Supplemental Coverage from Space
Engaging Rural Carriers

Rural Wireless Association
February 7, 2024

Presented by Tony DeTora
VP Government Affairs


LYNK


LYNK

A Note on Terminology

- Carrier: Mobile Network Operator (MNO), terrestrial operator, terrestrial network
- Supplemental Coverage from Space: SCS, SCS Provider, Satellite Operator, Direct-to-Device (D2D), satellite to unmodified phone (sat2phone)
- Unmodified Phone: Any standard-use cellular phone (also implies other devices)
- Specialized Device: Satellite Phone, Starlink Terminal, OneWeb Terminal, etc.

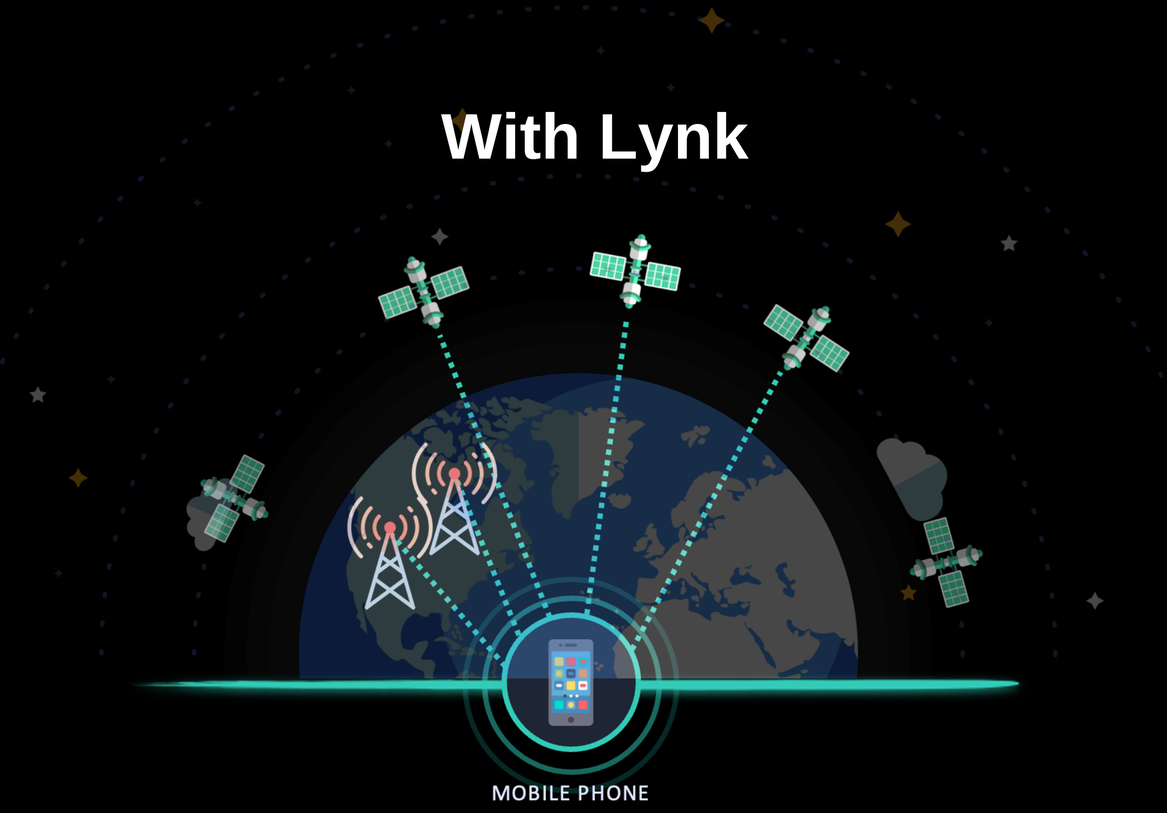
What is Supplemental Coverage from Space (SCS)?

Connecting directly from your phone to the satellite network

Without Lynk

Limited terrestrial base stations provide local coverage, with a very expensive and separate satellite phone and subscription required for global coverage

With Lynk



With Lynk, subscribers receive coverage from mobile towers when they have it and satellite coverage when they need it, all from their existing phone

How is SCS Different from Satellite Phones?

- Satellite Phone vs Standard Unmodified Phone
- Terrestrial Frequencies vs Satellite Frequencies
  - ➢ New Regulations Needed for Terrestrial Frequencies
  - ➢ Use of Satellite Frequencies Usually Requires Changes to the Phone
- Low Earth Orbit (NGSO) vs Geosynchronous Orbit (Geostationary Orbit)

Who are the SCS Players?

- Satellite Companies looking to expand into this service
  - OmniSpace, SpaceX, Iridium, Yahsat (UAE), GlobalStar (w/ Apple), etc.

- Startups looking to serve the market
  - Lynk
  - AST SpaceMobile

How Does Lynk Approach SCS?

- Crawl, Walk, Run Approach
- Start with small satellites to end 0G everywhere
- Start with small constellation to meet most critical needs first
- Build confidence, capability, and relationships with all stakeholders
- Increase constellation size and capabilities to serve more needs

Lynk Mobile Broadband Everywhere

Enabling various applications on the phone

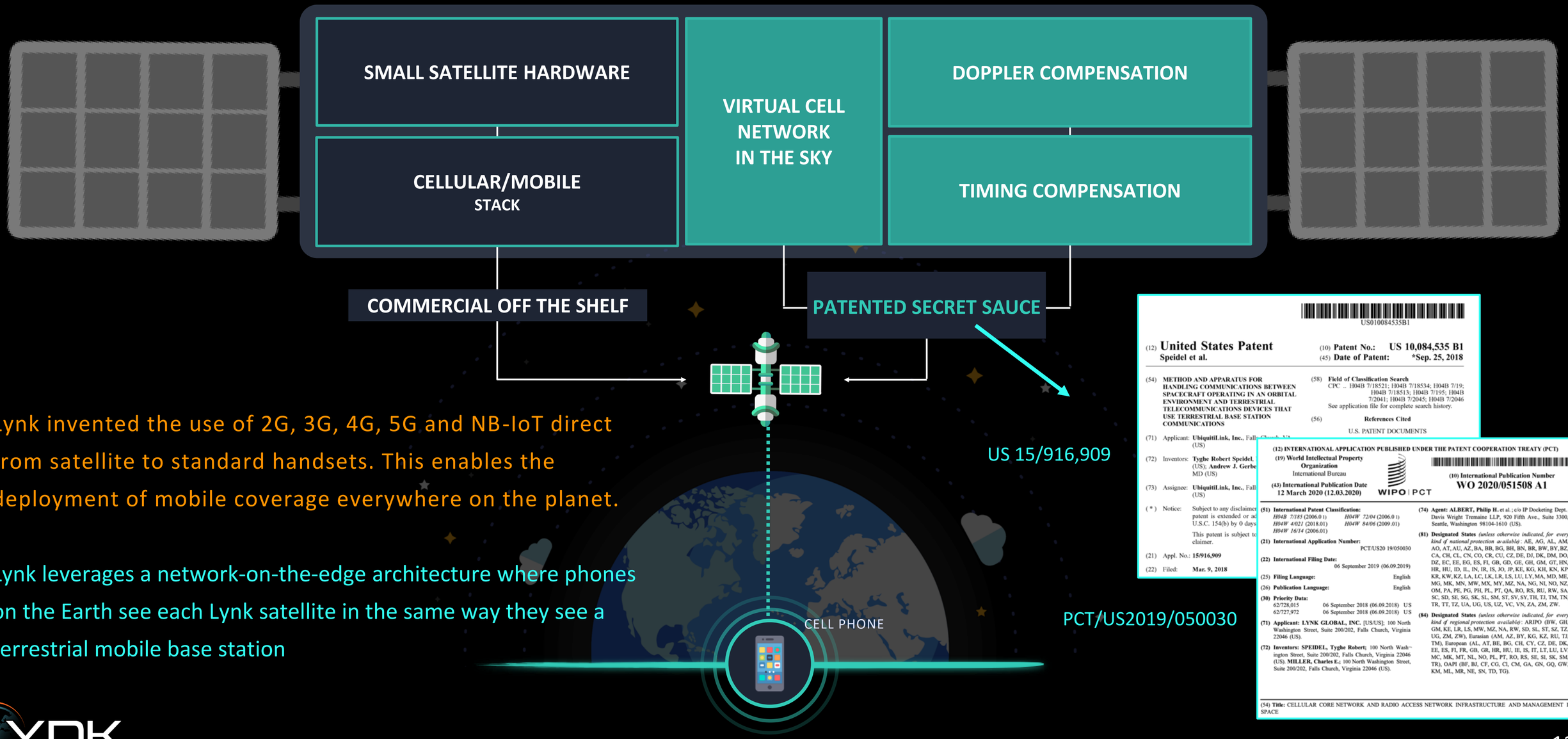
Customer Focus – How Does SCS Interface with Customers?

- SCS providers partner with terrestrial MNOs to expand service offerings
- Most initial SCS providers do not wish to compete with MNOs – this may change over time
- MNOs add subscribers to our network remotely and transparently to end-user
- MNO maintains subscriber relationship
- Lynk says “We partner with you to serve your customers, on your spectrum, where you can’t reach them.”

Business Model

- Provide universal geographic coverage for existing mobile phones in un-lit areas
- A shared roaming provider for all MNOs
- Sold to subscribers through MNOs in various ways
- MNO shares revenue with Lynk or pays wholesale for service

Lynk's SCS Technology is Patented in 55 Countries



Lynk invented the use of 2G, 3G, 4G, 5G and NB-IoT direct from satellite to standard handsets. This enables the deployment of mobile coverage everywhere on the planet.

Lynk leverages a network-on-the-edge architecture where phones on the Earth see each Lynk satellite in the same way they see a terrestrial mobile base station

US 15/916,909

US010084535B1

(12) **United States Patent**
Speidel et al.

(10) **Patent No.: US 10,084,535 B1**
(45) **Date of Patent: *Sep. 25, 2018**

(54) **METHOD AND APPARATUS FOR HANDLING COMMUNICATIONS BETWEEN SPACECRAFT OPERATING IN AN ORBITAL ENVIRONMENT AND TERRESTRIAL TELECOMMUNICATIONS DEVICES THAT USE TERRESTRIAL BASE STATION COMMUNICATIONS**

(71) Applicant: **UbiquitiLink, Inc.**, Fall (US)

(72) Inventors: **Tyghe Robert Speidel**, (US); **Andrew J. Gerbe** MD (US)

(73) Assignee: **UbiquitiLink, Inc.**, Fall (US)

(*) Notice: Subject to any disclaimer patent is extended or a U.S.C. 154(b) by 0 days

This patent is subject to claimer.

(21) Appl. No.: **15/916,909**

(22) Filed: **Mar. 9, 2018**

(58) **Field of Classification Search**
CPC .. H04B 7/18521; H04B 7/18534; H04B 7/19; H04B 7/18513; H04B 7/195; H04B 7/2041; H04B 7/2045; H04B 7/2046
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

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12 March 2020 (12.03.2020)

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H04W 4/021 (2018.01) *H04W 84/06* (2009 .01)
H04W 16/14 (2006.01)

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, Ci, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

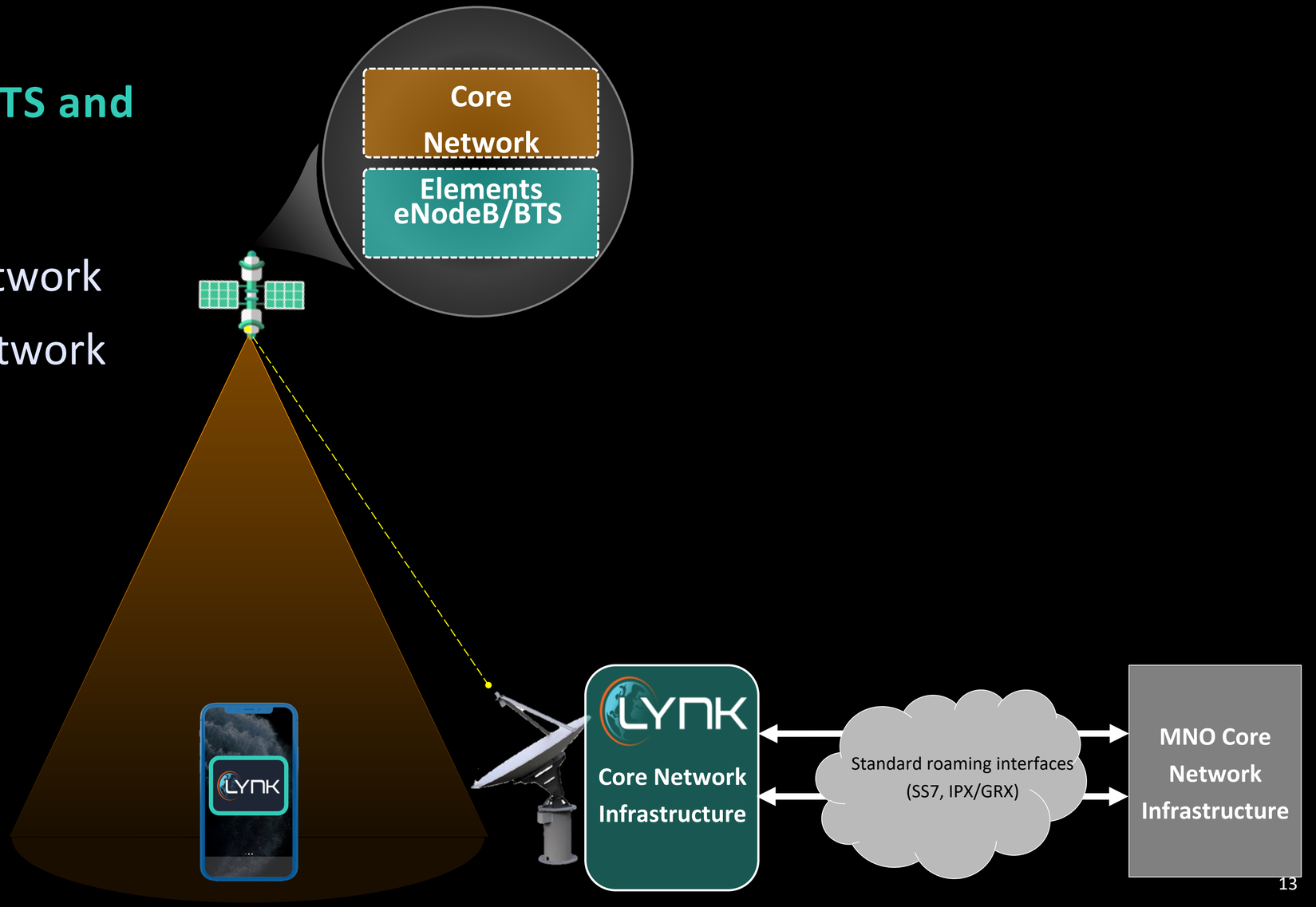
(54) **Title:** CELLULAR CORE NETWORK AND RADIO ACCESS NETWORK INFRASTRUCTURE AND MANAGEMENT I SPACE

PCT/US2019/050030

Lynk Network-on-the-Edge Architecture

Lynk satellites contain eNodeB/BTS and elements of the core network

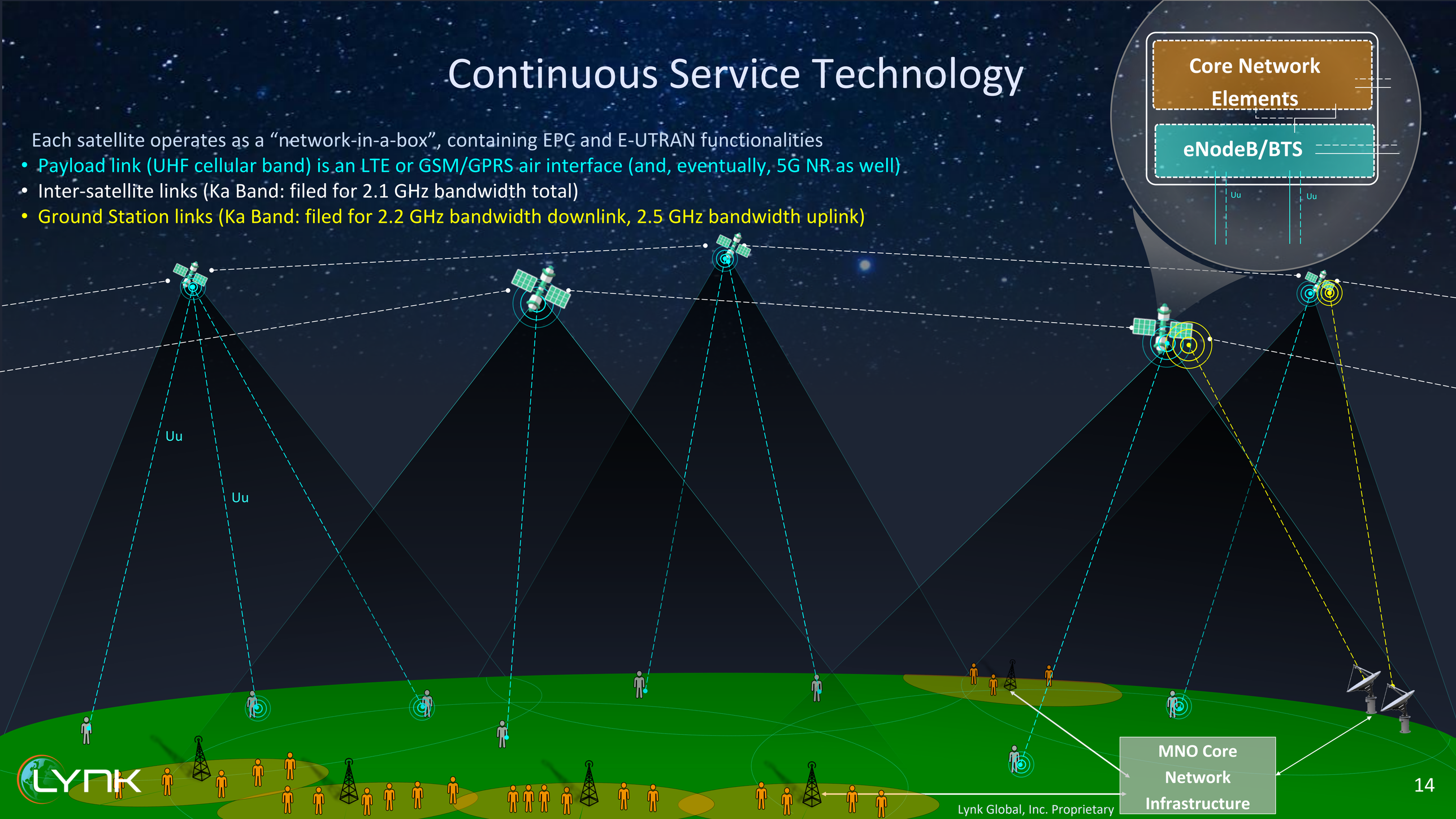
- Lynk will appear as a roaming network
- Processing is handled on Lynk network
- Lower latency
- Increased reliability



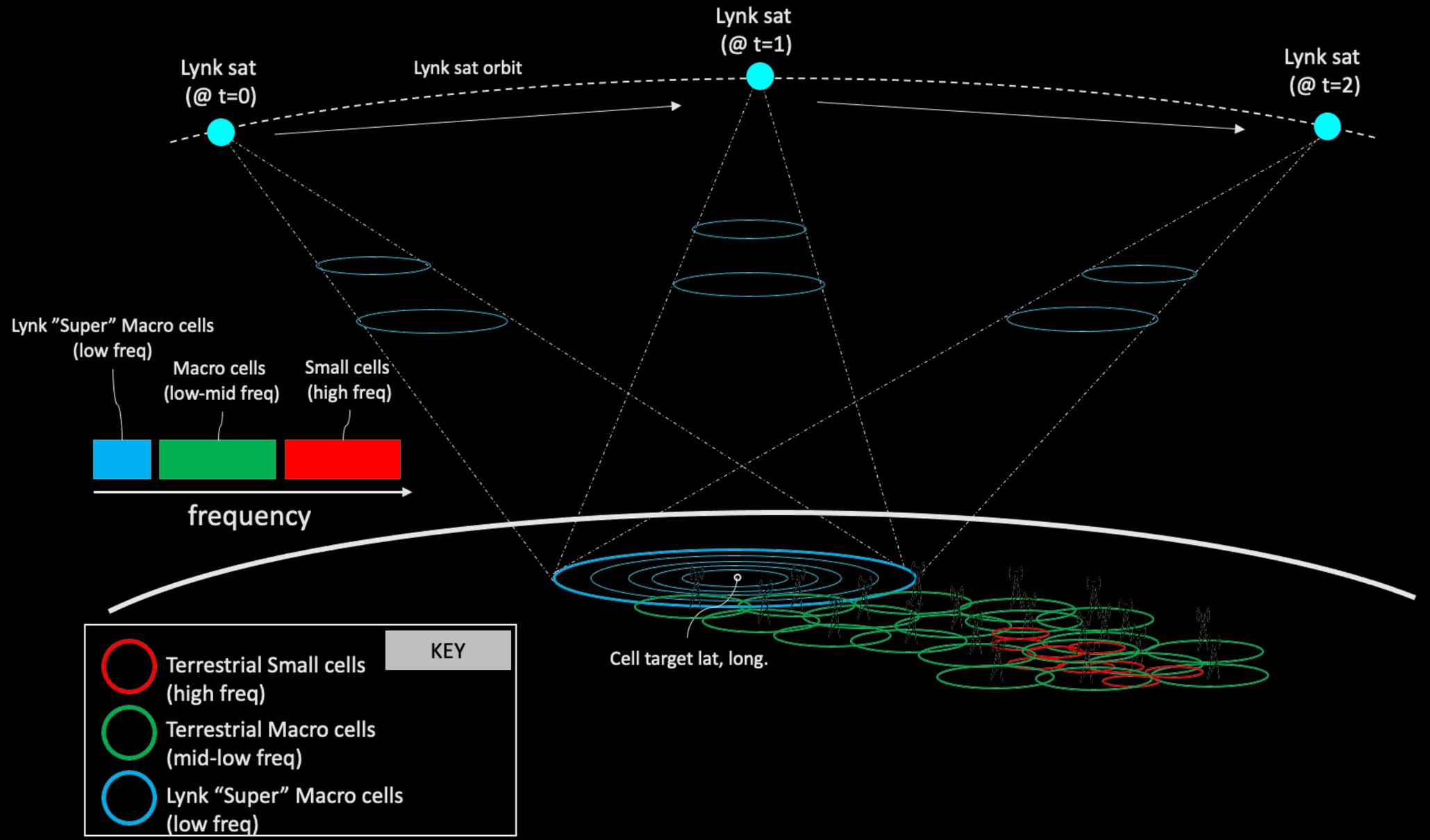
Continuous Service Technology

Each satellite operates as a “network-in-a-box”, containing EPC and E-UTRAN functionalities

- Payload link (UHF cellular band) is an LTE or GSM/GPRS air interface (and, eventually, 5G NR as well)
- Inter-satellite links (Ka Band: filed for 2.1 GHz bandwidth total)
- Ground Station links (Ka Band: filed for 2.2 GHz bandwidth downlink, 2.5 GHz bandwidth uplink)



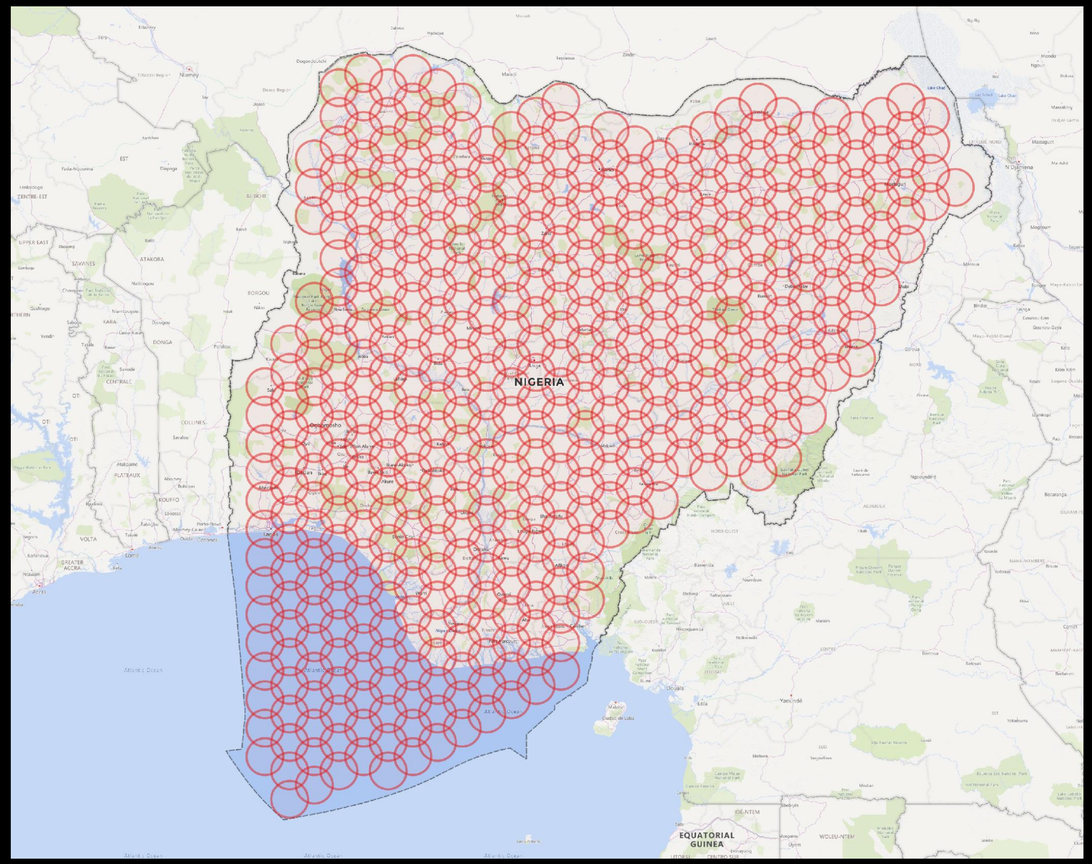
Lynk “Super” Cell



With an Expanded Constellation

Continuous coverage requires a constellation of ~900 satellites in most of United States

Continue expansion to Lynk Full Service Constellation of 5,000+ satellites for 24/7 coverage with increased throughput and broadband services



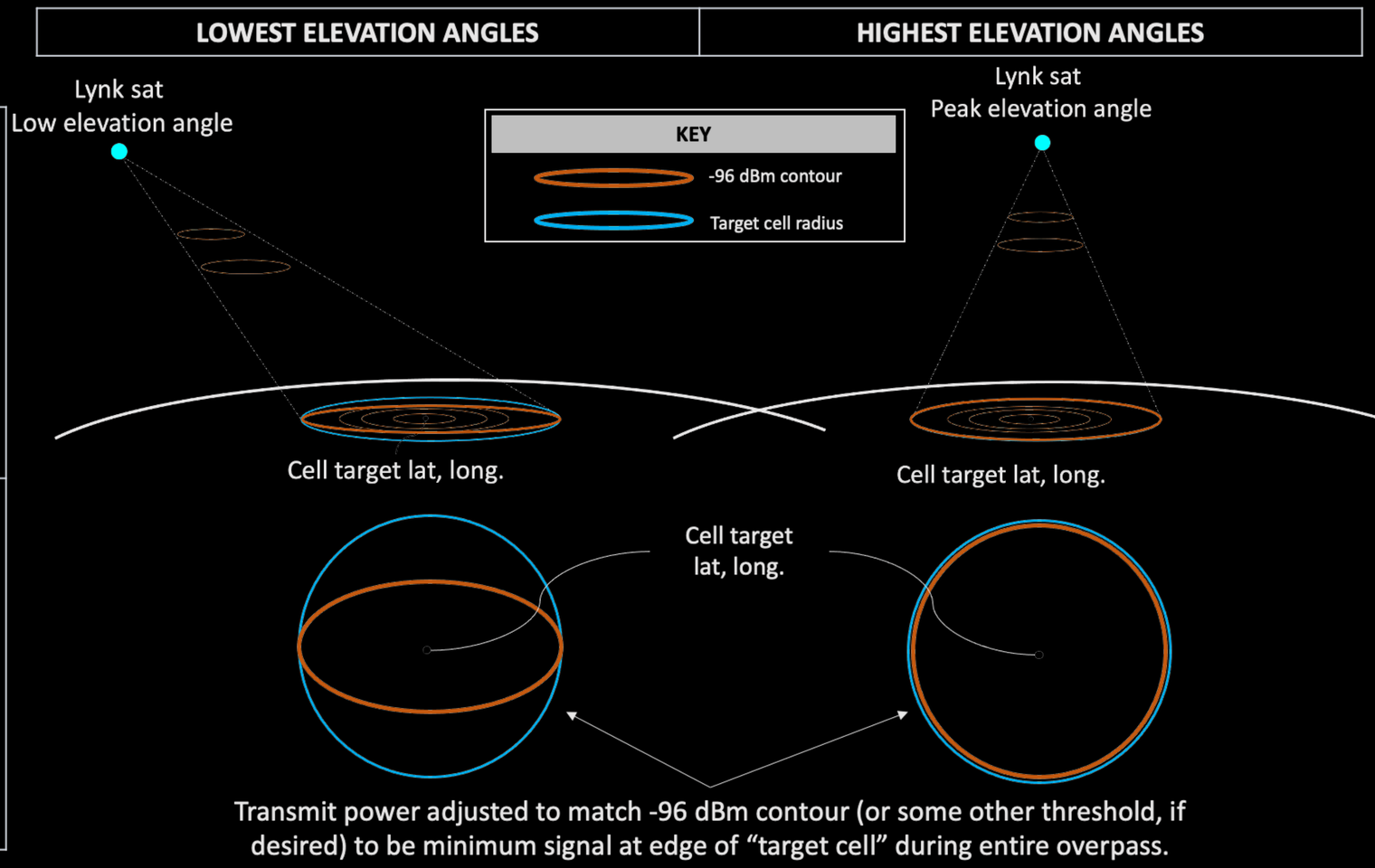
Lynk Satellites can control power and steering of beams to fit a desired contour

Parameters	Value	Units
Field Strength Limit at CGSA Edge (dB)		dBμV/m
Field Strength Limit at CGSA Edge (base)		V/m
Characteristic Impedance of Air		Ohms
Power flux Density (base)		W/m^2
Power flux Density (dBm/m^2)		dBm/m^2
Wavelength, λ, of 856.5 MHz signal		cm
Effective 0 dBi antenna area ($\lambda^2/4\pi$)		m^2
Corresponding signal power at cell phone		dBm

*47 CFR Part 22.983(a) from FCC 14-181 R&O and FNPRM. Available on-line as of Feb. 22, 2021 at: https://www.law.cornell.edu/cfr/text/47/22.983

Perspective View

Top Down View



Satellite Beam Deployment Sim

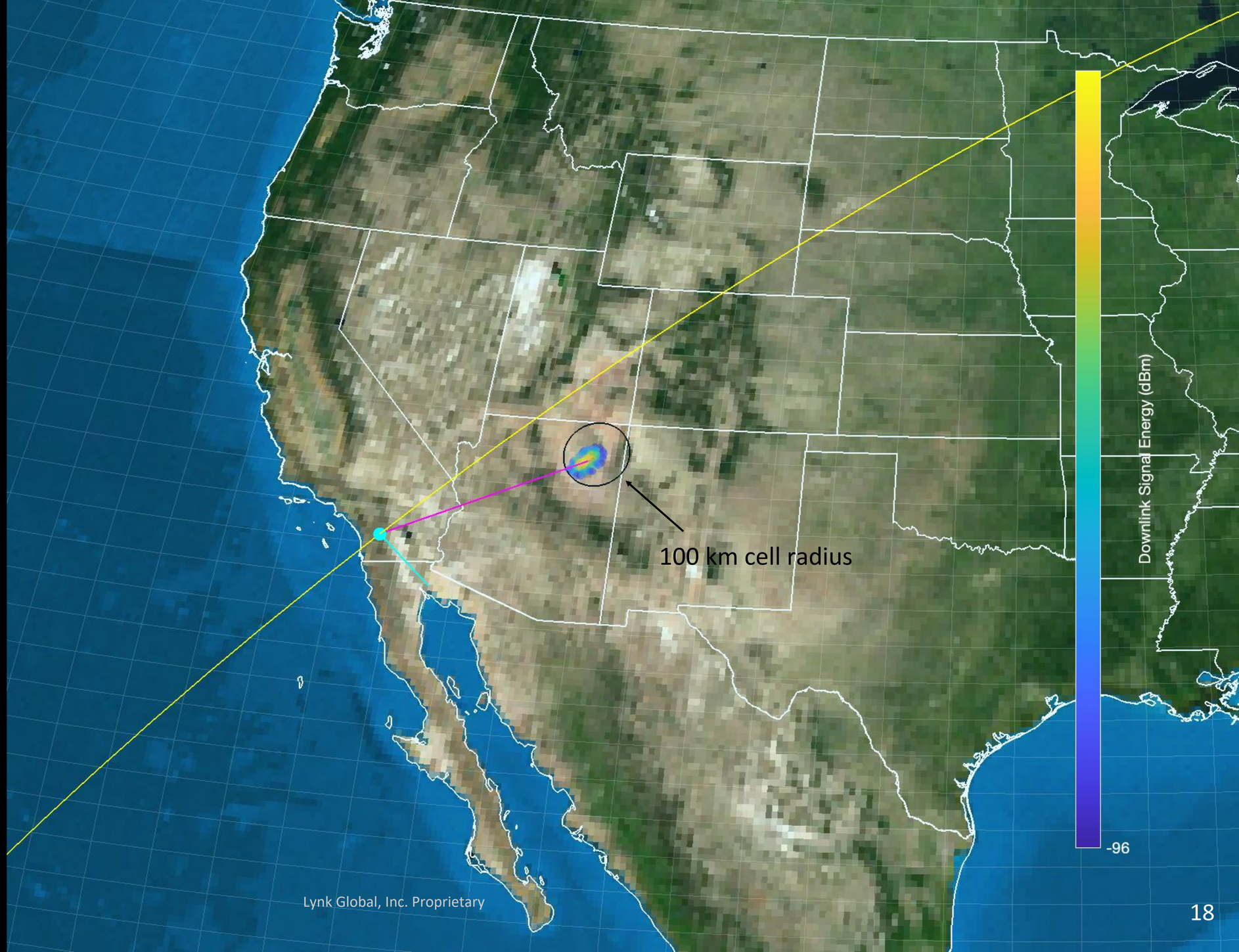
KEY

- Satellite
- Nadir Vector
- Steering Vector
- Satellite Orbit/Trajectory
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 3.9 W

Elevation Angle: 34.91°



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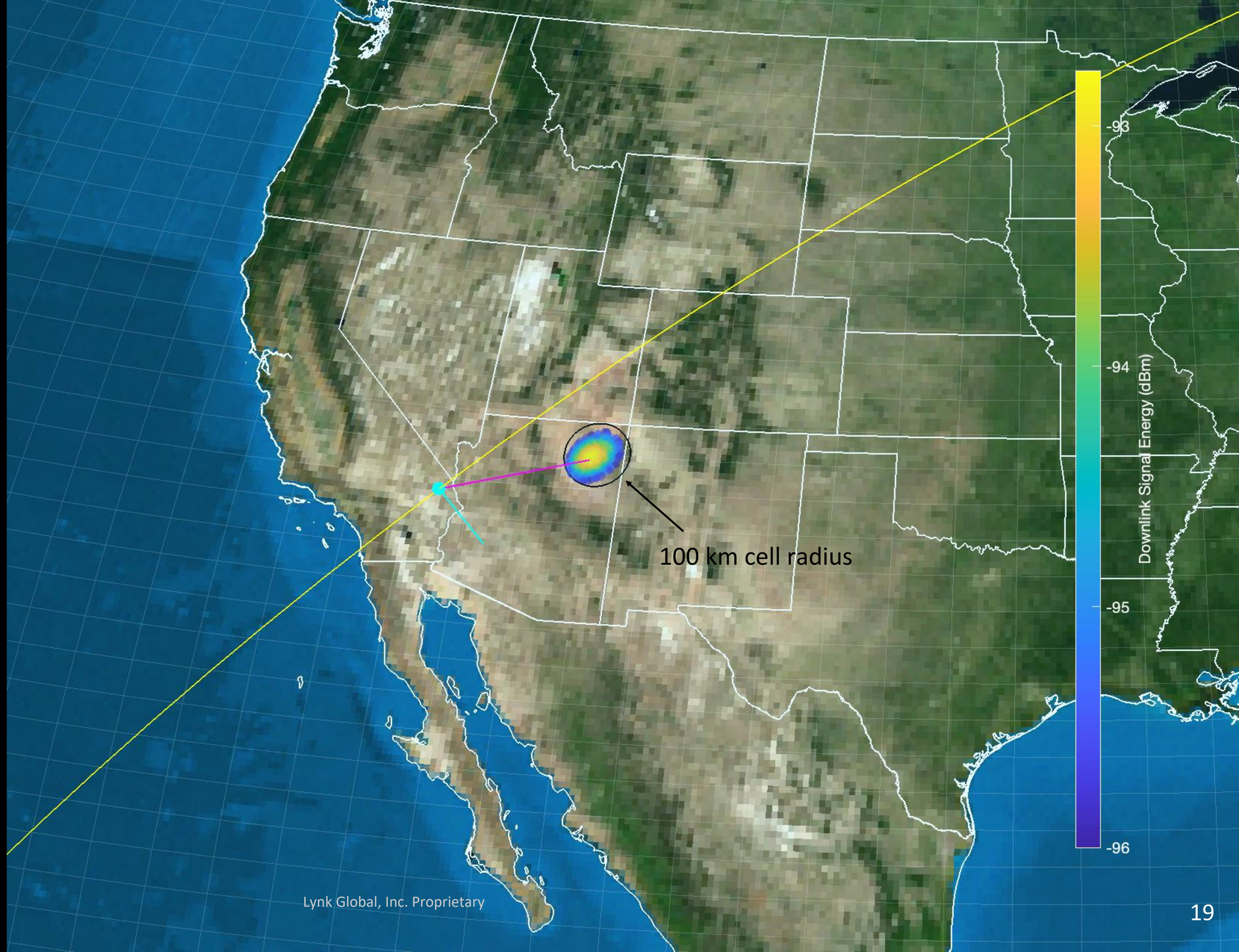
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 4.7 W

Elevation Angle: 47.32°



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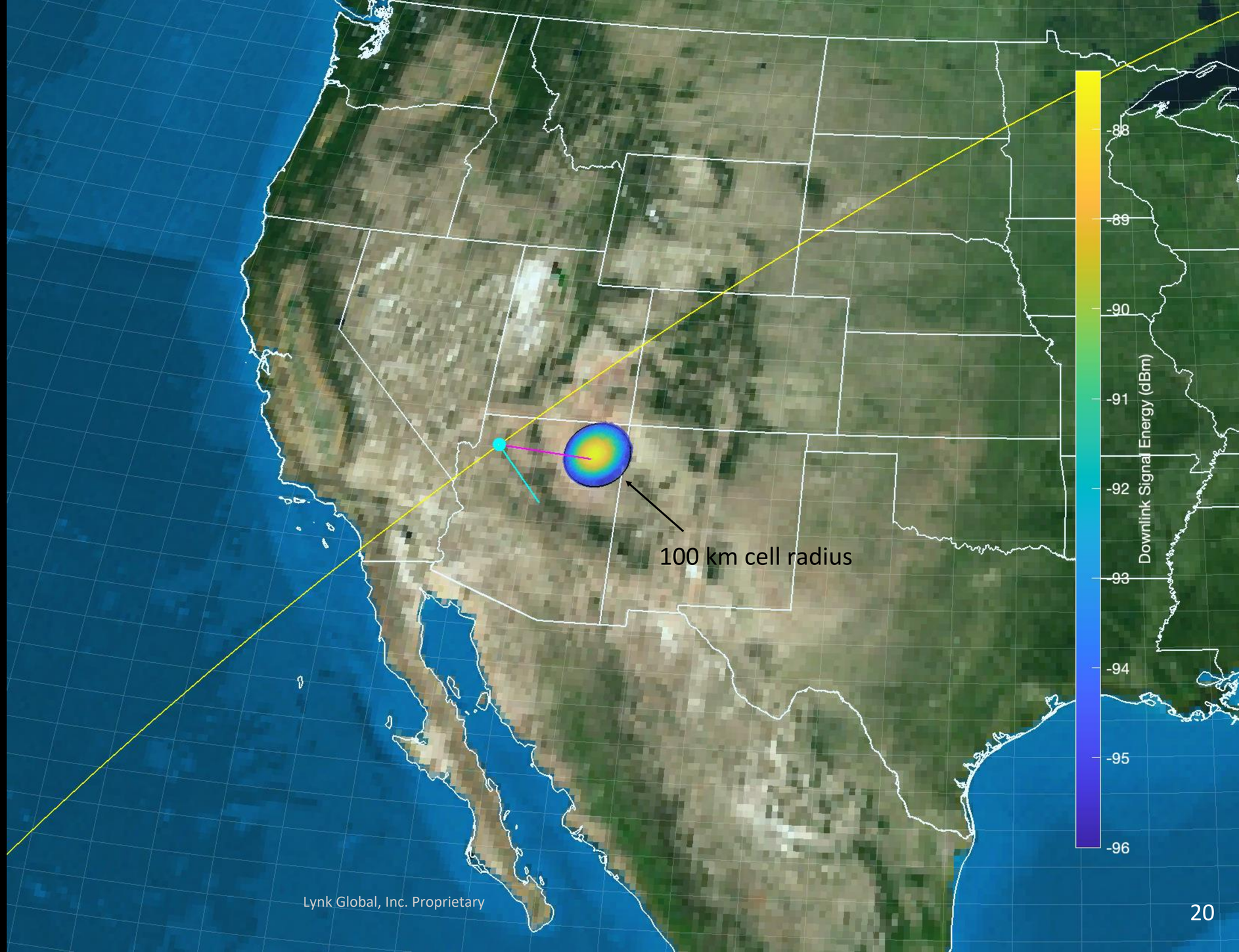
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 9.3 W

Elevation Angle: 65.66°



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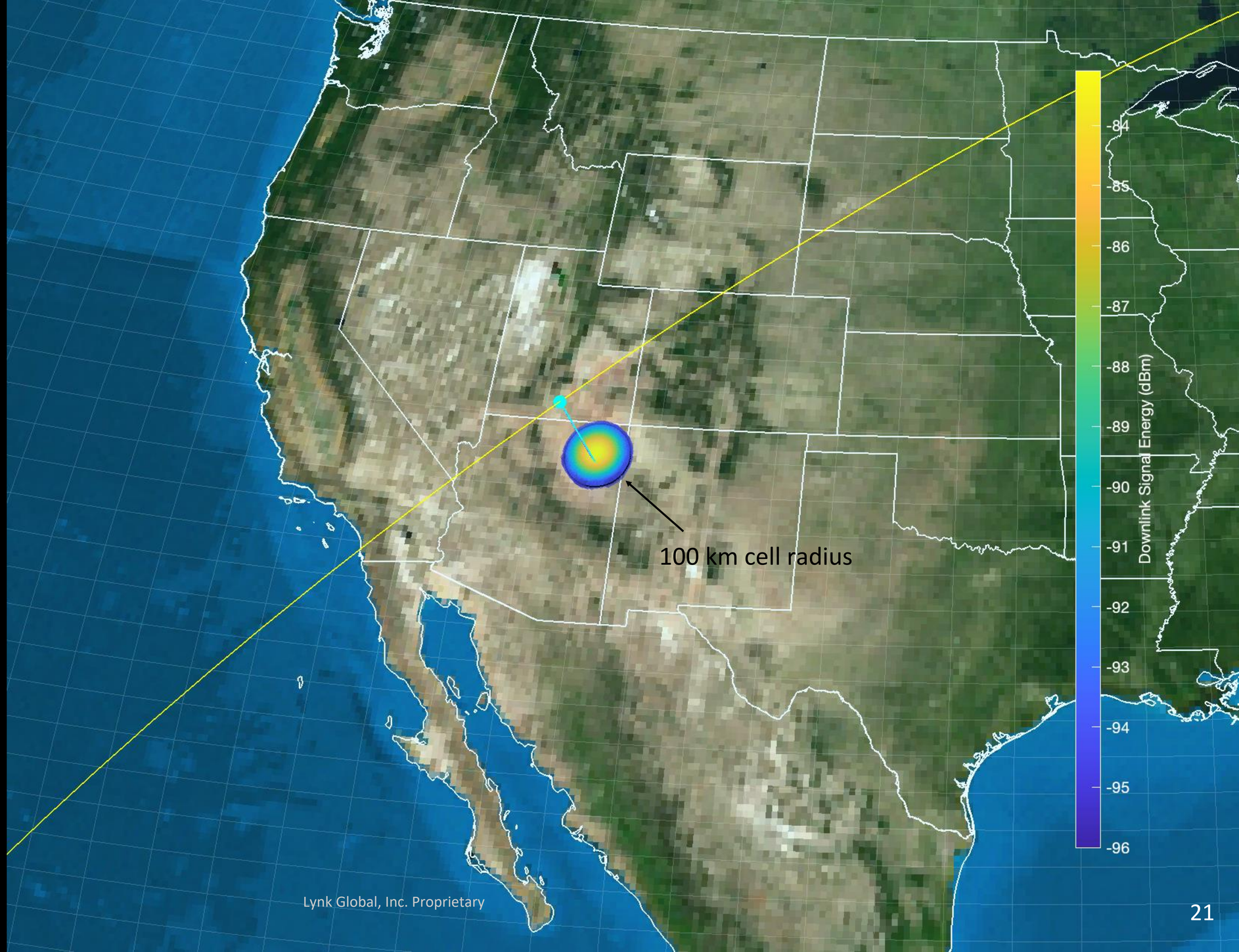
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 13.48 W

Elevation Angle: 88.28°



Satellite Beam Deployment Sim

KEY

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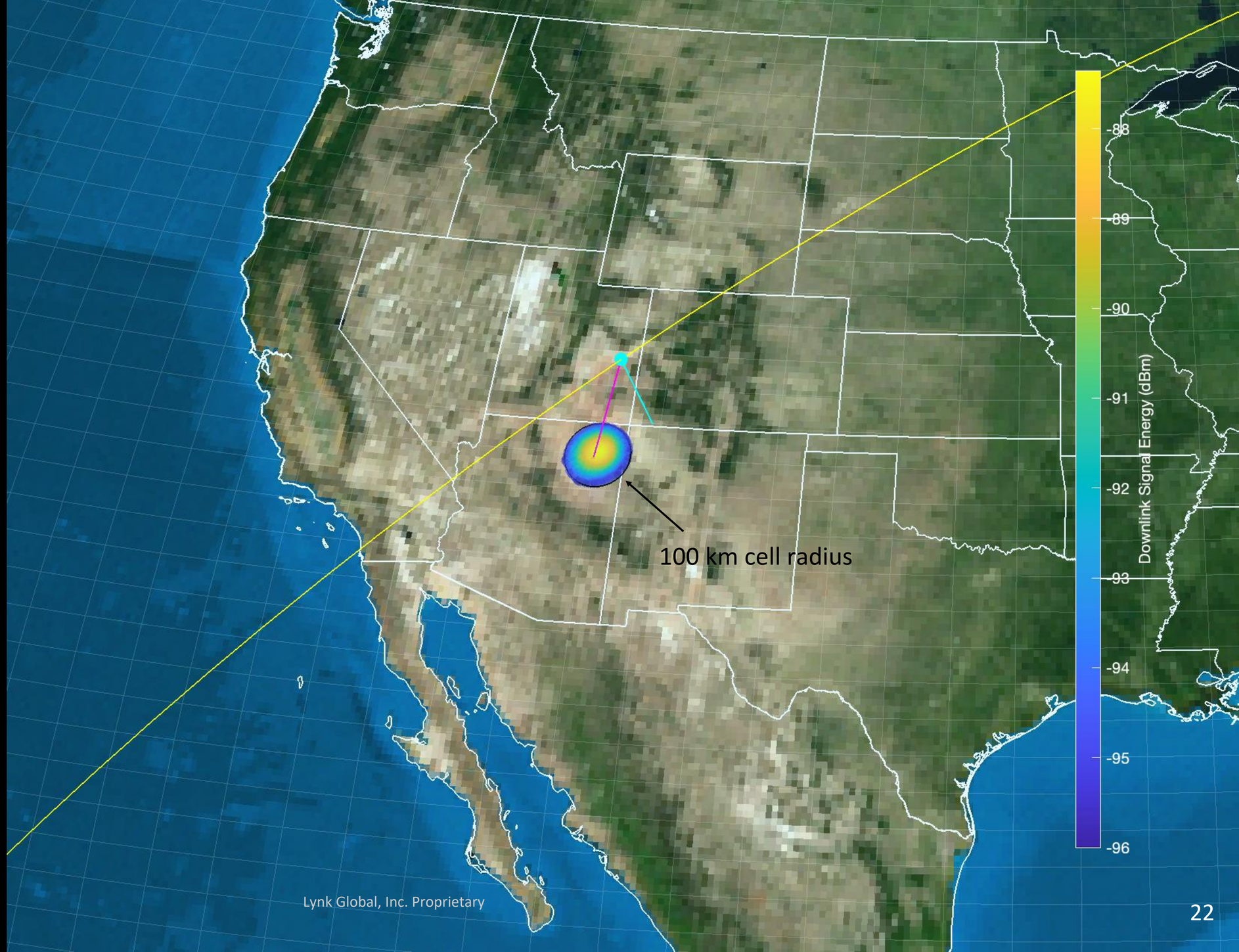
- Satellite Orbit/Trajectory
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 9.2 W

Elevation Angle: 65.57°



Satellite Beam Deployment Sim

KEY

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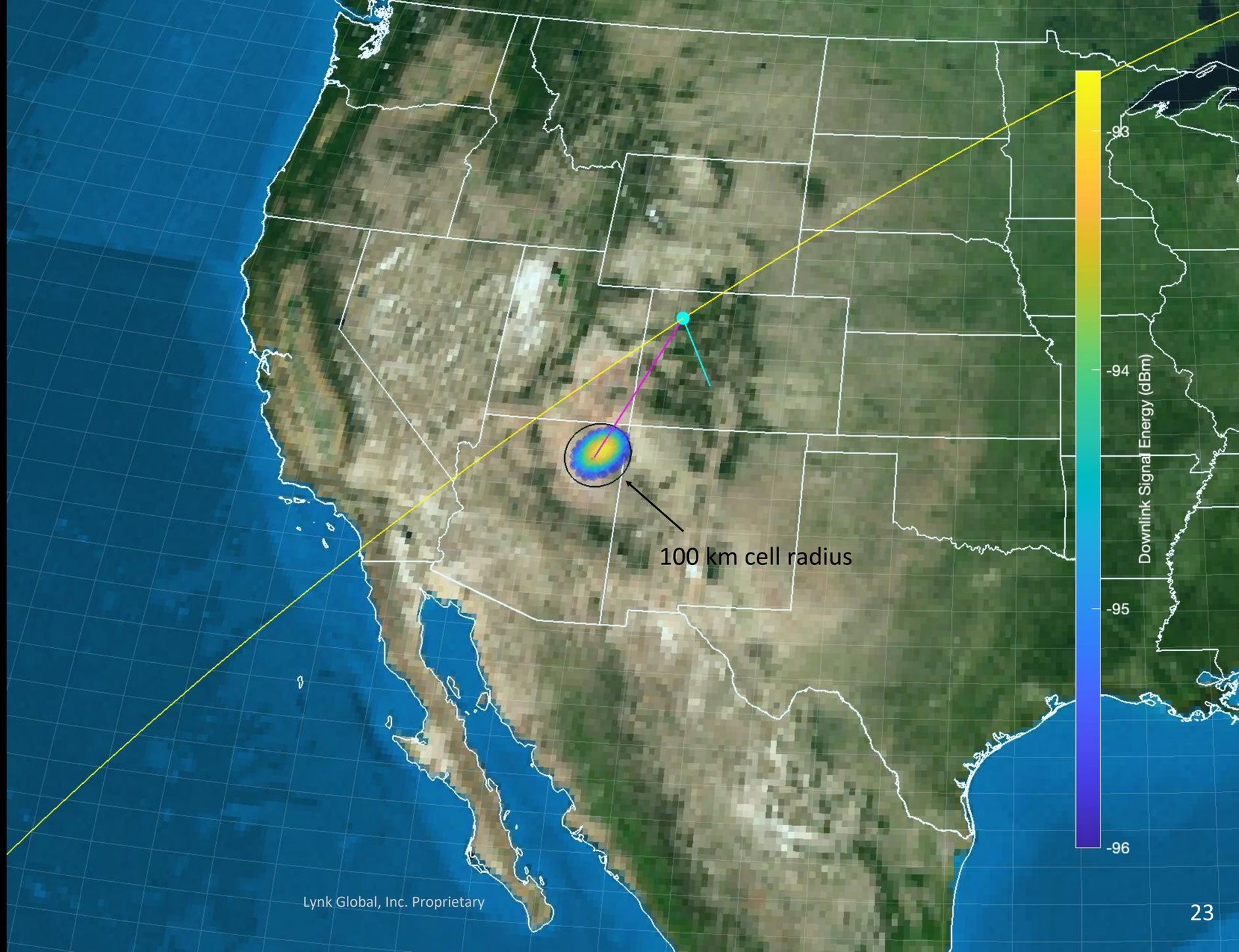
- Satellite Orbit/Trajectory
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 4.4 W

Elevation Angle: 47.16°



Satellite Beam Deployment Sim

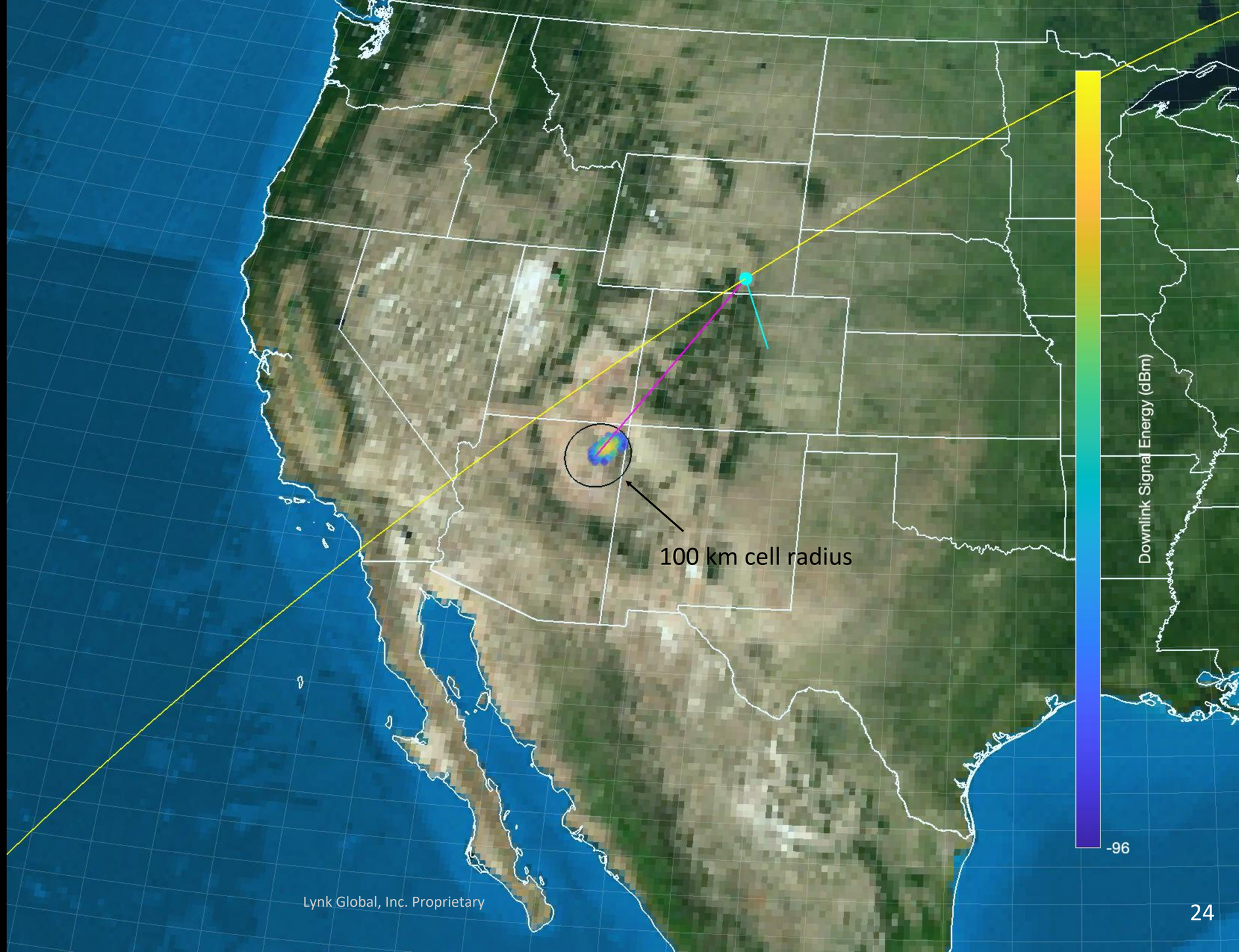
KEY

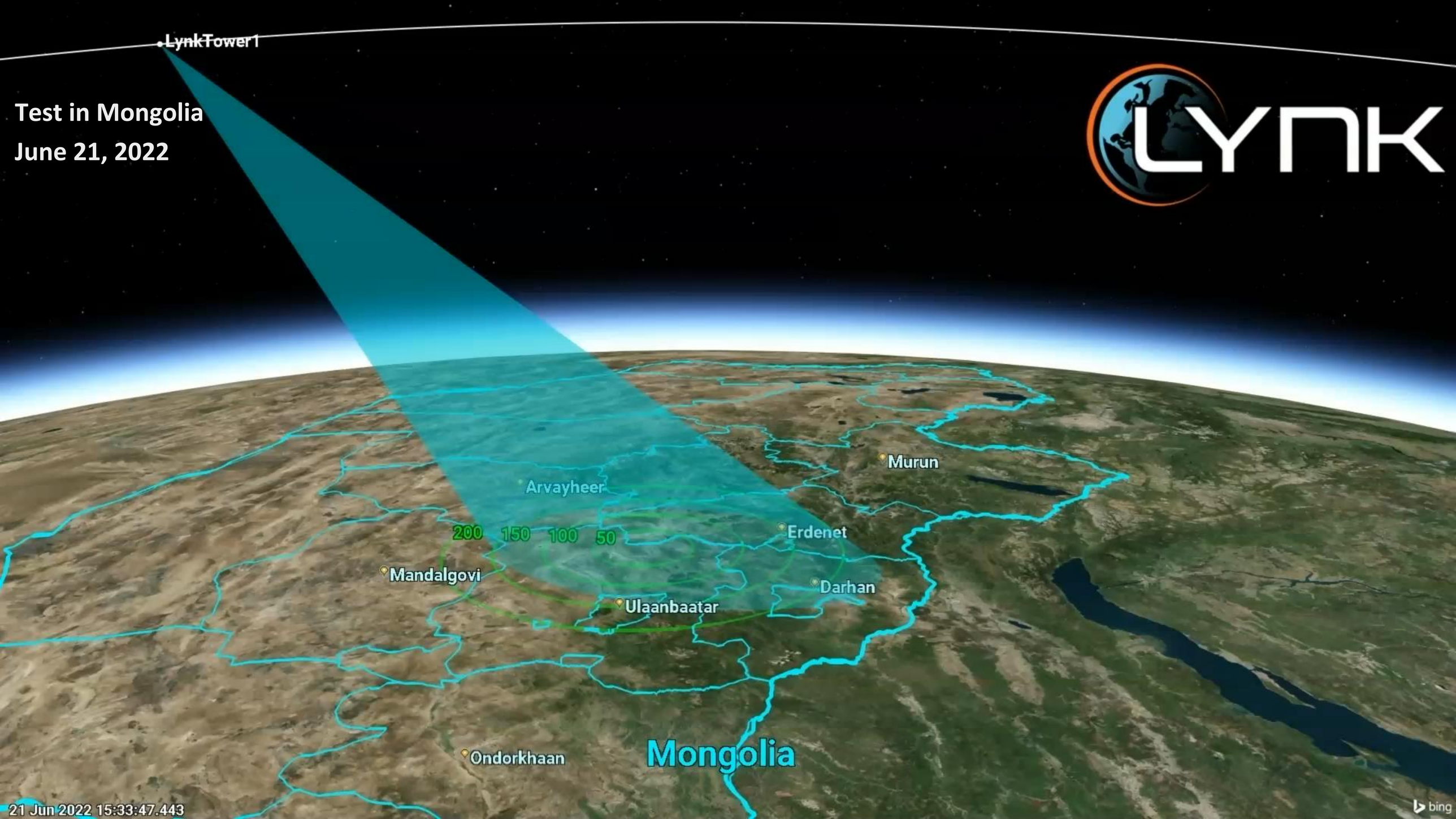
- Satellite
- Nadir Vector
- Steering Vector
- Satellite Orbit/Trajectory
- dBm contour

Spotbeam over Navajo (35.95° N, 110.84° W)

Tx Power: 3.42 W

Elevation Angle: 34.71°




LynkTower1
Test in Mongolia
June 21, 2022
LYNK
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Lynk Satellites Connected
with thousands of mobile phones

Successful tests on 7 continents

Connected to phones of 8 of top 10 MNOs (by rev)

Connected to iPhones, Android & feature phones

Connected to cars, trucks, tablets, and tractors

Actual map of phones during a 3-minute overpass on U.S. east coast Sep. 23, 2021

5th Satellite — launched June 30, 2021

SCS Product Availability Depends on Bandwidth and Throughput

As Bandwidth and Throughput Increases, Additional Products Become Available

SMS Messaging

IP Messaging

Messaging APP

Mobile Apps

Emergency Messaging

911

Emergency Alerts

ALERT

LynkCast

Weather, News,..

Weather at

16 Feb 12:32

IoT

Mobile Money

Push-to Talk

Broadband Data

Voice

Web Browsing

Broadcast Video

Sat-TV

SCS and Interference to Terrestrial Use

The Lynk Co-Channel Interference analysis is organized by the following dimensions:

Geospatial Dimension

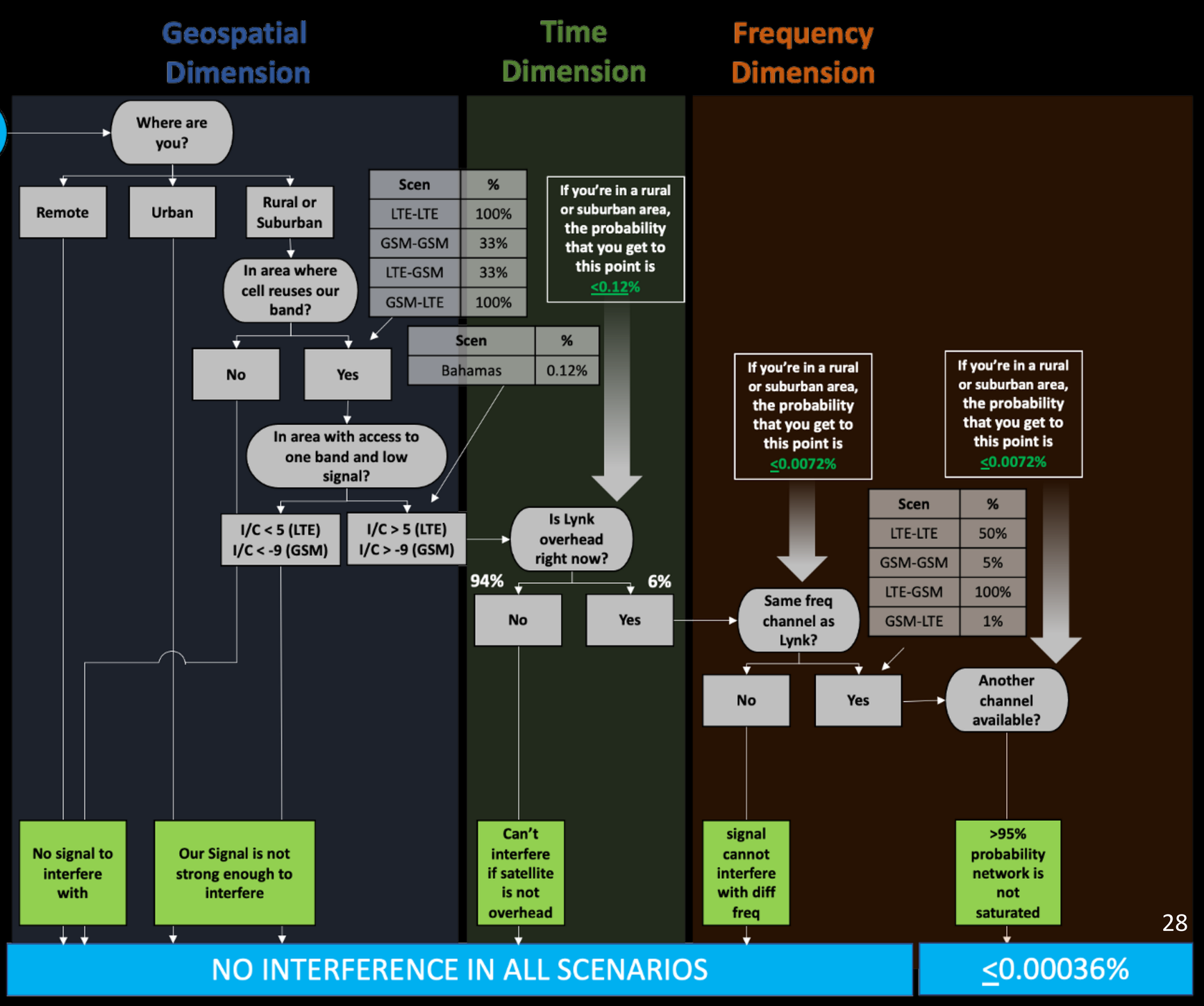
Where are you? (remote, rural/suburban, urban)
Are you using the same band as Lynk?
Do you only have access to that band and is the signal level relatively low?

Time Dimension

Is Lynk overhead right now?

Frequency Dimension

Are you on the same frequency channel as Lynk satellite?
Is another channel available for allocation?



How is SCS Regulated?

- Currently regulated in the United States under waivers allowing satellite networks to use terrestrial spectrum for testing and demonstration only
- Only one commercial SCS license in the United States so far (issued to Lynk) and only for commercial service internationally, not within the U.S.
- Nations around the world are using various approaches

FCC’s SCS Proposed Rules

- Geographically Isolated Areas (GIAs)
- Co-primary on Table of Allocations
- One-to-one relationships between MNO and SCS Provider
- Signed contract required before SCS license process
- Handsets require additional approvals
- Other provisions

In Conclusion….

- SCS can provide a significant benefit to MNOs and their subscribers if allowed to participate by the FCC
- Some of the proposed FCC rules will make it difficult/challenging for rural carriers to participate
- If rural carriers are not allowed to participate, the divide between the nationwide carriers and rural carriers could grow dramatically

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