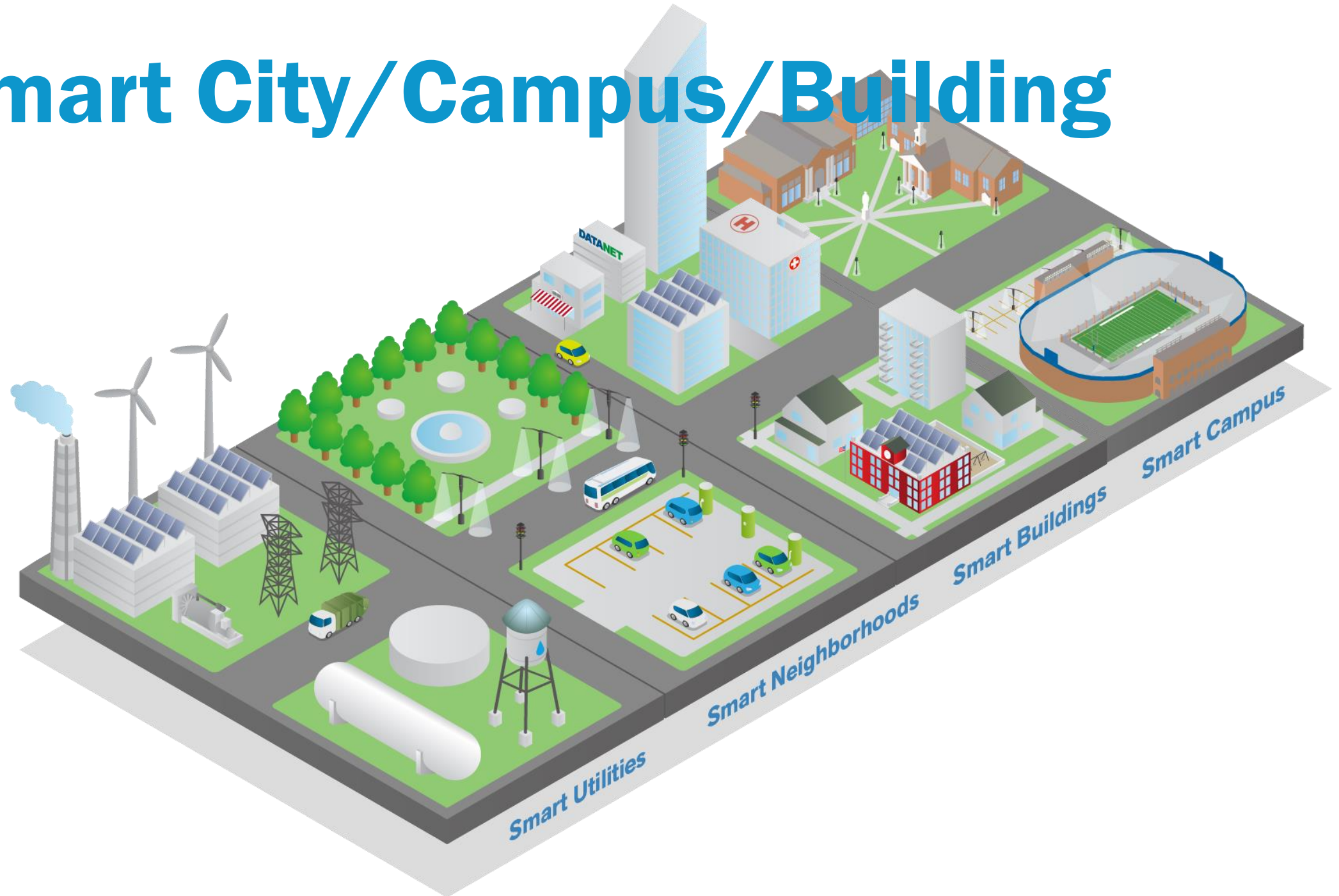


# Smart City/Campus/Building





# LIGHTS? WATER? **WIRELESS!**

In office buildings and facilities across America, basic amenities like electrical, gas and plumbing are essential components that are planned and constructed.

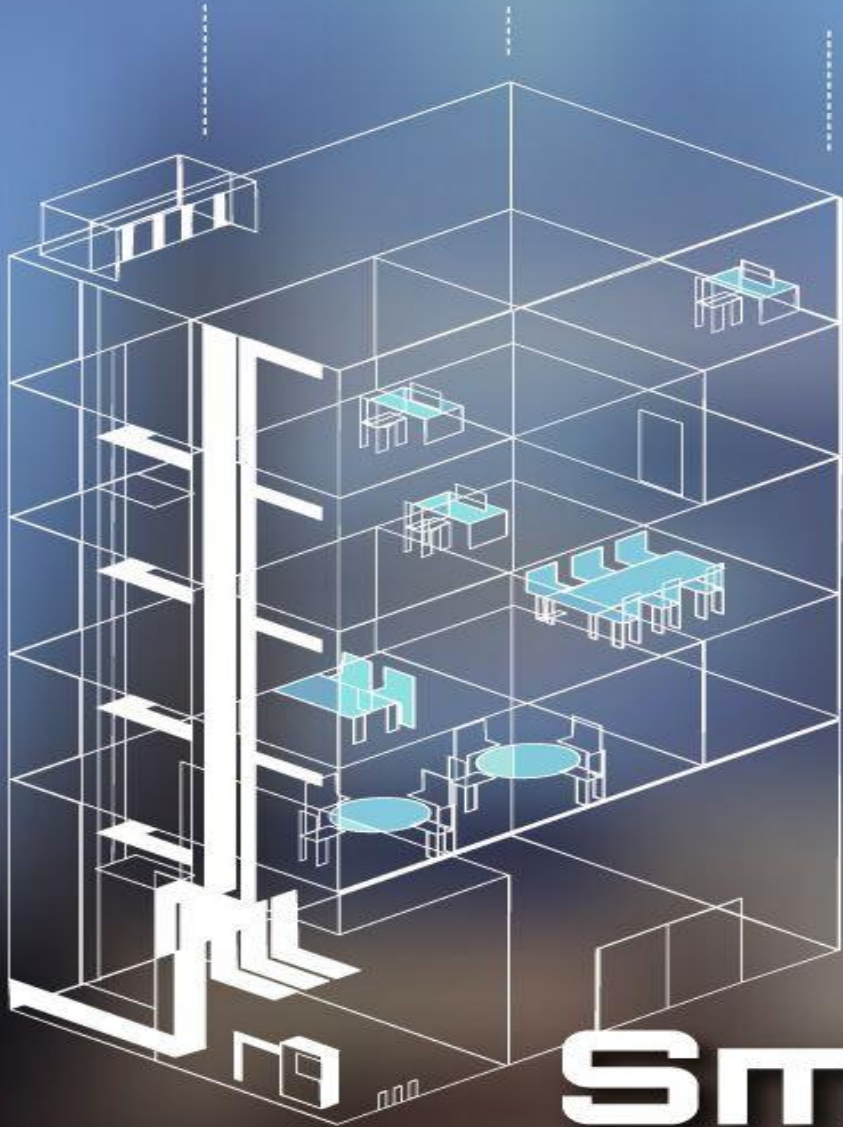
The new amenity being planned or added by building owners, architects and operators?

**Reliable, in-building wireless coverage.**



- IoT Sensors & Controls
- Security
- Access Controls
- IPTV
- Lighting Controls
- Building Automation
- Passive Optical Network
- WiFi
- Distributed Antenna Systems – cell, public safety, private radio, paging
- Voice
- Telemetry
- Any IP-based System

# BUILDING MANAGEMENT SYSTEM



# Smart Buildings

# Capacity

# Coverage



# Bandwidth

ENTER

[click here for more information](#)

# IN-BUILDING WIRELESS INFRASTRUCTURE

## WHY INVEST?

- It's needed everywhere: In commercial offices, university buildings, stadiums, retail spaces – anywhere teams of employees, tenants or large crowds gather.
- With 80% of mobile traffic starting and ending in a building, owners, operators and commercial developers recognize wireless infrastructure is crucial – just like HVAC, electrical and plumbing.



## BUILD YOUR OWN COVERAGE

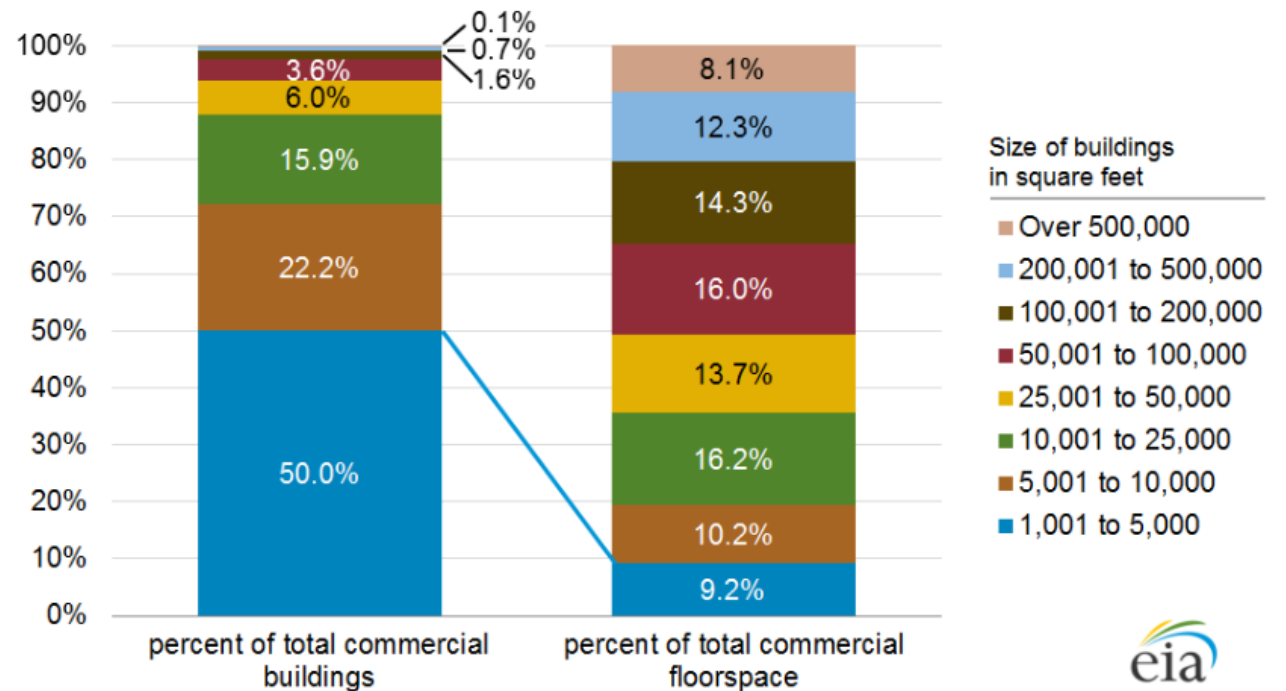
### T-MOBILE HELPS BUILD INDOOR WIRELESS NETWORKS FOR:

- Arenas / Stadiums
- Casinos
- Commercial Real Estate
- Government Buildings
- Hospitals
- Hotels
- Malls
- Military Facilities
- Resorts
- Residential Buildings
- University Campuses
- Warehouses

# In-Building Public Safety – US Market Size

- 5.6 million commercial buildings in the United States in 2012
- 87 billion square feet of floorspace
- 14% increase in the number of buildings and a 21% increase in floorspace since 2003

Figure 2. About half of all commercial buildings make up less than 10% of total floorspace



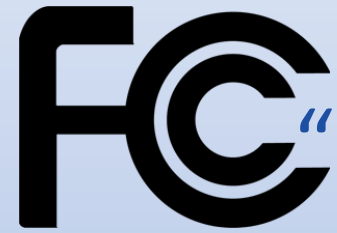
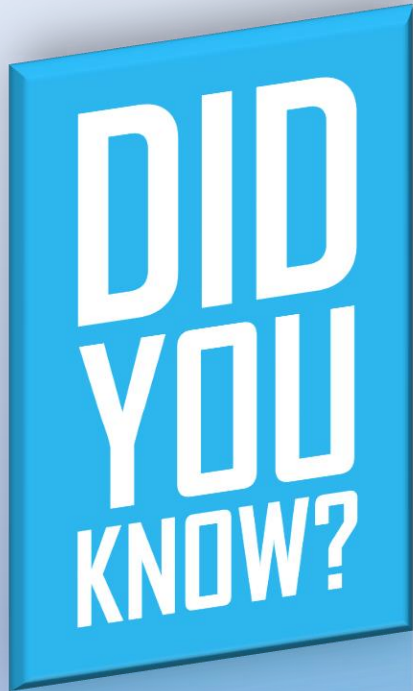
Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey

Source:  
Commercial Buildings  
Energy Consumption Survey  
(CBECS)





# Driver: NG911 Location Accuracy



“The FCC estimates that a one minute improvement in 9-1-1 dispatch time could save 10,000 lives each year”

# Low-e Glass

6 mm Glass Pane = **-0.8 dB** @ 900 MHz

Double Glazing w/ 2 coated Glass Pane = **-23 dB** @ 900 MHz

	Material	Source	Shielding effect / dB		
			900 MHz	1800 MHz	3 GHz
Glazing	Glass pane 6 mm	[8]	-0.8	-1.3	-1.9
	Double glazing 4 mm/air 12 mm/5mm	[5]	-0.8	-1.1	-1.2
	Double glazing with commercial low-e 4 mm coated/air 12 mm/5mm	[5]	-30.6	-26.8	-27
	Double glazing with 2 coated glass	[2]	-23	-30	-36
	Double glazing with square pattern (4 %) low-e coating 4 mm coated/air 12 mm/5mm (measured)	[5]	-1.3	-1.3	-1.9
Glazing with patterned low-e	Double glazing with triangle pattern (2 %) low-e coating 4 mm coated/air 12 mm/5mm (measured/ <i>simulated</i> )	This work	-2.0/-2.0	-2.3/-2.2	-4.0/-3.9
	Double glazing with triangle pattern (2 %) low-e coating 4 mm coated/air 8 mm/5mm ( <i>simulated</i> )	This work	-2.1	-3.2	-1.5
	Double glazing with triangle pattern (2 %) low-e coating 4 mm coated/air 16 mm/5mm ( <i>simulated</i> )	This work	-1.8	-1.4	-7.1

**Source:** Bouvard, Olivia & Lanini, Matteo & Burnier, Luc & Witte, Reiner & Cuttat, Bernard & Salvadè, Andrea & Schüler, Andreas. (2017). Mobile communication through insulating windows: a new type of low emissivity coating. Energy Procedia. 122. 781-786. 10.1016/j.egypro.2017.07.396.

# DAS



## 55 Water Street - Lower Manhattan

- The largest commercial office building in New York; second largest in the U.S.
- 72 stories; 4 million square feet.
- Approximately 30K people traffic through the building Monday through Friday.
- DAS consists of 32 high-power units located around the towers, combined with 1K interior antennas in the ceilings.
  - 9K feet of single-mode fiber optic cable to connect the remotes.
  - 110K feet of coaxial cable to connect the remote antenna units.
  - Access Points installed in lobby and two outdoor parks.



## Business Model

01



### Granite Approach

- Serve 98% users Day-1
- In-building wireless service provided by Granite to building owners and developers
- Project executed by Granite
- Granite retains control of in-building wireless service

### Past Industry Approach

- In-building wireless system led by one operator and equipment vendor
- Project executed by system integrator or operator
- Operators retain effective control of the system
- Repeat for second, third and fourth operators

02



## GETTING STARTED: BYOC STEP-BY-STEP

T-Mobile’s network team and operational experts have deployed countless numbers of indoor wireless networks of every shape, size and configuration. Our BYOC team removes building professionals’ pain points and streamlines the technology deployment process.



The first step is to find a strategic partner to help create a wireless infrastructure plan. We can help develop an RFP or find the right OEM or integrator.

Meet the local market and/or national BYOC team, learn more, and sign-up.

We will gather information including general system characteristics, proposed T-Mobile role and system signal power allocation, and backhaul requirements for budget approval.

We will reach out to your integrators for design files in iBwave format based on broadcast channels and bands. We will then finalize the signal source T-Mobile will provide.

The BYOC License Agreement will need to be signed by both parties. During legal review and after design approval, our local market teams will visit the site to develop lease exhibit drawings.

Once the license is fully executed, we will move to the deployment phase.

# Successful Business Case

## Proof Point: Senior-Living Apartments



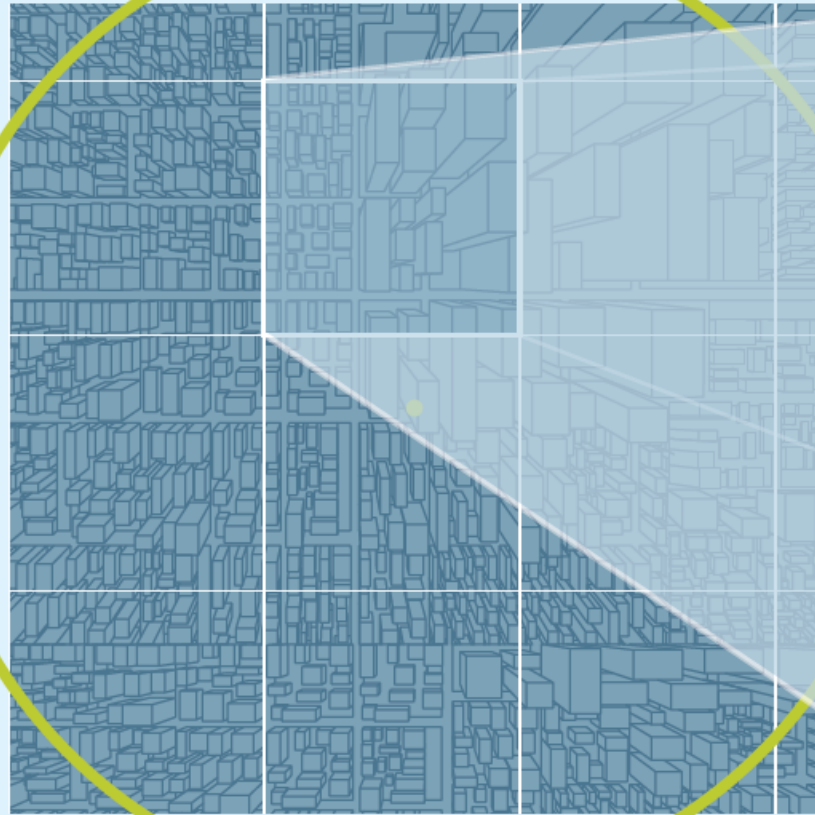
### Signal Improvements

- Located in Lake Worth, FL
- Measurements from first floor of main building
- Spectrum
  - AT&T: 850 MHz
  - Sprint: 1900 MHz
  - T-Mobile: 1900 MHz
  - Verizon: 700 MHz
- Signal source
  - AT&T and Verizon: femtocells
  - Sprint and T-Mobile: over-the-air



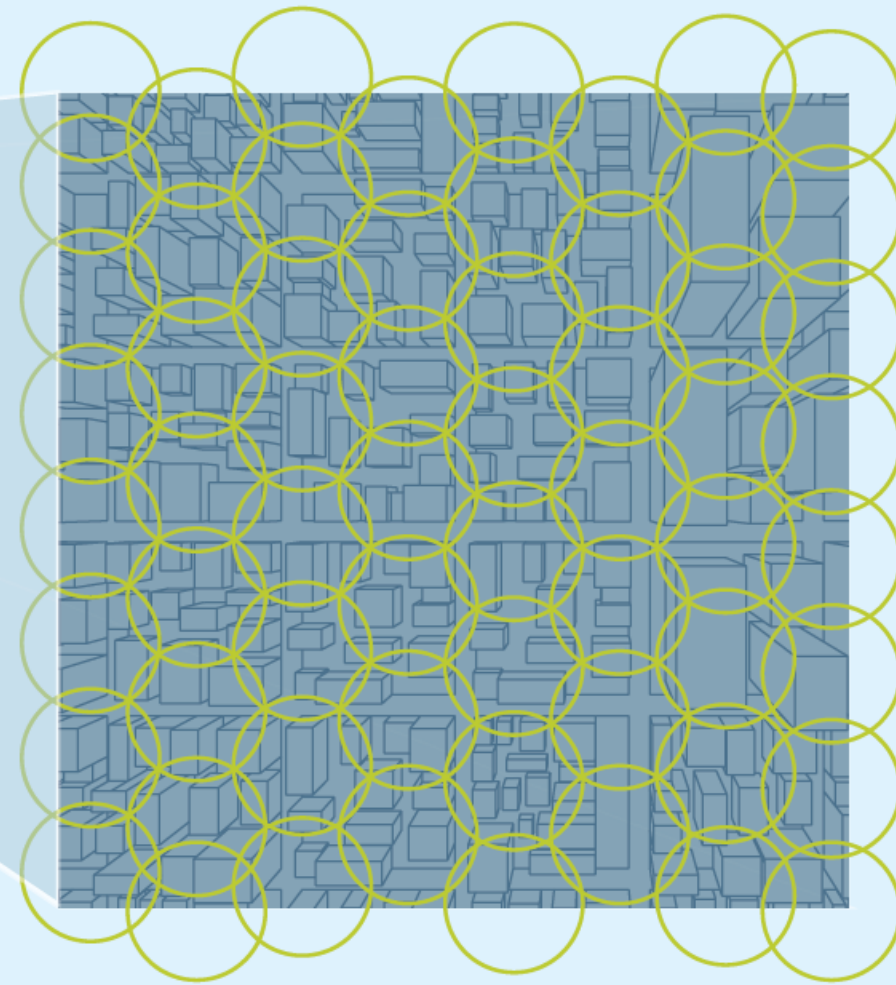


# Why 5G Differs From Existing Cellular Networks



## TODAY'S 4G NETWORK

This sketch (which does not depict an actual city) shows the range of a single 4G macro cell at the center of the circle. Such a small cell, served by fiber, can potentially serve 10 square miles. The white square shows one square mile.



## FUTURE 5G NETWORK

This sketch, showing one square mile, provides one estimate of how many 5G cells would be needed: 60, each covering a 750-foot diameter area. These small cells could require about eight miles of fiber.

*The sketch is conceptual. Actual deployments would be customized for local conditions and demand, and might need additional or fewer 5G cells.<sup>5</sup>*

Indoor wireless networks create outstanding coverage and capacity in your building or venue – even when it’s at its most crowded – and this is crucial as mobile connectivity is revolutionized with 5G technologies.