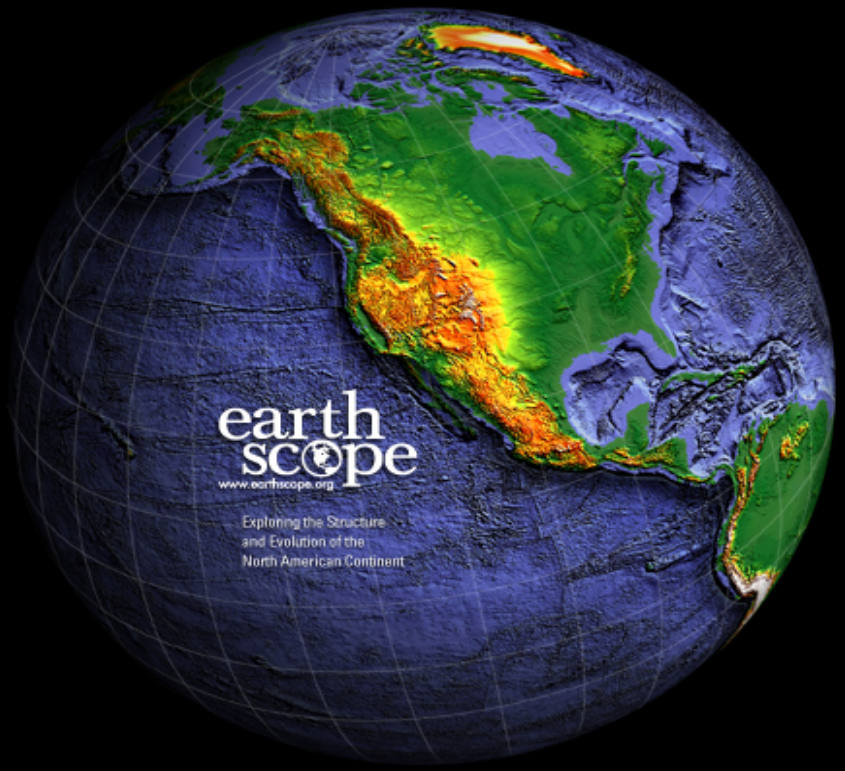
Updates and Plans for the Earthscope Alaska Transportable Array - 2016

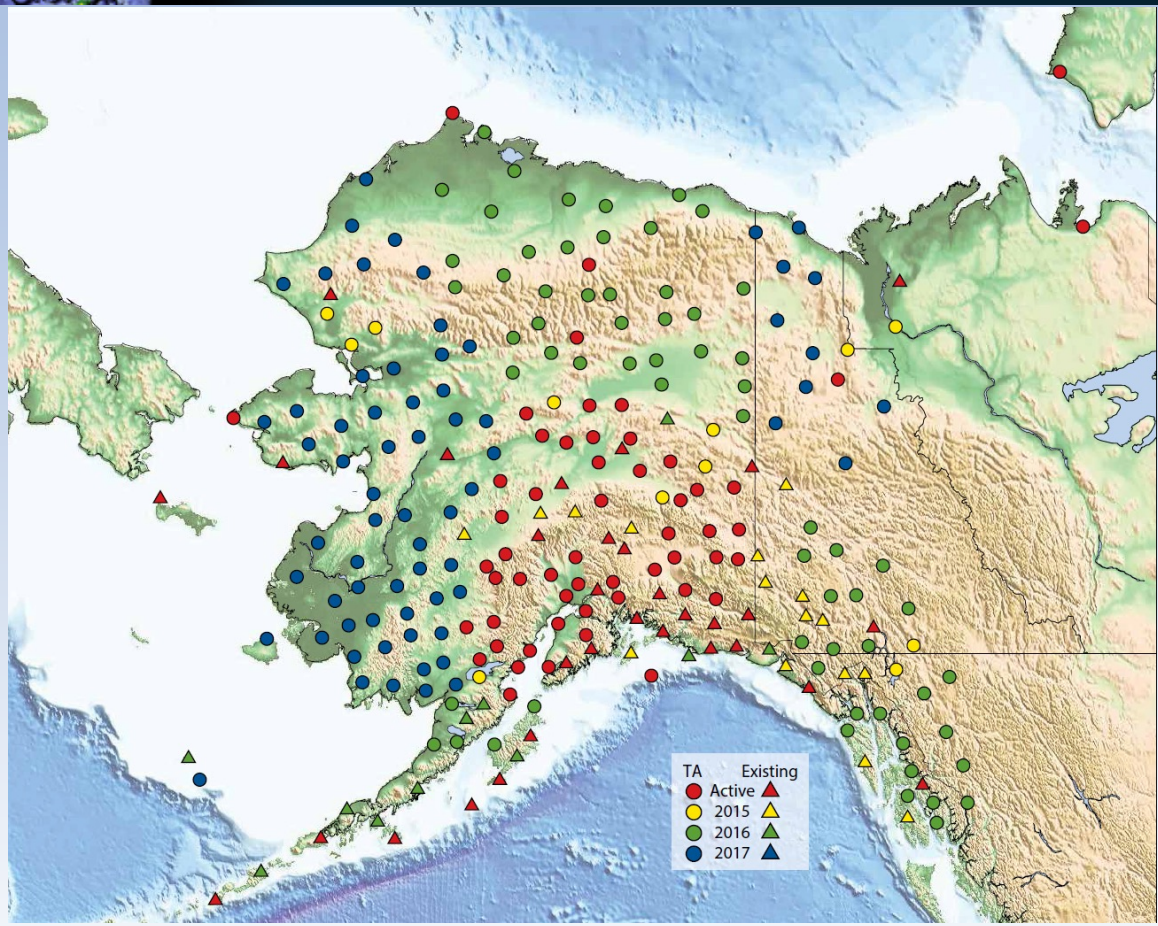


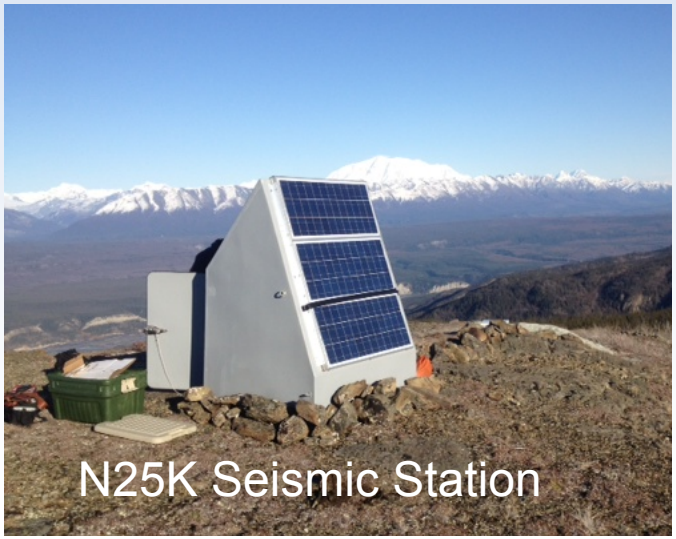
Ryan Bierma
Station Specialist/
Field Ops Manager

Polar Technology Conference
Littleton, CO
21-22 March, 2016

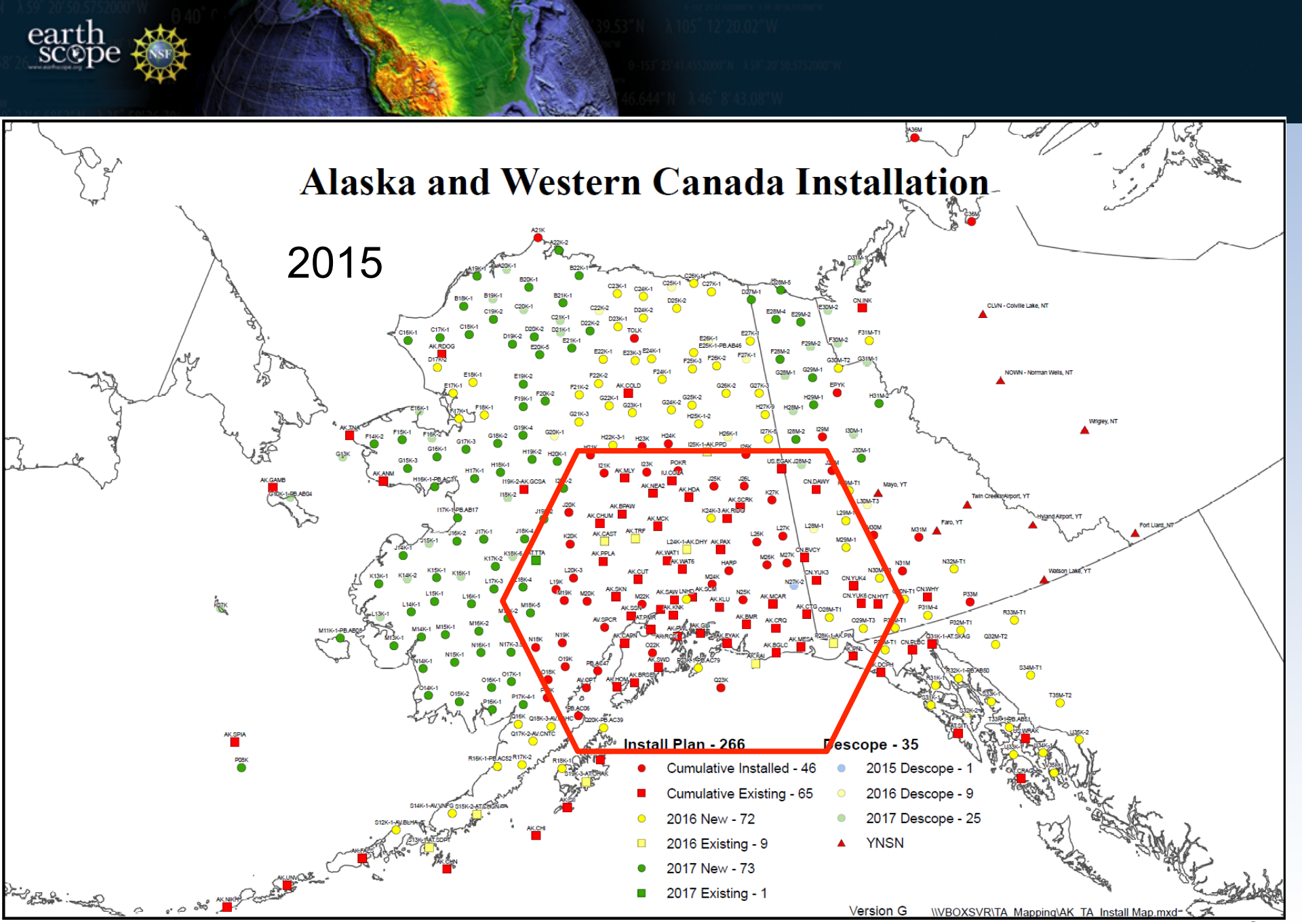
TA in Alaska / Canada

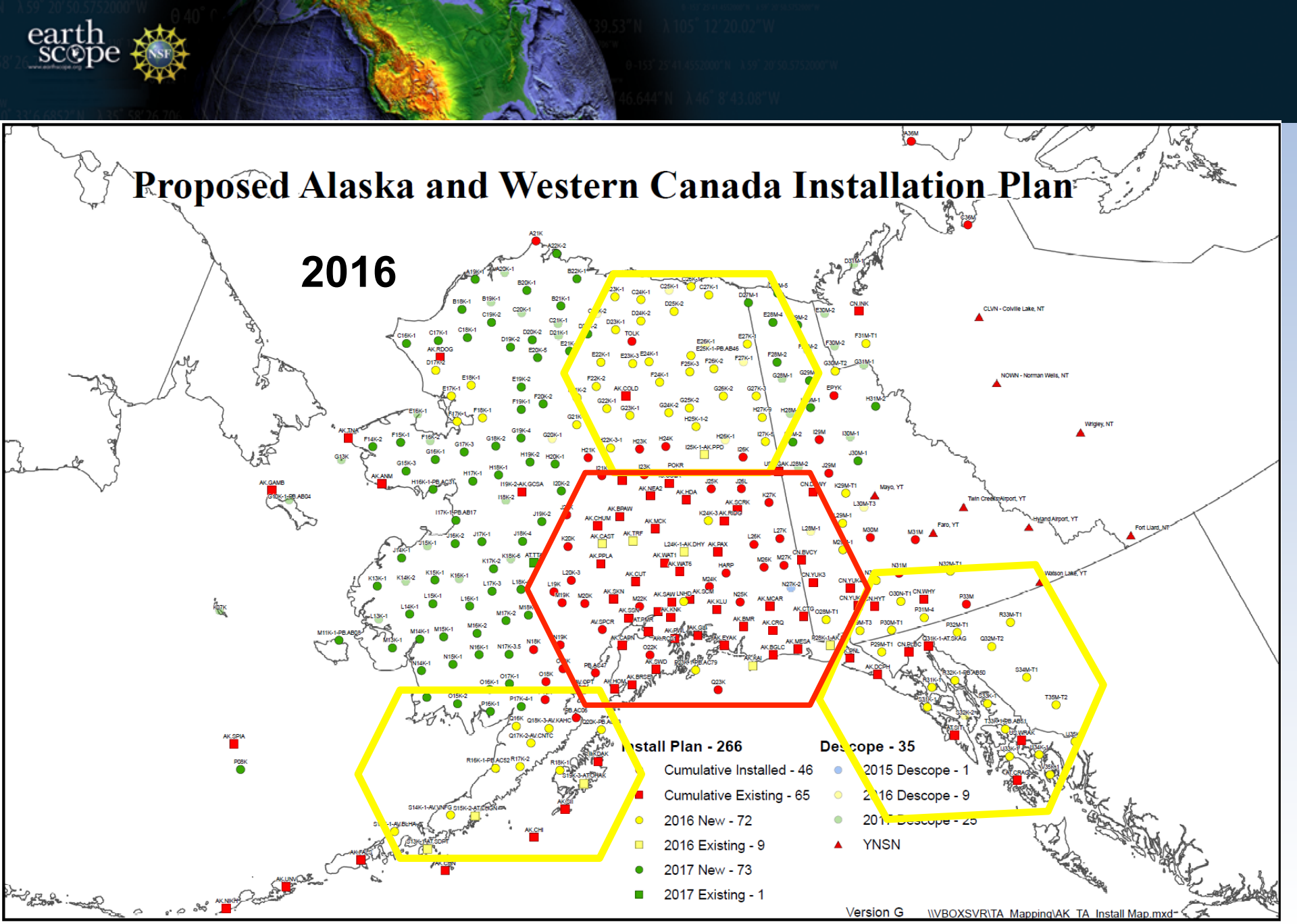
- ~265 sites, 190 new
- fully deployed 2017
- 85 km spacing
- Broadband Seismometers, Infrasound, pressure, Met
- Power and comms in fiberglass enclosure




N25K Seismic Station

www.usarray.org/alaska


Alaska and Western Canada Installation
2015
Install Plan - 266
Descope - 35
Cumulative Installed - 46
Cumulative Existing - 65
2016 New - 72
2016 Existing - 9
2017 New - 73
2017 Existing - 1
2015 Descope - 1
2016 Descope - 9
2017 Descope - 25
YNSN
Version G
\\VBOXSVR\TA_Mapping\AK_TA_Install Map.mxd


Proposed Alaska and Western Canada Installation Plan
2016
stall Plan - 266
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YNSN
Version G
\\VBOXSVR\TA_Mapping\AK_TA_Install Map.mxd

2015 – The Good

- 39 total new stations operational – 32 new and 7 upgraded existing sites (i.e. AEC, AVO, PBO)

2015 – The Not-As-Good

- Drilling complications – overheating, misfit gearing between compressor and motor, wear and tear.

- Wrinkles in Year 1 of the Genasun LiFEPO4 (LFP) and customized charge controller. Main issue was an internal battery switch. Issues with enclosure humidity causing corrosion on batteries.

- Worst Alaska forest fire season since 2004, ~5.5 million acres burned. 1 site lost.

Drilling challenges

Broken drill rig at I26K

Broken spider gear due to engine/ compressor gearing mismatch

Clogging due to conditions and some drilling inexperience. Learning curve.

ATA Lithium FePO4 Batteries

Genasun LiFePO4 Battery

- High Energy Density: 180 Ah @ 58 lbs with Aluminum casing (vs 100 Ah @ 70 lbs AGM)

- Each battery regulated by integrated Battery Management System (BMS)
- Tolerant of deep discharge (down to 5-10%) and minimal effect from cold
- CANbus protocol for MPPT data link with Controller and Q330. Still in development.

2015 ATA Battery System

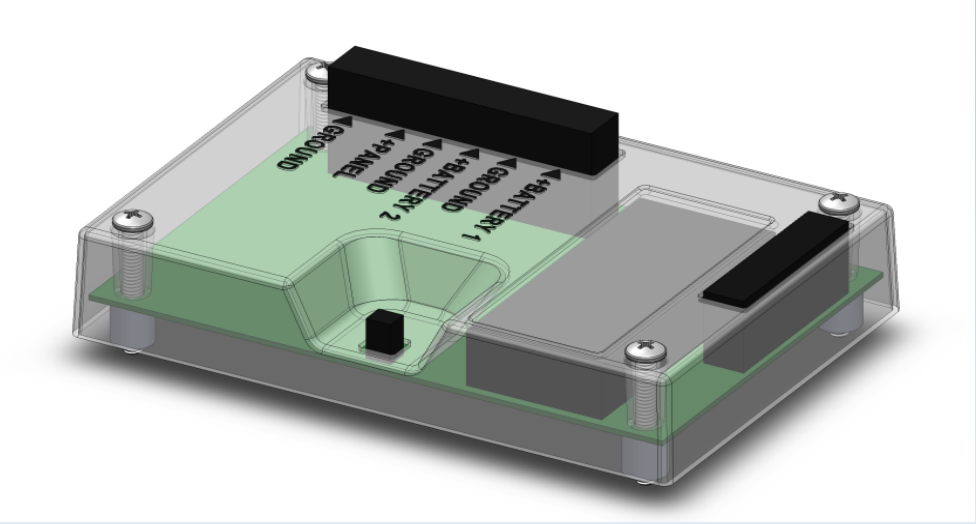
- Main (Batt1): 6 Genasun 180 Ah LiFePO4 batteries
- Primary (Batt2): 4 Concorde 100 Ah AGM lead acid batteries

- Nominal total of 1480 Ah in the system with half the weight of an equivalent AGM bank!

  =fewer helicopter trips
- After cold de-rating and allowable cycle depth,

  1 LiFePO4 ~ 3 AGM

Genasun Solar Controller



Genasun Solar Controller drawing, my pictures of controllers are always lousy!

- LiFePO4 batteries on Batt1 input (Main)
- AGM (backup) batteries on Batt2 input (Primary)
- Charging on both channels

2015 Power System Challenges

- Statistics of functionality this past winter are skewed due to a few bumps in the road

- 17 LFP systems deployed
- 5-6 worked with no problems, but we anticipate hardware upgrades this summer.
- Failures were likely due to 1 of 3 diagnosed problems…

Diagnosed power system issues

Problem 1: LFP Battery - Faulty Solid State Switch (SSS) on load output of Battery Mgmt System (BMS).

Solution: Genasun sourced a different SSS from vendor. Testing since 12/2015 has been positive. Required ATA staff to go through all stock and retrofit LFP batteries.

Diagnosed power system issues

Problem 2: Humidity inside enclosure huts appears to be causing corrosion on PCB inside LFP batteries.

Solution:

Improve venting on huts (in development).

Diagnosed power system issues

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Gore Vents ?

Diagnosed power system issues

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Install LFP batteries inside a moisture/vapor resistant bag.

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Solution:

Improve venting on huts (in development).

Install LFP batteries inside a moisture/vapor resistant bag.

Additional conformal coating on future LFP PCBs

Diagnosed power system issues

Problem 3: Charge Controller – we experienced some errors during firmware programming related to the sequence of events

Solution:

Testing by IRIS and the manufacturer helped determine the error and the proper sequence.

System update allows for “less invasive” firmware upgrades now.

Other firmware updates have optimized the MPPT algorithm and the LFP to AGM changeover.

Battery synopsis

- Year 1 had a few bumps, but that can be expected.
- Overall we are pleased with the LFP batteries and optimistic about the future.
- No flaws have been found in design or application
- Further complications may arise with air-shipping Lithium-based anything.

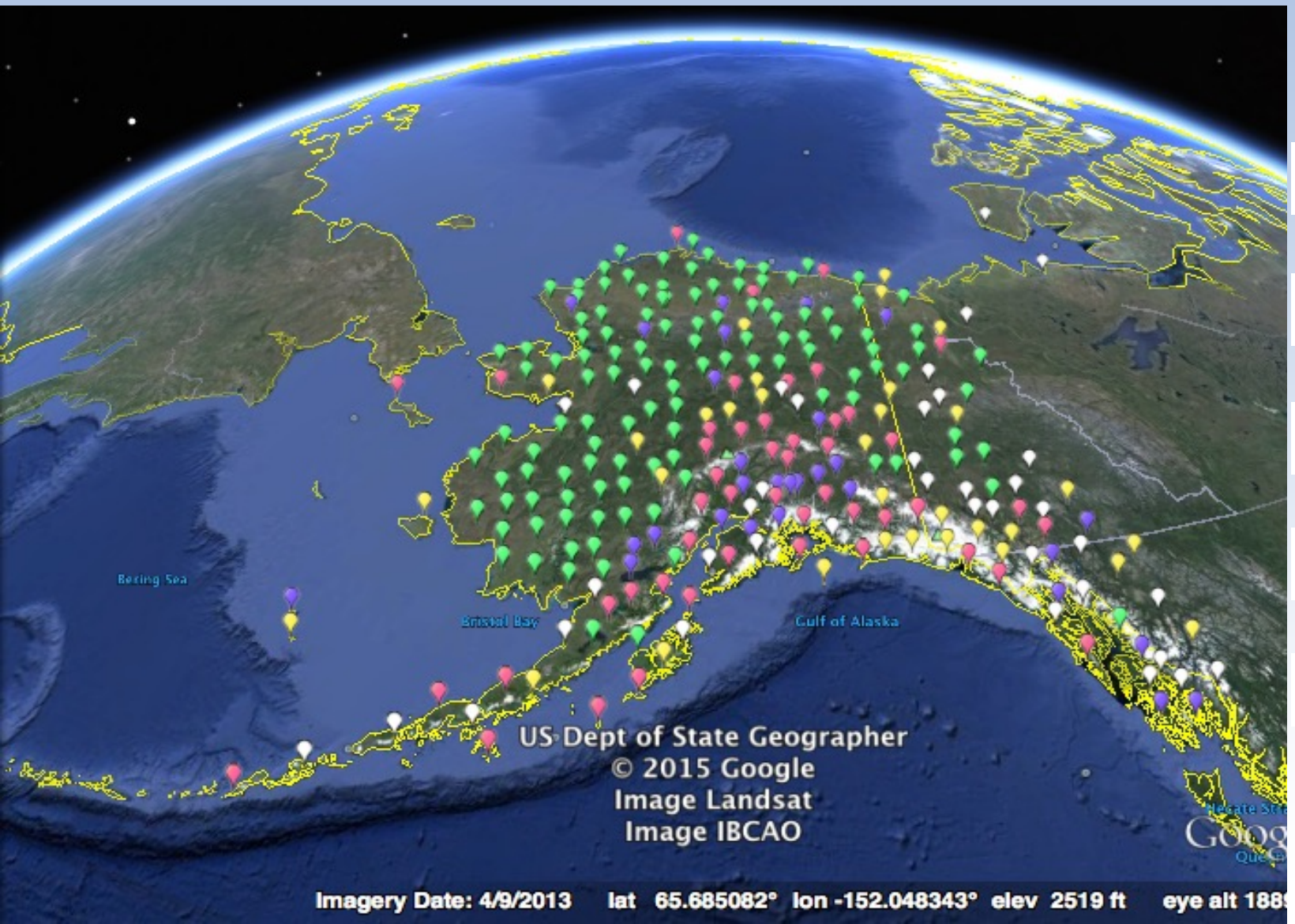
Fire!

Fire!

Fire!

M22K Willow – The Phoenix Rises

Complex Communications



BGAN

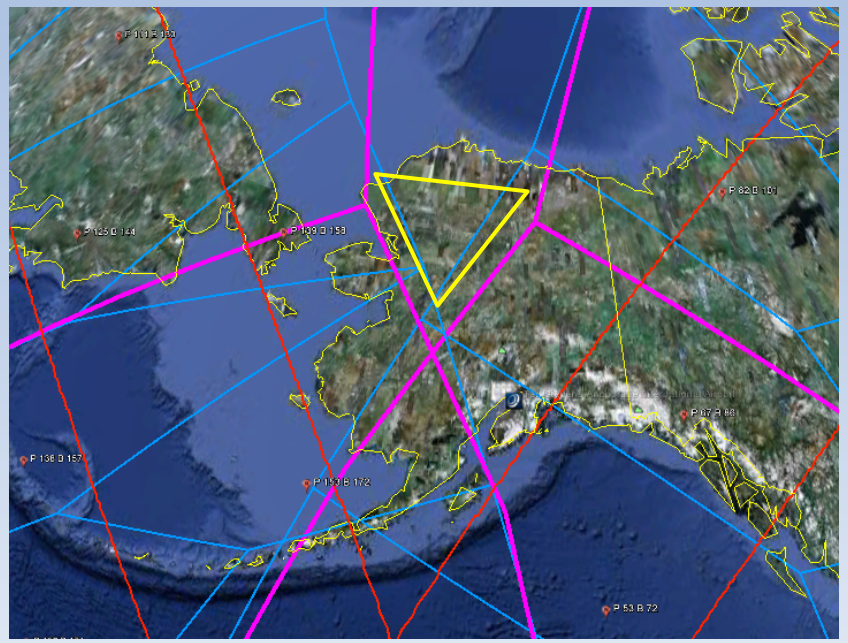
RADIO

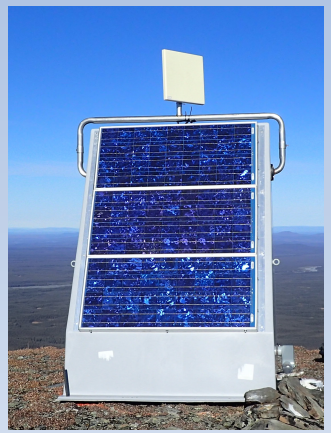
INTERNET

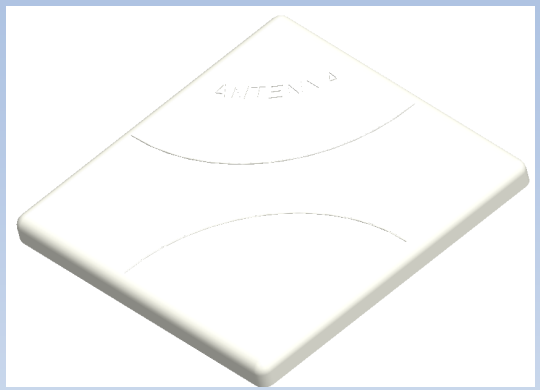
VSAT

CELL

Comms – InMarSat BGAN







15 x 15 x 2 inch flat plate

RED Lines = 10 Degree elevation = minimum recommended for BGAN
PINK Lines = Regional Beams of APAC and AMER satellites = Should Work
BLUE Lines = Narrow Beams = Hard to reach

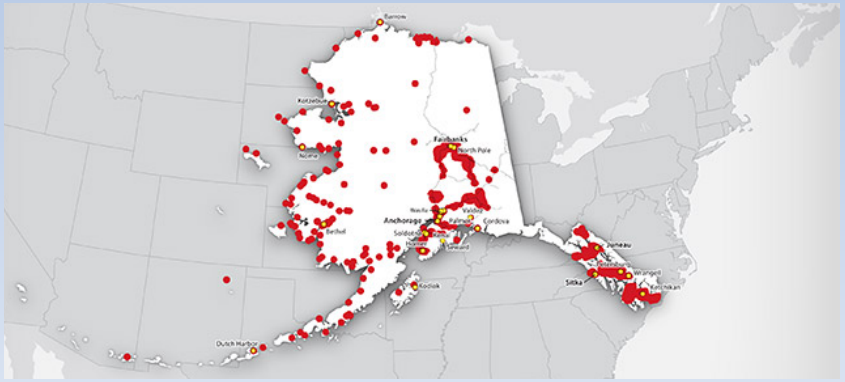
This map depicts Inmarsat's expectations of coverage, but does not represent a guarantee of service. The availability of service at the edge of coverage areas fluctuates depending on various conditions.

Cost ~ $1000/mo
350 kbps bandwidth
2Gbyte/mo throughput
~2W average

Comms – Other Limited Options

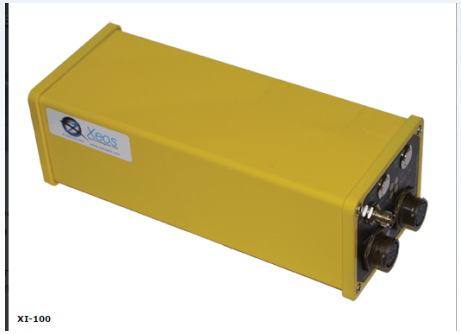
Internet Connection (direct Connect or via radio link)
~$80-150/month

Cellular
~$40/month



Hughes VSAT
~$90/month

Xeos (Iridium)
~$290
-still in testing



2016 - Outlook

- New robust drill rig built - tested and en route to Alaska for initiation
- Engineering improvements with power system, especially LFP batteries, should yield better results– a more robust component swapped in and efforts to create a more suitable environment for batteries.
- Similar winter as 2015 – another bad fire season a real possibility.

Acknowledgements

- Bob Busby (TA Manager)
- Max Enders (ATA Deployment Coordinator)
- Jeremy Miner (ATA SS/ Field Ops Manager)
- Doug Bloomquist (ATA Station Specialist)

Ambitious schedule, Excellent Team!

- Max Enders (ATA Deployment Coordinator)
- Jeremy Miner (ATA SS/ Field Ops Manager)
- Ryan Bierma (ATA SS/ Field Ops Manager)
- Doug Bloomquist (ATA Station Specialist)
- Mike Couch (ATA Station Specialist)
- Crystal Tingook (ATA Warehouse Specialist)
- Jason Theis (ATA Station Specialist)
- Helena Buurman (AEC UAF liaison, Fairbanks)
- Molly Staats (ATA Permitting, Fairbanks)

TA Alaska