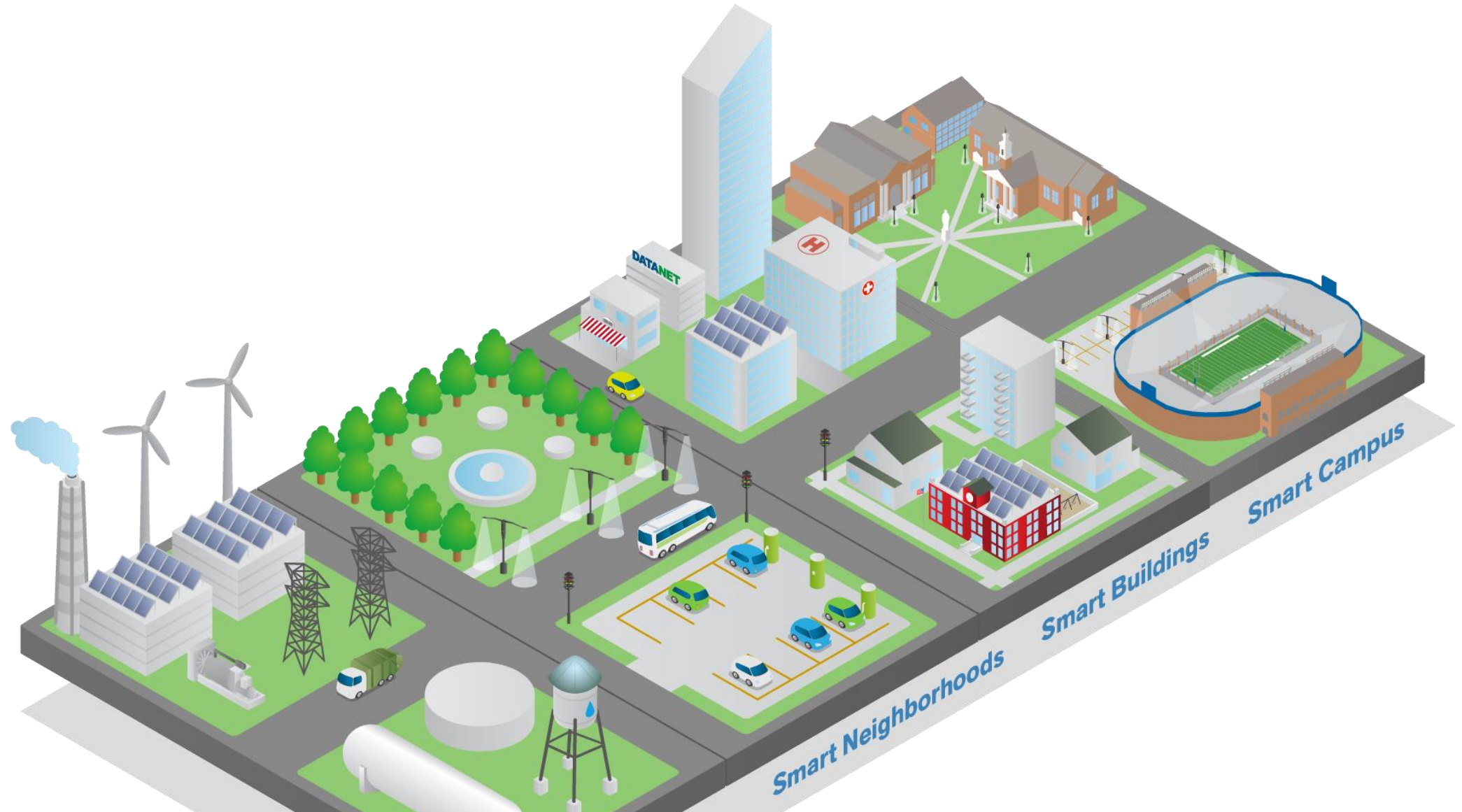


Smart City/Campus/Building





- 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

LAKE NONA

“HOW TO BUILD A GREAT AMERICAN CITY.”

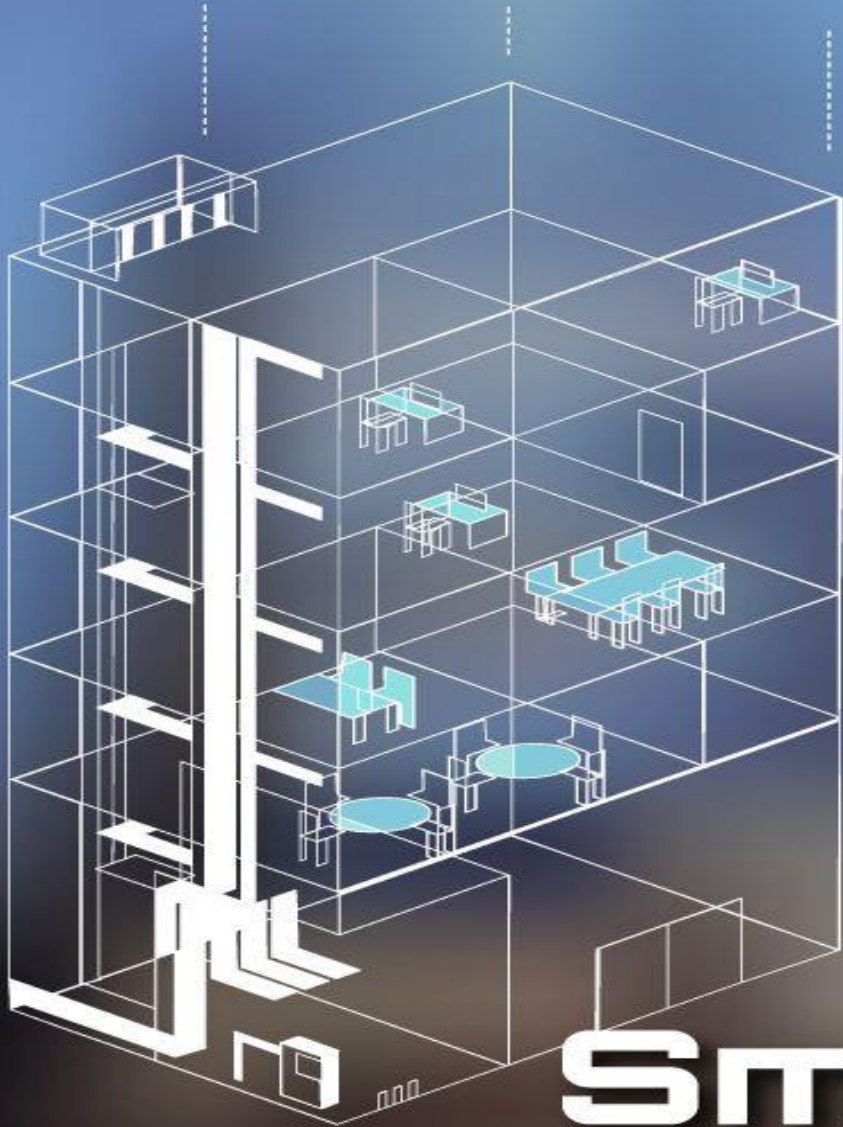
– FORTUNE

LAKE NONA[®]



Spring 2018

BUILDING MANAGEMENT SYSTEM



Smart Buildings

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.



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.

Capacity

Coverage

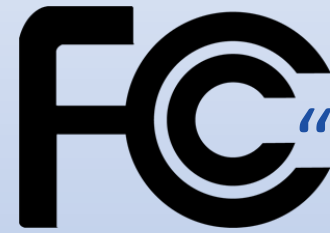
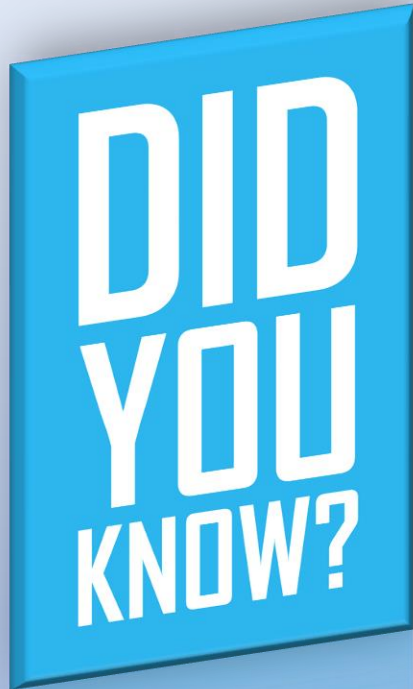


Bandwidth

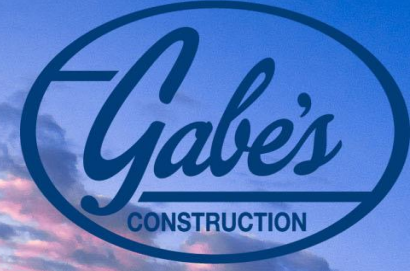
ENTER

[click here for more information](#)

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”



4G LTE

4G LTE

4G LTE

Electric Forest Music Festival

40,000 People

Densification

Capacity and Coverage



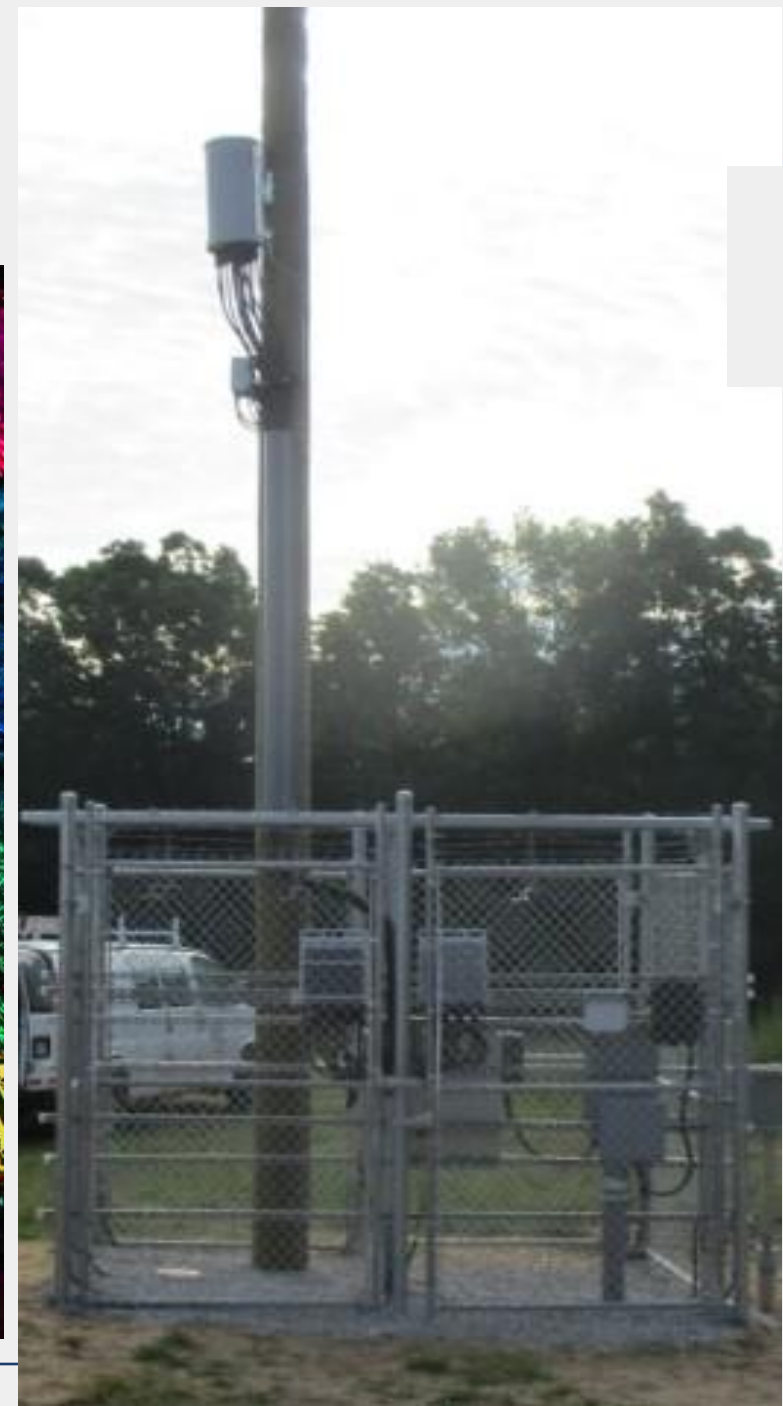
4G LTE



Pop Up City Mini Macro



Gabe's Construction Co.





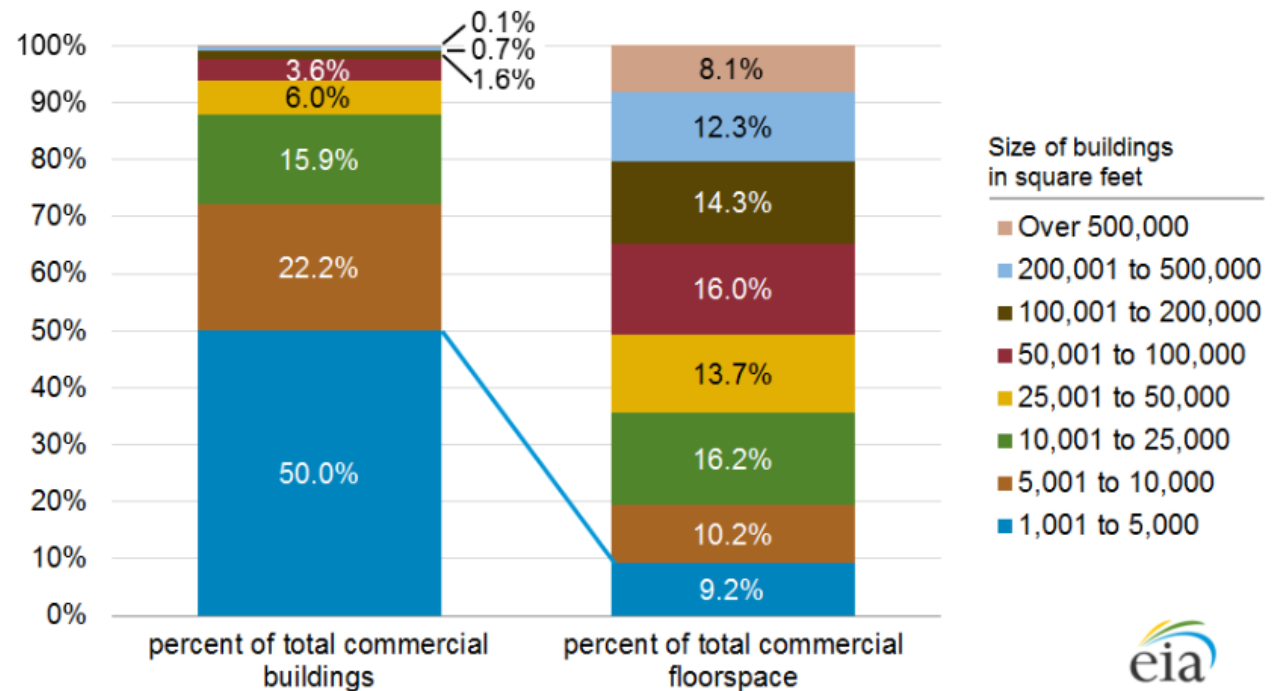
911 - What can go wrong?



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)



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

Business Model



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



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



5G Technology Basket

“Its all good but you don't have to eat everything!”



5G

Spectrum: Expanded, Shared, Dynamic, mmWave

Topology: Distributed, User & Control Separation

Antennas: Massive MIMO, Beam Forming

Edge Computing: Applications, APIs

Security: Authentication, Privacy

Radio: New Radio (NR), Software, Micro Cells

IoT: Low Power, Low Latency, NB-IoT, CAT-M

Network: Slicing, Virtualization, SDN, SON, COTS

Interoperability: Path from 4G (NSA), Coexist with 4G (SA)

5G Deployment 28 GHz mmWave

University of Michigan

Rooftop

Non Penetrating Sleds



LAKE NONA TOWN CENTER



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