



Connected City
Smart City

Peter Murray, Executive Director

Dense Networks, Smart Communities Inc.

- 30 + years Telecom
 - MCI, Verizon, Level 3
 - PECO/Adelphia Partnership
- Professor, Temple University
- US Department of Commerce
NTIA Broadband Grant Reviewer
- Consultant to Orange and Lee
Counties, Florida





Connected Cities Tour "Getting to Smart"

Presenting Sponsor: **Graybar**

2022

The Tour returns in 2022 with a focus on how Network Technology and the Cloud are enabling innovative new capabilities and services.

We will look at successful Use Cases, Technology Architectures, Business Models and Funding mechanisms for Cities, Schools, Building Owners, Utilities and Transportation.

For More Information Contact:
PeterMurray@DenseNetworks.com
☎ 267-237-5907

May	24	Denver	Smart Cities Week
June	08	Virtual	Broadband Funding
June	23	Virtual	CBRS/Private Wireless 101
July	13	Virtual	IoT Networks-LoRa
August	11	Aurora	Connected Cities Tour
September	15	Virtual	Broadband Funding
September	22	Philadelphia	Connected Cities Tour
October	06	Virtual	Fiber Optic Deployment
October	13	New York	Smart Building Networks
October	25	Los Angeles	Connected Cities Tour
November	06	Virtual	Smart Cities
December	08	Virtual	5G



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www.densenetworks.com

Agenda

- 9:05** **Introduction** **Peter Murray, Executive Director, Dense Networks**
- 9:15** **Keynote** **Jim Stritzinger, Director, Broadband Office, State of South Carolina**
- 9:40** **Broadband Programs-Funding, Mapping, Programs**

 Jim Stritzinger, Director, Broadband Office, State of South Carolina
 Bryan Darr, VP, Ookla
- 10:30** **Break**
- 11:00** **Network Solutions-5G, Fiber, IoT, PLTE, WiFi**

 Kent Winrich, CTO, Open Broadband
 Jerry Gard, Sr. Engineering Manager, Motorola Solutions
 Greg Spraetz, CRO, Network Connex
 Scott Jackson, Broadband Market Manager, Graybar
- 12:00** **Lunch and Networking**



Thank You!!



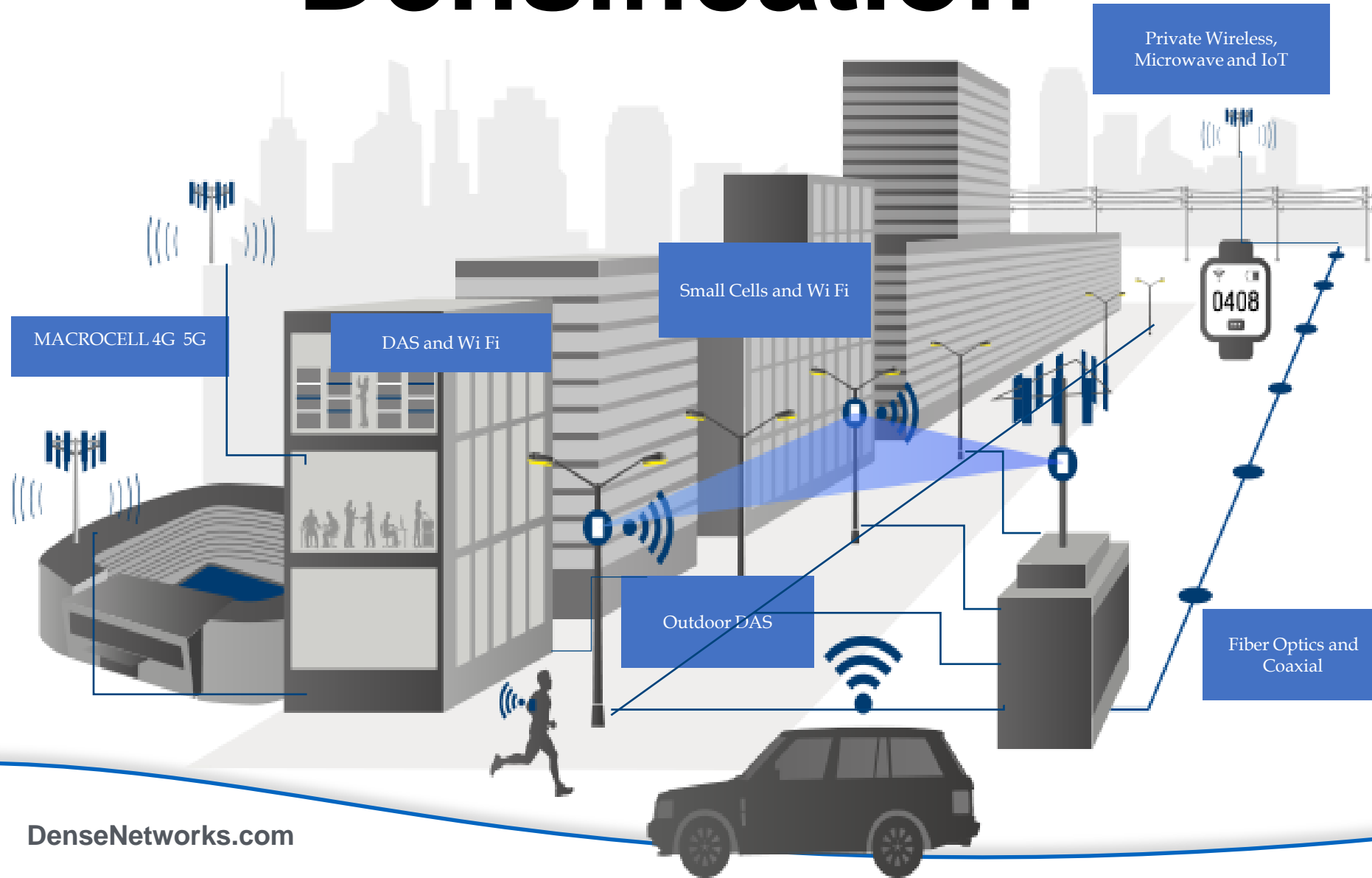
Smart
Cities
Council

Infrastructure
Innovation
Forum



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Densification

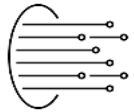


Digital Infrastructure

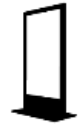
Scalable/Success Based

Valuation 3 to 5 X vs. Network Providers
Digital Colony/SBA/Crown (REIT) vs. AT&T, Comcast

Fiber IoT Cell-Macro, Small & DAS Wi Fi Private LTE & 5G Smart Poles Devices



Cameras



Kiosks



Computers/Tablets



Sensors

LoRa®



DenseNetworks.com

Broadband Strategy San Jose

Emerging landscape for voice and DATA

Effective in Dense Urban, Urban, and Suburban

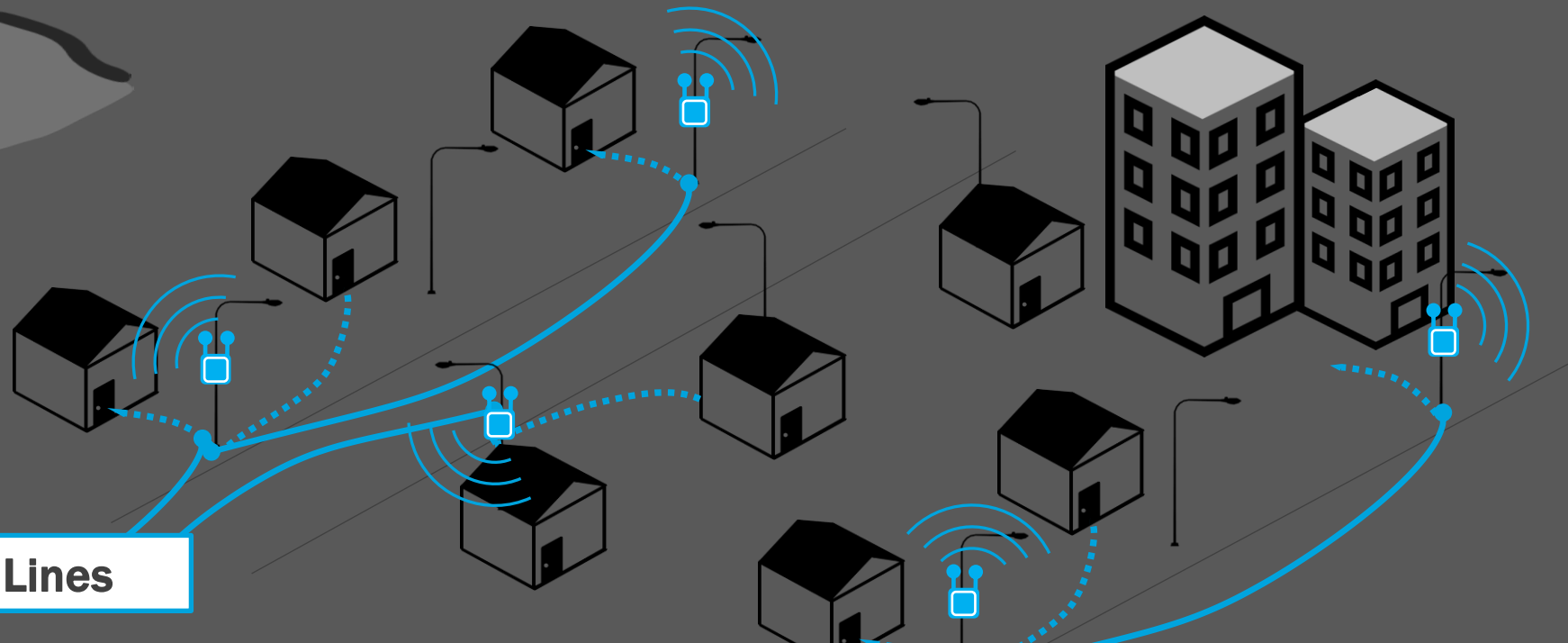
Cell towers: carry all mobile voice & some data

 4G/5G Small-Cells

Gigabit speed
up to 50x faster

Fiber Lines

Light pole is most valuable asset for broadband



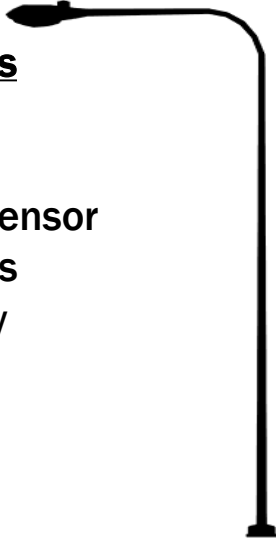
Broadband Strategy San Jose

STREETLIGHT

Light/Safety

Properties

- Height
- Power
- Light Sensor
- Lumens
- Density

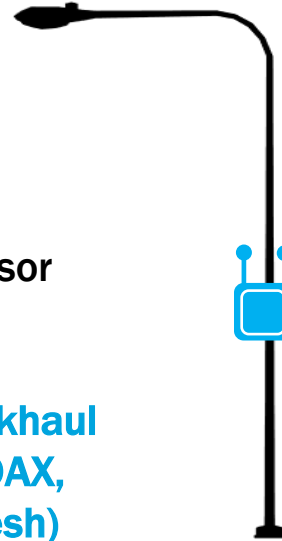


SMALL CELLS

Broadband Digital Infrastructure

Properties

- Height
- Power
- Light Sensor
- Lumens
- Density
- **Data Backhaul (Fiber, COAX, Radio mesh)**

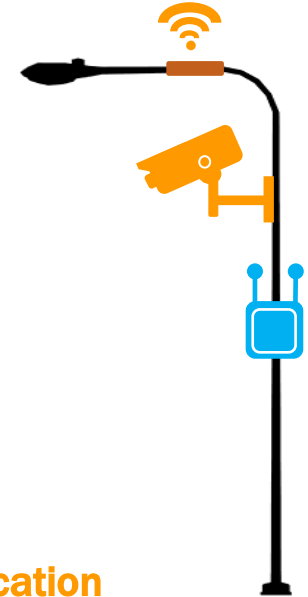


INTERNET OF THINGS

Smart Cities

Properties

- Height
- Power
- Light Sensor
- Lumens
- Density
- **Data Backhaul**
- **Sensors**
- **Cameras**
- **2-way Communication**
- **Banner Advertising**



Maturity:

Mature

Emerging

Extremely Immature

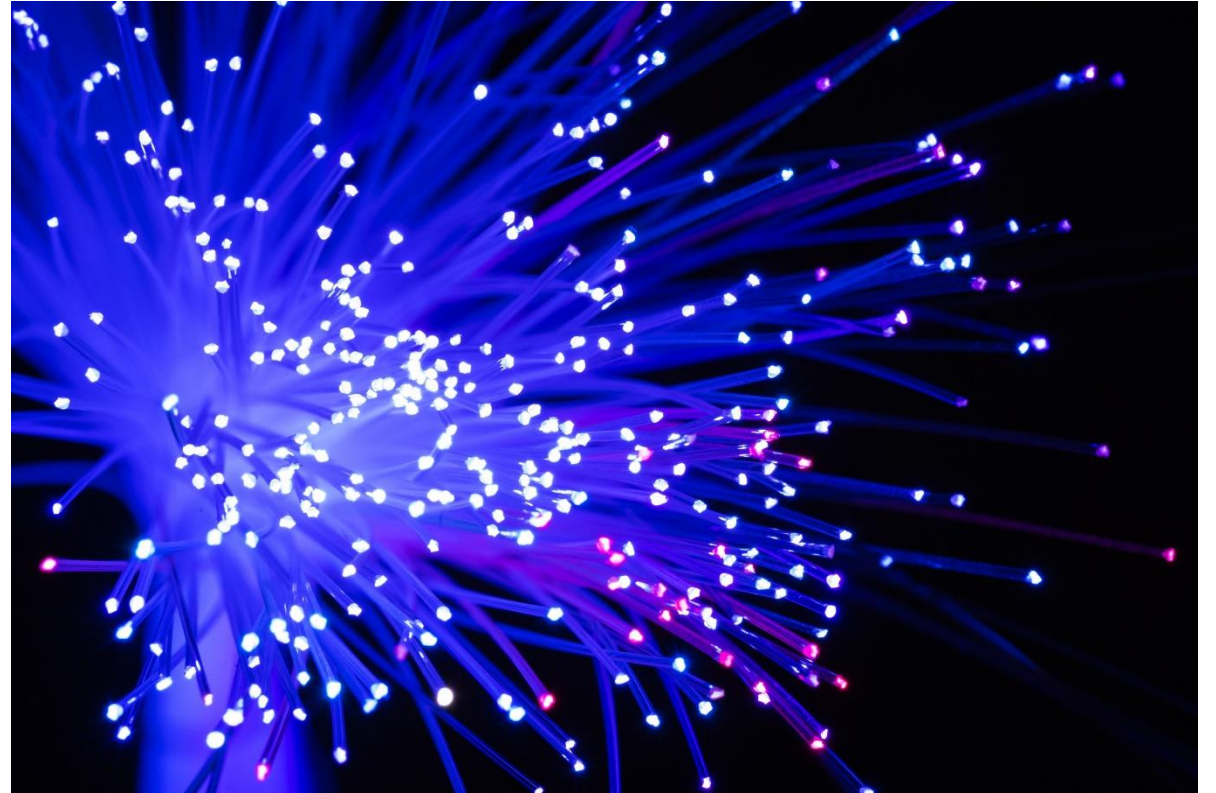
Possible Action:

Proceed w/ LED Light Replacement Only

Re-examine in Broadband Strategy

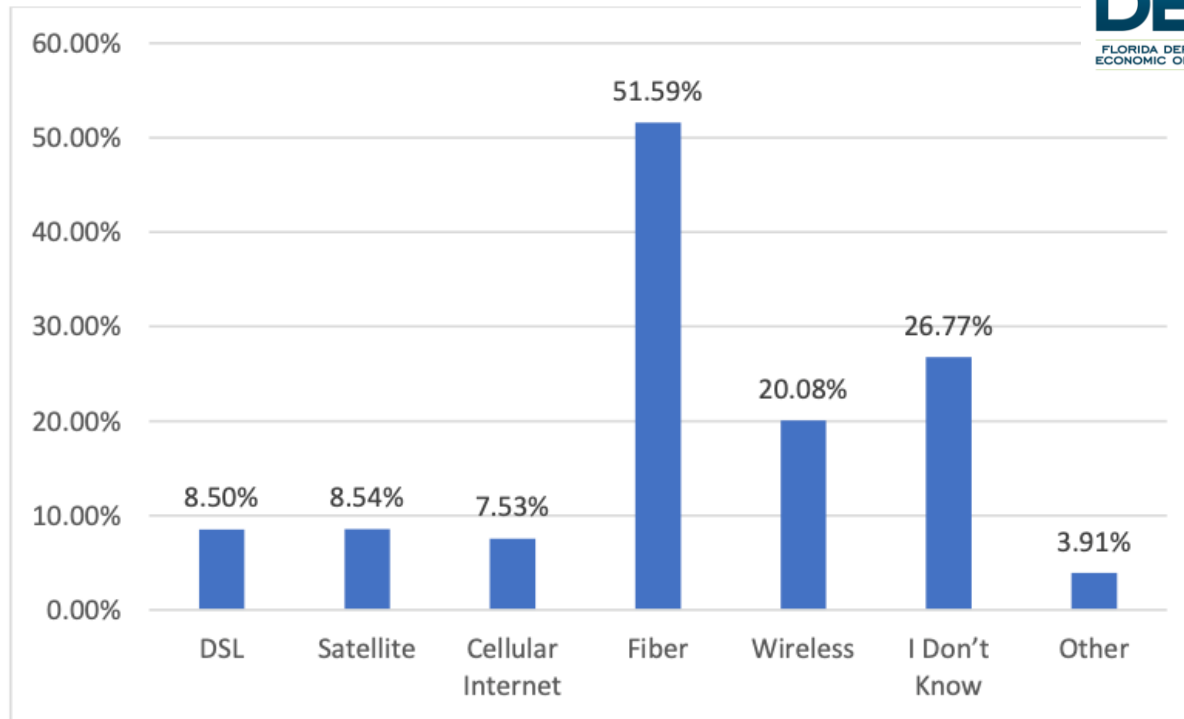
Seek to Understand with Knight IoT Grant

Broadband and Digital Equity



Question 5: What type of technology do you believe would make internet more accessible in your community?

Answered: 2,764 Skipped: 14



Historical Context

\$65 billion in funding is unprecedented level of funding for broadband deployment.

CURRENT PROGRAMS:

Federal Communications Commission

1. Connect America Fund Program
2. Schools and Libraries (E-Rate) Program
3. Rural Health Care Program
4. Lifeline Program
5. Rural Digital Opportunity Fund
6. 5G Fund for Rural America
7. Emergency Connectivity Fund
8. Affordable Connectivity Program*
9. COVID-19 Telehealth Program

Rural Utilities Service (USDA)

1. Rural Broadband Access Loan Program
2. Telecommunications Infrastructure Loans Program
3. Community Connect Grant Program
4. ReConnect Program*
5. Distance Learning and Telemedicine (DLT) Grant Program

National Telecommunications and Information Administration

1. Connecting Minority Communities
2. Broadband Infrastructure Program
3. Tribal Broadband Connectivity Grant Program*

Treasury Department

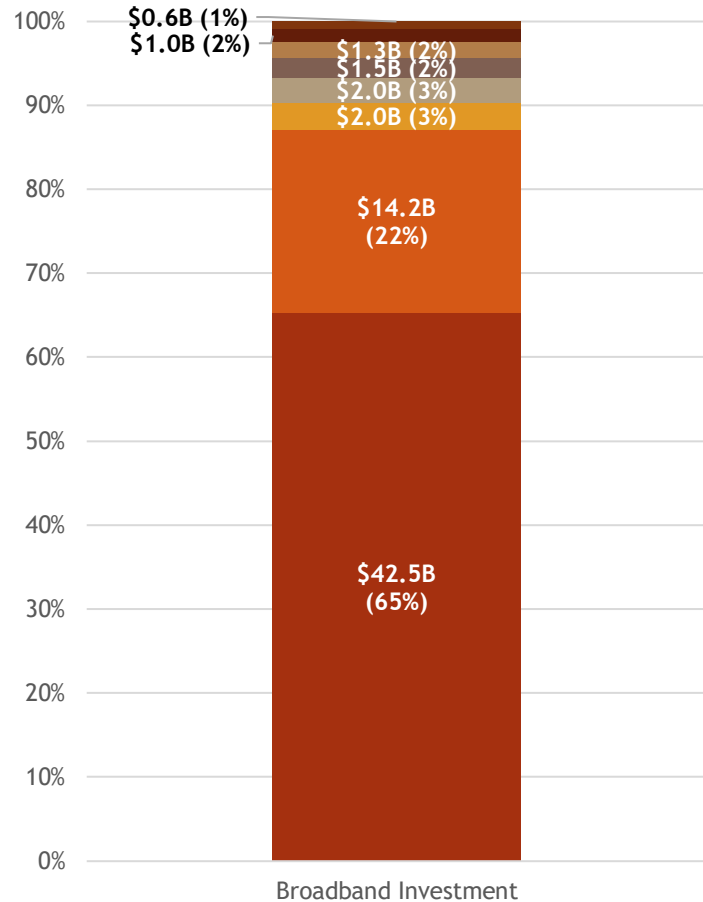
1. Coronavirus State and Local Fiscal Recovery Funds
2. Coronavirus Capital Projects Fund

* These programs received further funding through the IIJA.

American Rescue Plan Act (ARPA) – Treasury Department

Program	Funds Allocated	Program Details	Eligible Recipients	Application Window
State and Local Fiscal Recovery Funds	\$350 billion	<p>Program seeks to support urgent pandemic-response efforts, replace lost revenue for state and local governments, strengthen support for vital public services, and address public health and economic challenges.</p> <p>Allows recipients to use funds for broadband infrastructure, among other investments such as public health, replacement of public sector revenues, premium pay for essential workers, etc.</p> <p>Requires networks symmetrical speeds of 100 Mbps, unless exemption, then 100/20 Mbps but scalable to symmetrical 100 Mbps.</p>	<p>Grants awarded to states</p> <p>No restrictions on eligibility for subgrants</p>	<p>States received 50% of funds in mid-2021, will receive rest in mid-2022.</p> <p>States will administer own subgrant programs, but all funds must be expended by end of 2024.</p>
Coronavirus Capital Projects Fund	\$10 billion	<p>Program designed to allow recipients to invest in capital assets, including infrastructure, that meet communities' critical needs in the short- and long-term.</p> <p>Key priority of program is for broadband infrastructure and other digital connectivity technology projects.</p> <p>Requires networks symmetrical speeds of 100 Mbps, unless exemption, then 100/20 Mbps but scalable to symmetrical 100 Mbps.</p>	<p>Grants awarded to states</p> <p>No restrictions on eligibility for subgrants</p>	<p>Application window for states closed December 27, 2021; for Tribal governments, will close June 1, 2022.</p> <p>Sub-grantees may begin receiving funds in 2022 from state programs.</p>

Infrastructure Investment and Jobs Act: Broadband Overview



Allocation	Amount	Agency
Private activity broadband bonds	<i>\$0.6B allocated</i>	--
Enabling Middle Mile Broadband Infrastructure Program	<i>\$1.0B allocated</i>	NTIA
Digital Equity Competitive Grant Program	<i>\$1.25B allocated</i>	NTIA
State Digital Equity Capacity Grant Program	<i>\$1.5B allocated</i>	NTIA
ReConnect Program	<i>\$2.0B allocated</i>	USDA
Tribal Broadband Connectivity Program	<i>\$2.0B allocated</i>	NTIA
Affordable Connectivity Program	<i>\$14.2B allocated</i>	FCC
Broadband Equity, Access, and Deployment Program	<i>\$42.45B allocated</i>	NTIA

Broadband Equity, Access, and Deployment (BEAD) Program

Funds Allocated	Administering Agency	Eligible Recipients	Expected Timeline
\$42.45 billion	NTIA	Grants awarded to states No restrictions on eligibility for subgrants	<ul style="list-style-type: none">• NOFO within 180 days (mid-May 2022)• Initial \$100 million to each state likely disbursed soon after final proposals submitted• Remaining funds likely disbursed in late 2022/early 2023

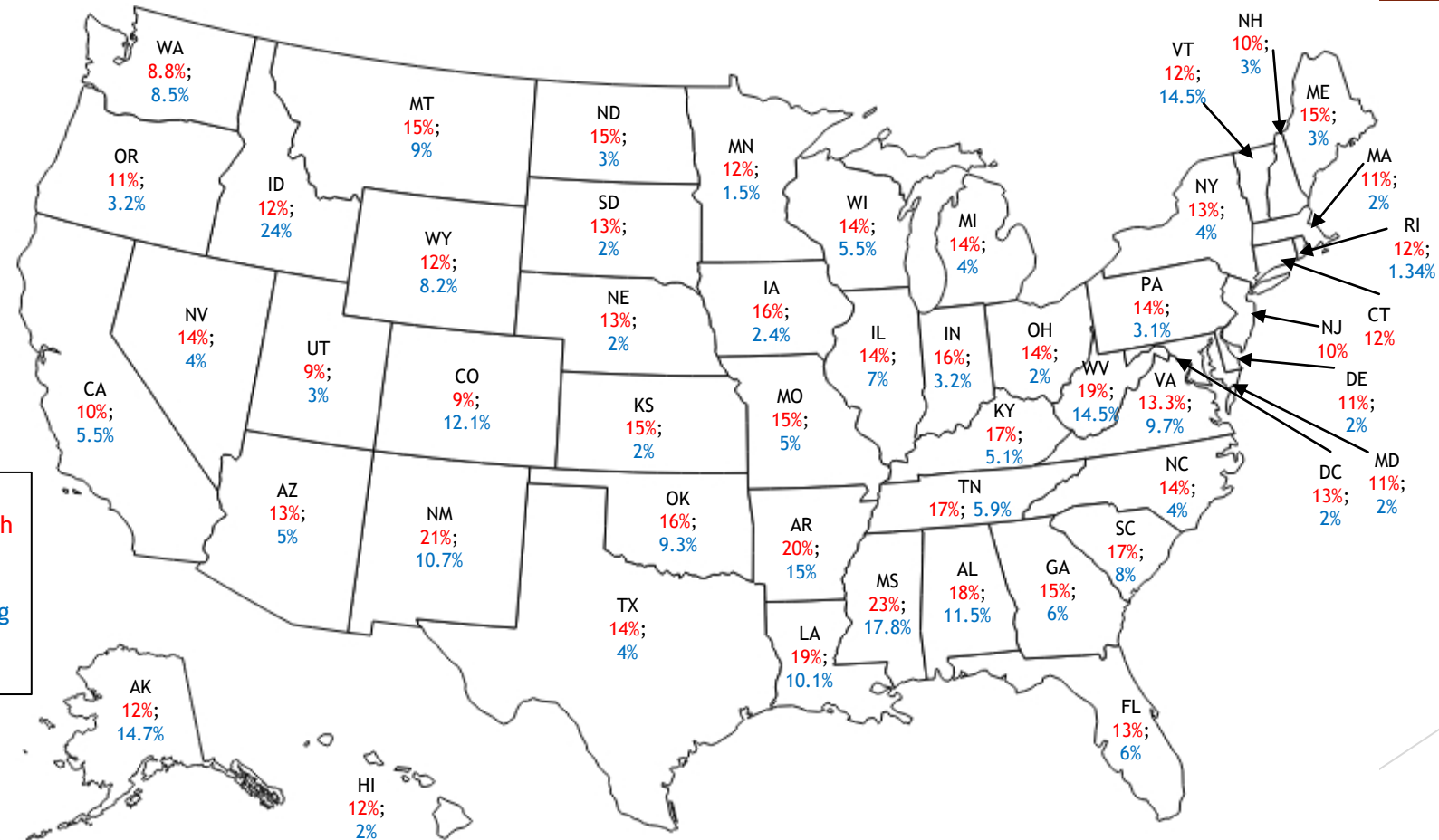
- Project objective is to close the availability gap as “access to affordable, reliable, high-speed broadband is essential to full participation in modern life in the United States”
- End-mile broadband infrastructure deployment
- Eligible uses of funds:
 - Deployment to unserved and underserved areas
 - Connecting community anchor institutions
 - Data collection, broadband mapping, and planning
 - Installation of broadband equipment or providing reduced-cost broadband to multi-family residential buildings
 - Broadband adoption programs

Broadband Equity, Access, and Deployment (BEAD) Program

Funds Disbursement

- States will receive funding from the NTIA, to disburse to subgrantees
- Amounts allocated to states, besides minimum \$100 million, will depend on (1) the number of unserved locations in each state and (2) the number of unserved locations in high-cost areas
- States will likely use existing state broadband programs or craft new programs under state broadband authorities or state Governor's Offices
- To receive funding, states will need to submit 5-year action plans and initial and final proposals, and may solicit or be receptive to industry feedback when drafting

The Digital Divide







KEY:
Red - % of households with internet subscription

Blue - % of residents living in areas with broadband

“Begin With the End in Mind”

Steven R. Covey, *7 Habits of Highly Effective People*

Speed Tiers (download / upload)





	100 Mbps / 100 Mbps (symmetric)
	100 Mbps / 20 Mbps
	25 Mbps / 3 Mbps
	Zero Households

DON'T INVEST HERE

Green: Already served. Meets or exceeds FCC's 25/3 Mbps

White: Nobody lives there.

Density of Unserved Households

	200 or More (per sq. mi.)
	25 - 199
	1 - 24
	> 0 and < 1

INVEST HERE!

Find the “freckles” and prioritize these. Freckles are high household density with poor Internet.

South Carolina

Areas of Need

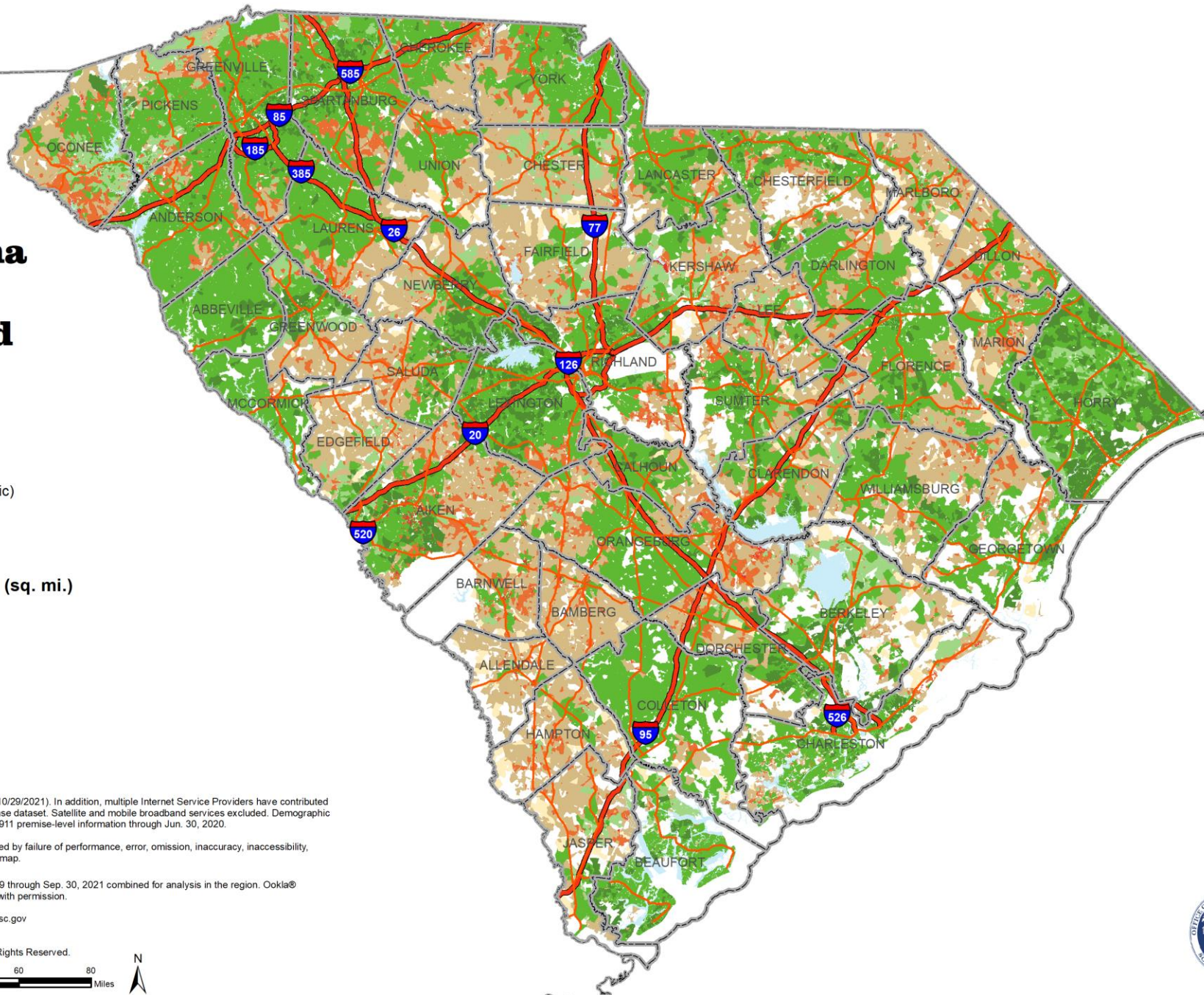
September 30, 2021

Speed Tiers (download / upload)

- >= 100 Mbps / 100 Mbps (symmetric)
- >= 100 Mbps / 20 Mbps
- >= 25 Mbps / 3 Mbps

Density of Unserved Households (sq. mi.)

- 200 or More
- 25 - 199
- 1 - 24
- > 0 and < 1
- Zero Households

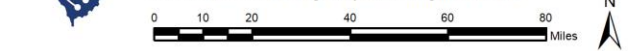


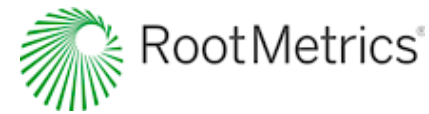
Data: Based on ORS analysis of FCC Form 477, Dec. 31, 2020 (pub. 10/29/2021). In addition, multiple Internet Service Providers have contributed their FCC Form 477, Jun. 30, 2021 data to augment and update the base dataset. Satellite and mobile broadband services excluded. Demographic data based on US Census 2020 information that was enhanced with E911 premise-level information through Jun. 30, 2020.

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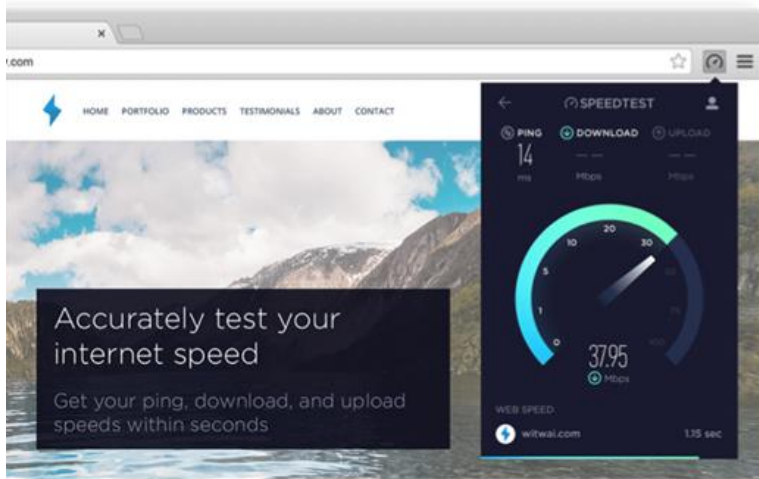
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- Founded in 2006
- Seattle, Memphis, Denver, Dublin (IE), Guildford (UK), Dubai (AE)
- 320 employees
- Stand alone subsidiary of Ziff Davis, Inc (NASDAQ: ZD)





- Mobile and fixed broadband measurements
- Precise location data (GPS) & detailed RF measurements
- Quality of Service (QoS) and Quality of Experience (QoE)
- Trusted by consumers, privacy focused
- Includes “failed & partial” test data



The Role for Crowdsourced Data

- **Volume** – Scale of data capture is exponential relative to other efforts
- **Consistency** – Fewer spikes and troughs in data collection due to loyal user base
- **Diversity** – Captures the many ways people use the internet
- **Validation** – Proof of service provisioning by each ISP in a given geographic area
- **History** – Years of data allows for measuring of progress over time

Broadband Data Act

“As part of the efforts of the Commission to facilitate the ability of entities and individuals to submit information under paragraph (1), the Commission shall— (A) prioritize the consideration of data provided by data collection applications used by consumers that the Commission has determined— (i) are highly reliable; and (ii) have proven methodologies for determining network coverage and network performance;”

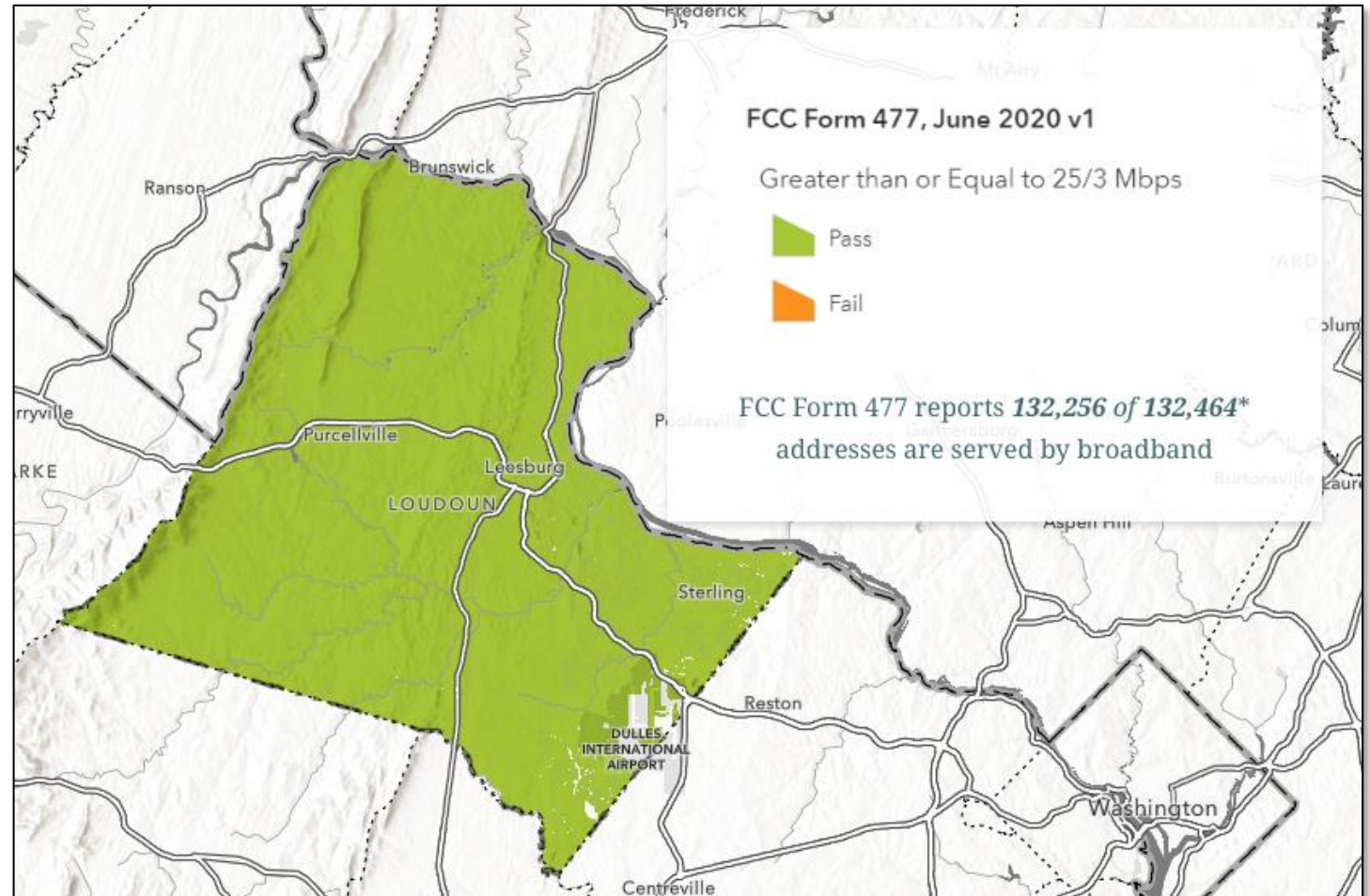


Loudoun County, Virginia

FCC claims 99.8% of addresses are served by broadband
FCC claims 97.2% of addresses are served Cable, Fiber & DSL

The Situation

In an effort to close the digital divide in rural and urban communities across the nation, the federal government has allocated billions of dollars in broadband funding with the American Rescue Plan (ARP) Act. Funding allocation is based on current federal broadband mapping through **FCC form 477 data**.



Loudoun County, Virginia

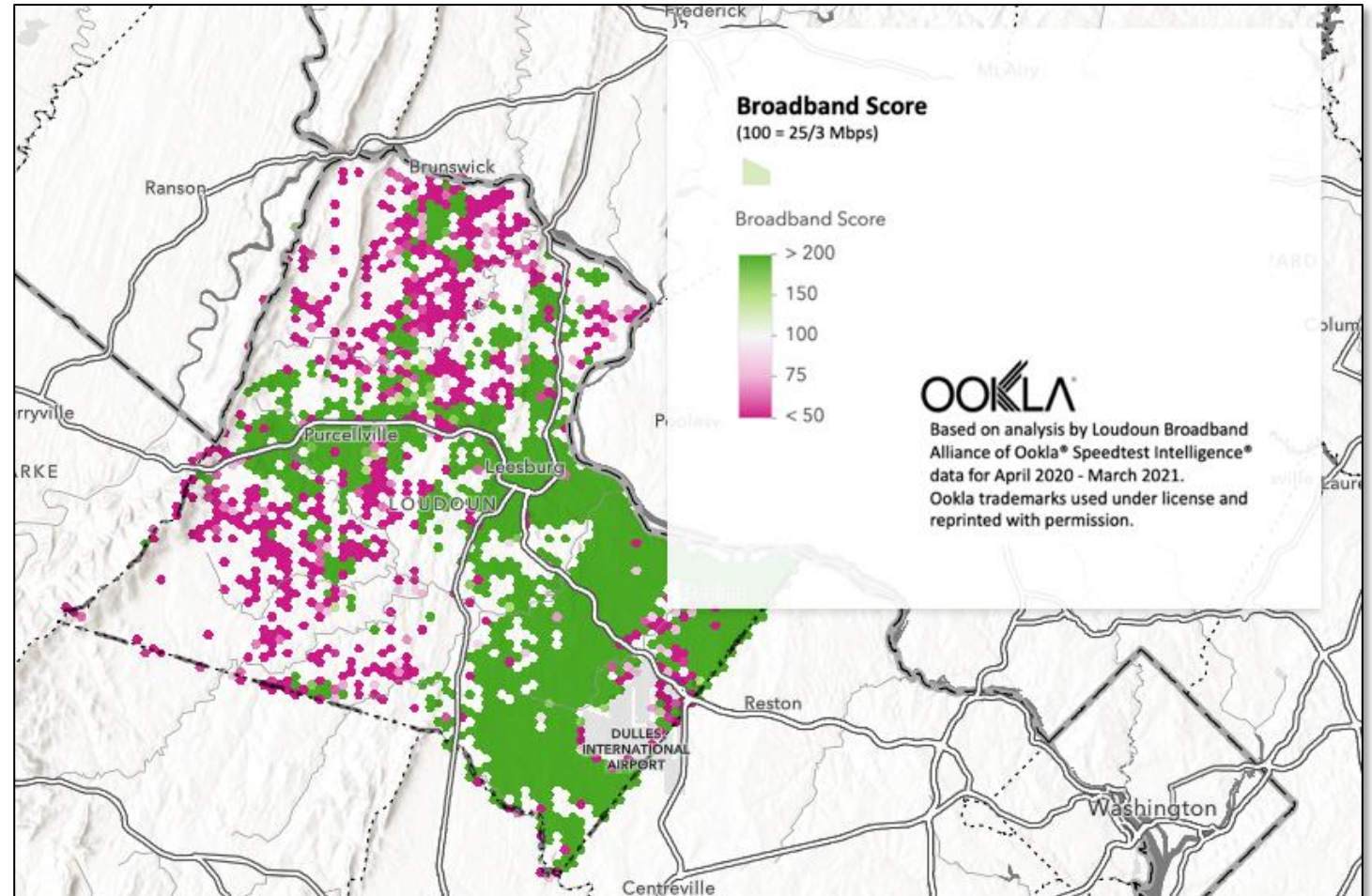
On-the-Ground Real World Experiences

93.9% of residents have access to broadband
leaving more than **6% of residents without broadband**

The Solution

Through analysis of Speedtest Intelligence data, LBA developed a broadband score, where a score of 100 means that the geolocation has access to FCC minimum broadband requirements of 25 Mbps download and 3 Mbps upload speeds.

The pink spots on the map represent locations where residents did not have access to broadband.





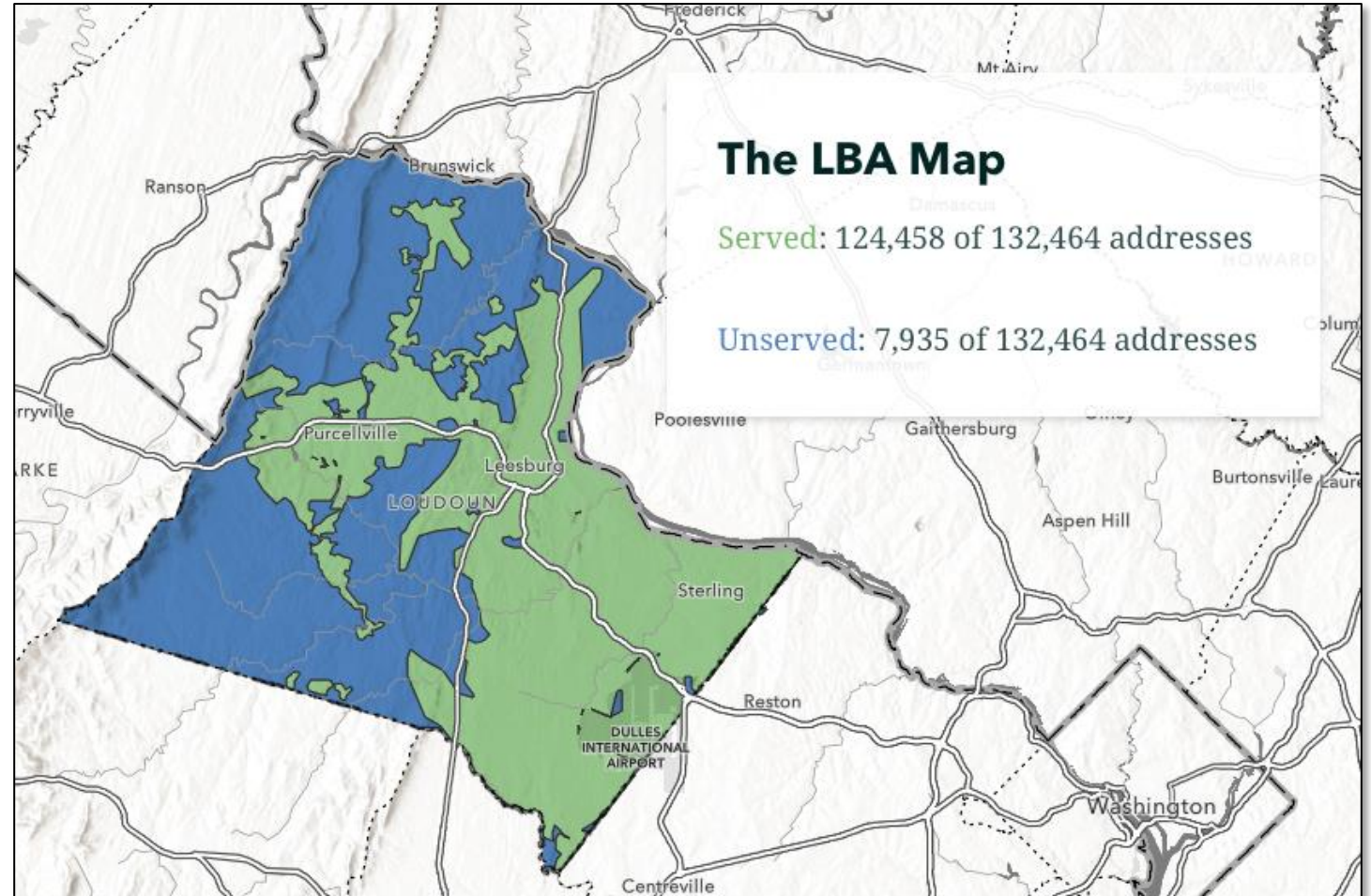
Loudoun County, Virginia

On-the-Ground Real World Experiences

93.9% of residents have access to broadband
leaving more than **6% of residents without broadband**

The Solution

Using this data aggregated with LBA's own local surveys and research, LBA was able to create their own map that showed a more accurate broadband availability map for the county.



**6% = 7,935
Addresses**

Funding won based
on study:

**\$17
million**



Residential Broadband Technology

Best Available Technology Class

- Fiber | Speeds \geq 100 Mbps/100 Mbps (symmetric)
- Cable (DOCSIS 3.1+) | Speeds \geq 100 Mbps/100 Mbps (symmetric)
- Cable (DOCSIS 3.0) | Speeds \geq 100 Mbps/20 Mbps
- Cable (DOCSIS < 2.0) | Speeds \geq 25 Mbps/3 Mbps
- VDSL (Fiber-To-The-Curb) | Speeds \geq 10 Mbps/1 Mbps
- ADSL2, ADSL2+ | Speeds \geq 6 Mbps/1 Mbps
- Fixed Wireless | Speeds \geq 10 Mbps/1 Mbps
- ADSL | Speeds \geq 3 Mbps/768 kbps
- No Internet Service Available
- Zero Households

Fiber and Cable

Easily deliver reliable 25/3. These areas are not our problem.

Copper and Fixed Wireless

Copper technology (xDSL) cannot deliver reliable 25/3. End of useful life.

Fixed Wireless requires optimum conditions to exceed 25/3; however, it delivers *Speed to Access* meaning that high need areas have the potential to get coverage fast while physical connections to each house are built.

No Internet Options Exist

This has nothing to do with affordability
Customers in these areas cannot receive service at their physical address

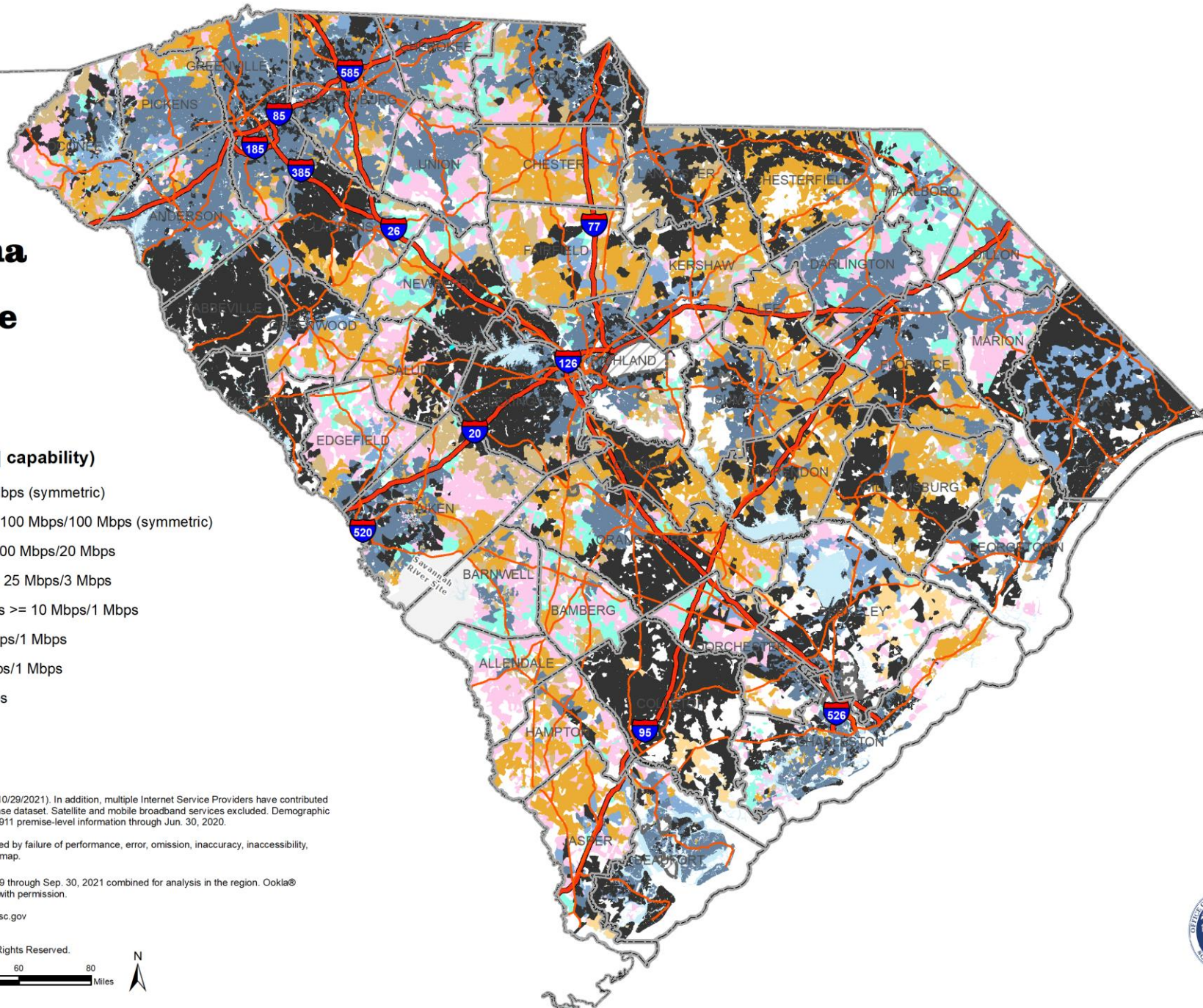
South Carolina

Best Available Technology

September 30, 2021

Best Available Technology (type | capability)

- Fiber | Speeds \geq 100 Mbps/100 Mbps (symmetric)
- Cable (DOCSIS 3.1+) | Speeds \geq 100 Mbps/100 Mbps (symmetric)
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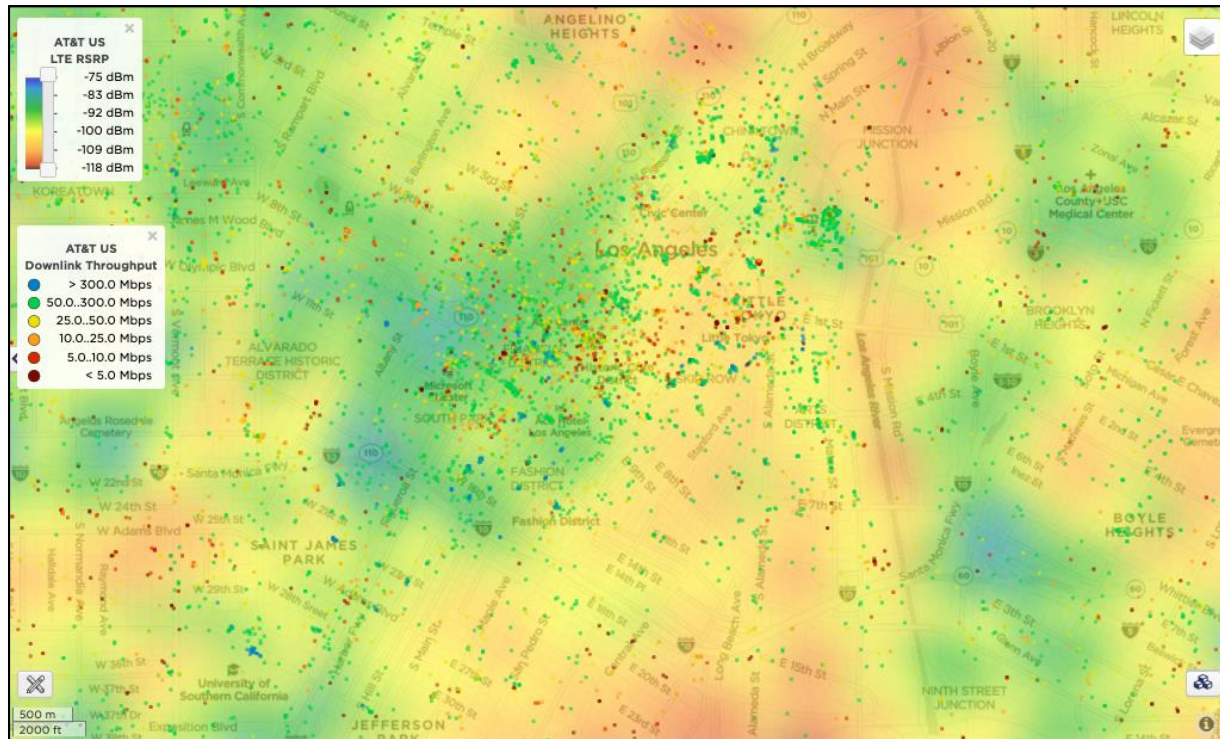


BROADBAND OFFICE

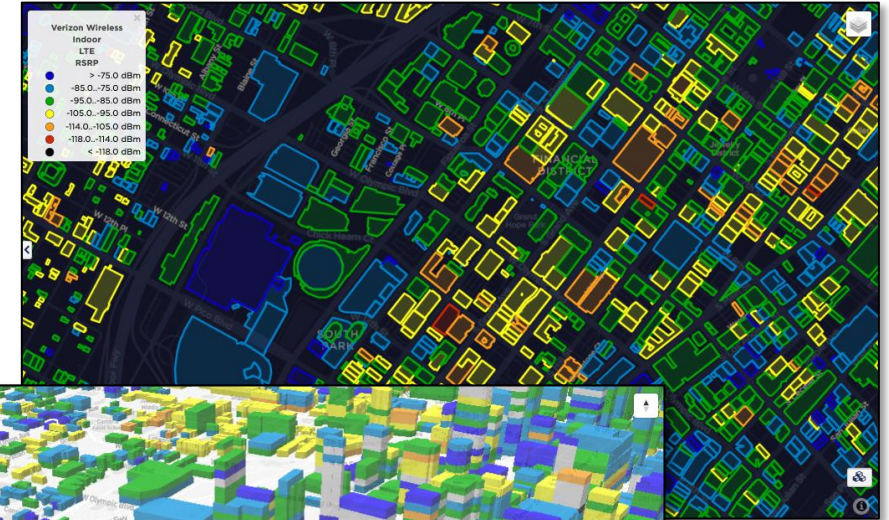
Cell Analytics™

Performance, coverage and signal measurement data

Signal strength and quality

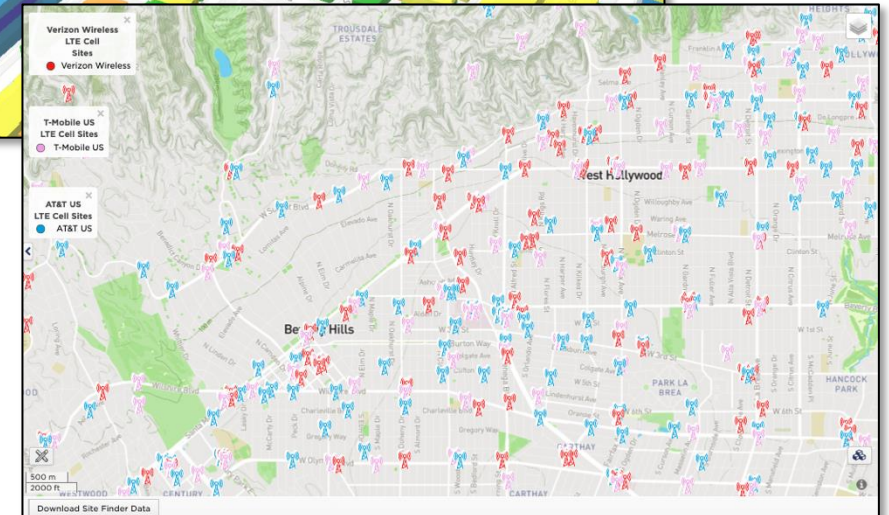


Indoor coverage



3D with z-axis

Tower locations

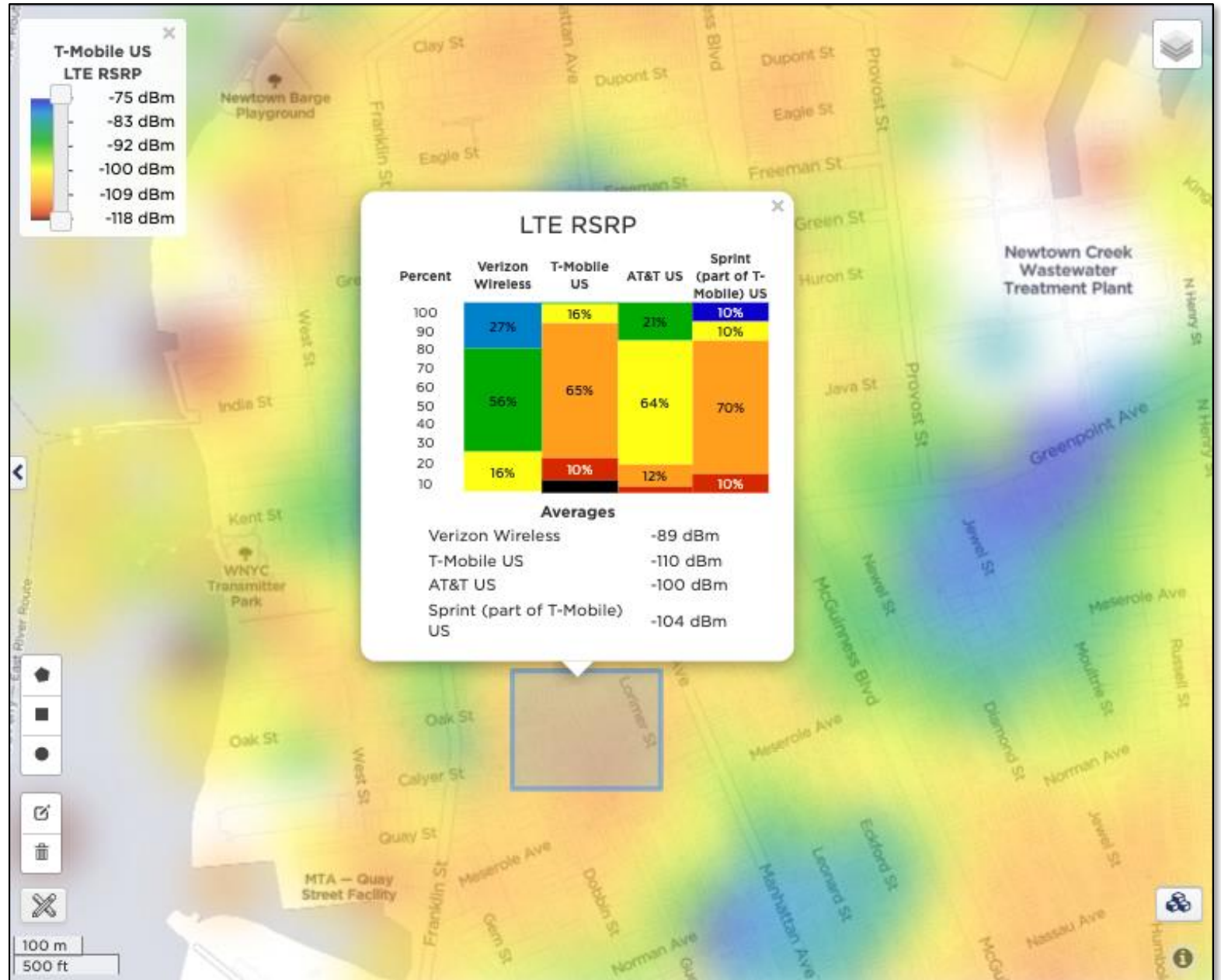
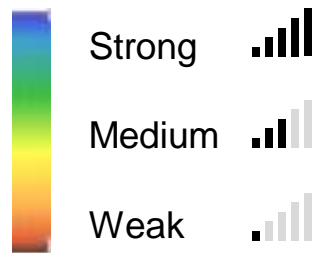


Cell Analytics™

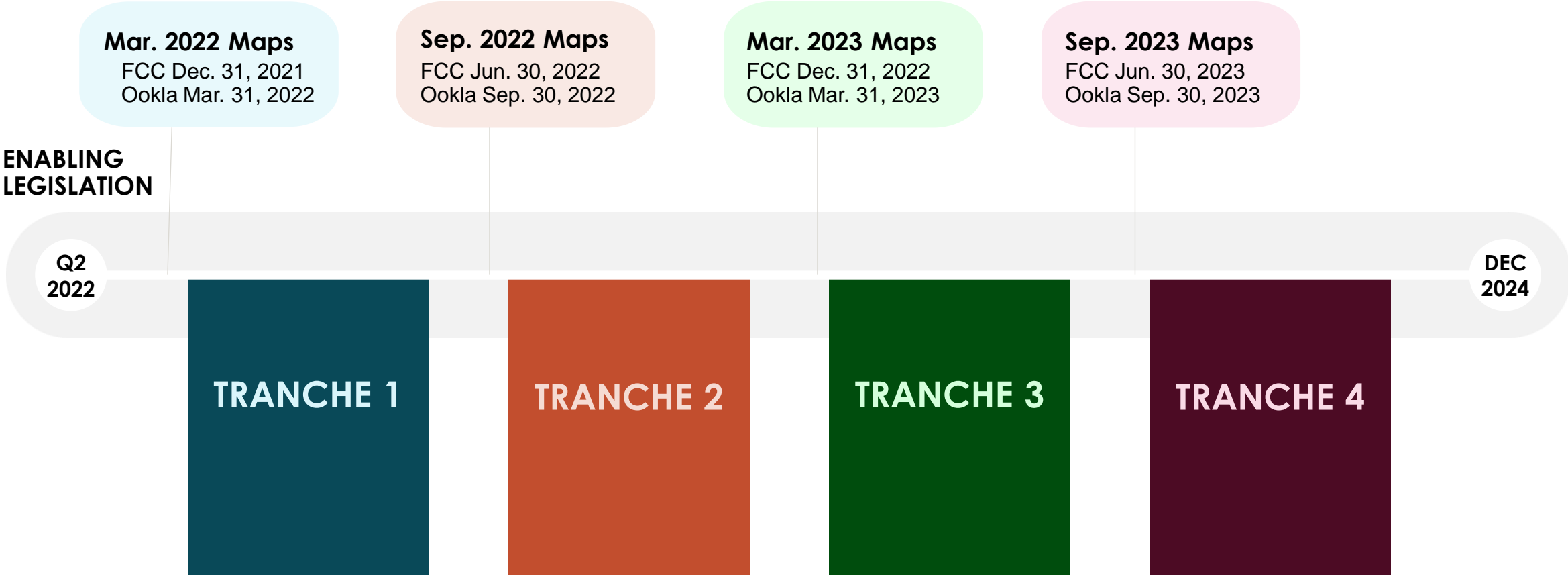
- Solving for Wi-Fi/LTE hotspot deployment – choose best wireless operator in each area
- Direct students to better coverage areas
- Target neighborhoods for EBB funding
- Analyze areas of need for private LTE networks
- Coordinate with state for broadband prioritization



Signal Strength



SC BROADBAND ARPA INVESTMENT ROADMAP

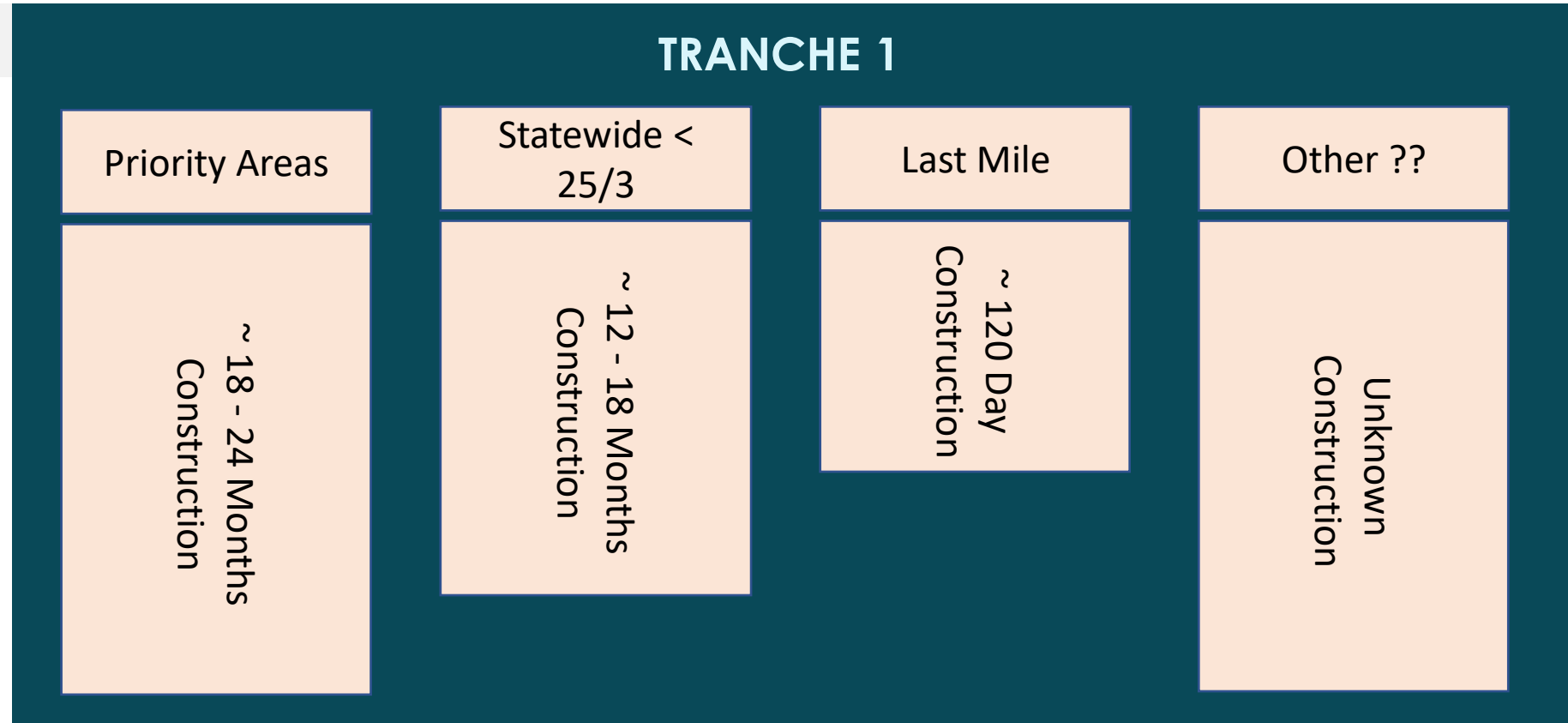


SC BROADBAND GRANT PROGRAM IDEAS

ENABLING
LEGISLATION

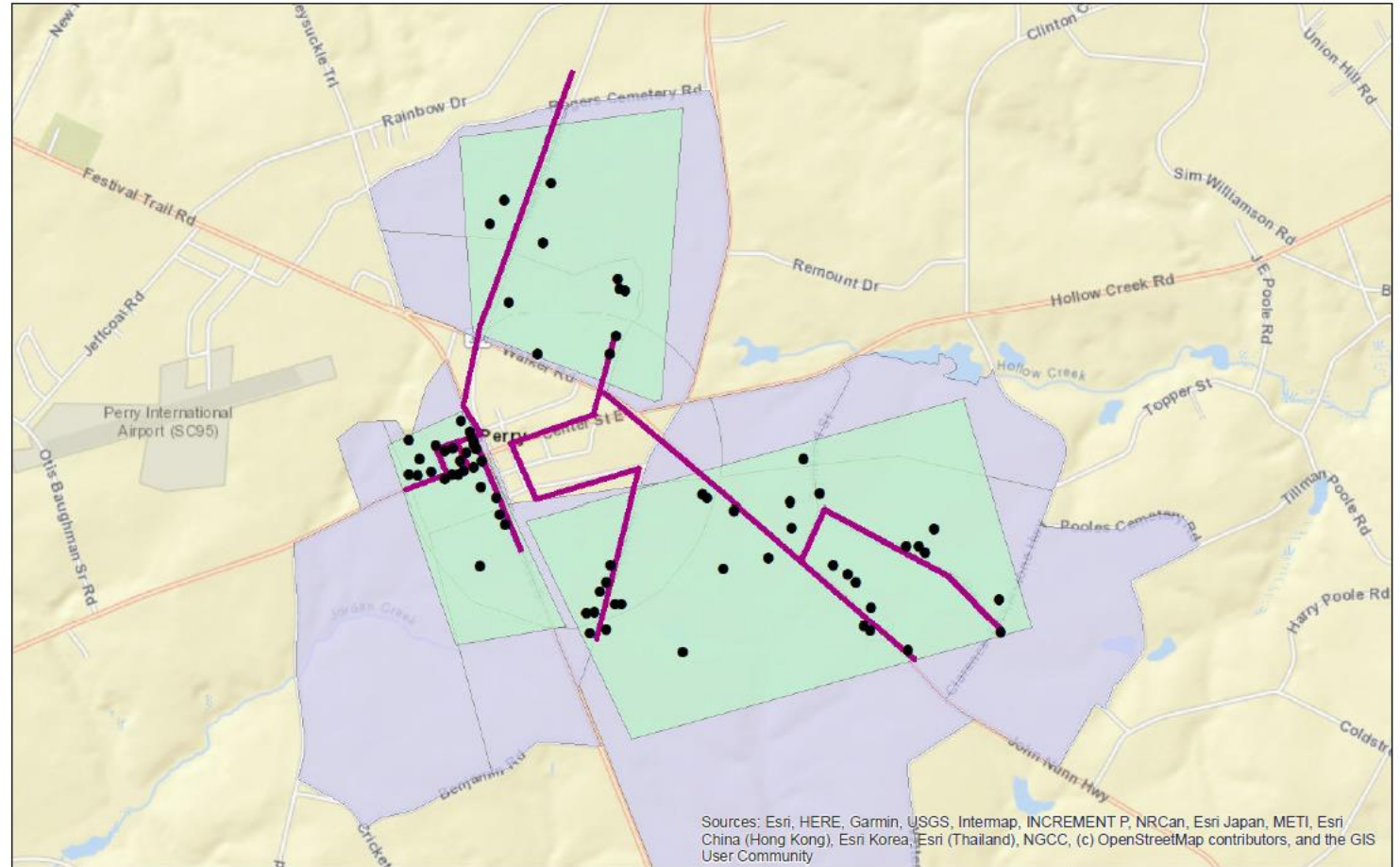
Q2
2022

TRANCHE 1



Project Design Template

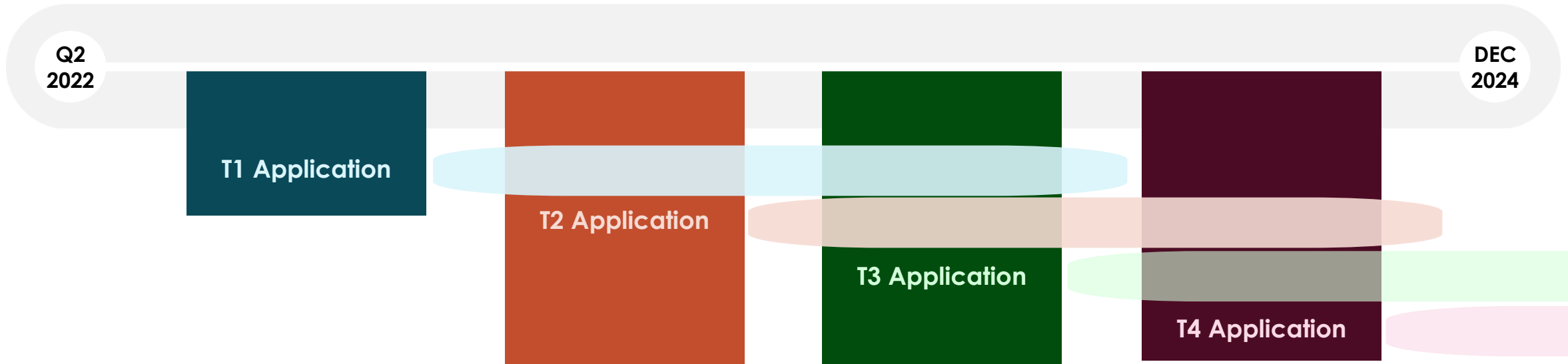
- 1) Census 2020 Blocks
- 2) Project Area
- 3) Main Fiber Routes
- 4) Impacted Households



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Exhibit K	Project Location Map Example	Legend <ul style="list-style-type: none">● Proposed Served Home or Business~ Proposed Fiber or Cable Line■ Proposed Service Area■ Proposed 2020 Census Block in Proposed Area	ISP Initial Here: _____ Date: _____
 BROADBAND OFFICE Map prepared by ORS on: <Date Goes Here>	2022 ARPA 1.0	4,000 Feet 	Data Source: <ISP Name Goes Here>

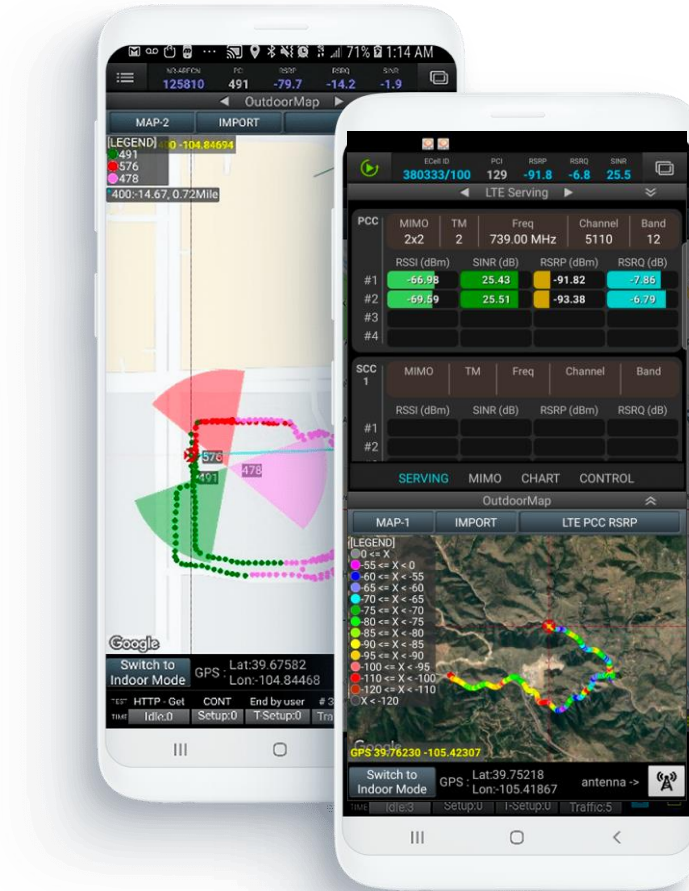
SC BROADBAND TYPICAL ISP





Ookla Wind

- CBRS / Private LTE network deployment and monitoring
- FirstNet coverage validation
- Troubleshooting connectivity issues underrepresented areas
- Embed into existing equipment





Kent Winrich
CTO, Open Broadband



Greg Spraez
CRO, Network Connex



Scott Jackson
National Market Manager



Jerry Gard
Director, Engineering, Motorola



FCC Internet Benchmarks

Qualifies for Federal & State Investment

Date Adopted	Minimum Download	Minimum Upload	FCC Commissioner
2015	25 Mbps	3 Mbps	Tom Wheeler, D
2010	4 Mbps	1 Mbps	Julius Genachowski, D
1996	200 Kbps	200 Kbps	William Kennard, D

Federal Construction Requirements

Reliable 100/20 Mbps scalable to 100/100 Mbps (symmetric)



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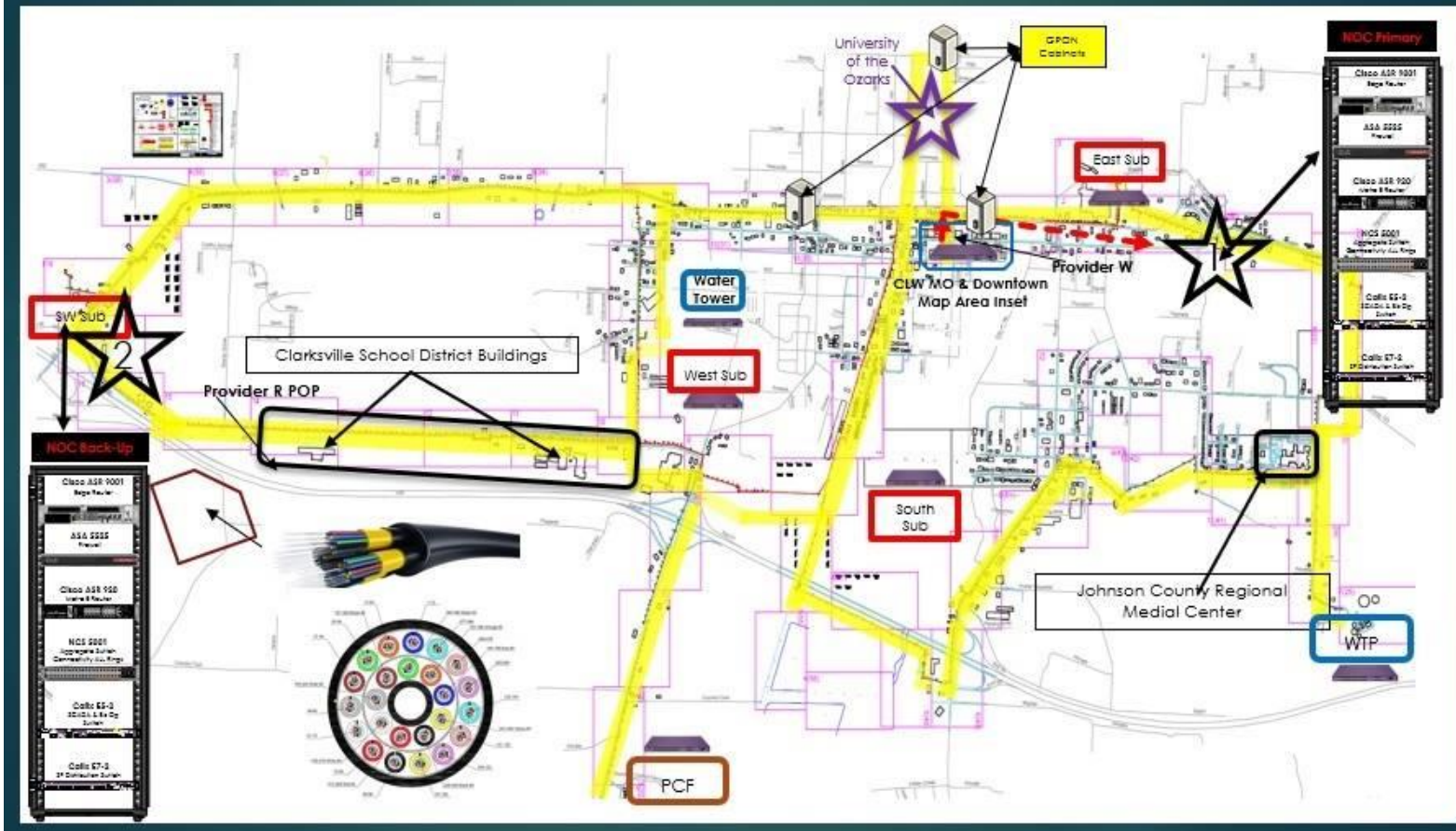
No Internet Options Exist

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17+ Miles Fiber Optic Network, Already Installed

Yellow Highlight Indicates the Exist "Core" Route around Clarksville

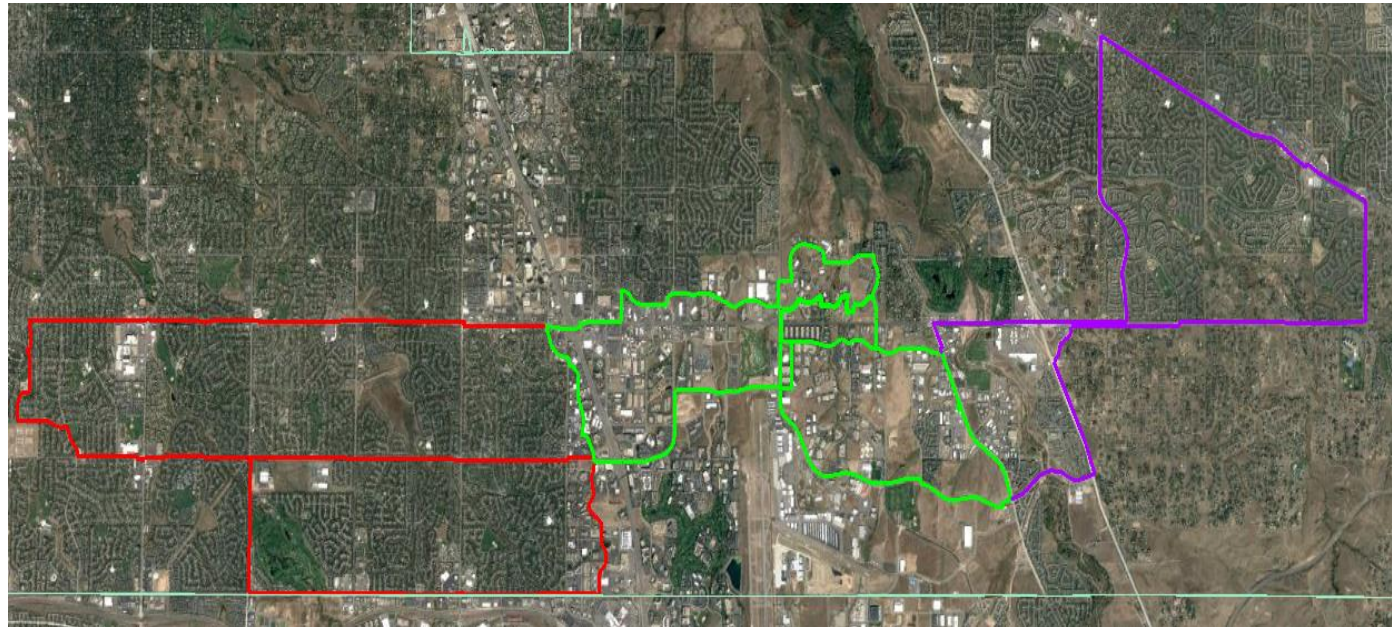


CLARKSVILLE
CONNECTED UTILITIES






DenseNetworks.com

Fiber Backbone-Open Access Model



Fiber Backbone – Rings and Status

-  Central Ring – Constructed
-  East Ring – Under Construction
-  West Ring – Constructed



The Spectrum Highway is Changing:

↑ Previous

Enterprise 5G



40

Current Licensed Spectrum

- Licensed 600 thru 2500 MHz
- AT&T: 150 MHz, Verizon: 115 MHz, T-Mobile: 110 MHz, Sprint: 200 MHz, Other: ~120 MHz

+ Mid-Band Spectrum

- 3550 to 3700 MHz (150 MHz) CBRS
- 3700 to 4200 MHz (500 MHz FCC) C Band
- 5925 to 6425 MHz (500 MHz FCC)
- 6425 to 7125 MHz (700 MHz FCC)

+ mmWave Spectrum

- 27.5 – 28.35 GHz (2X425 MHz)
- 37.6 – 38.6 GHz (5X200 MHz)
- 38.6 – 40 GHz (7x200 MHz)

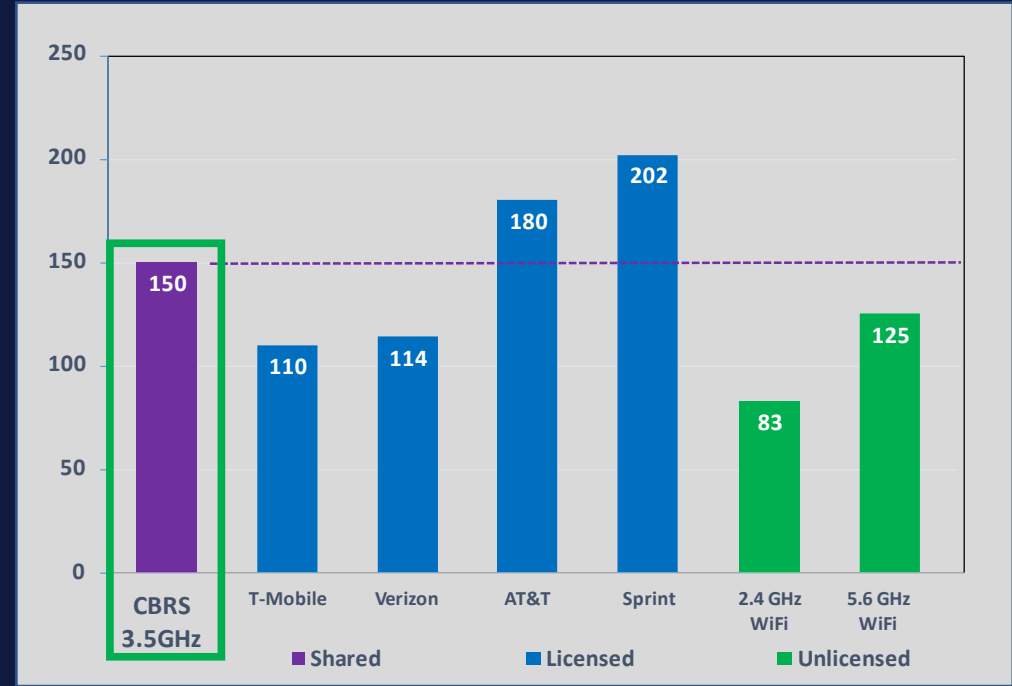
↓ Next



What is Private Cellular/CBRS?

- It is a cellular network that leverages a private core element instead of connecting to AT&T/VZ/TMO Public Wireless Network.
- Provides connectivity for enterprise members and their applications using 150 MHz of spectrum in the 3.5GHz Range – “CBRS”
- CBRS = Citizens Broadband Radio Service or LTE Band 48: Up to 150 MHz Fully Dedicated to Single Venue, Enterprise, or Community
- LTE Based Technology, Full Compatibility with Global Mobile Networks
- 15 Channels up to 160 Mbps Each
- 5G Friendly

Enterprise 5G



Basic Use Cases

- Fiber Alternative for Backhaul and Transport, Wi-Fi Offload, Network Densification, Low Latency Performance, User Mobility, Voice Services

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Building Blocks for Private Cellular Networks to Deliver True Mobility and Connectivity for All



CBRS expansion of the cellular spectrum enables enterprises to launch wireless networks using cellular networking technologies



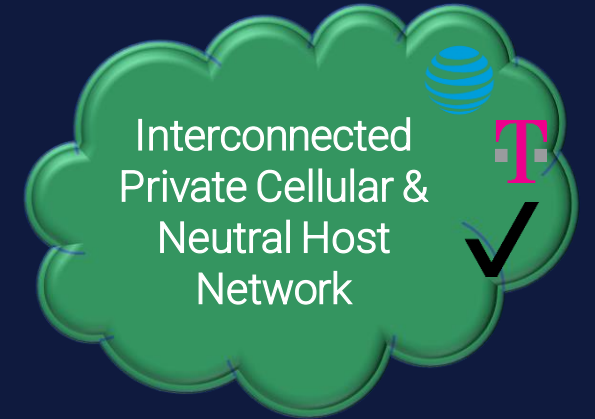
Low-cost cellular/CBRS small cells makes private Radio Access Networks (RANs) attractive



Core
Core powers your Private LTE/5G network and serves as a trusted party between enterprises and major *public* cellular carriers. Connect to Core, and your enterprise is **interconnected**

Trade
Trade is a service management platform that provides insights into user experience and in-building analytics

SIM Cards -
Core Connected Devices



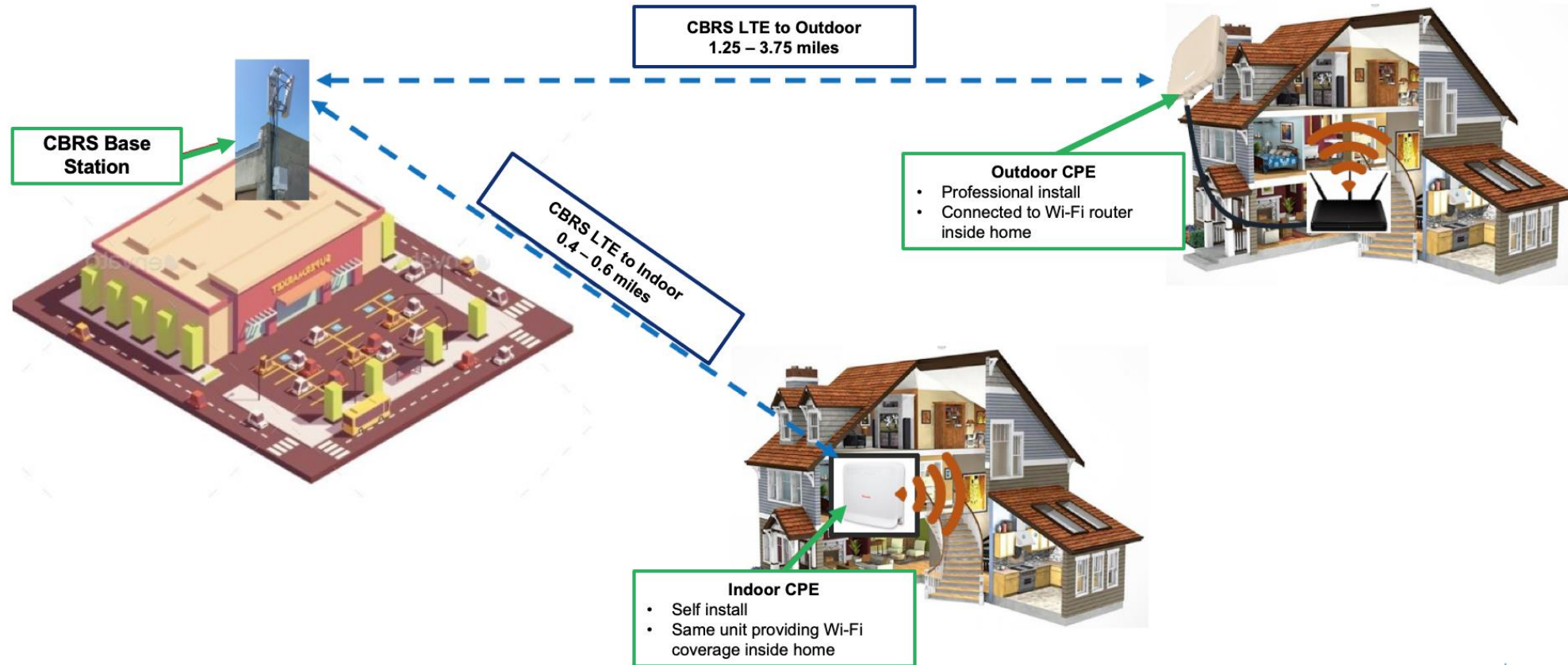
One private network,
Two key benefits:

- 1) Secure, high-performance network tailored to enterprise venue and user community
- 2) Neutral Host multi-carrier subscriber support

Residential Broadband Service using CBRS LTE Solution



Base stations are deployed at the school or another central location; once a base station is deployed, homes can be served within a range of 0.4 – 3.75 miles, depending on their corresponding infrastructure

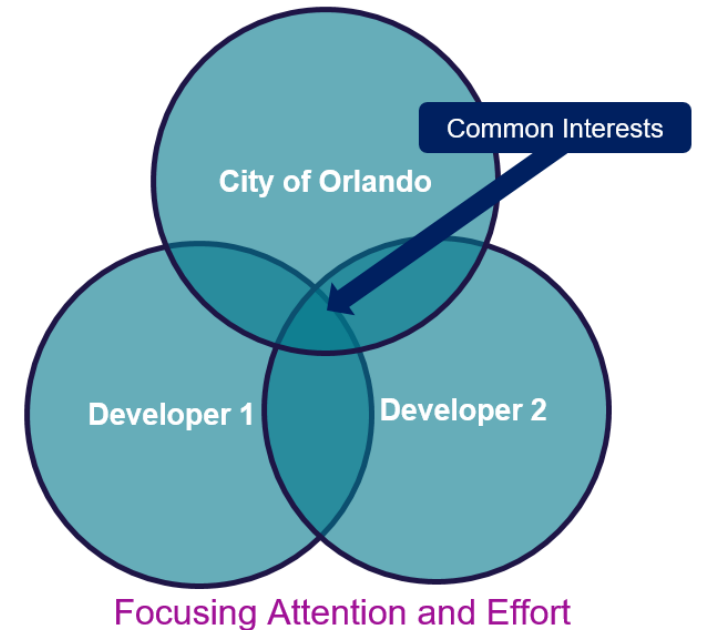


Fiber, Power & Poles are the Foundation for a Smart City



The Utilities' Leverage

- Use of assets
 - Street Lighting poles – allowing small cell growth in territory
 - Data access and availability
- Expansion of our fiber network
 - Pilot opportunities
- Facilitating Conversations
 - Utility is a common stakeholder in all smart city verticals



OMNIA

PARTNERS

POWER. ACCESS. TRUST.

**OMNIA
PARTNERS
PUBLIC SECTOR
COOPERATIVE
PROGRAM**



- Competed Contract satisfies Public Solicitation Process
- Kansas City – Lead public agency
- Products & Services eligible
- National Volume
- 23 years and 20,000 cities / agencies
- No Cost / Non-Binding
- Best in Class Vendors
- Best Overall Value

Key Benefits:

- **No RFP or Solicitation required**
- **Flexibility to choose suppliers and installation partners**
- **Shorten timeframes from concept to completion**
- **Great pricing resulting from competed contract**



2020 CARES Act \$ Paid for Network & Devices to support Homework Gap



CBRS Connected Wi-Fi Hotspot



City of Tucson Use Case Examples:

↑ Previous



Park Wi-Fi



City Smartphone Service



Analytics for City Pools



Mobile Data Terminal Service



City Mobile Tablet Service

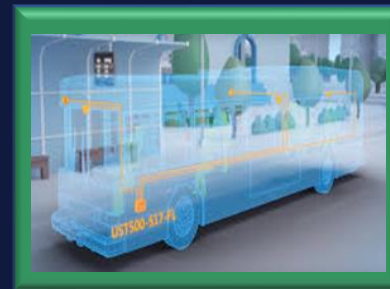
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Digital Divide Broadband



In-Building Neutral Host



City Transportation & Service Efficiency



Traffic Efficiency

This is Geoverse

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DenseNetworks.com