Ookla®

Global Approaches to Regulatory Challenges

ITU Workshop on "Telecommunication Service Quality"
Amman, Jordan - 17-18 October 2022

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Agenda

- Ookla Overview
- Select Use Cases
- Conclusion

Private and confidential

About Ookla

OOKLA®

The Connectivity Company

- Ookla's mission is measure, understand, and help improve connected experiences
- Global headquarters in Seattle, WA with offices in Dubai, Dublin, Denver, London and Memphis and employees in 28 countries
- Trusted data and software provider to CSPs, governments, NGOs, academic institutions, trade groups, and industry analysts
- Enterprise clients in 150 countries

Ookla is a bridge between consumers and the industry

Consumer engagement and crowdsourcing at global scale, leading in consumer brand trust and recognition

SPEEDTEST

Consumer-Initiated Network Testing

600+ million
app installs

18+ million
daily tests

45+ billion
tests taken to date

16,000+
global testing servers

Downdetector

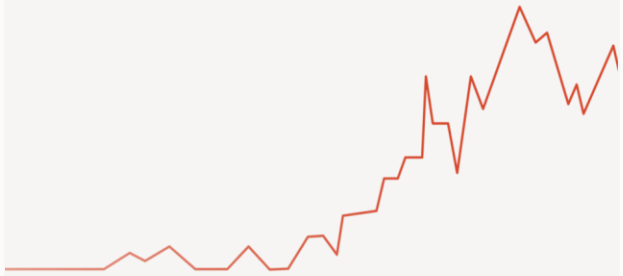
Incident Detection

200+ million
unique users

25+ million
monthly problem reports

12,000+
services monitored

45+
Countries



Global Media Share

48,000+
ARTICLES PUBLISHED ANNUALLY REFERENCING OOKLA BRANDS

330b+
UNIQUE MONTHLY VIEWERS TO PUBLICATIONS CITING OOKLA DATA

48.1%
SHARE OF VOICE COMPARED TO COMPETITORS IN THE INDUSTRY

Radio Network & User Experience Insights

1+ billion
unique devices

100+ billion
samples per day

800+
CDNs and cloud providers

10,000+
content & app providers

190+
countries

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Government Use Cases

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Telecommunications Regulatory Commission - Jordan

Reliable and Resilient Connectivity

- Early adopter of crowdsourced network intelligence
  - ITU SG12 E.806 and ITU SG12 E.812 recommendations
- Network resiliency during the pandemic
  - March 2020 spectrum allocation
  - Safely and remotely oversee all coverage and quality issues
    - Consumer problem mitigation
  - Prioritize remote coverage improvements
- Consumer connectivity environments
  - Indoor consumer connectivity experiences
  - Cross-border handoff improvements

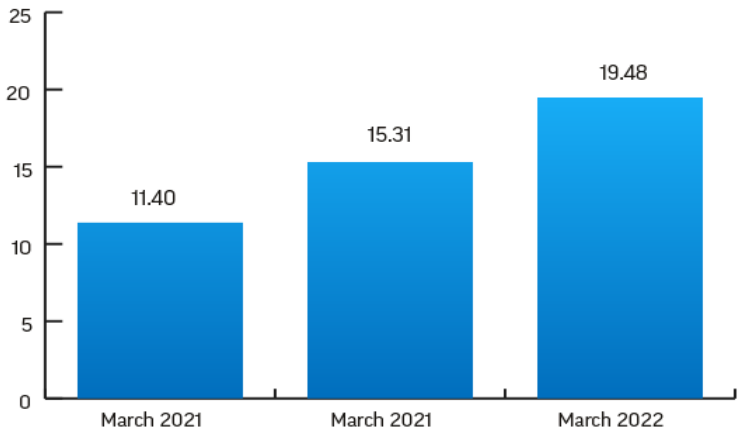
Telecommunications Regulatory Commission - Jordan

Reliable and Resilient Connectivity

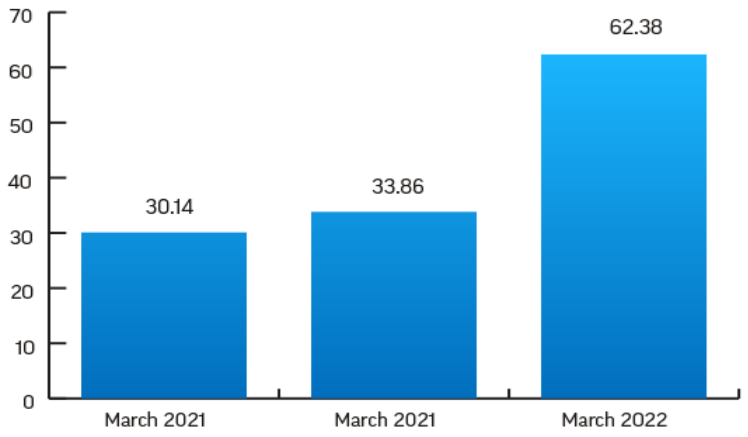
Key outcomes

- Cost and efficiency improvements with wellness in mind
- 97% consumer problem mitigation
- Monitoring of pandemic spectrum allocation
- Massive national broadband performance improvements

Jordan's Mobile Median Download Speed (Mbps)
Speedtest Intelligence® | March 2020 – March 2022



Jordan's Fixed Median Download Speed (Mbps)
Speedtest Intelligence® | March 2020 – March 2022



Data-driven spectrum policy decisions

- Kingdom of Saudi Arabia's Vision 2030
  - Supported by CITC - fifth-generation (G5) ICT regulator
  - Broad use of network performance and radio engineering data
  - Focused on increasing competition and network performance
- Three-year spectrum roadmap
  - Evidence-based approach to spectrum assignment
  - Consultative approach to data analysis and market research
  - Spectrum utilization and performance assessments

Communications and Information Technology Commission – Kingdom of Saudi Arabia

Data-driven spectrum policy decisions

CITC Spectrum Planning Roadmap

	2019	2020	2021	2022 & Beyond
5G spectrum available to Saudi operators	~ 200 MHz* (FR1)	~ 200 MHz (FR1)	~ 300 MHz (FR1)	~ 300 MHz (FR1), ~ 1000 MHz (FR2)
5G bandwidth capabilities of commercially available 5G devices	100 MHz (FR1)	100 MHz (FR1)	200 MHz (FR1)	300 MHz (FR1), 1000 MHz (FR2)
Examples of 5G-capable devices/modems	Huawei Mate 20 X 5G (HiSilicon Balong 5000), Samsung Galaxy Note 10+ 5G (Exynos 5100), ZTE Axon 10 Pro 5G (Qualcomm X50)	Apple iPhone 12 (Qualcomm X55), Samsung Galaxy S20 Ultra 5G (Exynos 990)	Huawei CPE Pro 2 (HiSilicon Balong 5000), Samsung Galaxy Fold 3 5G (Qualcomm X60)	Qualcomm X65

** Since 2019, stc: 200 MHz (n40, n78); Mobily: 200 MHz (n41, n78); Zain: 190 MHz (n41, n78). Zain implemented 5G CA for their n41 and n78 5G carriers.*

SPEEDTEST

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National Fiber Optics and Connectivity Plan (NFCP)

Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

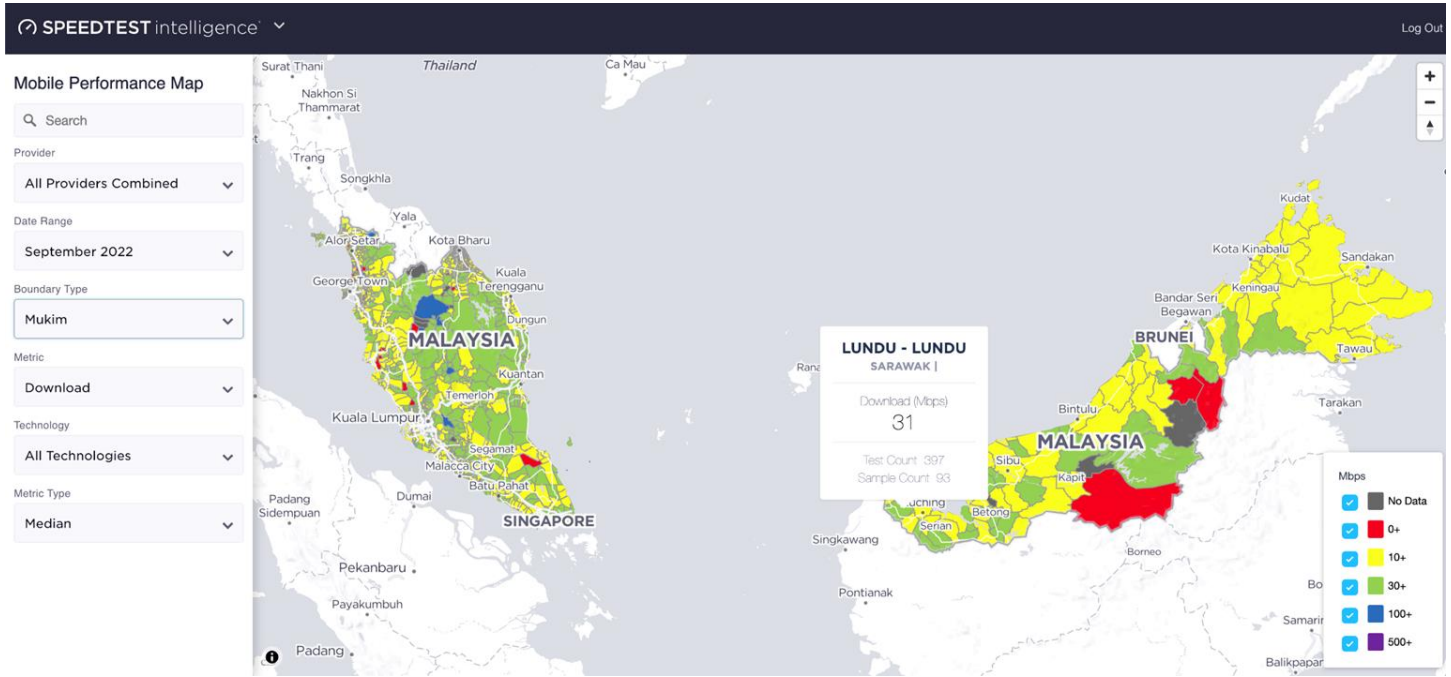
- National Aspirations
  - Gigabit access for fixed broadband
  - 100 Mbps mobile broadband
  - 100% 4G coverage
- Initial NFCP Goals
  - Accelerate infrastructure development; balanced urban / rural
  - NFCP performance and implementation monitoring
- JENDELA Project Targets - 2020-2022
  - 83% premises nationwide with gigabit fixed broadband access
  - Increase mobile 4G coverage from 91.8% to 96.9%
  - Increase mobile broadband speed from 25 Mbps to 35 Mbps
  - 3G sunset, upgrade of 4G and fiberisation

Malaysian Communications and Multimedia Commission - Malaysia

National Digital Infrastructure Plan (JENDELA)

Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

- JENDELA Broadband Mapping Efforts
  - Internal regulatory mapping and data visualization
  - Custom Speedtest Intelligence SaaS

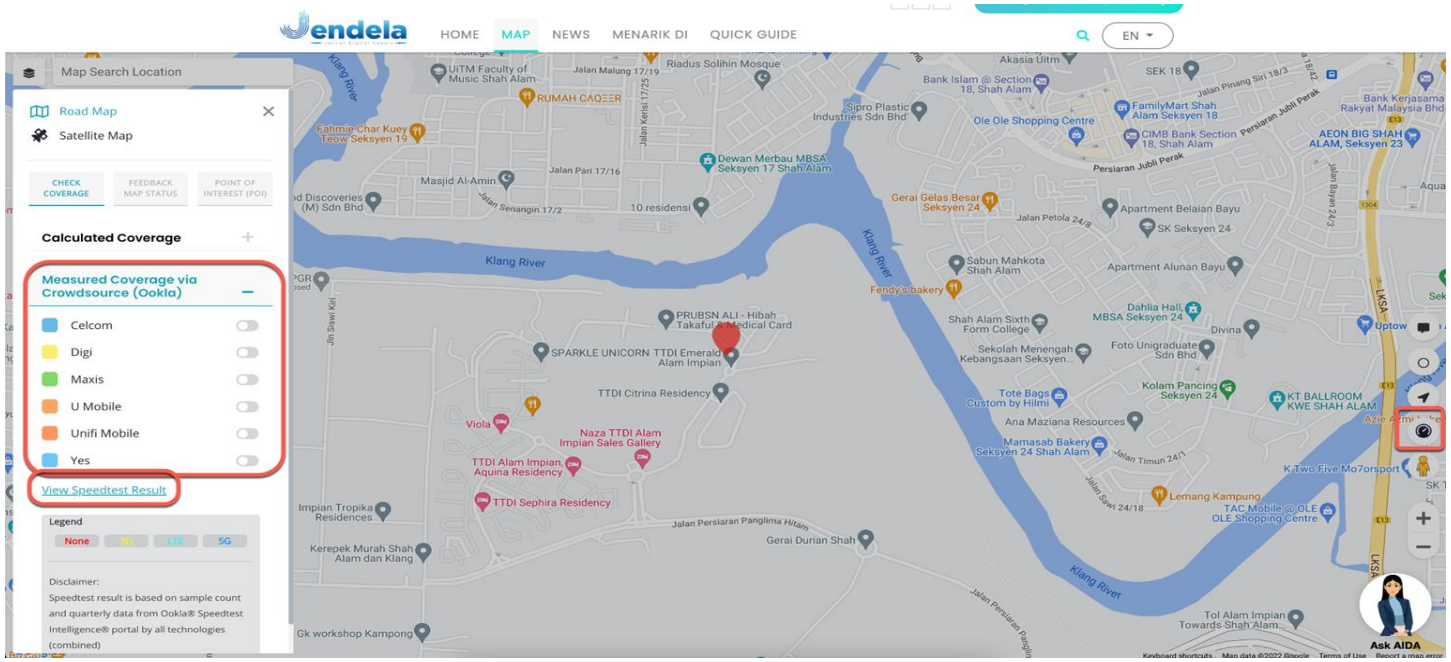


Malaysian Communications and Multimedia Commission - Malaysia

National Digital Infrastructure Plan (JENDELA)

Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

- JENDELA Broadband Mapping Efforts
  - Public network availability maps
  - Network performance, coverage, measurement and feedback



Federal Communications Commission - United States

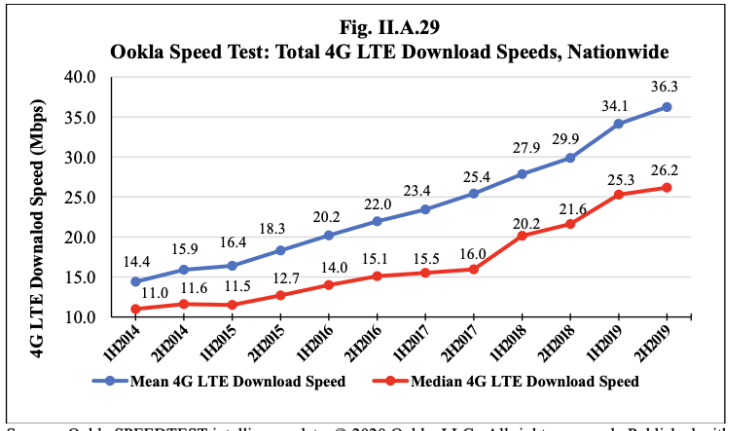
FCC Communications Reporting / Broadband Funding

Fig. II.A.28
Ookla Speedtest - Estimated 4G LTE Upload Speeds by Service Provider, Nationwide

Service Provider	2H2018			1H2019			2H2019		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests ('000s)	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests ('000s)	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests ('000s)
AT&T	7.88	5.34	2,642	9.18	6.90	3,167	9.89	7.93	3,188
Sprint	3.28	2.48	1,794	3.61	2.70	1,594	4.18	3.15	1,441
T-Mobile	11.75	9.54	3,052	12.98	10.40	2,688	14.23	11.61	3,180
Verizon Wireless	9.90	6.99	3,886	10.48	7.52	3,419	10.94	7.81	3,708

Source: Ookla SPEEDTEST intelligence data, © 2020 Ookla, LLC. All rights reserved. Published with permission of Ookla.

Fig. II.A.29
Ookla Speed Test: Total 4G LTE Download Speeds, Nationwide



Source: Ookla SPEEDTEST intelligence data, © 2020 Ookla, LLC. All rights reserved. Published with permission of Ookla.

- Biennial Communications Marketplace Report
  - Assesses the competitive state
  - Data sources pan-government, mobile operators, ISPs, crowdsourced and controlled measurements
  - Drives regulatory decisions to improve competition and consumer experiences
- Broadband Equity, Access, and Deployment (BEAD) Program
  - Provides $42.45 billion to expand high-speed internet
  - Required by Congress to include crowdsourced data in determining underserved and unserved areas
  - Crowdsourced data will also be used for challenges and compliance purposes

U.S. Department of Commerce - NTIA

- Works jointly with the FCC to distribute Broadband Equity, Access, and Deployment (BEAD) funding
- National Broadband Availability Map
  - Directed by Congress to acquire and utilize 3rd-party data
  - Works closely with states, territories, tribes and enterprises
  - Evaluated 10 years of Ookla Speedtest fixed and mobile data to establish historical performance benchmarks
  - Leverages predicted mobile network coverage and RF network quality data
  - Internal government resource identifying ‘areas of need’

What level of service is available?

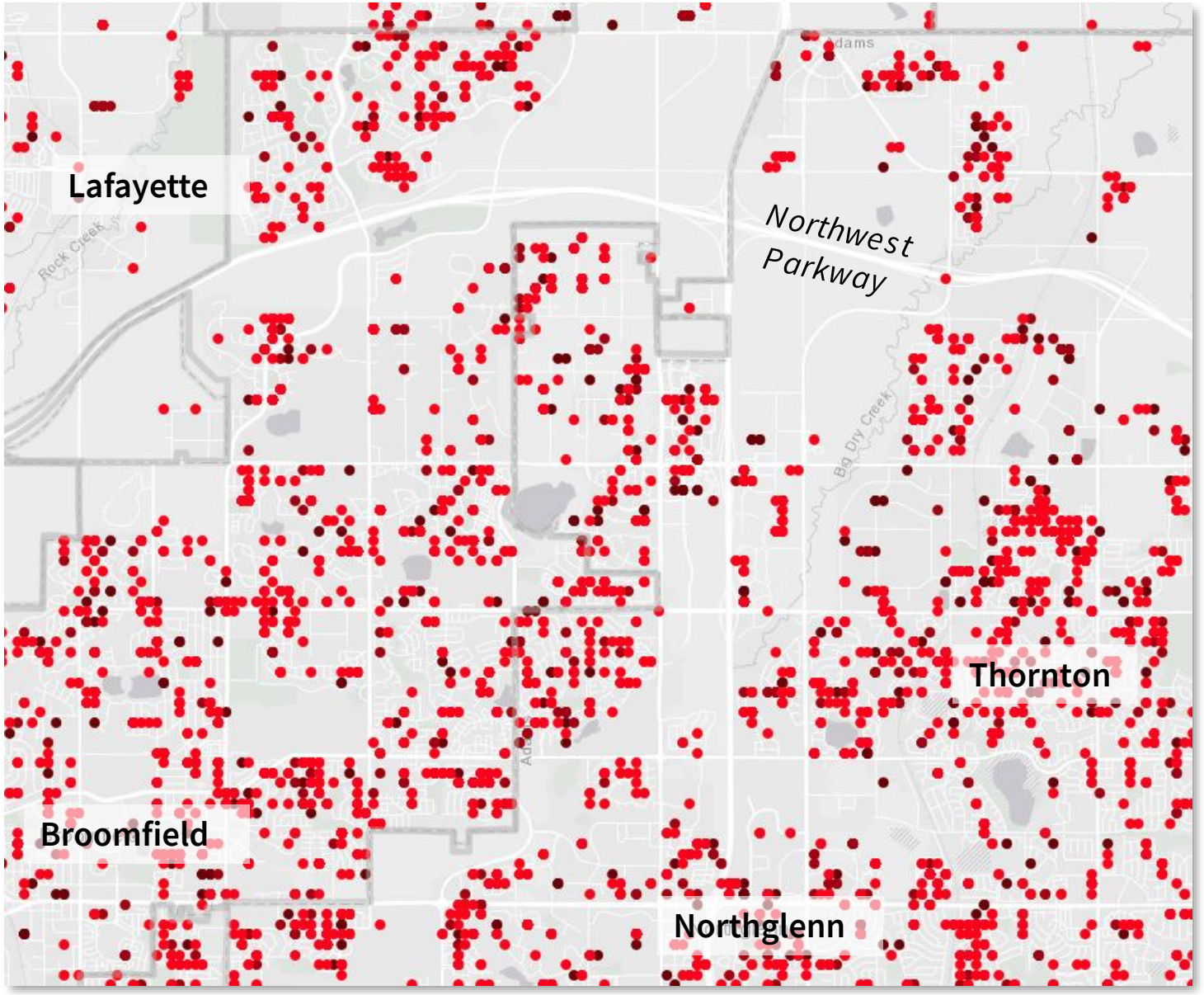
Example: Data from 2021

Northeast of Denver, CO

- Fixed operators tested via native mobile and desktop applications
- Filtered for records with GPS-provided longitude and latitude
- Layering with the fastest tests on top provides evidence for where broadband speeds are being met and where they are not
- Areas with significant evidence of being underserved can be targeted for investment

Speedtest® Measurements

Less than 25 Mbps



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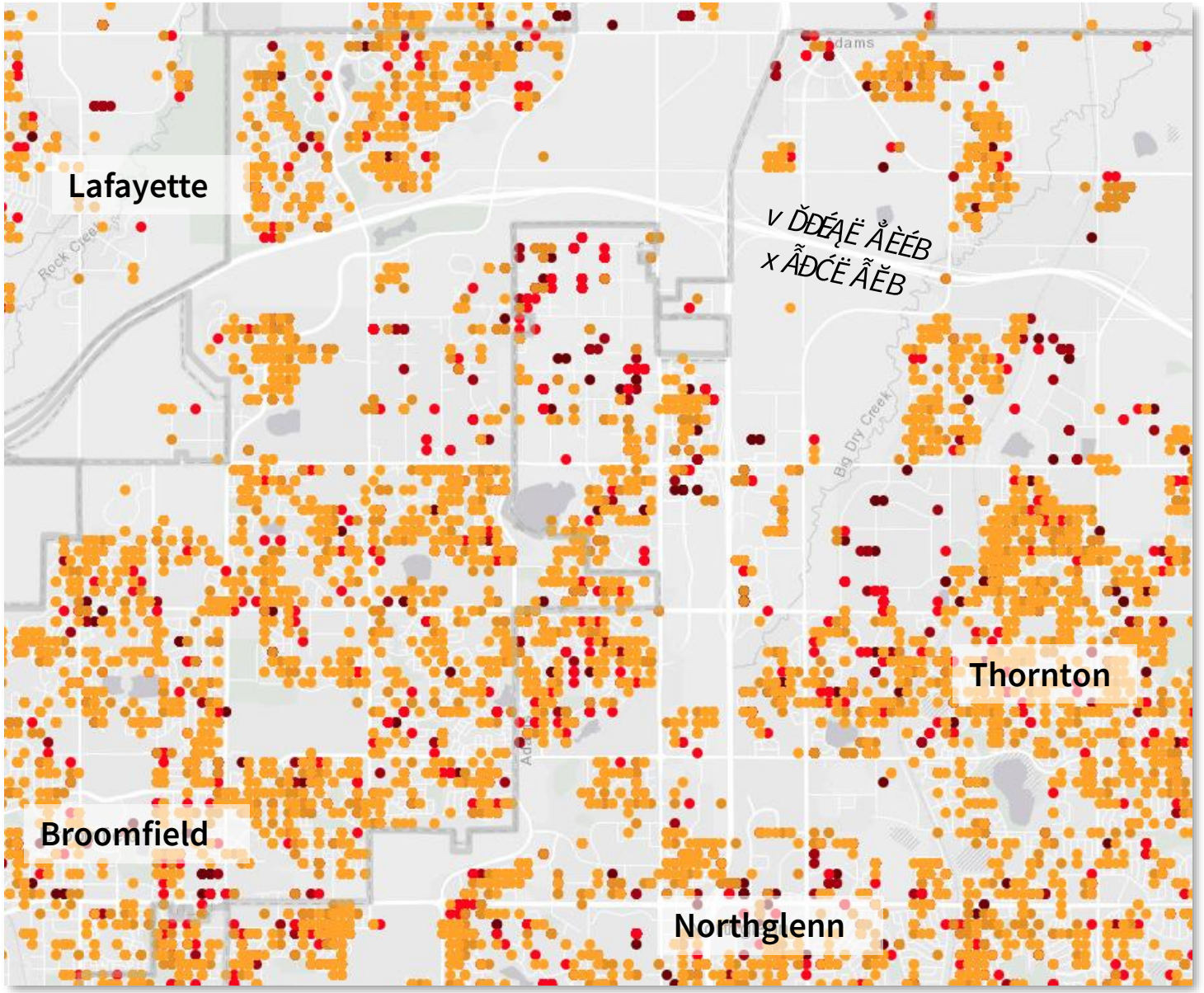
Speedtest® Measurements

Less than 25 Mbps

25 - 100 Mbps



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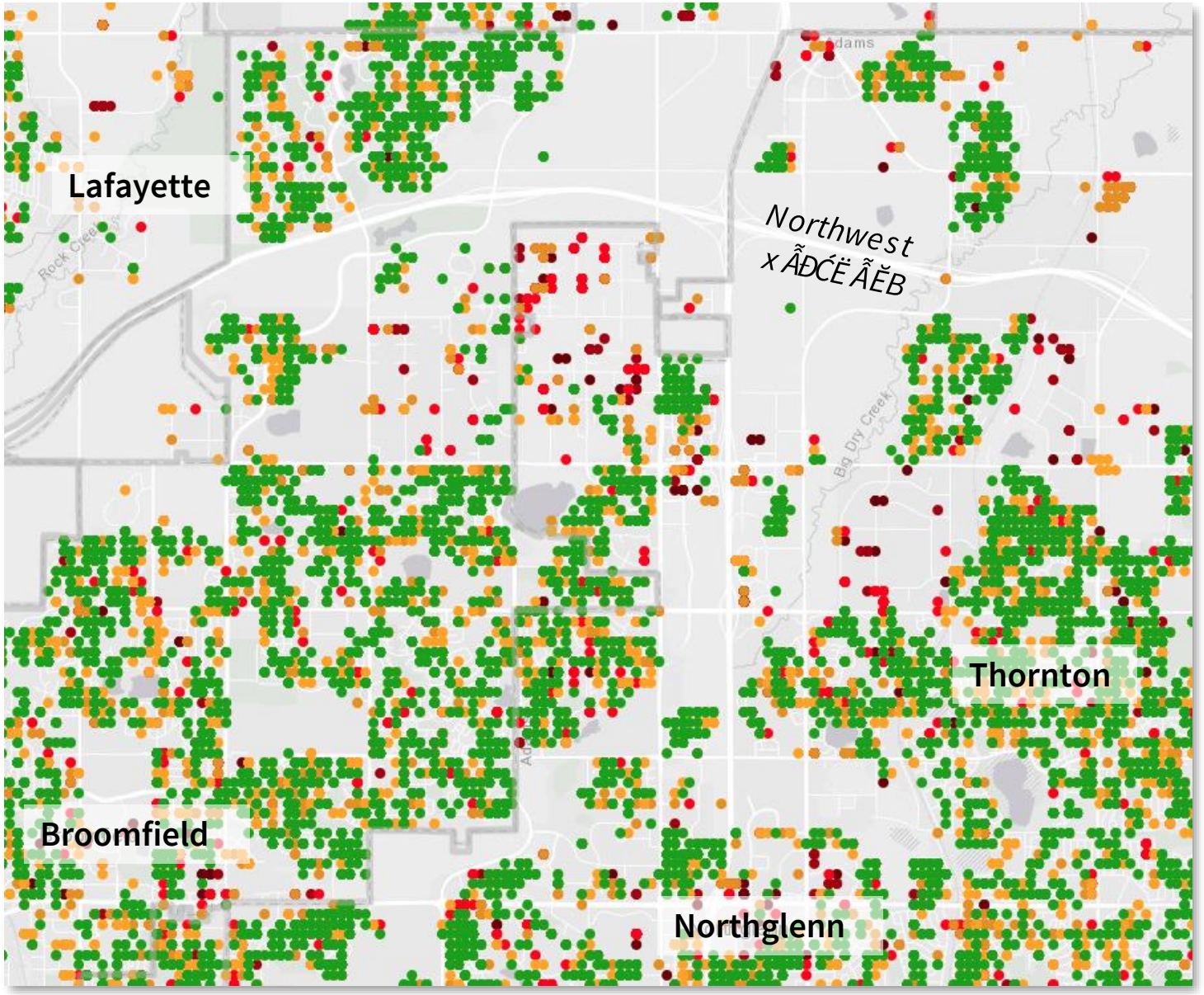
Speedtest® Measurements

- Less than 25 Mbps
- 25 - 100 Mbps
- 100 - 300 Mbps



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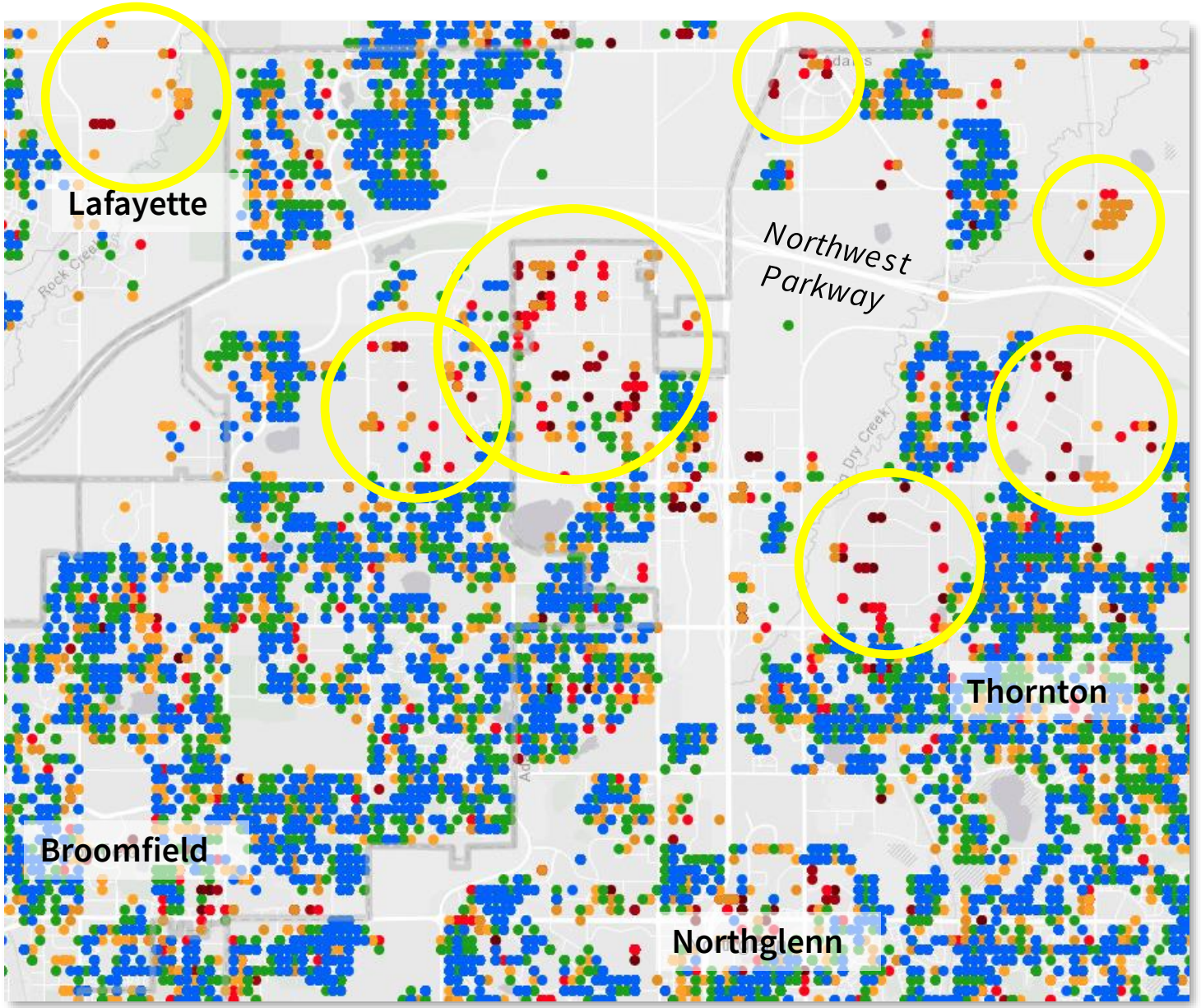
Speedtest® Measurements

- Less than 25 Mbps
- 25 - 100 Mbps
- 100 - 300 Mbps
- 300+ Mbps



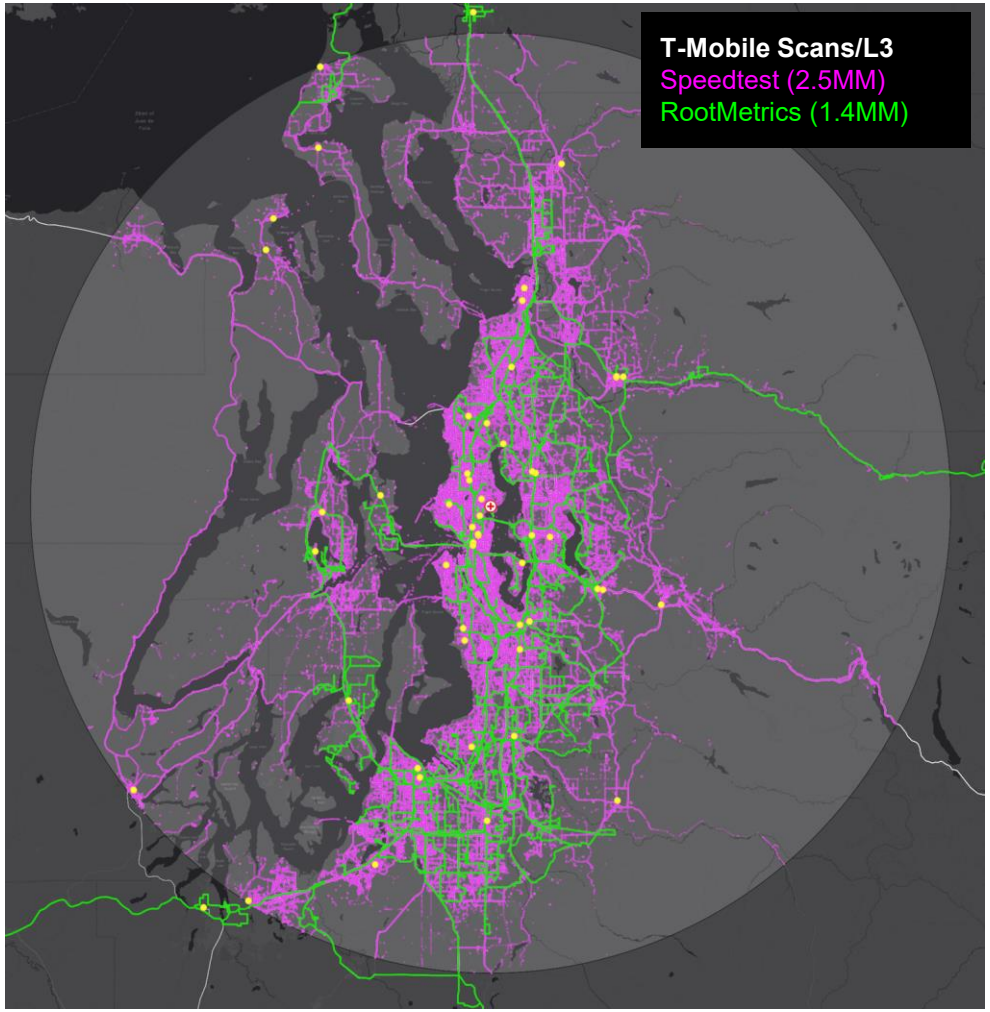
Seattle Children's Hospital and the University of Washington - United States

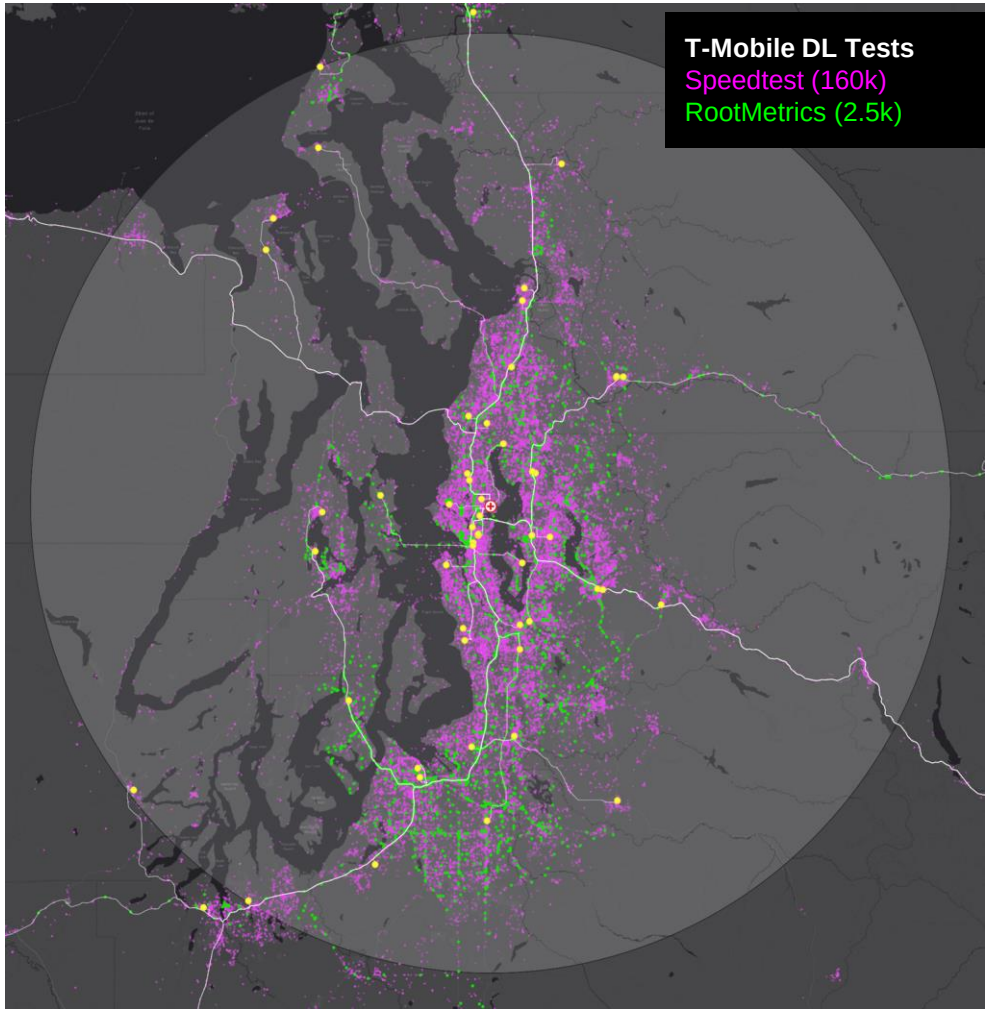
Critical Care and Route Connectivity

1. Problem Statement
    a. Ambulances route from rural hospitals to critical care facility
    b. En route - Which operator supports video the best?
2. Data Sources
    a. Speedtest Intelligence® & RootMetrics® (prior 2 quarters)
    b. Active Downlink performance & Signal Scans
3. Route Performance & Radio Frequency Analysis
    a. Maps, Comparison by Route

Seattle Children’s Hospital and the University of Washington - United States

Critical Care and Route Connectivity





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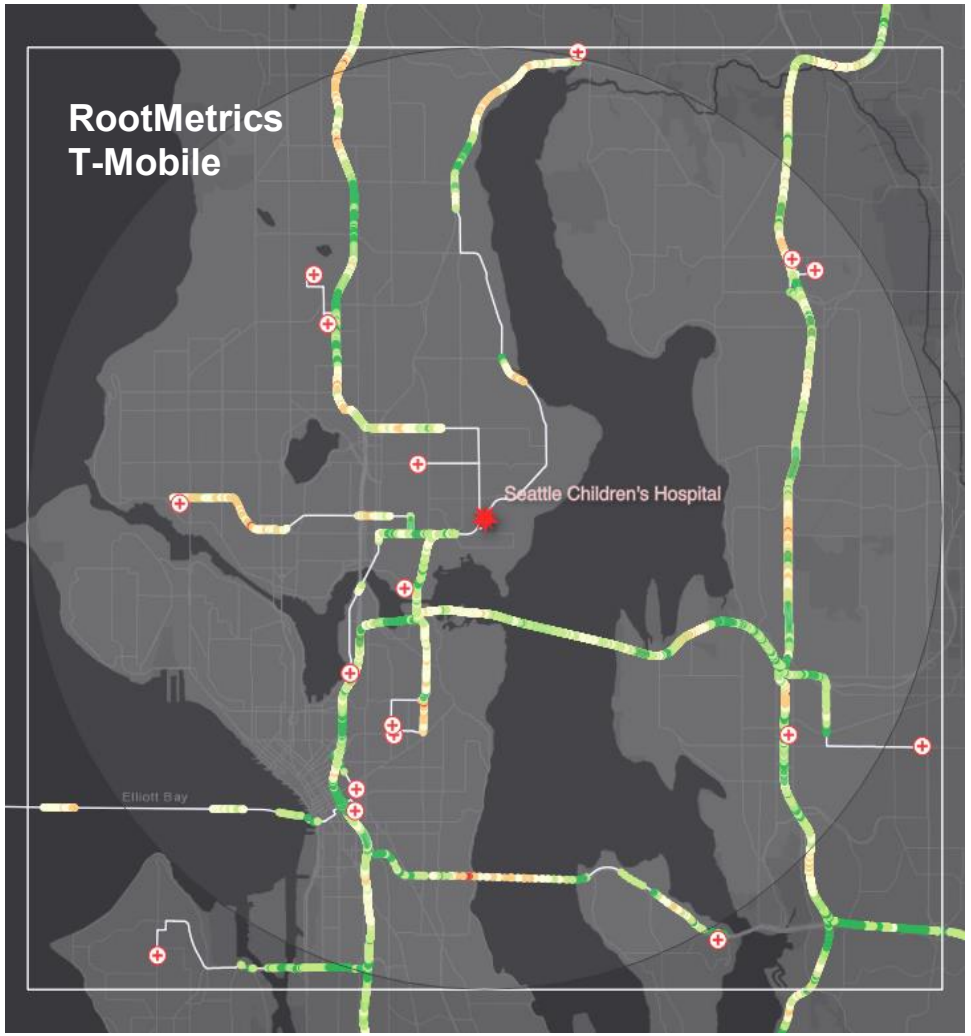
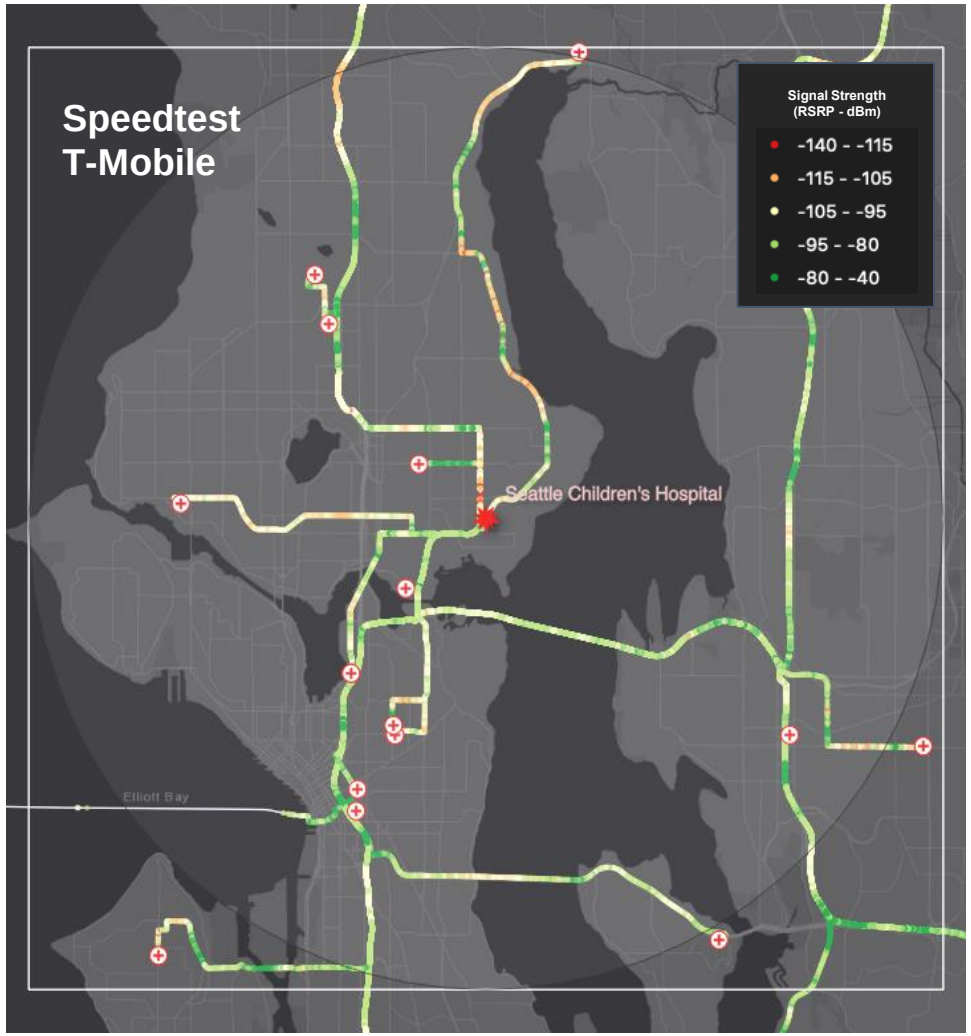
Critical Care and Route Connectivity





Critical Care and Route Connectivity

Conclusions

- Large amounts of data exist for this sort of route-profile use case
- Speedtest Intelligence & RootMetrics (or other drive test data) are complimentary and compensate for weaknesses
- Download performance
  - Averaged over all routes/data, T-Mobile > Verizon > AT&T/FirstNet 95% of the time, though all operators have speeds to manage video streaming
  - 90% of the time, T-Mobile's speeds are 50-100%+ higher than the next best operator
  - With routes within a total routed distance of 10mi of Seattle Children's Hospital
    - T-Mobile has speeds that might impact video < 1-2% of the time
    - For longer ranges (15 mi +), all the operators are similar

- RF Signal Strength
  - AT&T and T-Mobile are similar, 90% of the time having RSRP that would be considered reasonable to excellent (> -105 dBm)
  - Verizon typically had 3-5 dBm lower signal strength, but that is but one piece of quality of service

Measure, understand, and help improve connected experiences

- Crowdsourced data is proven
  - Relevant to consumers
  - Adopted by the global marketplace
  - Supports QoS and user experience needs
  - Additive to other data sets
- Embraced by governments
  - Consistent competitive benchmarks
  - Flexible data collection and visualization options
  - Efficiently assess operator compliance
- Be aspirational
  - Take advantage of analytical competencies
  - Ookla and regulators have mission alignment

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