, VoLTE offers a unified solution that allows for the final phasing out of older-generation networks. This is because VoLTE offers much greater spectral efficiency—up to 15 times the number of simultaneous users per MHz compared to 2G.

For users, VoLTE offers greatly improved call quality and enhanced connection reliability. The best results come when mobile devices on each end of the call are both using VoLTE. Video calls can also be made using video over LTE (ViLTE).

It can maintain this increased quality even under poor signal conditions—and even under heavy network load. For these reasons, major wireless operators began introducing VoLTE technology in their top-of-the-line devices in 2014 and continue to include it today.

Fast facts

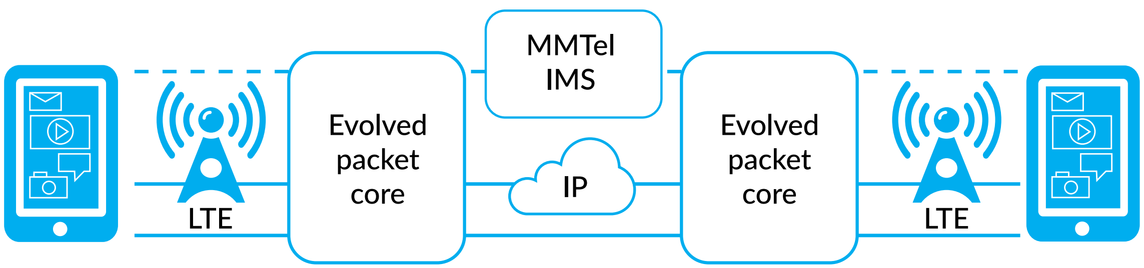
- VoLTE uses super-efficient codecs to carry voice over LTE networks instead of legacy 2G/3G networks
- Most major wireless operators began to introduce VoLTE capability into new devices in 2014
- VoLTE offers call quality at least on par with 3G, with much greater energy efficiency and quicker connections.
- VoLTE is also sometimes marketed as HD Voice or Enhanced Voice, as it uses a vocoder that gives enhanced voice quality
- When both ends of the connection use VoLTE-capable devices, HD Voice is used.
- VoLTE video calls (ViLTE) may count toward a user's data AND voice limits at the same time

#9 best practice: Voice over LTE (VoLTE)

What are the challenges of using VoLTE?

There are very few downsides to VoLTE for operators and enterprises, since it enables the re-allocation of 3G and 2G spectrum and can reduce OpEx associated with maintaining parallel networks. For the user, the biggest challenge is accurately accounting for data and voice usage.

One key challenge is the inherent complexity of VoLTE in how calls are set up and transmitted. It uses a hierarchy of services that must all be coordinated to deliver defined QoS. A VoLTE call is essentially an IP session rather than traditional circuit-switched call. This, in turn, depends on other services to maintain performance, like the radio network and the individual devices being used to connect. There are also some unresolved standards regarding how roaming and inter-network calls are handled, potentially introducing unexpected data costs for the user.



Did you know?

It's estimated that one minute of VoLTE video calling consumes 6–8 MB of data in addition to the minute of talk time.

There are currently more than 102 commercial VoLTE networks in 54 countries.

(LTE–GSA: Evolution to LTE Report, January 2017)

#9 best practice: Voice over LTE (VoLTE)

Equipment selection

- Cell edge coverage is especially important for VoLTE performance. Consider higher gain antennas to boost signal strength and reduce interference.
- Implement four-way receive diversity (4R) to improve uplink coverage at the cell edge.
- Further enhance uplink performance by using tower-mounted amplifiers.

Environmental practices

- Low-band frequencies are preferred for VoLTE, providing better indoor penetration and connection stability.
- Activate optimization features such as header compression and TTI bundling.
- Include QoS monitoring solutions that can capture session-based data and signaling information to better understand network impact on VoLTE performance.

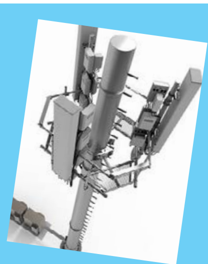
Installation practices

- Proper antenna alignment is critical to optimizing the call quality, connection reliability and energy efficiency of VoLTE services.
- Drive test and optimize coverage and handover parameters to enhance voice quality and minimize call drops and handovers to 2G/3G. A self-optimizing network (SON) solution can be effective in maintaining VoLTE performance as the network evolves.

Additional resources

Blog

The move to 4X2 MIMO in wireless networks



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Blog

The resurgence of RF conditioning devices

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Blog

Japan—capacity challenges in a mature LTE network

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Video

Today's most inspiring technology? The network.

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Article

VoLTE

Is your infrastructure in for a VoLTE of shock?

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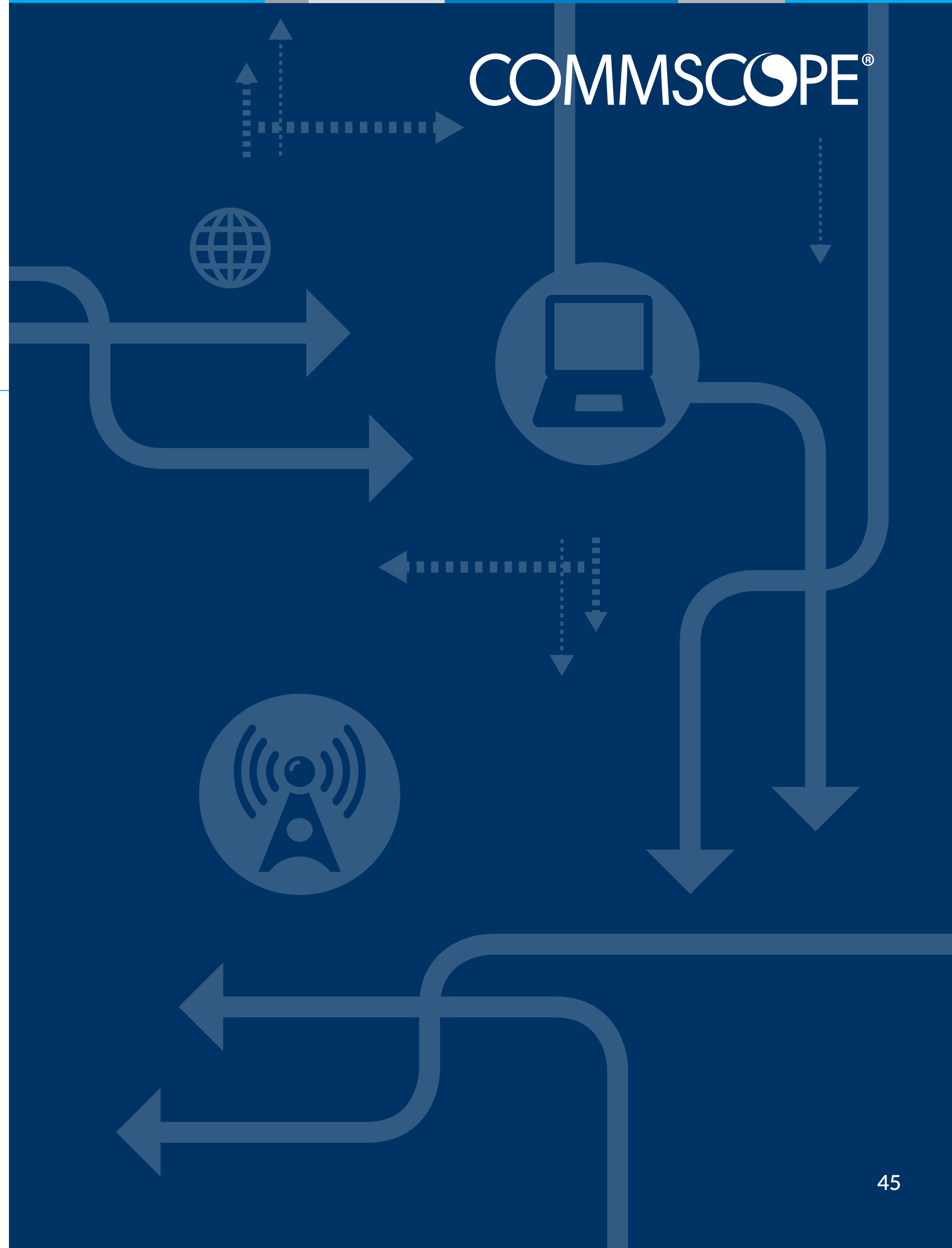
BEST PRACTICE

#10 Microwave backhaul



#10 best practice: Microwave backhaul

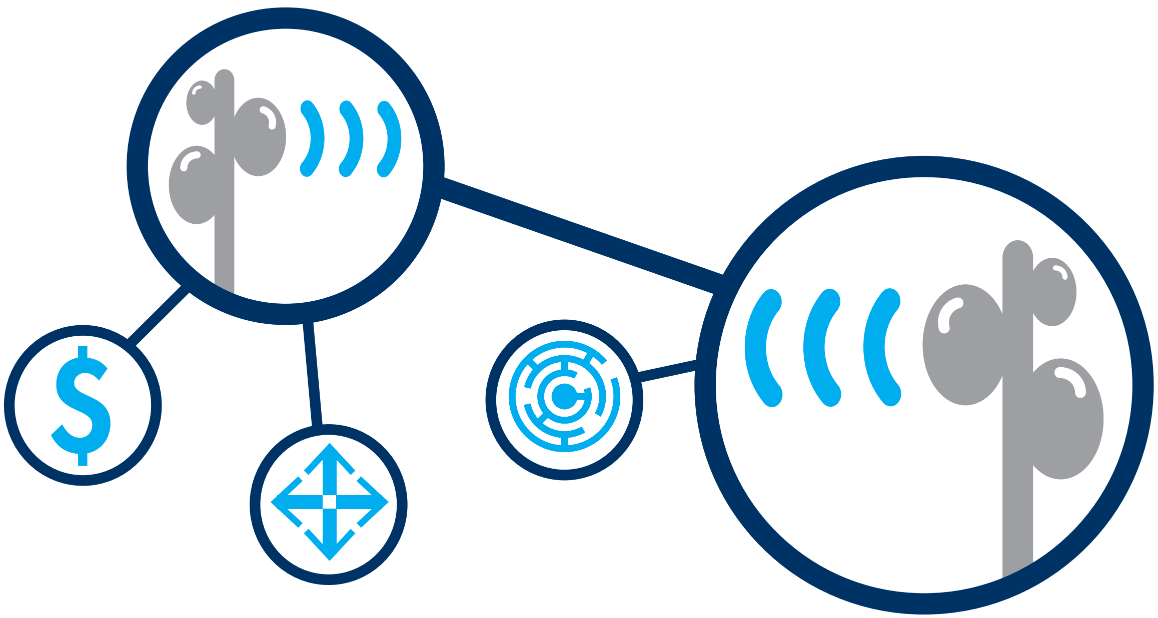
What backhaul challenges are specific to LTE networks?

LTE networks exist to serve the skyrocketing demand for data. As a result, the backhaul needed to move such massive amounts of data calls for a solution of greater capacity and performance than was needed for previous generations of mobile networks.

What is backhaul?

Backhaul is the aggregation of a cell site's traffic—voice and data, transmitting and receiving—condensed into a single data stream connecting the cell site to the network's backbone.

The data-intensive demands of LTE networks mean backhaul must support higher traffic capacities than earlier networks. Globally, the most common and cost-effective way to achieve this is using microwave radios to provide the connectivity between sites.



Fast facts

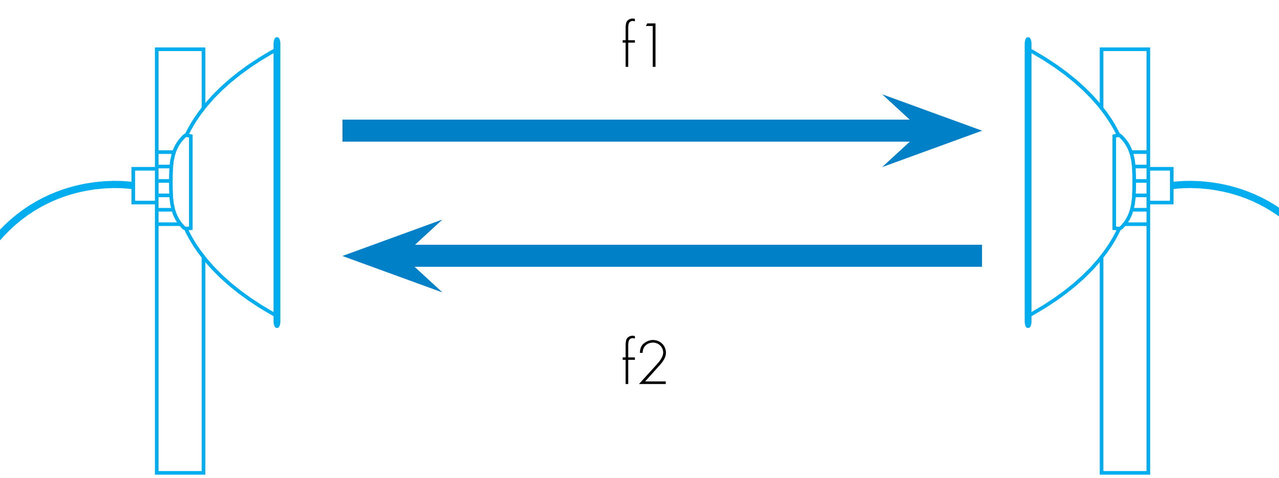
- An aggregated, line-of-sight microwave signal connects a cell site to the network's backbone via one or more links
- ETSI Class 4-compliant antennas greatly improve backhaul performance and efficiency over Class 3
- Lower sidelobes and better interference discrimination improve backhaul performance
- Smaller backhaul antennas reduce tower weight, wind load and costs

#10 best practice: Microwave backhaul

What challenges exist to effective backhaul?

Because backhaul networks rely on precise, line-of-sight connections between distant antenna dishes, misalignment due to installation errors or structurally inadequate towers can greatly reduce link efficiency. In addition, interference from poorly-planned adjacent networks can degrade link performance.

Fortunately, recent advances in microwave antenna design have given rise to cost-effective antennas that are compliant to the ETSI Class 4 specification. These antennas have greatly enhanced radiation pattern envelopes (RPEs) with lower sidelobes, allowing these antennas to support higher modulation schemes and, hence, increased data throughput. The superior RPEs also give better immunity from interference, improved spectrum reuse and, consequently, the ability to deploy far more links in a given area—critical for the high cell density of an LTE network.



Did you know?

Backhaul matters because mobile data is expected to increase eight-fold between 2016 and 2022.

(Ericsson Mobility report, June 2016)

#10 best practice: Microwave backhaul

Equipment selection

- Always choose quality and proper specification over price. While less-expensive antennas may save a little money up front, the purchase itself is a small part of the total cost of ownership when operational expenses are considered.
- Compliant Class 4 antennas provide more link availability, more capacity, and more efficient use of spectrum. Smaller antennas may be able to be deployed, reducing shipping and tower lease costs.
- Avoid third-party add-ons that have never been qualified with the antenna.

Environmental practices

- When designing a new microwave backhaul path, consider potential interference sources. The planned link must not interfere with adjacent links or other operators in the area.
- Microwave links require line-of-sight clearance. There can be no obstructions between transmitter and receiver, including the curvature of the Earth.
- Towers and mounting points must be capable of supporting the antenna without deflecting, even under wind speeds approaching the survival rating of the antenna.
- Ensure that antennas are installed in accordance with the manufacturer's instructions and that all hardware is correctly tightened.

Installation practices

- Rain, snow and other precipitation can degrade microwave links. Careful link design and choice of suitable frequencies can mitigate the effects of bad weather.
- Weather also affects a microwave installation's physical integrity. Accumulation of snow or ice adds weight, which must be accounted for in the site's design.
- Ensure your equipment is rated to withstand the maximum wind speed likely to be found at the site location and installation height.
- Ensure that the tower has a good grounding system and all components are correctly grounded.

Additional resources

Training

SP6105
Microwave radio antenna link fundamentals

Learn more

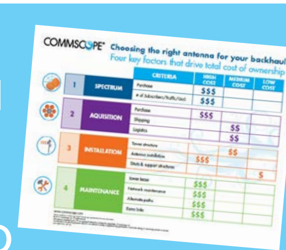
Tip sheet

Top five tips for optimizing microwave backhaul quality of service (QoS)

Learn more

Matrix

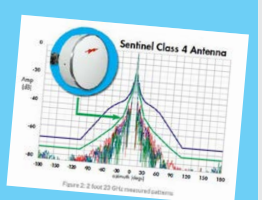
Choosing the right backhaul antenna: Four key factors that drive TCO



Learn more

White paper

Sentinel® antennas address growing capacity challenge in today's microwave backhaul network



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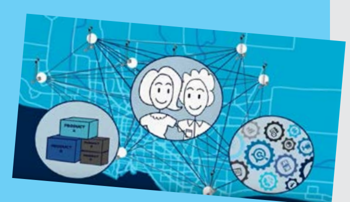
Video

Why microwave antenna side lobes matter



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Article

Top three antenna-related limiters to backhaul capacity

Learn more

BEST PRACTICE

#11 Fiber backhaul

#11 best practice: **Fiber backhaul**

What is FIBER backhaul and how is it different from MICROWAVE backhaul?

As shown in best practice 10, ***microwave backhaul*** moves aggregated voice and data traffic from a local connection point—that is, an antenna and radio—on and off the core network via focused, point-to-point microwave transmissions that "hop" from one antenna to the next until it reaches the central office. ***Fiber backhaul*** accomplishes this same task via a high-speed, low-latency fiber-optic network instead.

Why does fiber backhaul matter in LTE networks?

Simply put, fiber offers incredible potential that operators can put to work right away. It also has the capacity to support fast-approaching new technologies. Dedicated fiber backhaul infrastructure delivers high capacity without microwave backhaul's distance limitations, which can occur when the signal is converted between links. The capacity of a fiber can be further increased by multiplexing, a simple technique that pushes multiple channels (wavelengths) down a single fiber.

What are the challenges of using fiber backhaul in LTE networks?

From an initial investment standpoint, deploying new dedicated fiber backhaul can be an expensive option, as the cabling, installation and labor involved can present high up-front costs, particularly as compared to using microwave antennas. However, over the long term, fiber offers lower total cost of ownership (TCO) due to its high capacity, adaptability to new technologies, and its higher reliability.

Fast facts

80 percent of wireless traffic originates from indoors, yet only 2 percent of commercial spaces have dedicated in-building wireless solutions like small cells.

(Wireless In Buildings report, February 2016)

Deployments of small cells in public and commercial spaces are expected to grow 66 percent by 2021.

(Small cell deployments and installed base 2015-2020, 2016)

#11 best practice: Fiber backhaul

Equipment selection

- Choose fiber-optic closures and panels that offer both superior fiber management and are also user friendly both to install on day one and to work on subsequently.
- Plug-and-play connectivity solutions are key to long-term flexibility and cost-effective network rollouts.
- Consider using solutions offering value-added modules (VAMs) that simplify access to your fiber, for easier monitoring and troubleshooting with the addition of small, plug-and-play remote devices.

Environmental practices

- In locations where it is too expensive to add fiber cables, consider utilizing passive wavelength division multiplexing (WDM), an affordable way to run several feeds simultaneously on a single fiber in an already-installed cable. This helps existing fiber carry more traffic.
- Passive WDM solutions allow for multiplexing without the expense of additional power and space requirements at the remote location.

Installation practices

- Where financially feasible, install fiber counts within your cable in order to provide vital additional capacity for future applications like 5G, cell site densification and IoT applications.
- Observe minimum bend radius and support ratings of the cable used in order to prevent damage.
- Source fiber-optic infrastructure from one manufacturer to streamline installations, help establish repeatable processes and reduce costs.

Additional resources

Brochure

Fiber-optic connectivity solutions for wireless backhaul infrastructure

Learn more

Brochure

Think Fiber.
Think CommScope.

Learn more

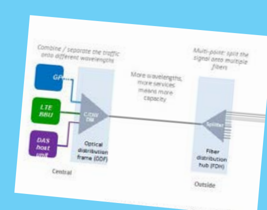
White paper

Introducing the NG4access® ODF platform

Learn more

Blog

CommScope definitions: What is fiber network convergence?



Learn more

Did you know?

CommScope's market analysis shows North American wireless operators are deploying more than 15 million feet of fiber per year.

90 percent believe advanced fiber will be fundamental to enabling 5G.

(Broadband Outlook report, October 2016)

BEST PRACTICE

#12 C-RAN

#12 best practice: C-RAN

What is C-RAN—and what is C-RAN?

C-RAN is shorthand for two distinct but related concepts, ***centralized radio access networks*** and ***cloud-based radio access networks.***

Centralized RAN is a revolutionary architecture now being deployed in the field. Its high-speed, low-latency fiber infrastructure removes the baseband unit (BBU) from the cell site to a shared, centralized location. Here, it shares space with BBUs from other sites to connect to the core network.

This arrangement is necessary for cloud-based RAN, wherein the functions of these BBUs can be virtualized in affordable, readily-available servers located in central offices and BBU pooling locations.

What do both kinds of C-RAN mean to LTE networks?

Regarding centralized RAN, taking BBUs away from the cell site reduces the amount of equipment needed at the site, which reduces complexity, latency and site space leasing costs.

Cloud-based RAN simplifies network management and makes it possible to more efficiently pool and coordinate network resources to improve network performance and reliability. Both are regarded as important parts of a successful 5G network strategy in the years ahead.

What are the challenges of deploying C-RAN?

Selection and provisioning of the fronthaul technology—the link between the BBU and the cell site—is one of the biggest challenges when deploying C-RAN. Network operators will need to consider a number of possible methods, such as:

- Traditional point-to-point microwave
- High-throughput millimeter wave (mmWave)
- Dedicated fiber (sometimes called "dark fiber" because it is not being used for something else first)
- Wavelength-division multiplexing (WDM) that combines multiple signals on a single fiber
- Existing passive optical networks (PON)

Another challenge is identifying and securing ideally-placed network-edge data centers where they will be most efficient and reduce interference.

Fast facts

C-RAN actually describes two concepts: centralized radio access networks and cloud-based radio access networks

Centralized RAN moves RF processing from the cell site to a shared central location

Cloud-based RAN removes BBUs altogether by virtualizing their function in data center servers

Both benefit from the remote BBU or server farm in a location nearest the cell edges for maximum efficiency

#12 best practice: C-RAN

Equipment selection

- Since C-RAN hub locations must manage a large amount of fiber, ensure you select fiber frames and panels that offer superior cable management and ease of use
- In locations where fiber is in short supply for the fronthaul link, WDM solutions can provide a quick fix to fiber shortage issues
- Optical distribution frame (ODF) systems should allow for upgradeable passive elements and optical modules for a "build as you grow" model

Environmental practices

- To efficiently connect cell sites, use environmentally-hardened optical connectors to protect against extreme temperature, moisture, UV, chemical exposure and other harsh conditions typically found in the outside plant
- C-RAN BBU pooling allows for lower energy consumption and reduced OpEx and CapEx costs
- Consider smaller terminals, which take up less space on a pole, hand-hole, side of a building, or wherever else they are installed

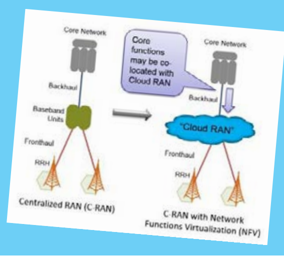
Installation practices

- Intuitive, plug-and-play connection to hardened adapters on terminals or closures decreases installation and maintenance hours by minimizing splicing required in outside plant networks
- All fibers should be protected throughout the network from accidental damage by technicians and equipment
- The best networks are built to be not only reliable, but also flexible, expandable, and—most of all—adaptable to whatever changing technology may require

Additional resources

Blog

CommScope definitions: What is C-RAN



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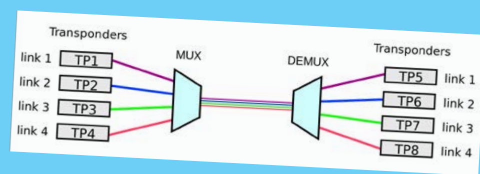
Blog

What is WDM?



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Article

WDM makes C-RAN affordable for network operators

Learn more

Brochure

Fiber optic connectivity solutions for wireless backhaul infrastructure

Learn more

Did you know?

More than half of respondents see reduced CapEx and simpler architecture as the biggest benefits of C-RAN adoption.

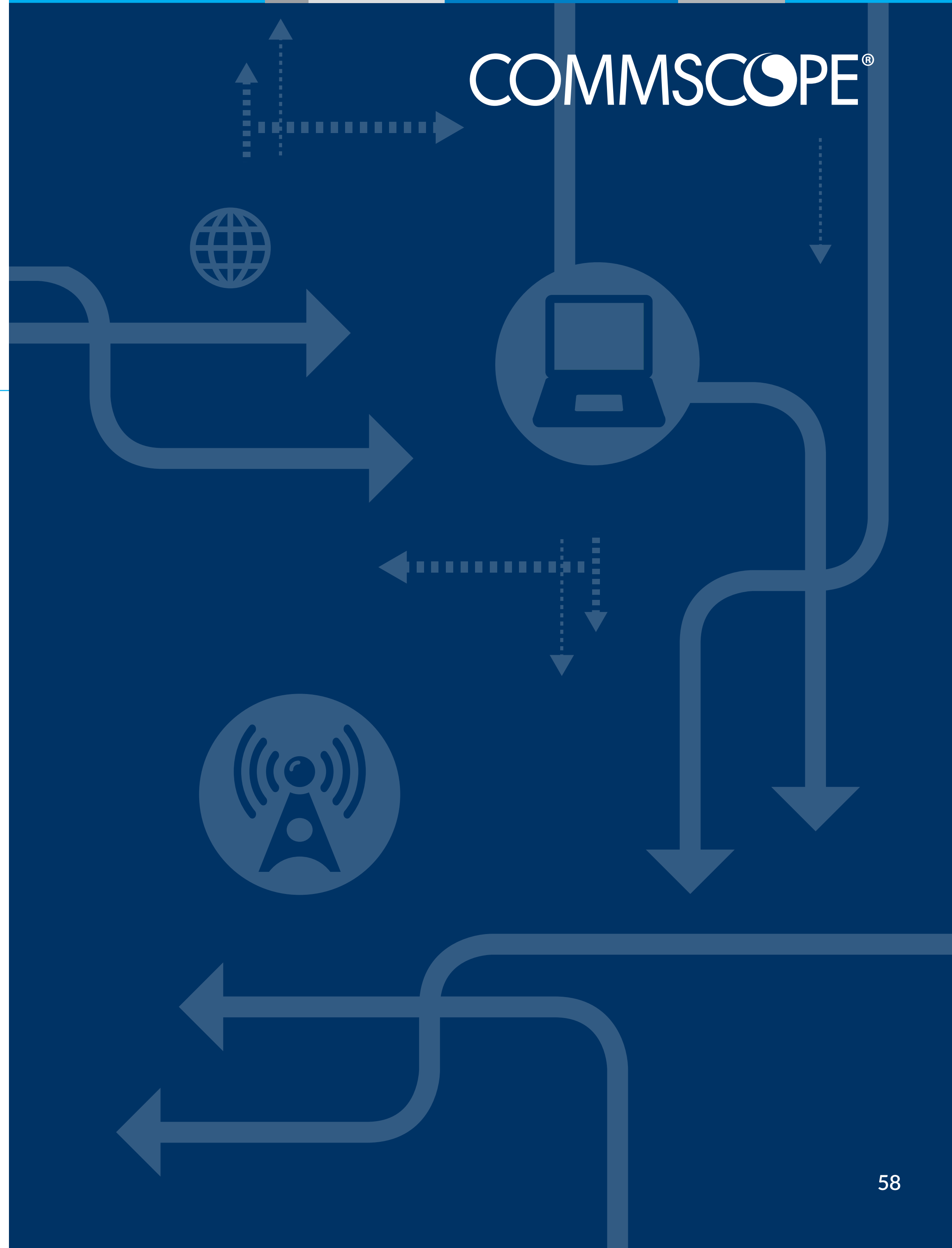
(Broadband Outlook report, October 2016)

C-RAN users enjoy improved battery life because their devices only have to track a single cell.

(Virtualizing the Cell, May 2016)

BEST PRACTICE

#13 Indoor small cells



#13 best practice: Indoor small cells

What are indoor small cells—and how are they different from DAS?

As their name suggests, indoor small cells are designed to bring wireless connectivity to an indoor area, rather than a swath of outdoor space (we cover outdoor small cells in best practice 14). Unlike DAS, indoor small cells include fully-functioning base stations that connect to an operator's core network. DAS uses a third-party base station instead.

How do indoor small cells fit into the larger LTE picture?

Indoor small cells provide localized coverage in structures that are poorly served by the macro network outside due to location, user density or materials used in the building's construction. Indoor small cells are particularly suited to medium-sized structures such as office buildings, small arenas, hospitals and schools where DAS may not be economical.

What are the challenges of indoor small cells?

Indoor small cells are typically less expensive to purchase and easier to install than DAS solutions, but they lack the capacity available in a high-end DAS. Also, small cells are operator specific, so multi-operator deployments require redundant infrastructure.

In a high-density deployment, the large number of individual small cells required to serve the space can lead to interference-causing areas of cell overlap. This reduces voice quality and data throughput, and forces frequent handovers as users move about the building. One way to address this challenge is with cloud radio access network (C-RAN) small cells, in which the access points are centrally coordinated to form a single "super cell" that removes sector boundaries altogether for better performance and QoS for the user. C-RAN small cells are also simpler and less expensive to deploy.

Fast facts

Indoor small cells are best for smaller structures where DAS is not practical or economical

Indoor small cells have their own integrated base station—unlike DAS, which uses a third-party solution to connect to the macro network

Cloud radio access network (Cloud RAN) is a new indoor small cell technology that eliminates cell border interference, greatly improving deployment economics and QoS.

Did you know?

A C-RAN indoor small cell system can serve a venue up to a million square feet with thousands of users.

#13 best practice: Indoor small cells

Equipment selection

- Standalone small cells are a good choice for smaller environments such as restaurants, retail shops or branch offices. C-RAN small cells are for larger environments such as hotels, shopping malls and office buildings.
- C-RAN solutions eliminate cell borders by creating a single “super cell” for the entire network. This eliminates interference so users enjoy good connections throughout the covered space.
- Some indoor small cell solutions can run on standard Ethernet cabling and switches—an economical and IT-friendly way to deploy.

Environmental practices

- Aesthetics matter with indoor spaces. Access points should be attractive and unobtrusive. They should be plenum-rated so they can be installed above a hung ceiling, if desired.
- Choose ruggedized options for environmentally unprotected areas like parking lots, courtyards and entryways.

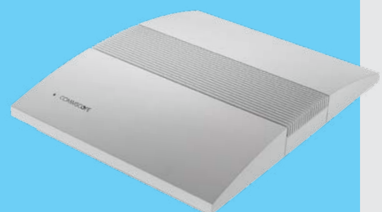
Installation practices

- The wireless operator’s management system is a vital part of the deployment. It accelerates provisioning and optimization and simplifies ongoing management of an indoor small cell deployment.
- With some solutions, Power over Ethernet (PoE) can be used to provide both power and data connectivity to each indoor small cell access point.

Additional resources

Web page

C-RAN small cells



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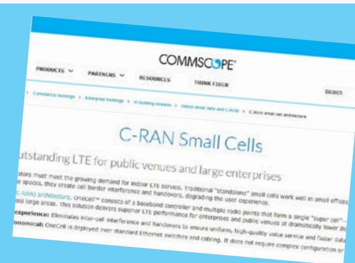
Web page

OneCell® C-RAN small cell system



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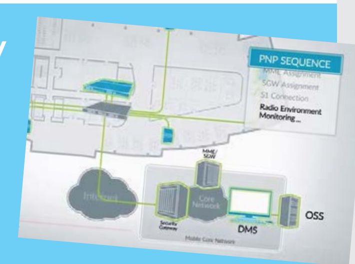
Web page

Plug and play with OneCell DMS



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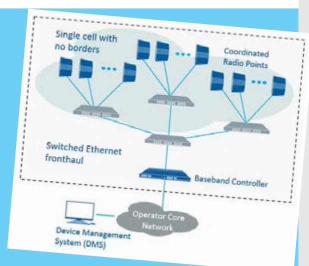
Web page

What are C-RAN small cells?



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Video

OneCell explained

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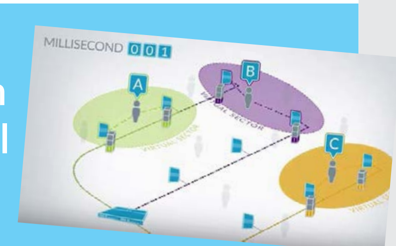
Video

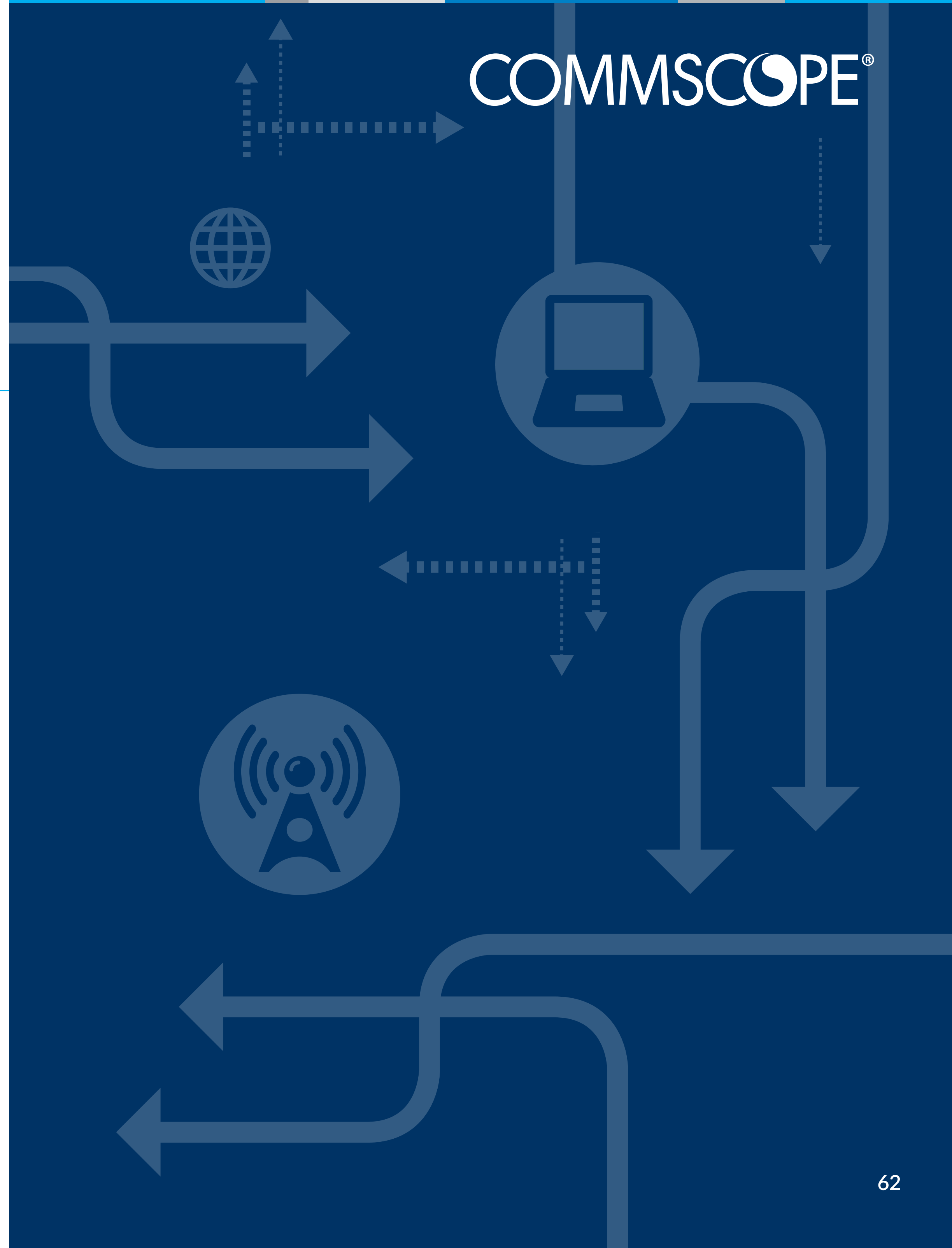
Cell virtualization with OneCell



Learn more

BEST PRACTICE

#14 Metro cells



#14 best practice: Metro cells

What are metro cells?

Metro cells are a part of the larger family of small cell solutions used to enhance coverage and capacity in densely-populated areas where adding macro network infrastructure is impractical. They include femtocells (small “hotspots” serving a house-sized area), picocells (serving from 50 to 100 users in a larger area), and microcells (indoor or outdoor sites that work like a macro site, but smaller).

Metro cells are an example of a microcell architecture, with many unique advantages in how they can be deployed and operated.

What makes a metro cell different from ordinary macro sites?

Metro cells are small, unobtrusive outdoor cell installations. They provide the same kind of coverage and capacity as a traditional cell site, but are designed to blend into their environment and become almost invisible. Only a few feet tall, metro cells can be mounted on light poles, rails, rooftops and other low-cost, close-to-demand locations in urban locations, earning them the name “metro cell.” This is a big advantage as many local jurisdictions enforce strict limits on size, weight and appearance on outdoor sites.

What macro LTE network features power metro cells?

Metro cells distinguish themselves from other small cell solutions in that their small form factor still includes a complete, integrated LTE-capable system, including customizable antennas, radomes, backhaul solutions and power solutions. They support multiple operators and multiple technologies.

Perhaps most importantly, they also feature capacity-optimizing technology like remote electrical tilt (RET) that is otherwise generally found only in macro LTE site deployments. RET allows the antennas to be adjusted remotely to maximize coverage, boost reliability and reduce interference with other sectors.

Fast facts

- Metro cells are considered microcells, a subset of the small cell ecosystem of solutions
- Metro cells are designed to blend with their surroundings to provide coverage and capacity in more regulated spaces
- Being small and light, metro cells can be deployed on light poles, railings, rooftops or other low-cost lease spots
- Metro cells are complete, integrated LTE-capable sites that share macro site advantages of multi-operator, multi-tech and RET-optimized service

#14 best practice: Metro cells

Equipment selection

- Choose antennas with patterns that minimize sector overlap in the azimuth (horizontal) plane.
- Ensure that antennas have electrical downtilt, allowing for fine-tuning coverage and a sharp cell edge.
- Select antennas with maximum upper sidelobe suppression available to avoid interference.
- Choose a combiner that covers both bands used by diplexers and splitters.

Environmental practices

- Choose a design that blends in with the surrounding area to improve chances of trouble-free permitting.
- Attempt to utilize convection-cooled designs in order to minimize noise.
- Ensure that energy-efficient practices are followed throughout the deployment.

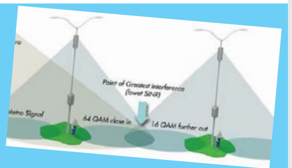
Installation practices

- Perform a proper structural analysis (wind loading, terrain category, foundations, soil type and so forth) prior to installation.
- Identify all sources of PIM and leverage antenna nulls to minimize or eliminate its effects.
- Ensure RF connectors are properly torqued and waterproofed to manufacturer specifications.
- Ensure all equipment is bonded properly and equipped with surge suppression where required.
- Secure and protect cabling to prevent strain, vibration or environmental damage.

Additional resources

White paper

Improving metro cell performance with electrical downtilt and upper sidelobe suppression



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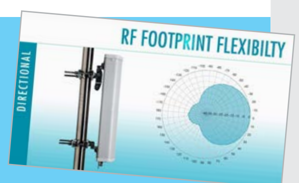
Video

CommScope's integrated Metro Cell solution

Learn more

Video

CommScope's Metro Cell solution delivers superior value and cost efficiency from day one.



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Success story

Ooredoo Tunisia turns to CommScope for rapid-deployment concealment solutions

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Did you know?

LTE will account for more than 40 percent of all connections—the largest share of the market—and 72 percent of all wireless traffic by the year 2020.

(Cisco VNI Mobile forecast, February 2017)

BEST PRACTICE

#15 MIMO implementation

#15 best practice: MIMO implementation

What is MIMO?

Multiple-input, multiple-output (MIMO) is a technique that uses multiple transmit and receive antennas to greatly increase the capacity and coverage of a cell site. MIMO exploits multipath propagation to simultaneously send and receive more than one data stream (either one signal or multiple signals) over a given channel—effectively multiplying the capacity of that channel and vastly increasing network performance.

Why does MIMO matter in LTE networks?

MIMO offers an innovative, low-cost way to increase capacity and coverage, a critical advantage to fast-growing LTE networks. By installing MIMO-supporting radios, an existing site can be upgraded to 2x2 MIMO to double capacity (or even quadruple it, with 4x4 MIMO). This can be an affordable alternative to building out new sites to increase capacity.

MIMO increases spectral efficiency, or how much traffic a network can carry across a given set of frequencies. This improves the user experience and increases customer satisfaction—making it one of the best features around.

What are the challenges of MIMO in LTE networks?

The gains from MIMO described here are theoretical. In actual practice, MIMO performance is extremely sensitive to interference. A high signal-to-interference-plus-noise ratio (SINR) is critical to realizing full MIMO benefits. A SINR greater than 20 dB is ideal, yielding performance and QoS improvements approaching the theoretical limits. When SINR drops to about 15 dB, these benefits virtually disappear. At a SINR of 10 or less, MIMO may even degrade performance compared to simpler transmission modes like transmit diversity or SISO (single input single output) systems.

Therefore, to realize MIMO's full potential, interference (including PIM) must be kept at an absolute minimum—a goal that underpins many LTE best practices in addition to MIMO.

Fast facts

MIMO works by transmitting and receiving simultaneously multiple data streams over multiple antennas to increase channel capacity

2x2 MIMO is a system with two source (transmitter) and two destination (receiver) antennas, theoretically doubling a channel's throughput; 4x4 MIMO quadruples it

LTE Advanced supports up to 8x8 MIMO

By 2020, residential broadband requirements are expected to increase four-fold.

(Understanding 5G: Perspectives on future technological advancements in mobile, 2014)

#15 best practice: MIMO implementation

Equipment selection

- Use antennas with a high number of internal arrays to accommodate the greater antenna count that comes with MIMO configurations.
- Remote electrical tilt (RET) capability is desirable for antennas used in today's LTE networks.
- Select compact remote radio units (RRUs) that are MIMO compatible to maximize the tower space available for antennas.
- Beamforming is an essential part of efficient MIMO operation. Insist on high-quality antennas that offer high performance patterns and product reliability to get the most from your MIMO installation.

Environmental practices

- With greater numbers of deployed antenna ports, it's particularly important that MIMO arrays and their connections are adequately weatherproofed.
- Since interference quickly drains MIMO benefits, ensure that any external interference is properly mitigated. Use interference mitigation filters (IMFs) if necessary.
- Be sure to purchase products that are specified and tested over the full range of environmental conditions appropriate to the location.

Installation practices

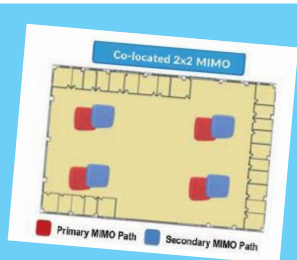
- Installation can be greatly accelerated and simplified by using a pre-assembled tower top that can be pre-configured and placed on the tower as a single assembly.
- PIM is a major source of performance-sapping interference at cell sites. Ensure all connections are properly torqued and sealed to reduce PIM in the RF path.
- Effective PIM testing can help identify any potential problems in MIMO-upgraded sites, particularly in the uplink path.
- Mapping radios to antenna ports is crucial in activating the correct internal antenna arrays, particularly when using multiband antennas.

#15 best practice: MIMO implementation

Additional resources

White paper

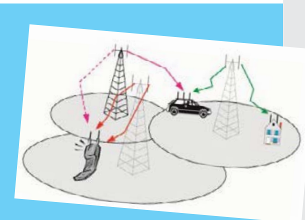
Interleaved MIMO



Learn more

Blog

CommScope definitions: What is MIMO



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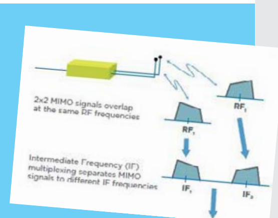
White paper

Distributed antenna systems and MIMO technology



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Blog

Strengthening the business case for MIMO over DAS

Learn more

Did you know?

"Massive MIMO" is an emerging evolution that uses 8x8 configurations (64 elements) or more and may someday grow to even hundreds or thousands of antennas (think 100x100!) to further increase efficiency, reliability and throughput.

75 percent of the world's wireless data traffic will be video by 2020.

(Cisco VNI Mobile forecast, February 2017)

LTE best practices: Conclusion

LTE: a new generation, a new set of rules

The LTE revolution comes with its own set of rules. Its increased complexity poses new challenges for wireless operators all over the world—challenges including:

- Sharing sites with other technologies
- Increasing backhaul capacity
- Adapting to changes in tower-top architecture
- Eliminating interference and overcoming PIM

These best practices cover the basics of these new rules and we sincerely hope you have found them interesting and useful. However, there are other solutions and other strategies to discover that can help you build a better LTE network.

Wireless networks all over the world run on CommScope. As an industry leader with decades of expertise and innovation, we design and build the solutions that power LTE and other wireless technologies. We collaborate with operators around the world to help them get optimal results from every investment. We invite you to contact your CommScope representative to see how collaboration can help you build a better LTE network—and a better business.

Need to discuss best practices for your LTE network?

Contact us now.

Everyone communicates. It's the essence of the human experience. ***How*** we communicate is evolving. Technology is reshaping the way we live, learn and thrive. The epicenter of this transformation is the network—our passion. Our experts are rethinking the purpose, role and usage of networks to help our customers increase bandwidth, expand capacity, enhance efficiency, speed deployment and simplify migration. From remote cell sites to massive sports arenas, from busy airports to state-of-the-art data centers—we provide the essential expertise and vital infrastructure your business needs to succeed. The world's most advanced networks rely on CommScope connectivity.

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