CORNING

Future-Ready Mobility

Small cells, DAS, and crafting a future-ready mobility landscape

No bars? No thank you.

Executive Summary

The enterprise rallying cry of "no bars, no thank you" is heard far and wide across the land. It can be heard in real estate acquisition and lease renewal. It can also be heard when enterprise facilities managers shift well-connected employees to an area with insufficient cellular coverage. When employees loudly push back due to poor service, it's a clear sign that mobility is not just an optional amenity, but it's mission critical.

Richer apps and experiences that incorporate video will continue to drive the tremendous traffic growth in enterprise cellular consumption, accelerating wholesale replacement and integration of enterprise communications platforms. This will, in turn, accelerate the adoption of progressive strategies that value both Wi-Fi and cellular as equally important halves of a total wireless solution.

Exciting times, indeed.

In this white paper, we will illustrate how:

- Buildings of all sizes, educational and business campuses, and geographic areas can be easily equipped with a solid mobile foundation.
- Taking a future-ready stance in acquiring systems today will help this investment carry over into the 5G era.
- Capacity in long-lived transport infrastructure needs to be able to satisfy the expected 48% CAGR of smartphone traffic.
- The flexibility of enterprise small cells can address a variety of cellular demands, including replacement of legacy base stations.
- Small cells and DAS can be integrated to provide a flexible environment that incorporates emerging cellular technologies.

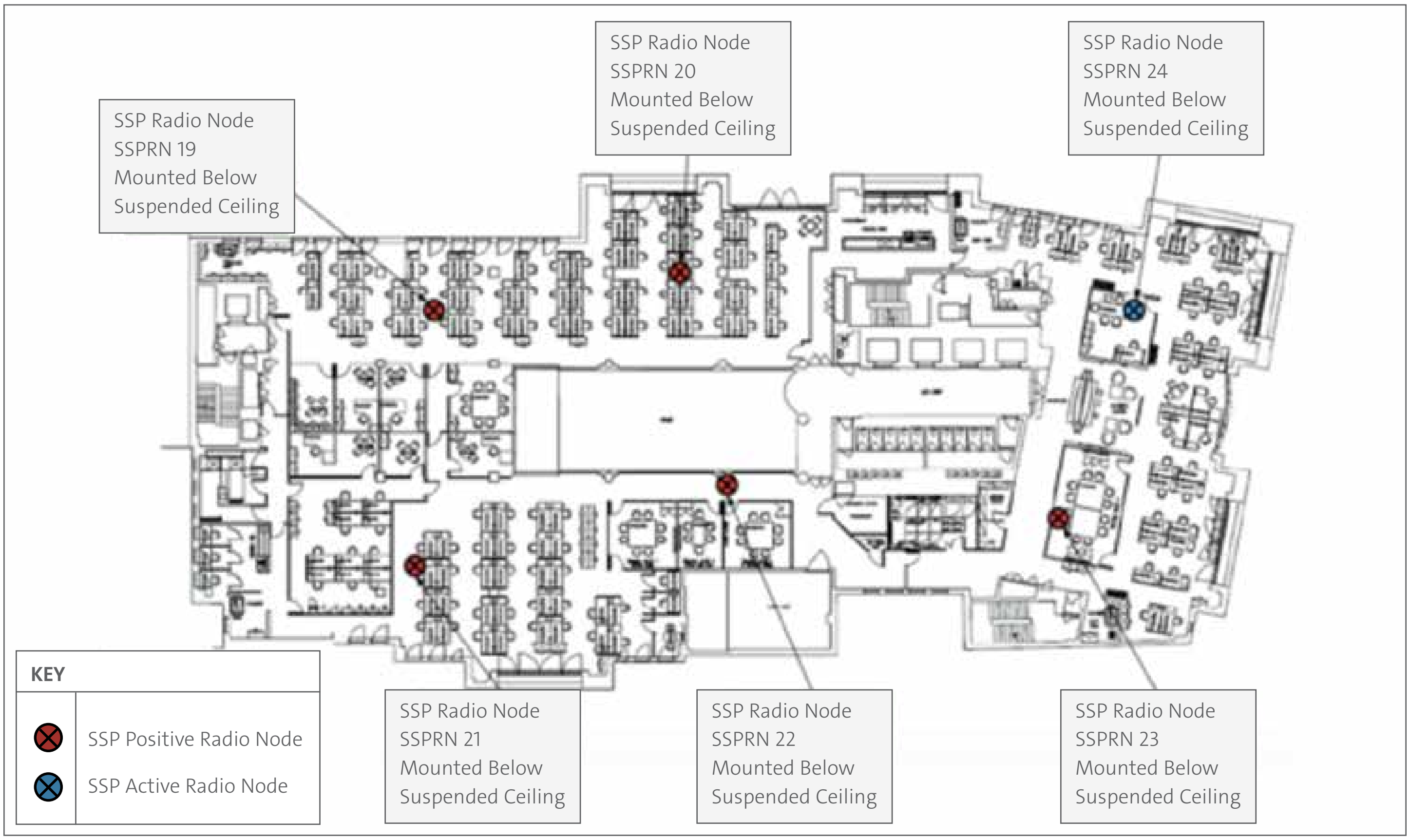
Introduction

The term "future-ready" implies that investments in cellular systems today can be used at least in part for the 5G transition that's coming. Simply put, future-ready infrastructure investments are made a forward-leaning direction, so that they can be valuable during 5G transition. The term "future-proof" does not apply in this situation, because it implies a guarantee that the whole investment will carry over.

Now, let's examine each portion of the technology stack and identify a future-ready posture based on what we know today.

Transport Infrastructure

Let's start at the bottom of the technology stack, which will be based on optical transport in our future-ready infrastructure. Optical infrastructure has been the sole solution in the vertical telecom riser since the 1990s, so there is nothing new to consider here. In greenfield construction, the expected 48 percent CAGR of cellular traffic combined with more than 20 years of depreciation drives the installation of riser cabling with massive fiber counts. Given the significant construction costs to remediate an undersized cable plant, installing at least a 500-fiber cable to each floor's telecom closets is the more practical approach to take.



Actual As-Built Densification Floor Plan

Horizontally, technology is shifting from copper to fiber. Indoor cellular will almost certainly require optical transport to handle the planned data rates of the future. Beyond data rates, the other driver that creates system capacity is densification, or many smaller cells/sectors. Devices perform better on smaller cells because there are less devices contending for each cell's finite resources. Densification implies that estimated coverage areas must be assumed during design and plenum cabling must be installed in the overhead to feed them. Similar to riser environments, installing higher fiber count is recommended. Additionally, to power a coverage area's network infrastructure, use composite cabling that has copper conductors for power along with the optical fibers for network traffic. This strategy reduces implementation costs and long-term operations expenses by centralizing the floor's horizontal infrastructure power and network to its telecom closet(s).

> "future-ready infrastructure will be based on optical transport"

Distributed Antenna System (DAS)

After establishing a future-ready transport, active electronics must be connected. For most buildings today, there is a desire to support two or more mobile operators. The two major U.S. operators are important to enterprises due to their national network coverage and focus on the enterprise market. Depending on building size, the solution of choice could be small cells or DAS; however, let's assume that we want to choose DAS for a building.

There are several generations of technology competing against each other in the DAS market, and many may not be future-ready. To simplify the discussion, let's compare this to cars. Today, if a luxury car company was still building 2009 model vehicles alongside 2019 models, would you really buy a 2009 version if you had a 2019 version available? This is the state of available DAS solutions – options range from coax cables with very lengthy hand-crafted installations to software-driven modular optical platforms that operate by software and a keyboard. The 2019 models support mmWave, 5G-NR, user speeds well above 1 Gbps, and cell densification.

DAS 5G-NR Test Results

Pass

Band: PCS (Band 2)
CH BW: 20 MHz
CH Power: 33 dBm
RMS EVM: 0.8%
(limit 3.5% max)

Most important future-ready consideration is that most DAS installed today will experience spectrum refarming. Refarming means that the LTE signal source on the DAS headend will be replaced with a 5G signal source. At Corning, our engineering teams have already tested and successfully passed 5G-NR over our optical DAS solution. When evaluating products today, a future-ready DAS already has 5G-NR test results available.

> "future-ready DAS already has 5G-NR test results available"

Small Cells

The Corning SpiderCloud® enterprise radio access network (E-RAN), with a broad family of radios, flexible deployment topology, and IP/Ethernet transport, is the key to servicing more locations than ever before. The radio nodes enable unprecedented cellular coverage and capacity through secure IP/IPSec data connections over readily available Ethernet and internet services. An E-RAN system is made up of one services node that manages a group of radio nodes (access points) that are attached to it.

Services Node

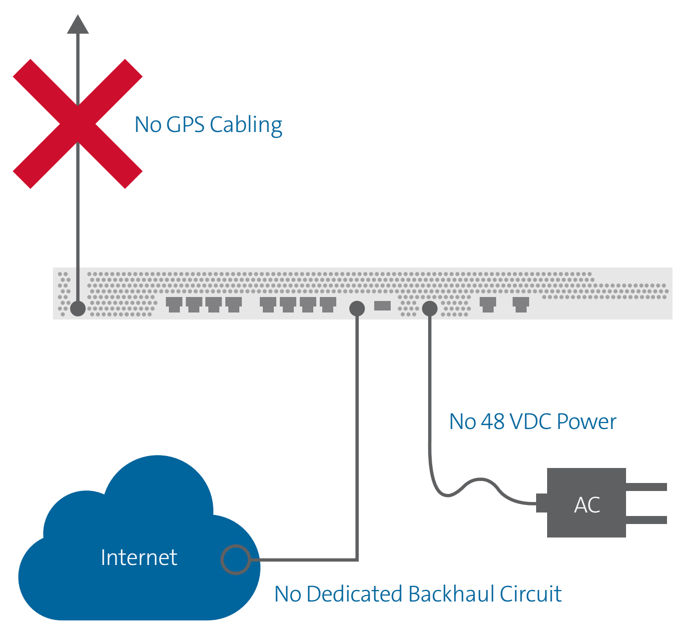
The services node lies at the heart of the SpiderCloud E-RAN solution. It ensures that the E-RAN system is easy to deploy and manage and that it delivers the performance mobile operators expect. The services node is access technology agnostic, supporting UMTS, LTE, and LTE-LAA. It orchestrates the self-organizing network (SON) process, controls the operation of different radio nodes during neighbor discovery, gathers information from different radio nodes, and creates optimized neighbor lists based on information received from the neighbor scans.

SON capabilities include:

- Discovering macro cells in the area, along with the internal small cell and Wi-Fi topology.
- Assigning UMTS primary scrambling codes, LTE physical cell identifier, and LAA unlicensed channels.
- Setting maximum transmit power levels.
- Automatically configuring cell neighbor lists to make the system operational.

Installation benefits for E-RAN compared to base stations include:

- No GPS cable required; typical installation cost is $3,000-$6,000 and up to $50,000 in a high-rise building.
- No -48 VDC power source required.
- Two standard 110 VAC wall outlets required for services node. That's it.
- No dedicated backhaul circuit required. A 1 Gbps MPLS or metro Ethernet drop can cost thousands of dollars per month.
- 1 RU (1.75-in) of space required in 19-in rack.



Radio Nodes
Like Wi-Fi access points, radio nodes are small with low profiles. The E-RAN offers a wide range of radio nodes for many applications and mobile operator configurations. All models are powered by PoE+ (802.11at) Ethernet switch ports.

Installation is quick and easy using commonly available PoE+.
1. Pull a structured cable (CAT 5e or greater).
2. Attach the radio to a wall or ceiling.
3. Connect Ethernet patch cords at both ends.

The available family of radio nodes is shown below.

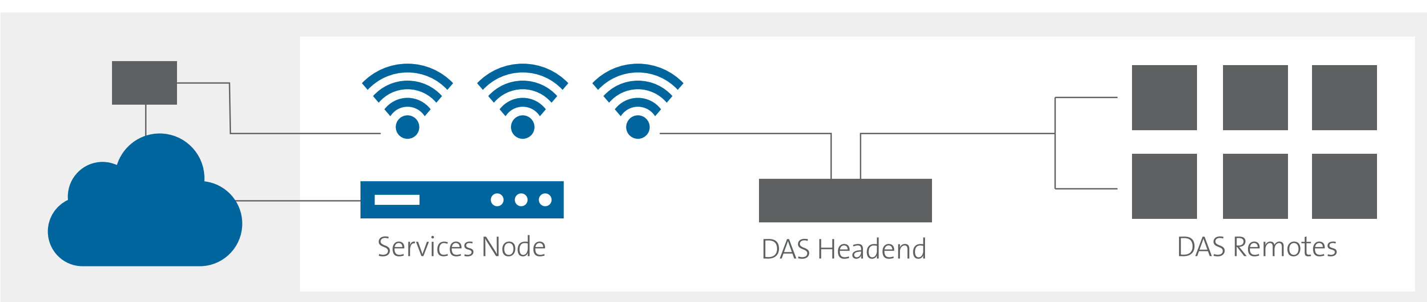
Capabilities	SCRN-310 Dual LTE	SCRN-220 Agile LTE	SCRN-320 LTE-LAA	SCRN-330 TDD-LTE CBRS	SCRN-340 Dual LTE
Available bands	Band 4 & 13 Band 4 & 2	Band 4 (66), Band 2 (25), Band 12, or Band 13	Band 4 + 5 GHz Band 2 + 5 GHz Band 4 (66) + 5 GHz	Band 41 (Sprint) or 48 (CBRS)	Band 2 (25)/4 (66) and Band 13/14 (FirstNet)
Peak speed (Mbps)	225 Mbps (-0413) 300 Mbps (-04L2)	150	270 Mbps (Chan 32 only) 400 Mbps (3 CCA)	Peak DL rate of 100 Mbps with FC2	150 Mbps
Transmit power	250 mW	500 mW	500 mW	500 mW	500 mW
Coverage	8,000 – 10,000	10,000 – 13,000	10,000 – 13,000	10,000 – 13,000	10,000 – 13,000
Antennas	Internal External as option	Internal External as option	Internal External as option	Internal External as option	Internal External as option

Deployment Options

The E-RAN is very flexible and can be deployed in three modes to maximize use of resources and provide the premium quality cellular services that subscribers expect. From a 10,000 sq ft retail shop to a 1,000,000 sq ft building, there is a solution.

E-RAN has three deployment modes:

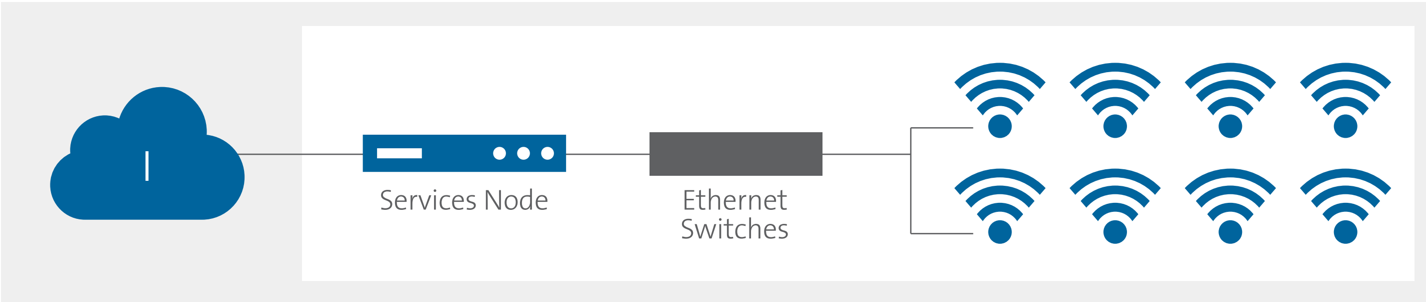
Driving DAS Headend



On a per-sector basis, E-RAN can save an operator or enterprise 30 percent over a traditional base station. Multiple mobile operators have already switched to E-RAN for their enterprise DAS customers. Additionally, the internet is used to connect to each operator's core network instead of through expensive private networks.

Corning has developed a mounting rail, brackets, and passives kit for use in E-RAN headend construction. It ensures that DAS installations have a stable radio installation. It also creates a point-of-interface (POI) to the DAS headend for use in operations and management.

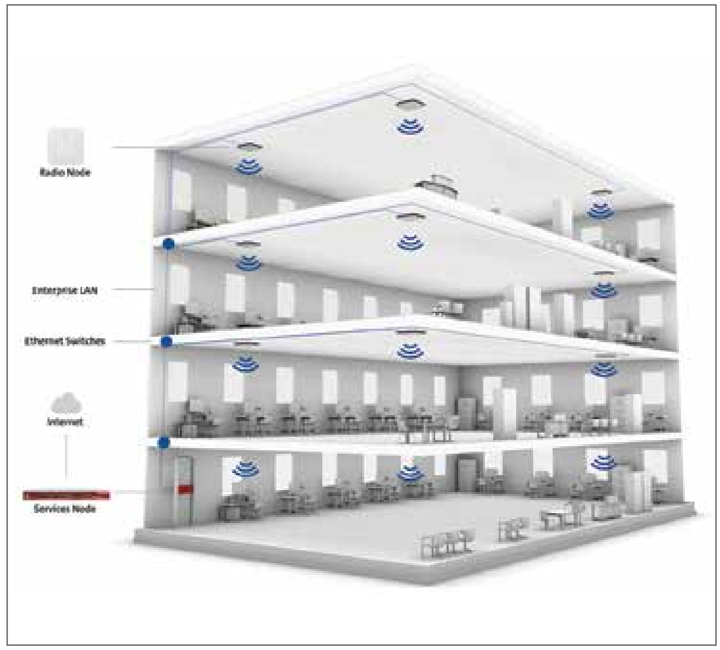
Traditional Small Cell



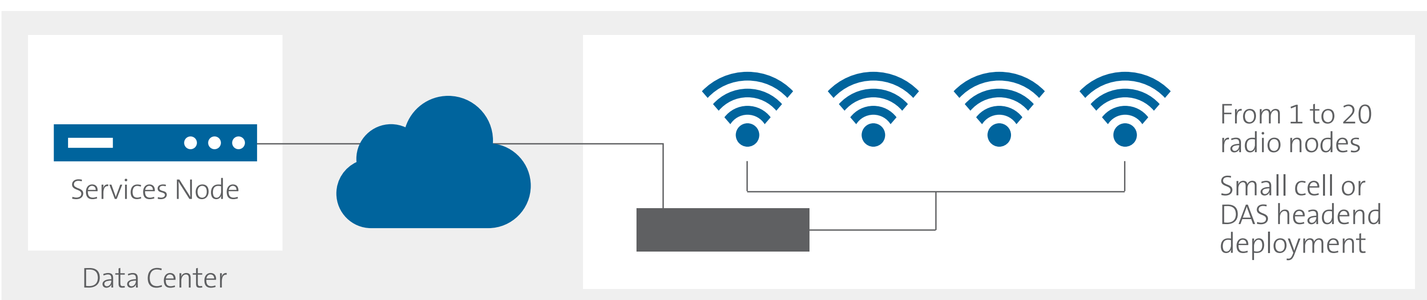
E-RAN can be deployed like a Wi-Fi network throughout a commercial structure using an Ethernet VLAN supplied by the enterprise for transport. When a single operator configuration is required and throughput-per-square-foot matters, E-RAN shines for cost savings, ease of installation, and quality.

In tight budgetary situations, an E-RAN can get the first operator in-service and during next budget cycle, a Corning DAS solution can be implemented that reconfigures the E-RAN for use in the headend.

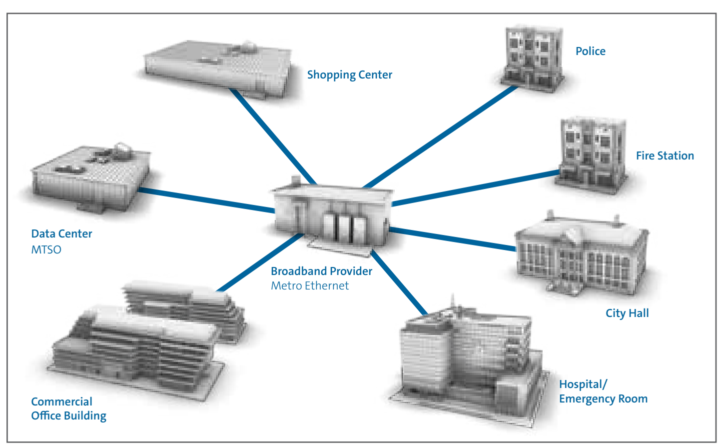
INVESTMENT PROTECTION:
E-RAN "distributed small cells" installation can be pulled back to headend and drive Corning® ONE™ DAS solution when enterprise is ready to add additional operators.



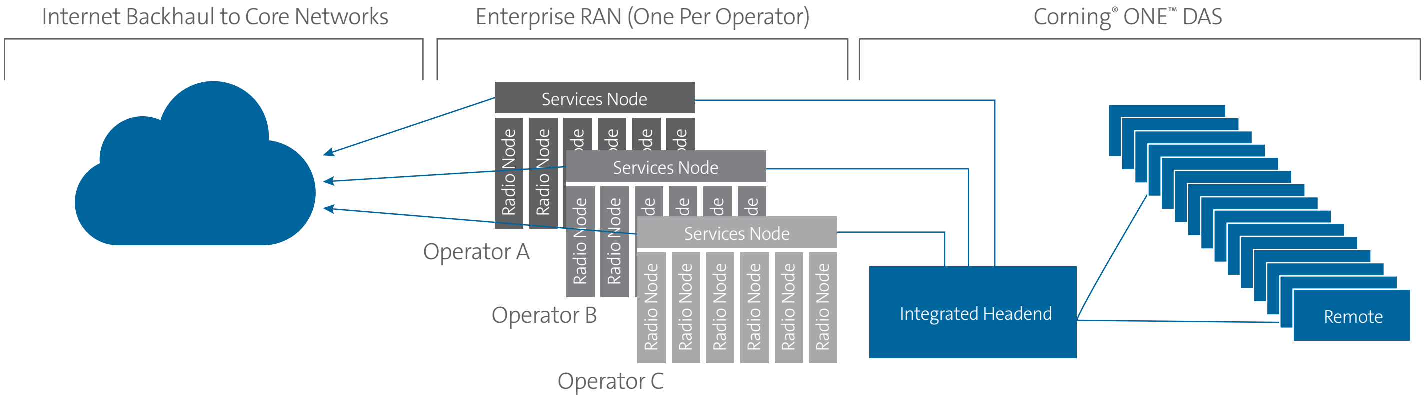
Centralized Services Node



E-RAN can also be used to support a geographic region, like a college campus or downtown area. In this deployment, the services node is shared in a data center. The buildings are IP connected via installed radio nodes. This shares the capacity of the services node and internet backhaul across all of the attached buildings. This installation can easily drive traditional small cell or DAS headend configurations in remote buildings. Example urban configuration outlined below.



Hybrid Integration



The pain of acquiring base stations directly from operators significantly improved in the last year when three of the four major U.S. mobile operators approved small cell E-RAN as a suitable replacement for the traditional base station. Corning has many E-RAN-fed DAS sites up and running across the U.S., and it is a proven solution. For enterprises who must fund entire installations, E-RAN offers the headend advantages of lower acquisition cost, monthly electricity use at a fraction of comparable alternatives, and lower physical space consumption.

Base Station	
146,765 kW	Annual Power Usage for Two eNodeB
62,026 kW	Annual Power Usage for 5 Tons Headend AC
216	Annual Tons of CO2 (Base Station + AC)
$40,297	Cost of Power (New York)
$28,395	Cost of Power (Dallas)
$38,417	Cost of Power (Los Angeles)

E-RAN	
6,010 kW	Annual Power Usage for Two ERAN
-	No AC Required in E-RAN Headend
6	Annual Tons of CO2
$1,160	Cost of Power (New York)
$817	Cost of Power (Dallas)
$1,106	Cost of Power (Los Angeles)

Corning E-RAN Business Savings	Year One	Year Two to Five
Savings by Purchasing Corning E-RAN	$207,474	-
Electricity Cost Avoidance (Dallas Cost Basis)	$27,578	$137,890
Carbon Footprint Reduction	210 Tons	1,049 Tons

Summary

Corning offers an end-to-end future-ready solution today that features:

- High-capacity optical transport to equip vertical risers and composite cables for horizontal zone-based designs.
- Software-driven optical DAS solutions that are proven to carry 5G-NR signals
- A SpiderCloud® E-RAN small cell platform that is approved by three of four major U.S. mobile operators and features a wide range of available cellular radios.

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From cabling to licensed/shared/unlicensed spectrum, Corning enables future-ready enterprise mobility. To explore further, visit **corning.com/wireless**.

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