# THE CHALLENGES OF BROADBAND NETWORKS IN THE ARCTIC

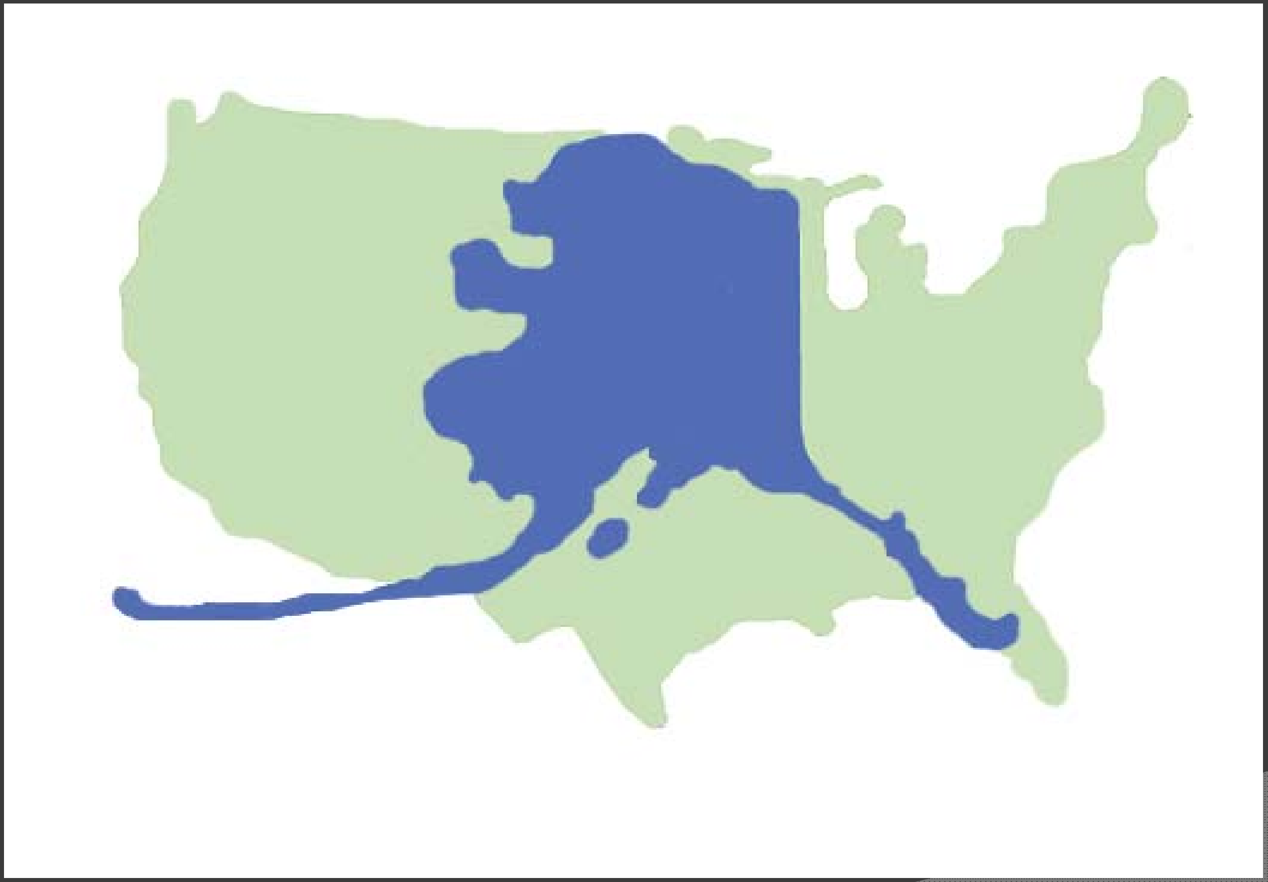
Steve Smith
Chief Information & Technology Officer
University of Alaska

# Alaska in Context

570,374 Square Miles or One Fifth the Continental United States

One Third of Alaska is Within the Arctic Circle

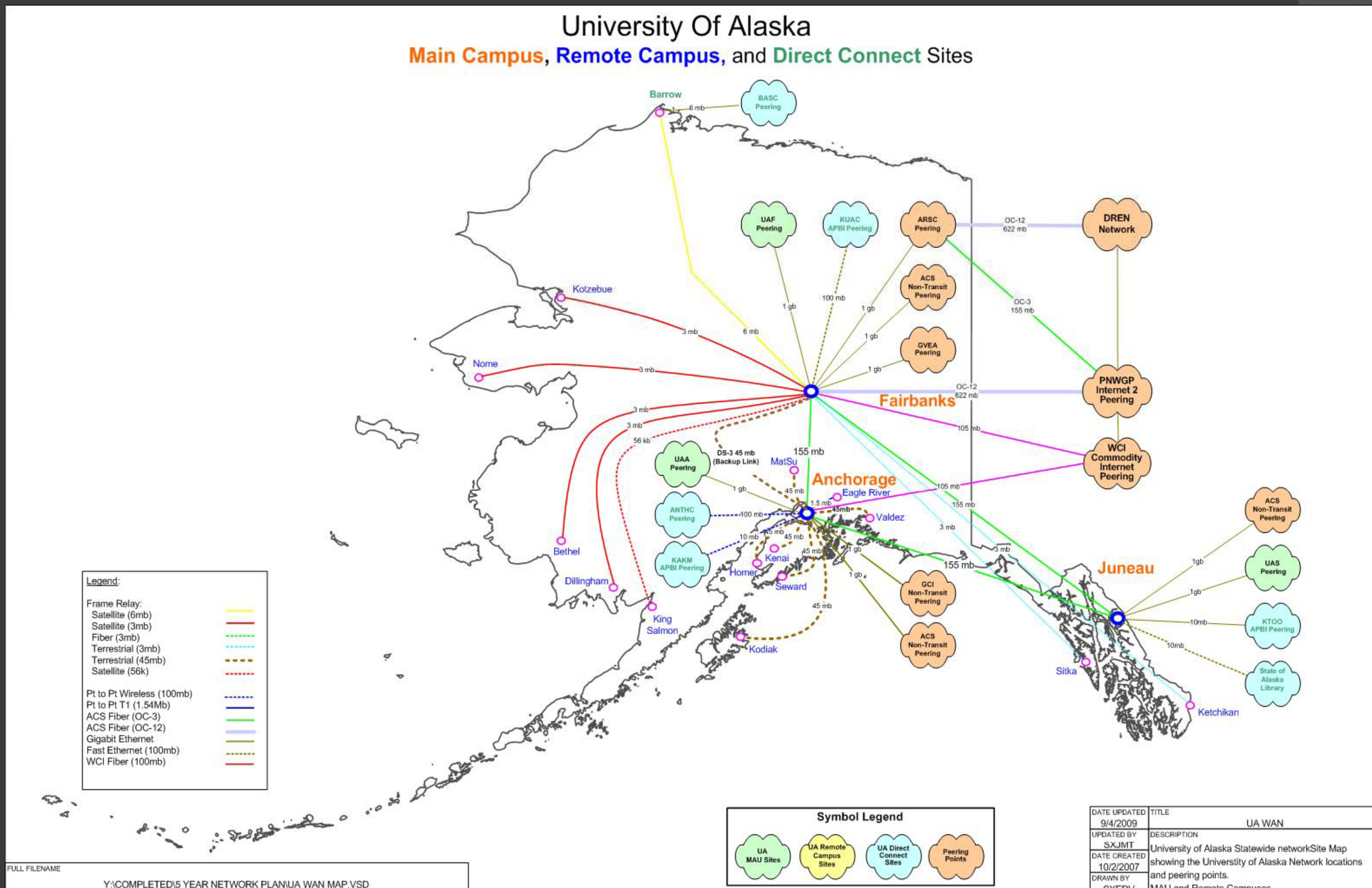
6,600 Miles of Coastline



# Alaskan Optical Fiber Cables


Map: Based on GCI

# University of Alaska WAN map



# Alaska Satellite Facility/ Geophysical Institute/ University of Alaska Fairbanks

**Photo: ASF/UAF**

# Area of Iceland from Synthetic Aperture Radar Satellite Data

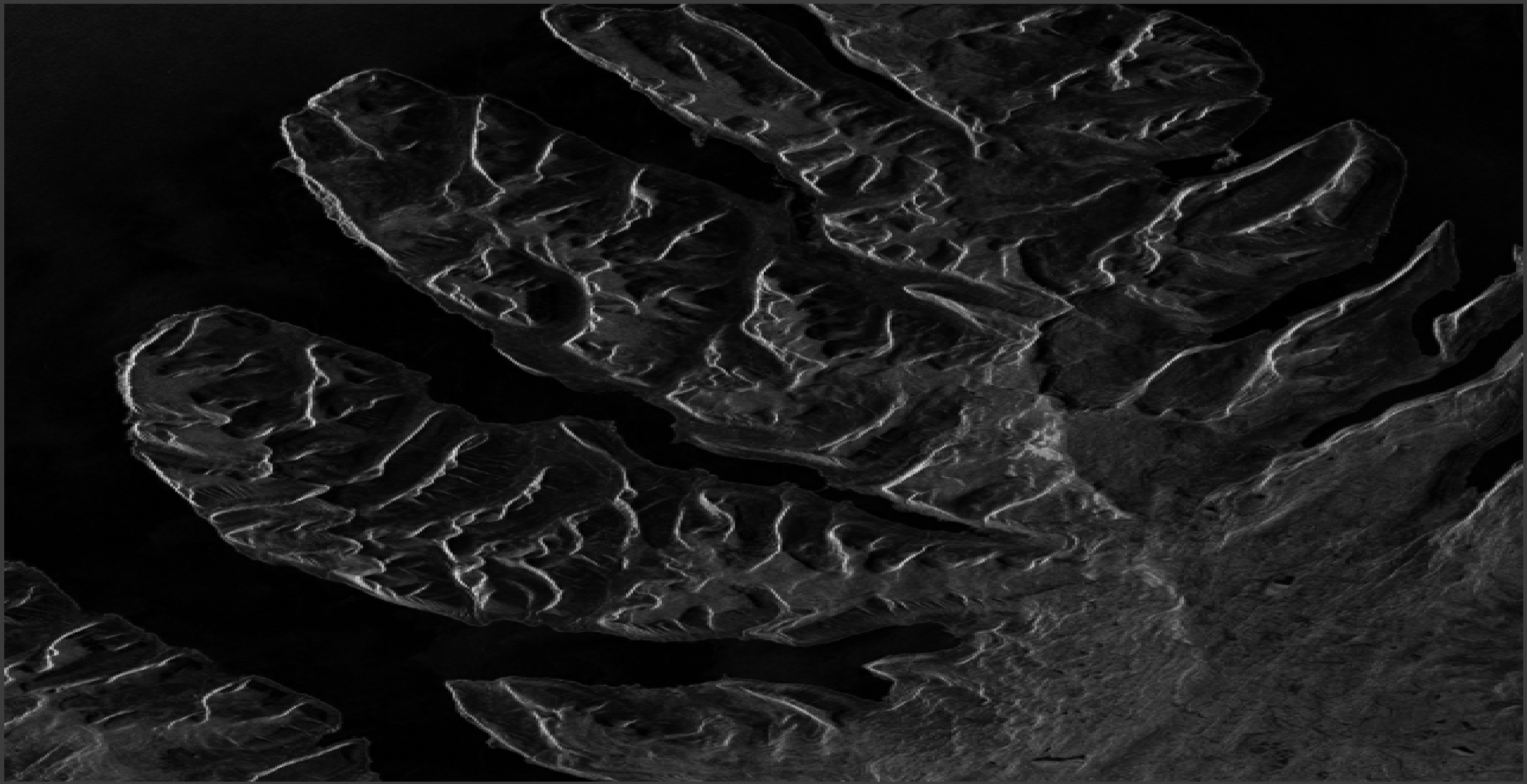


**Photo: ASF/UAF**

# Barrow Arctic Science Consortium: Total Bandwidth 4 T-1 Circuits (6Mgb) via Satellite

**Photo: BASC**

# The Challenges to Broadband in the Arctic

- High Capitalization and Operation & Maintenance Costs
- Low Population Density
- Confusing Regulatory Environment
- No Sustainable Business Case
- Satellite Remains the Dominant Technology for Large Regions

# Broadband Infrastructure Coastal Undersea Fiber Optic

- Shallow ocean depth & ice cover can result in scouring
- Outages in winter are most difficult to resolve
- Ring architecture is best
- Best for serving coastal communities

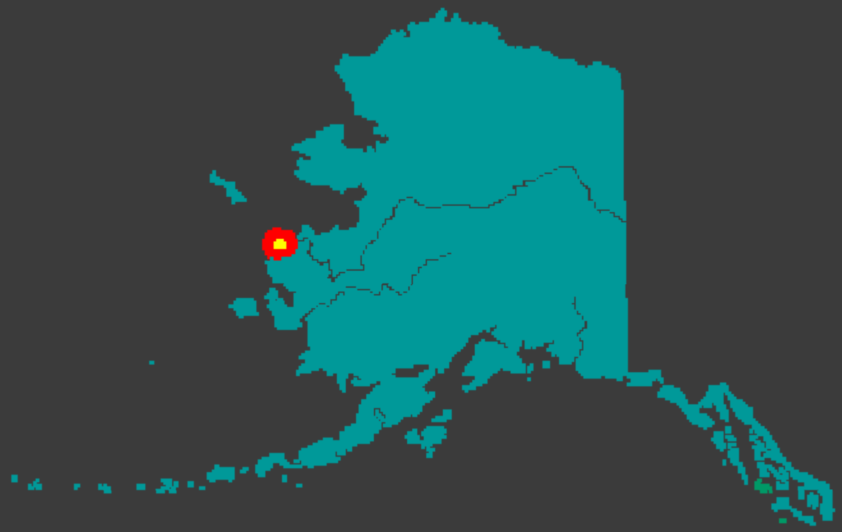
**Photo: KKCC**

# Opportunities for Coastal Undersea Cable Broadband

Photo: GCI

- Combine bandwidth with research
  - Shared landing facilities
  - Branching Units for research/sensor equipment
  - Assumes power in cable
- Can have long life with minimal maintenance

# Digital Microwave



Scammon Bay

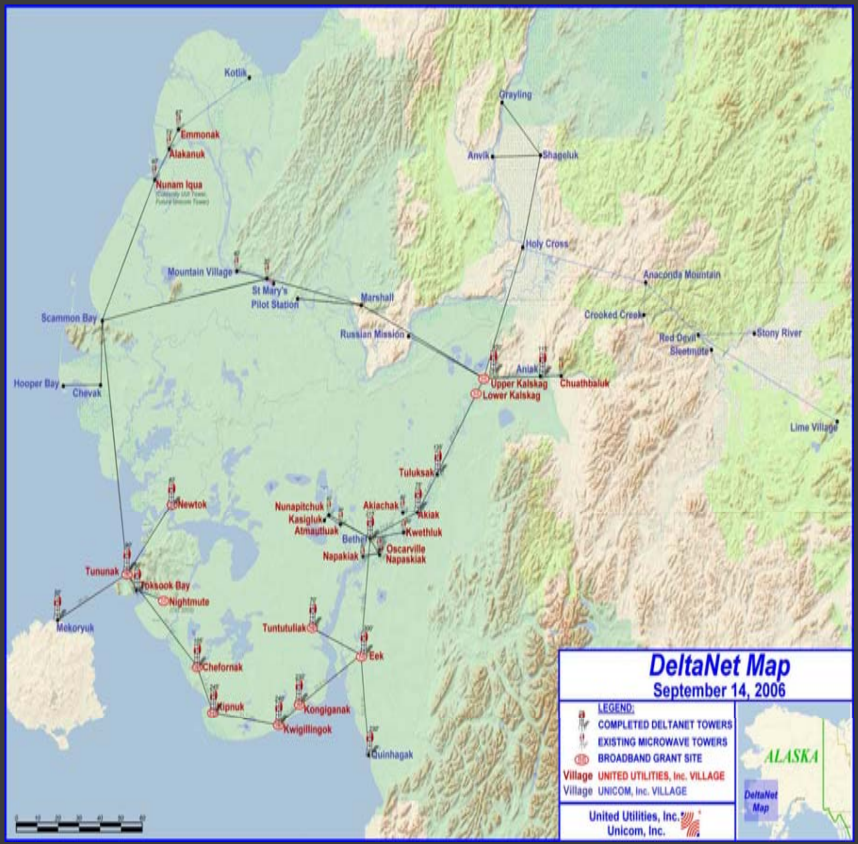
Photo: GCI

# Digital Microwave

Phtot: GCI

- Negatives
  - High installation cost
  - High maintenance cost
  - Reliable power
  - Bandwidth limitations -600Mbs
  - Current engineering based on decades old data
- Positives
  - Reliable in extremes
  - Limited bandwidth works for remote sensing loads
  - Use in combination with coastal cable

# DeltaNet: Digital Microwave System




Map: GCI

- High Availability
- Resilient Packet Ring Topology
- Layer Two Switched Network
- Redundant Electronics

# Need for Mobile Broadband

- United States' National Science Foundation Office of Polar Programs studying climate change requires "Tundra Net" connectivity for up to 50 scientists conducting scientific research on the Arctic coastal plain within a 10 mile radius.

**Photo: ASTAC**

# 700 MHz WiFi Coverage
## 93,000 Square Miles of Mobile Broadband

# Scientist's 700MHz/WiFi

Photo: ASTAC

- Licensed – not subject to interference
- Nomadic service
- Cost effective alternative to trenching new cable
- Transport to develop DSL and WiFi service
- Allows for quick set up for emergency response

# U.S. Coast Guard 700 MHz WiFi

**Photos: ASTAC**

# 700MHz Mobile Detail

Photo: ASTAC

- Licensed spectrum space (USA)
- Speeds in increments of 64kbps
- Each base station radio (BSR) is capable of transferring 2.4 mbps (net of all overhead requirements)
- Each BSR can support up to 252 subscribers
- Each tower site is scalable from 1-4 BSRs with a maximum aggregated throughput of 9.6 mbps per tower
- Supports both marine and land locations

# Some Proposed Solutions

Photo: GCI

- Fiber on the Tundra
- Fiber in the Riverbed\
- Coastal Fiber Ring with Digital Microwave Hubs
- Combination of Cable, Fixed and High Speed Mobile

# Toolik Lake Field Station:
# Site of "Fiber on the Tundra" Project

Nexans

**DATASHEET**

| Cable Design (all values in mm) | Thickness | Outer Diameter |
|---|---|---|
| Optical fibres 12, 24 or 48 off | - | 0.25 |
| Steel tube with tube filling | 0.2 | 3.0 [1)] |
| Inner sheath, polyethylene (HDPE), black | - | 5.3 |
| Armouring, galvanized steel wires, 20 off | 0.9 | 7.3 |
| Outer sheath, polyethylene (HDPE), black | - | 11 |
| **Physical Characteristics** | | |
| Bending diameter (min) | mm | 200 |
| Safe Working Load | kN | 5 |
| Breaking Load | kN | 20 |
| Weight in air (approximately) | kg/km | 185 |

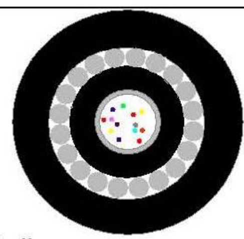
**Optical Characteristics**

Fibre types: G.651, G.652, G.554 , G.655 or combinations

| | | |
|---|---|---|
| Typical ITU-T G.652 characteristics | 1310 nm | 1550 nm |
| Optical attenuation , max (dB/km): | 0.36 | 0.20 |
| | 1288 – 1339 nm | 1550 nm |
| Chromatic dispersion, max (ps/nm·km) | 3.5 | 18 |

**Fibre Marking**

| Fibre colour | 0/0 | 1/50 | 1/25 | 2/50 | 2/25 |
|---|---|---|---|---|---|
| Red | 1 | 13 | 22 | 31 | 40 |
| Green | 2 | 14 | 23 | 32 | 41 |
| Blue | 3 | 15 | 24 | 33 | 42 |
| Yellow | 4 | 16 | 25 | 34 | 43 |
| White | 5 | 17 | 26 | 35 | 44 |
| Grey | 6 | NA | NA | NA | NA |
| Brown | 7 | NA | NA | NA | NA |
| Violet | 8 | NA | NA | NA | NA |
| Aqua | 9 | 18 | 27 | 36 | 45 |
| Black | 10 | NA | NA | NA | NA |
| Orange | 11 | 19 | 28 | 37 | 46 |
| Pink | 12 | 20 | 29 | 38 | 47 |
| Natural | NA | 21 | 30 | 39 | 48 |



**Drawing No:**
**D-7605 Issue 1**

[1)] Tube dimension will depend on fibre count: φ 2.3 with 12 fibres, φ 3.0 with 24 fibres, φ 3.7 with 48 fibres,

All data subject to change without prior notice

# Toolik Field Station

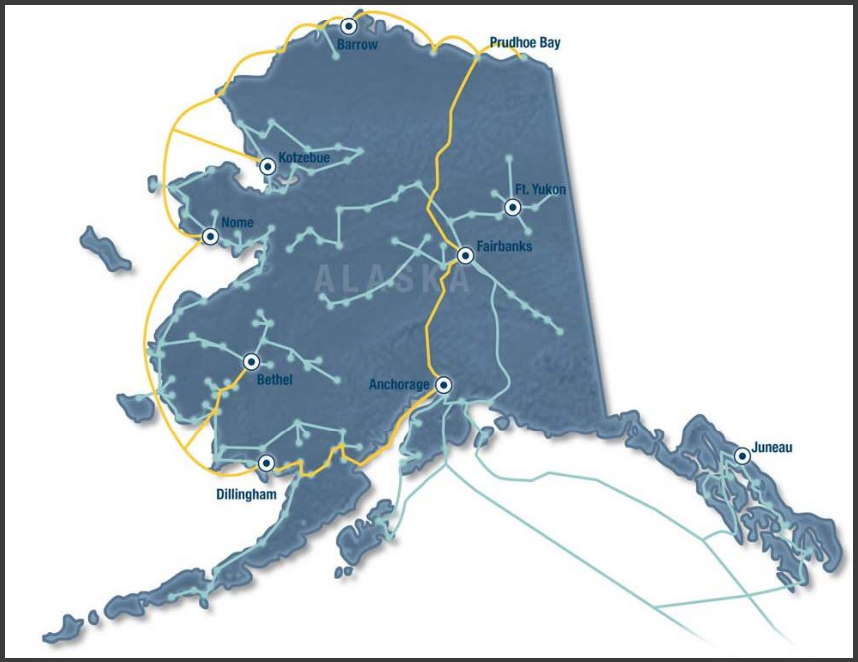
# Fiber-on-the-Tundra
# Challenges and Opportunities

- Opportunities
  - Attractive where terrain is relatively flat without too many drainage crossings
  - Possibly low installation costs if done in winter
  - Possibly low operations costs if cable is protected by tundra
  - Efficient routing
  - Future proof and long term solution
  - Ring protected architectures possible to reduce susceptibility to single outages
- Challenges
  - Long term effects on tundra unknown
  - How do surface disruptions (animals, snow machines) impact the cable
  - What sort of anchoring is needed
  - Stream crossings
  - Frequency of outages difficult to quantify
  - Permitting concerns will require careful preparation to address successfully

# Riverbed Fiber Systems: Challenges and Opportunities

- Opportunities
  - Attractive as a corridor since villages are clustered along rivers
  - May have fewer permitting concerns than overland corridors
- Challenges
  - May suffer many of the ice scour issues that coastal festoons in northern waters have
  - How to handle river ingress and egress
  - Impacts of spring river ice break-up

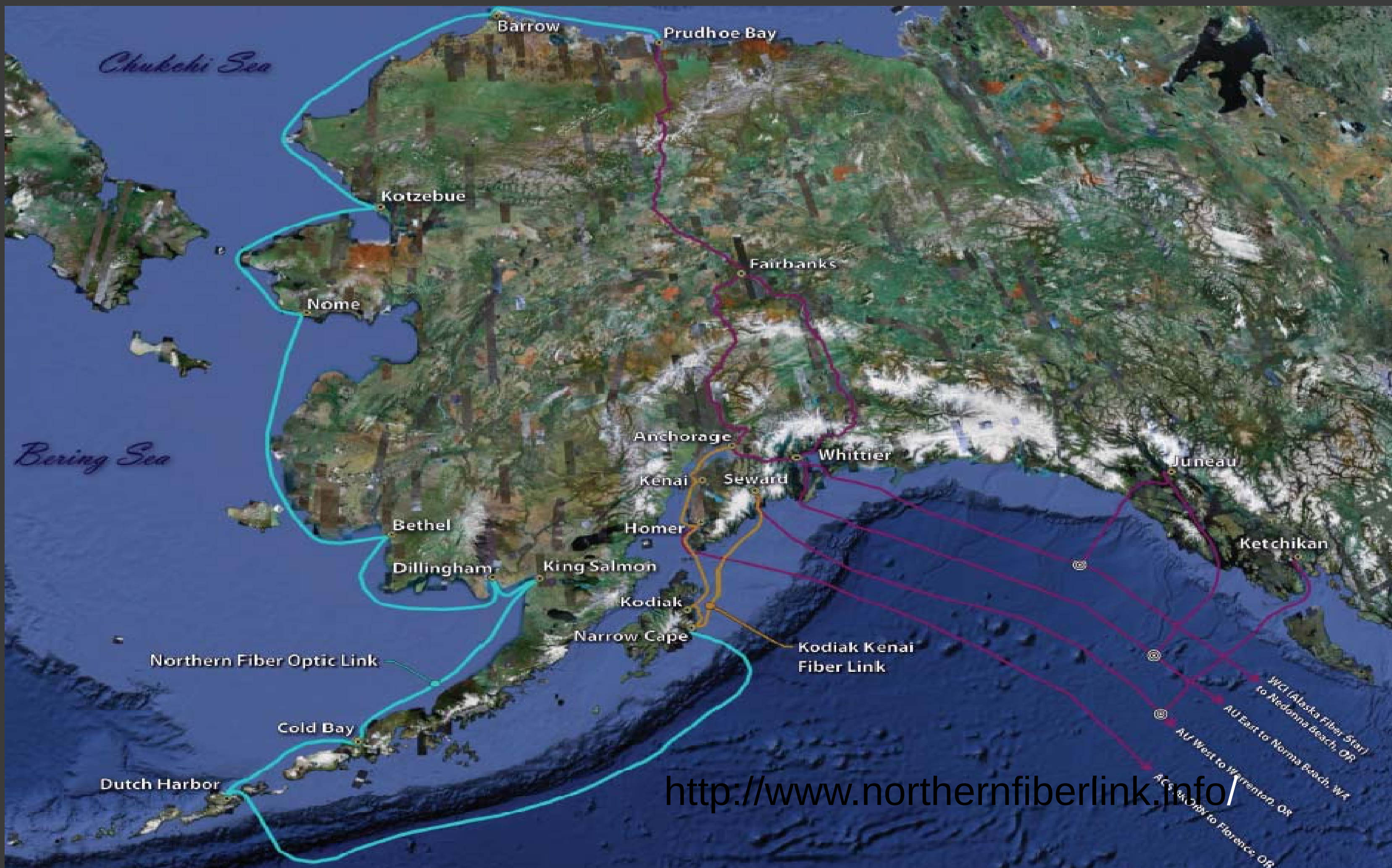
# TERRA Proposed Network: Regional Hubs, High Speed Backbone




- Regionally Hub Terrestrial Networks
- Combination of Microwave and Fiber Optic Segments
- Extend Existing Fiber Optic Network
  - Fault Tolerant Ring
  - High Speed Backbone

**Map: GCI**

# Northen Fiber Optic Link (NFOL) Proposed Network (in blue)



# NFOL Details

- Cable Length: 5432 Km
- Ten Cable Landings
- Two fiber pairs
- Initial Operating Capacity: 16 Wavelengths -160 Gbps
- Full Operating Capacity: 64 Wavelengths - 640 Gbps
- Carrier of Carriers

# Thanks….questions?

Photo: ASTAC