

# Routes

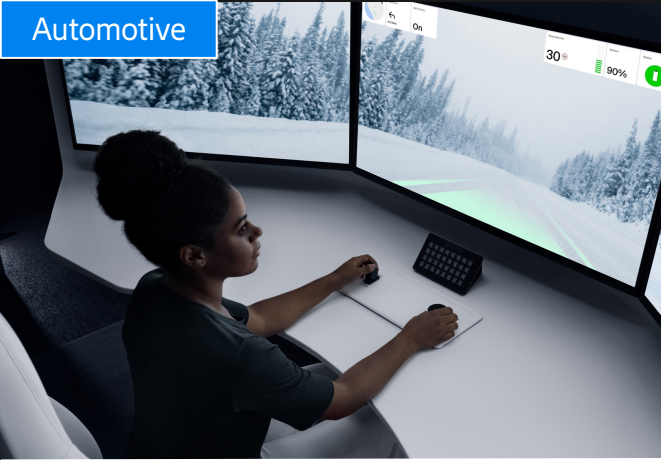
Informed Connectivity for Tele-Operations

- Gyan Ranjan, PhD  
CTO, Ericsson Routes

☰ ONE

# Tele-Operations: Sense-Infer-Actuate ...

Automotive



Tele-Medicine



Drones



O&M



**Applicability:** Multiple domains, varied use-cases, different requirements.

# Universally Acknowledged ...



*"Should a system fail in a manned vehicle, a safety driver may take over operation. Their control is enabled through redundant wireless connections."*

— Nuro's filing with NHTSA and 2022 vehicle safety report



*"NEMSAC recommends NHTSA promote the expansion of the EMS environment of care to include telehealth services, particularly in rural areas of the country."*

— National EMS Advisory Council, August 2020



*"With our approvals, we are able to install Scout systems in Nevada and Kansas, and remotely operate them from Boston, MA"*

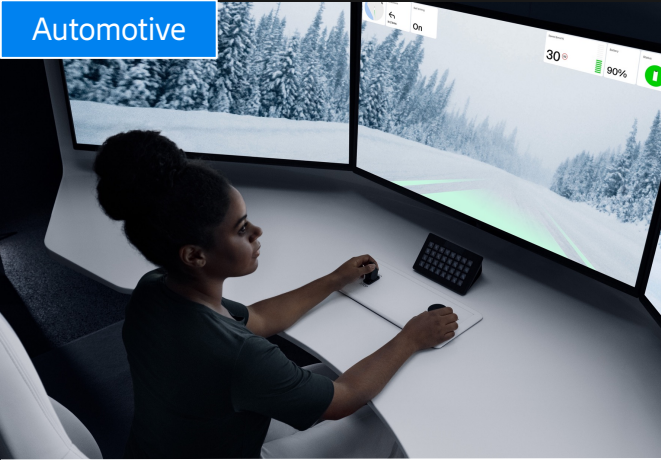
— American Robotics, first company approved to operate automated drones without humans on-site, January 2021

**Assumption:** Good infrastructure *is/will-be* available, *whenever and wherever* needed.



# Tele-Operations Require “Good” Connectivity ...

Automotive



Tele-Medicine



Drones



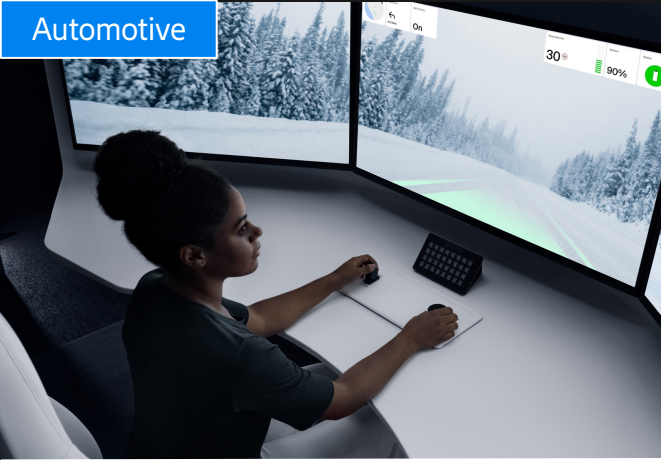
O&M



The Glue: Underlying network [ Resource provisioning and management ].

# Current Connectivity Choices ...

Automotive



Tele-Medicine



Drones



O&M

Contenders



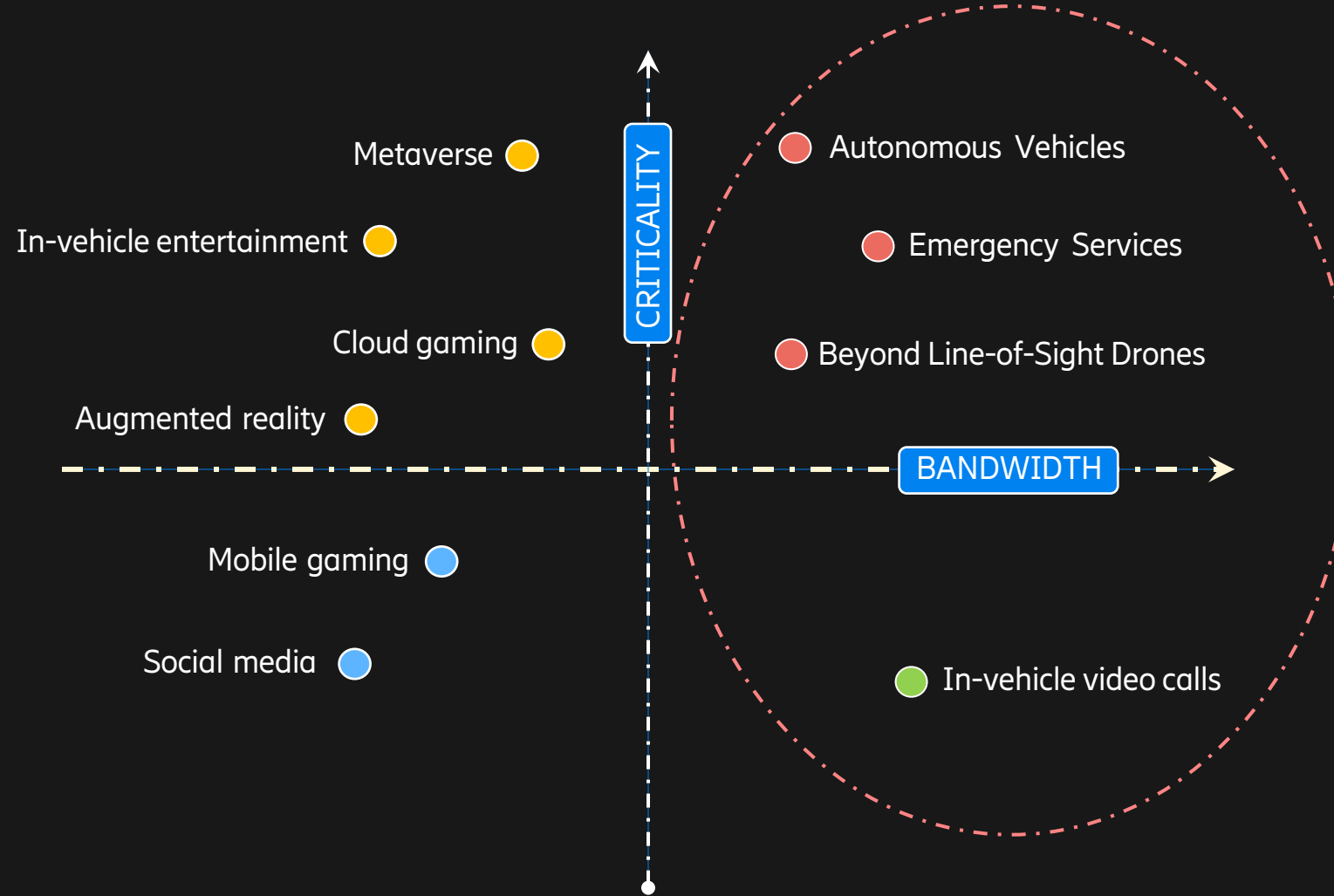
Cellular Networks

Wi-Fi Networks

Satellite Networks

**State-Of-The-Art: Public Cellular Networks are the Most Viable Option.**

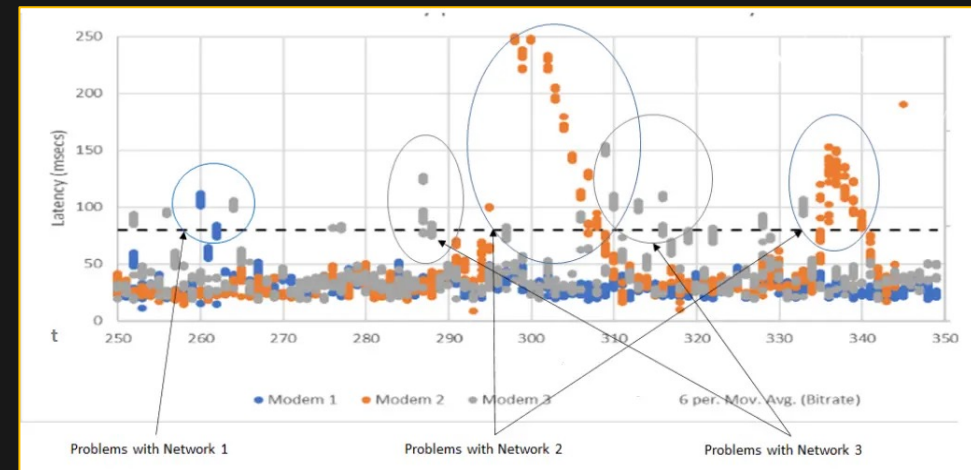
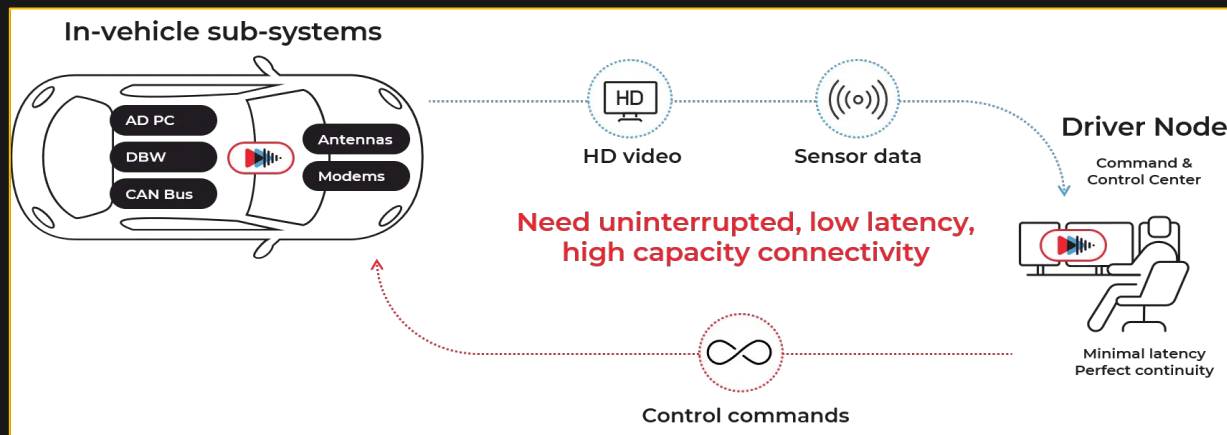
# Resource Requirements Vs. Criticality ...



**A Paradigm Shift:** High fidelity network requirements in the UPLINK direction.

# A Study by DriveU.auto ...

Source: <https://driveu.auto/blog/autonomous-vehicle-teleoperation-is-one-network-enough-for-remote-driving>



**Conclusion:** "No single network can provide the connectivity required for AV teleoperation – not even 5G."



Source: <https://www.thedrive.com/news/a-swarm-of-self-driving-cruise-taxis-blocked-san-francisco-traffic-for-hours>

## A Swarm of Self-Driving Cruise Taxis Blocked San Francisco Traffic for Hours

**More than a half-dozen Cruise-branded Chevy Bolts were reportedly stuck blocking lanes for hours.**

BY ROB STUMPF JUL 5, 2022 12:49 PM

**Conjecture:** What if the cause were network resource contention? Could it be avoided by predicting QoS?



# If Connectivity is Critical to Tele-Operations ...

... then so is knowing the **QUALITY** of that connectivity!

**Problem:** We often don't know how good/bad the underlying connectivity really is!

# So, who could Provide Network QoS Estimates?

## Operators



## Third-Parties



## Cloud Services



**Limitations:** Partial cadence, conflicts of interest, risks related to information sharing.

# Urgent Need: A Predictive System for Network QoS ...

High resolution

At any location and any given time

Adaptive

A priori and in real-time

Flexible

Accessible via API or web-based UI

Universal

Any operator

**Result:** A network observability PLATFORM.

303 2nd St, San Francisco, CA 94107

UCSF Medical Center

Add destination

Route options

Close

Avoid

☐ Highways

☒ Uplink less than 10 Mbps

☐ Tolls

☒ Latency more than 100 ms

☐ Ferries

☐ Downlink less than 30 Mbps

Send directions to your phone

via Fell St

Fastest route now due to traffic conditions

Details

20 min

5.3 miles

via Market St

Some traffic, as usual

22 min

5.0 miles

Gas

Groceries

Hotels

More

Courtesy: <https://www.google.com/maps>

Sign in

Union Square

303 2nd St

LAUREL HEIGHTS

JAPANTOWN

TENDERLOIN

SOMA

SOUTH BEACH

Oracle Park

Chase Center

Crane Cove Park

DOG PARK

POTRERO HILL

DIAMOND HEIGHTS

NOE VALLEY

MISSION DISTRICT

INNER SUNSET

HAIGHT-ASHBURY

de Young Museum

San Francisco Botanical Garden

Tank Hill

Sutro Tower

Twin Peaks

Copper St

Portola Dr

Castro St

Market St

Frederick St

Stanyan St

Fulton St

Balboa St

Geary Blvd

California St

Veterans

Fillmore St

Divisadero St

Bush St

Turk Blvd

Turk St

Webster St

Gough St

Franklin St

Turk St

Mission St

Howard St

Folsom St

4th St

Brannan St

16th St

24th St

Cesar Chavez

Evans Ave

20 min

5.3 miles

22 min

5 miles

Contention: QoS of network connectivity should inform route selection.

ARTS-22: 2022-07-19



# Observing is Believing ...

... imagine no longer

**Ericsson Routes:** Coming this fall to a road near you!

- Menu
- Route planning
- Dashboard
- Fleet management
- Developer's page
- Billing
- Account
- Feedback

Heat map





- Menu
- Route planner
- Heat Map
- Route prediction
- Fleet management
- Developer portal

Route planner

Route options

Option 1

Route score

84.1

Save to vehicle

Option 2

Route score

70.0

Map showing route options between 303 2nd Street and UCSF Medical Center. The route is highlighted in yellow and green, passing through various neighborhoods like Pacific Heights, Haight Ashbury, and Mission. The map includes street names, landmarks, and a network quality threshold bar at the bottom.

Network operators: Primary AT&T 1st backup B1 verizon 2nd backup B2 T-Mobile

Network quality threshold (Connected EMS): 0 Mbps 8 18 40 Mbps



- Menu
- Route planner
- Heat Map
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- Developer portal

Route planner

Route options

Option 1

303 2nd Stree... UCSF Medical ...

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- Menu
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Route planner

Route options

Option 1

303 2nd Street to UCSF Medical Center

Route score

84.1

Option 2

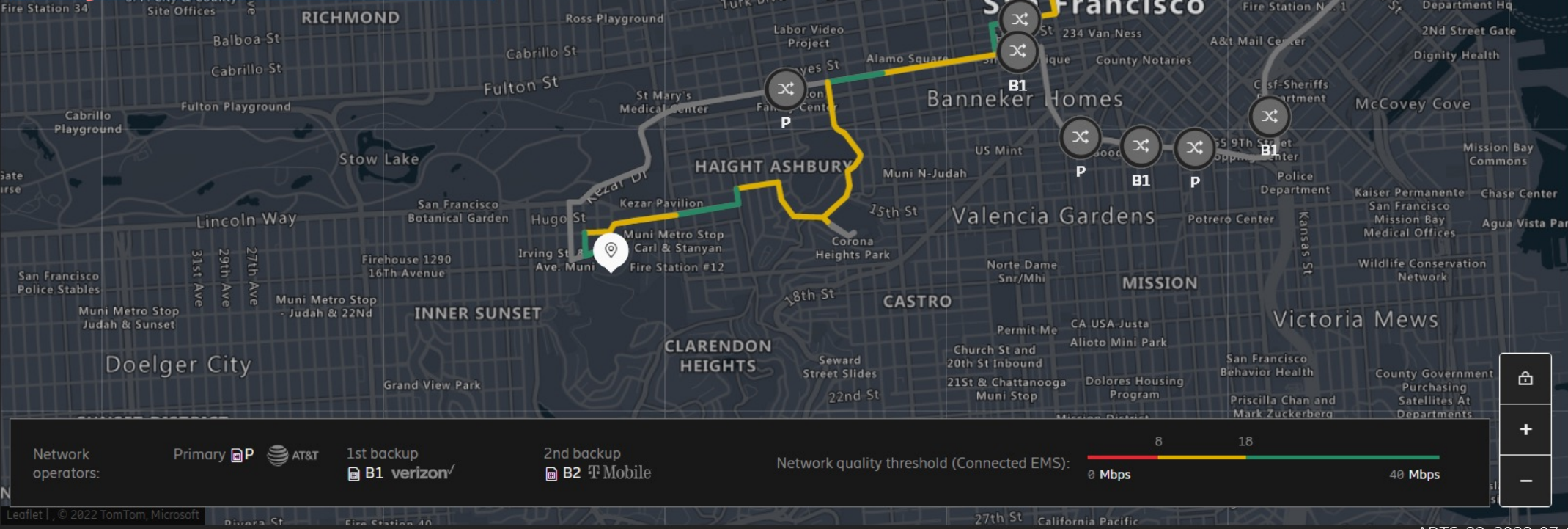
303 2nd Street to UCSF Medical Center

Route score

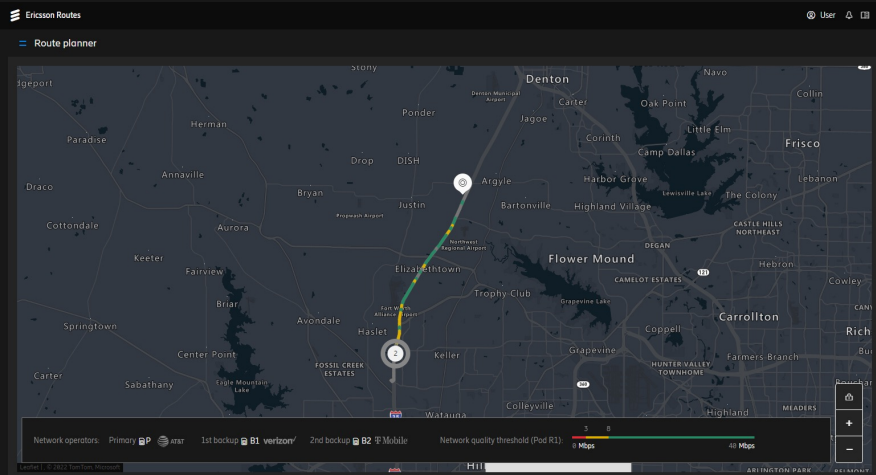
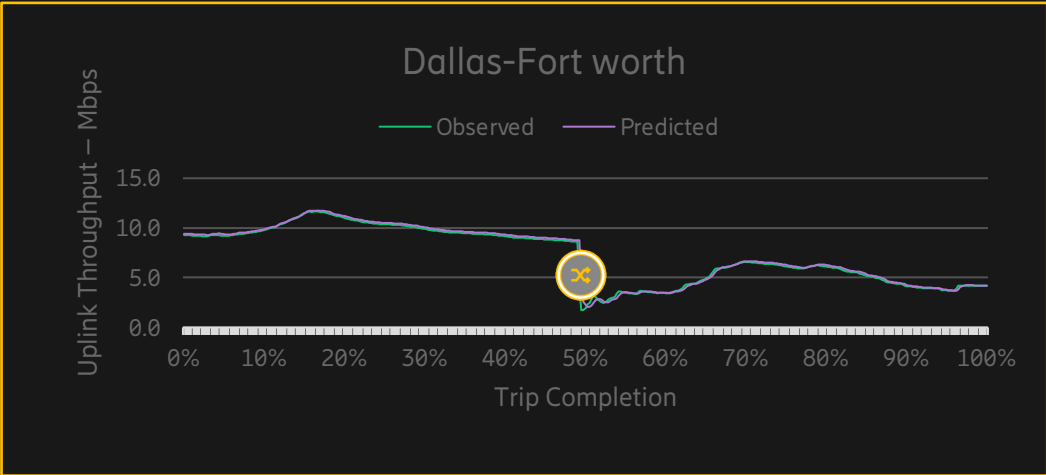
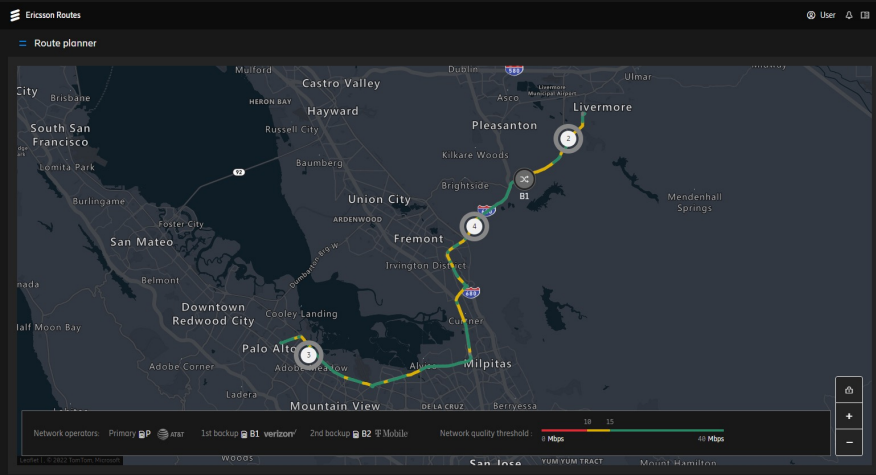
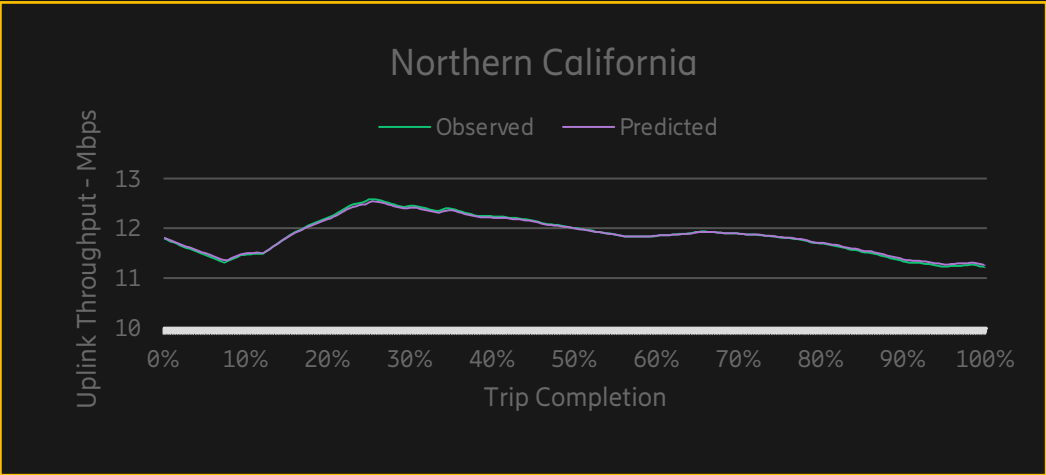
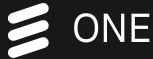
70.0

Save to vehicle

Comparative ranking by network quality of two otherwise *similar routes* based on high resolution predictions.



# Real-Time Predictions during a Trip ...



Prediction Accuracy: Over 94% in both territories in multi-day trials over multiple routes.

# Our Beta-Service is Currently Available ...

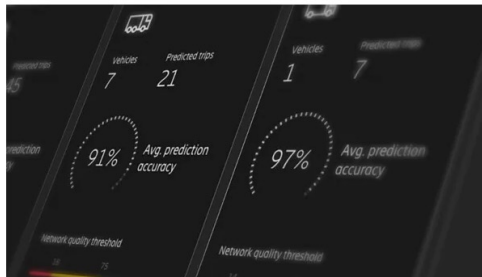
## San Francisco, CA

### Autonomous vehicles gain better access to reliable connectivity with Ericsson Routes in San Francisco, California

Autonomous and connected vehicle companies will benefit from a live environment in San Francisco, California, USA, to test the new Ericsson Routes service—at no cost—and provide direct feedback based on their needs.

NEWS | DEC 13, 2021

Connected vehicles



## Mobility Innovation Zone, TX

### Hillwood and Ericsson Routes partner to advance autonomous mobility

Autonomous and connected vehicle companies operating in the AllianceTexas Mobility Innovation Zone will benefit from knowing they will have secure and constant wireless 4G and 5G connectivity for their planning and operations through Ericsson Routes.

NEWS | APR 11, 2022

Connected vehicles

5G

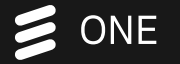
Innovation



On-Demand: Anywhere in the United States.



# Our Team at Ericsson ...



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Chief Executive Officer



**Emma Folkestad**  
Chief Operations Officer



**Dr. Gyan Ranjan**  
Chief Technology Officer



**Ali Awais**  
Head of Product Dev. & Ops.

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Network economics  
Carnegie Mellon University



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Radio networks  
Ericsson, formerly AT&T Wireless



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Network QoS predictions  
University of Minnesota



# Questions?

## Thank you!



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