Globalstar STX3 to STX4/Spot-X

An Evolution From Global Simplex To Global Duplex Communications for 1U Cubesats And Larger Vehicles

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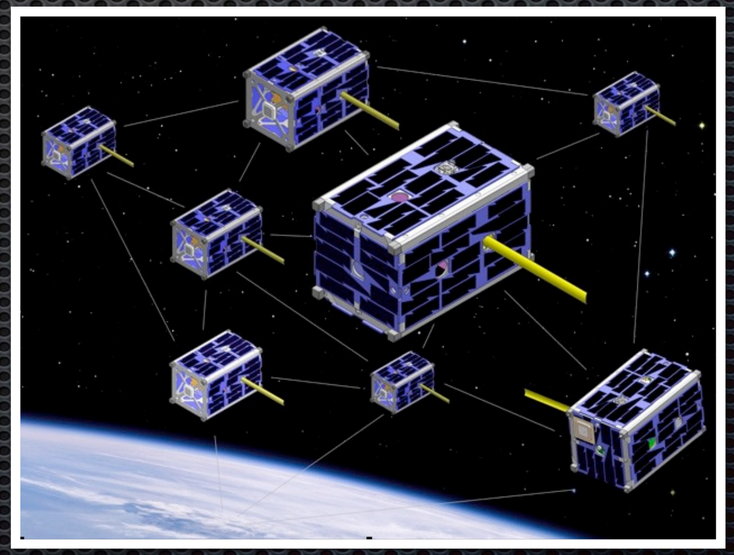
Background: The Problem…

- Cubesats and small satellites are limited in volume, power, and mass.
- High failure rate of small satellites and cubesats
- On board processing power limited
- **Limited communications**
  - Large amounts of data required for Tactical Intelligence, Surveillance, and Reconnaissance Functions
  - Data bottlenecks from cubesat to satellite
  - Data bottlenecks from cubesat to ground
  - Limited ground station coverage
  - Slow process to gather data to ascertain situational awareness on the ground and in space.
- Malicious software attacks…security
- Cubesats and small satellites are difficult to find and track after deployment…14 days or more to find them!



Value Stream Map: Current, Lost Satellite

What Makes Happy?

- Satellite Found (2-4 weeks)
- Restore Satellite (maybe)
- Orbit calculated (2-4 weeks)
- Satellite Status known (maybe)

What Makes Sad?

-Up to 4 week wait IF satellite found

- Cost to find satellite
- May never find satellite
- Satellite status may be unknown

Input

Flow

Find Lost Satellite

Review last message from satellite

Review last known location of satellite (maybe)

Review Satellite deployment

Send Messages hoping to communicate

Optically scan best guess

Flow

Listen for messages

Wait up to four weeks for positive response

Analyze Communications and satellite health data IF message received

Calculate orbit of satellite based on visual data if communications not established

Calculate orbit if communications established and GPS installed

Send message to satellite IF possible

Satellite Found (Maybe)

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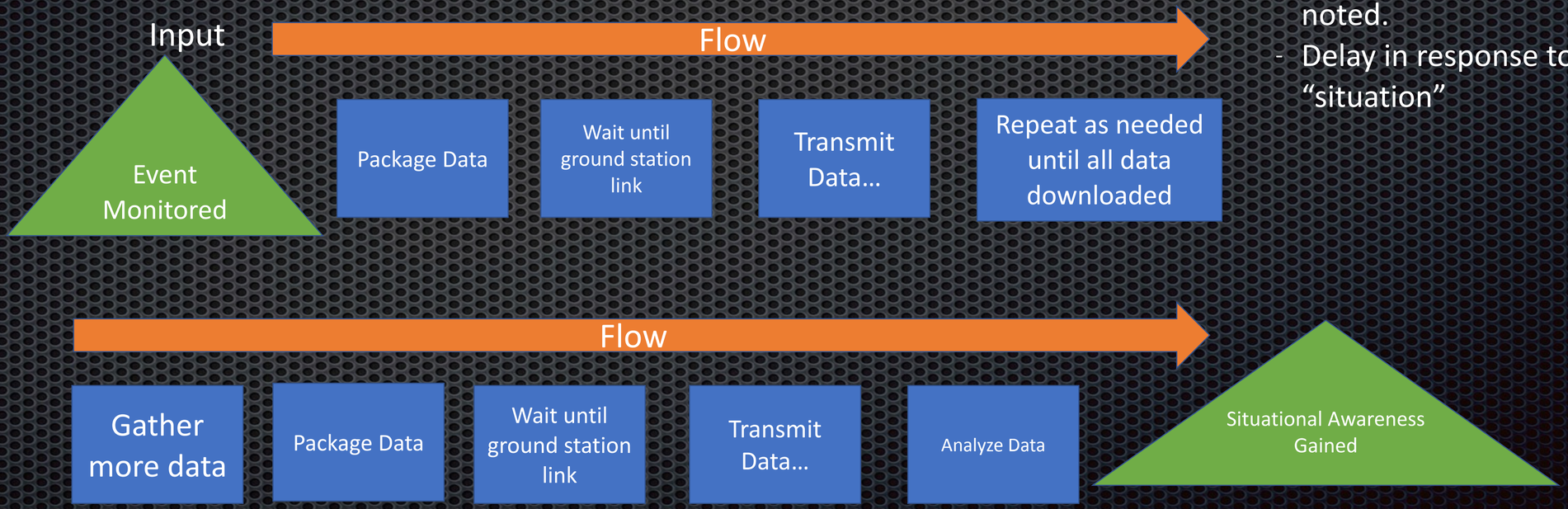
Value Stream Map: Limited Communications

What Makes Happy?
- Data downloaded
- Analyze data in secure cloud
- Situational Awareness Gained

What Makes Sad?
- May take several orbits to transmit all the data to the ground
- Hours/Days to determine if a “situation” should be noted.
- Delay in response to “situation”



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The Solution…*LinkStar-TRK with STX3 module*

LinkStar-TRK is a satellite radio system with integrated embedded computer and GPS with power backup capability that provides Tactical Intelligence, Surveillance, and Reconnaissance functions and can monitor the health and status of any payload and satellite. Data is transmitted to the ground in 200ms from over 95% of Low Earth Orbit, and can be viewed via a browser, mobile device and tablet. LinkStar-TRK is flight proven, and can be rapidly customized and deployed to meet our customer's needs.

- **Certified by *Globalstar*** (Only space vendor to reach this level of certification)
- FCC Modular Part 25 and Part 15A
- Support for CubeSat bus
- Integrated computer (*BeagleBone Black, BeagleBone AI or* Xilinx Zynq UltraScale+ MPSoC chip), communications interface, with optional GPS.
- Autonomy APIs and Functions for Vehicle Health Monitoring, Perception and Planning
- IC2, RS422, RS232, Space Wire, Serial, CAN, USB interfaces, UART
- *QuickSAT/VMS* environment for seamless control and software integration
- Optional Hypervisor for protection from malicious attacks.
- Interface via laptop, desktop, tablet and mobile device!
- **ICD available on website**

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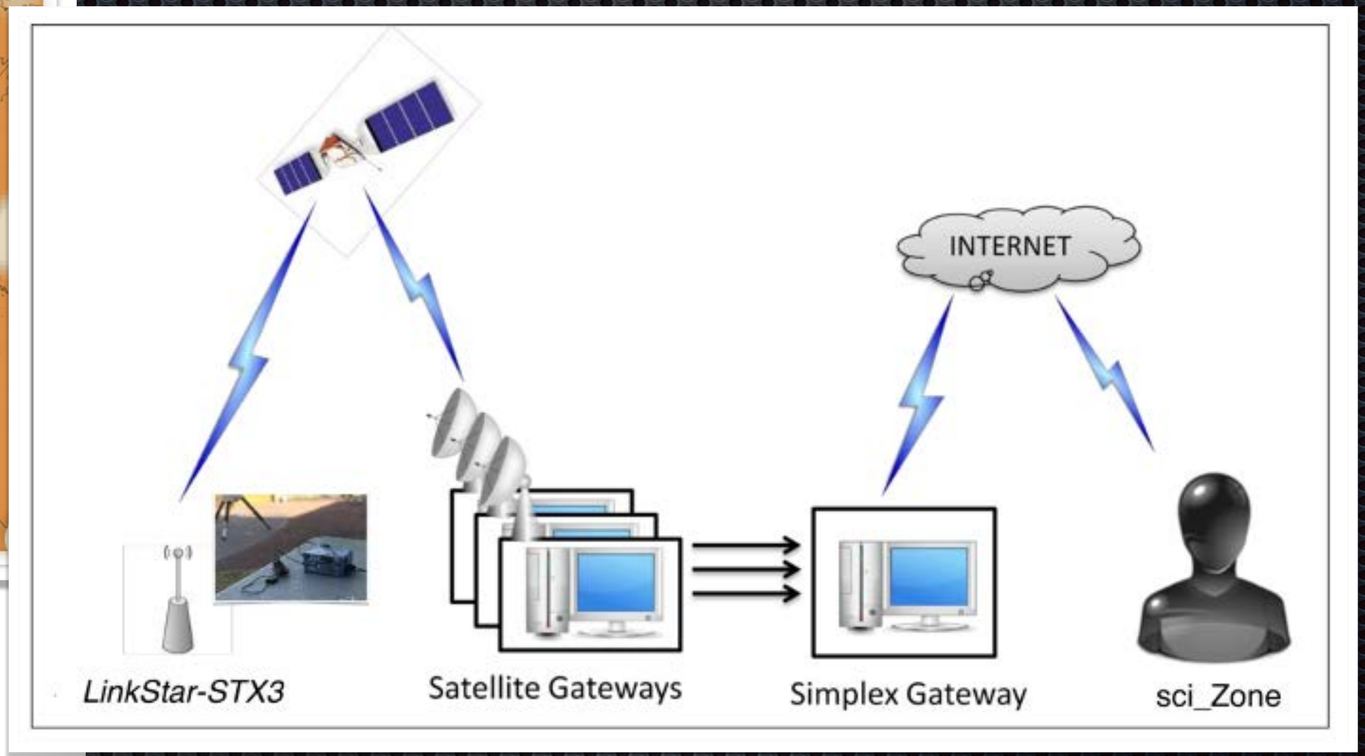

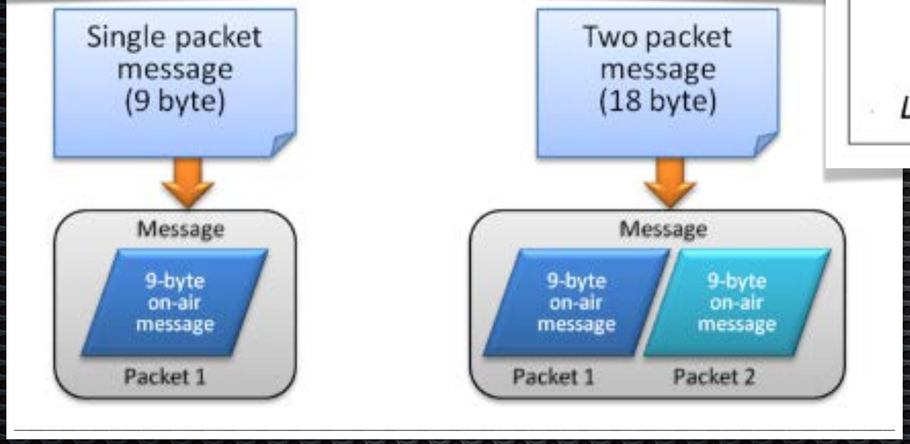

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Value Stream Map: *LinkStar-TRK*

Input

Flow

Find Lost Satellite

Messages sent with location and status up to every 5 minutes

Alert received within 15 seconds of activation

Satellite Status Known

Flow

Satellite location known within 4-6 minutes of activation

Send Command To Satellite

Satellite Found and Status Known

Value Proposition

- First message within 15 secs of activation
- Satellite Found within 4-6 minutes of activation
- Status likely known
- Satellite can be tumbling while messaging
- Secure Communications

Value Stream Map: *LinkStar-TRK System*

Input

Flow

Event Monitored

QuickSAT/ Autonomy analyzes data

"Situation Identified"

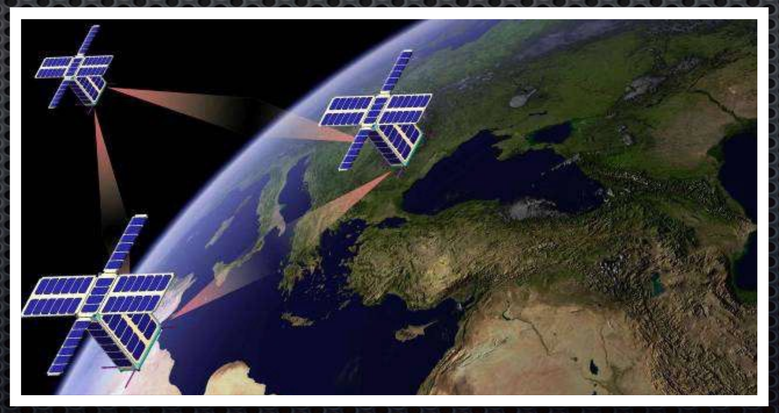
Situation Messaged to ground in 200ms

Flow

"Situation" monitored and updated every 2 minutes

Larger data set transmitted within 1-2 orbits

Situational Awareness Gained Quickly



Value Proposition

- Situation detected noted from small satellite
- Messaged Transmitted to ground in 200ms
- No wait time
- Can operate from cubesats
- Satellite can be tumbling while messaging
- Secure Communications

Great System, But those regulations…

- **FCC regulations and NASA Policy Directive NPD0 2570.E:** “all spacecraft shall be equipped with mechanisms to remotely cease EM emissions unless there is a human presence with this direct capability”

Added Requirements…

- Second radio required for an uplink commands to cease the emissions of the STX3 based radio.
- STX3 CANNOT broadcast if the receiver is out of communications for > 8 hrs.

The STX3 Module becomes dependent on a second radio and global communications capabilities are lost.

Spot-X: Expanding Applications

- “Half Duplex”
- Provides 2-way messaging
- Unique mobile number
- Connectivity via USB and BLE (Bluetooth Low Energy)

- Hiking and Camping
- Boating
- Emergency Rescue
- Remote Communications
- Fire Fighting
- *and now small satellite communications!*

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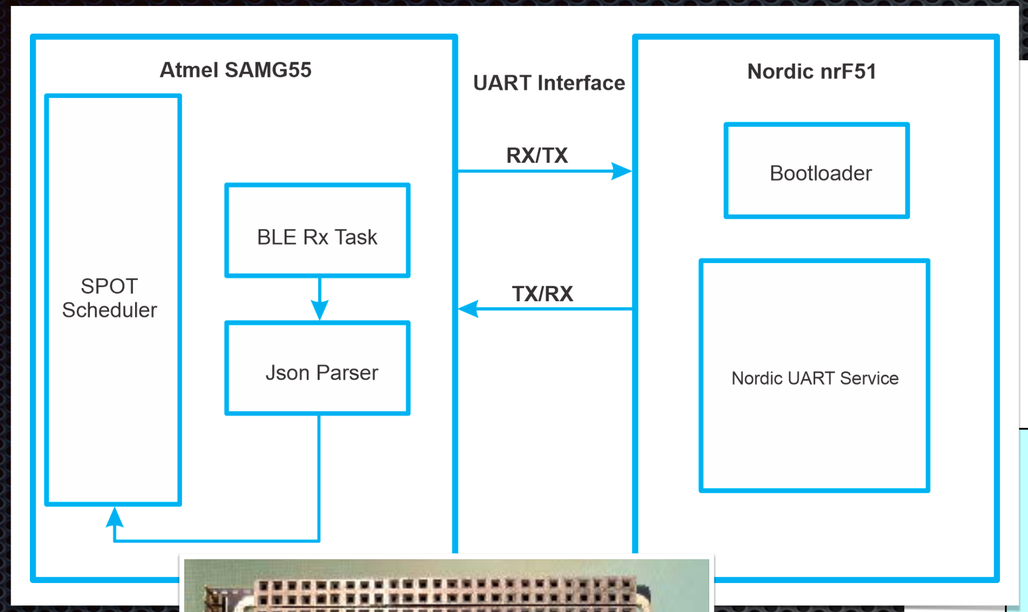
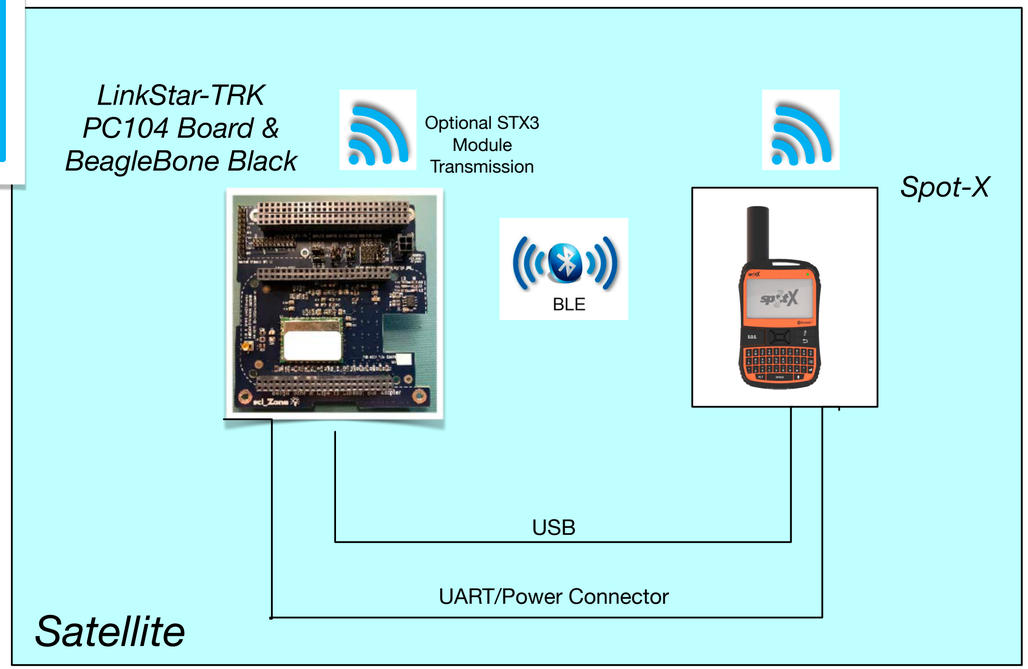
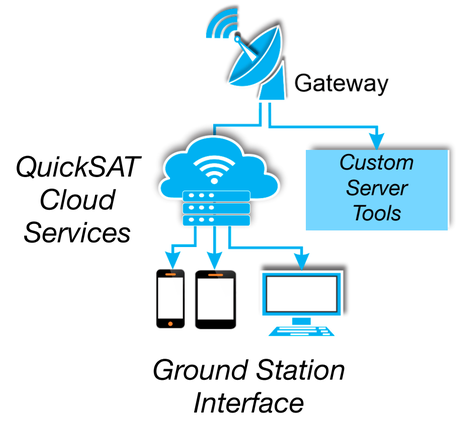
LinkStar-TRK/Spot-X Integration



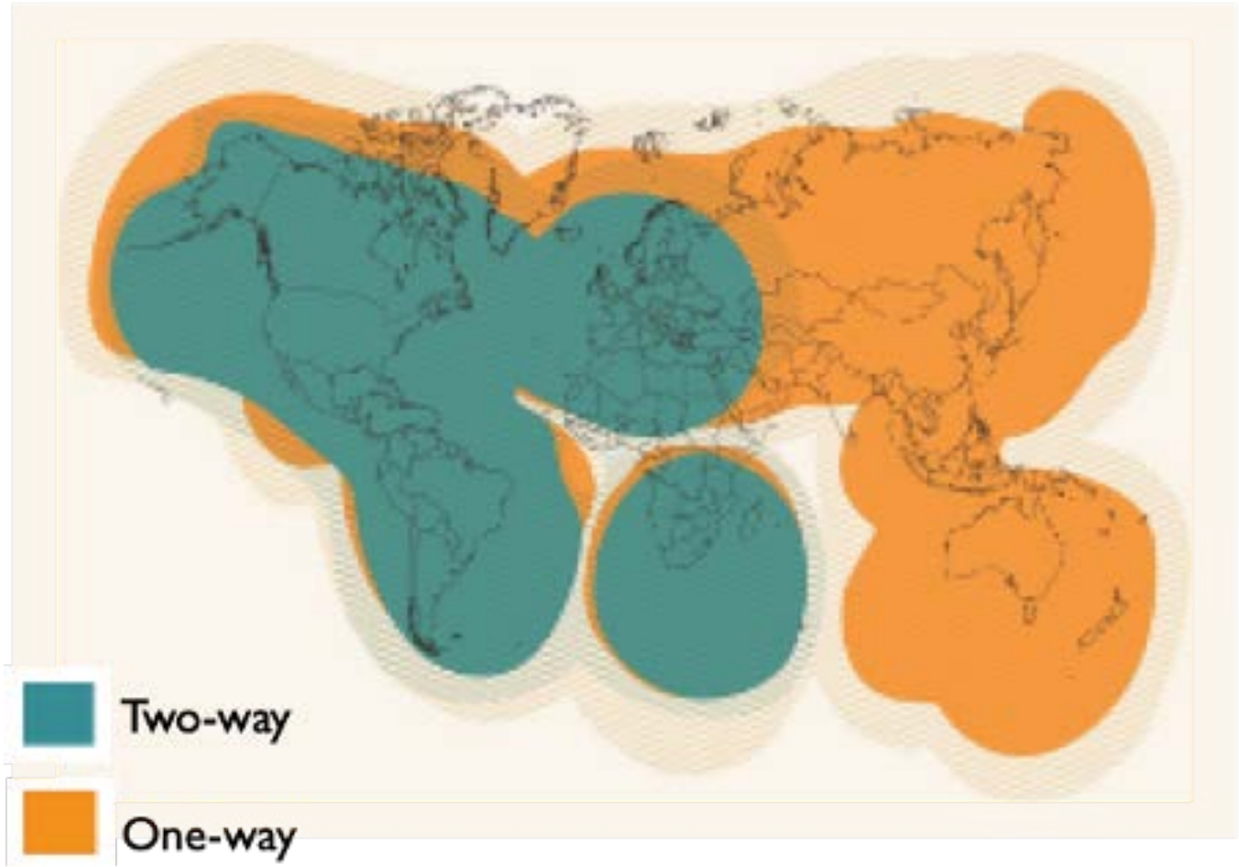
Globalstar satellite





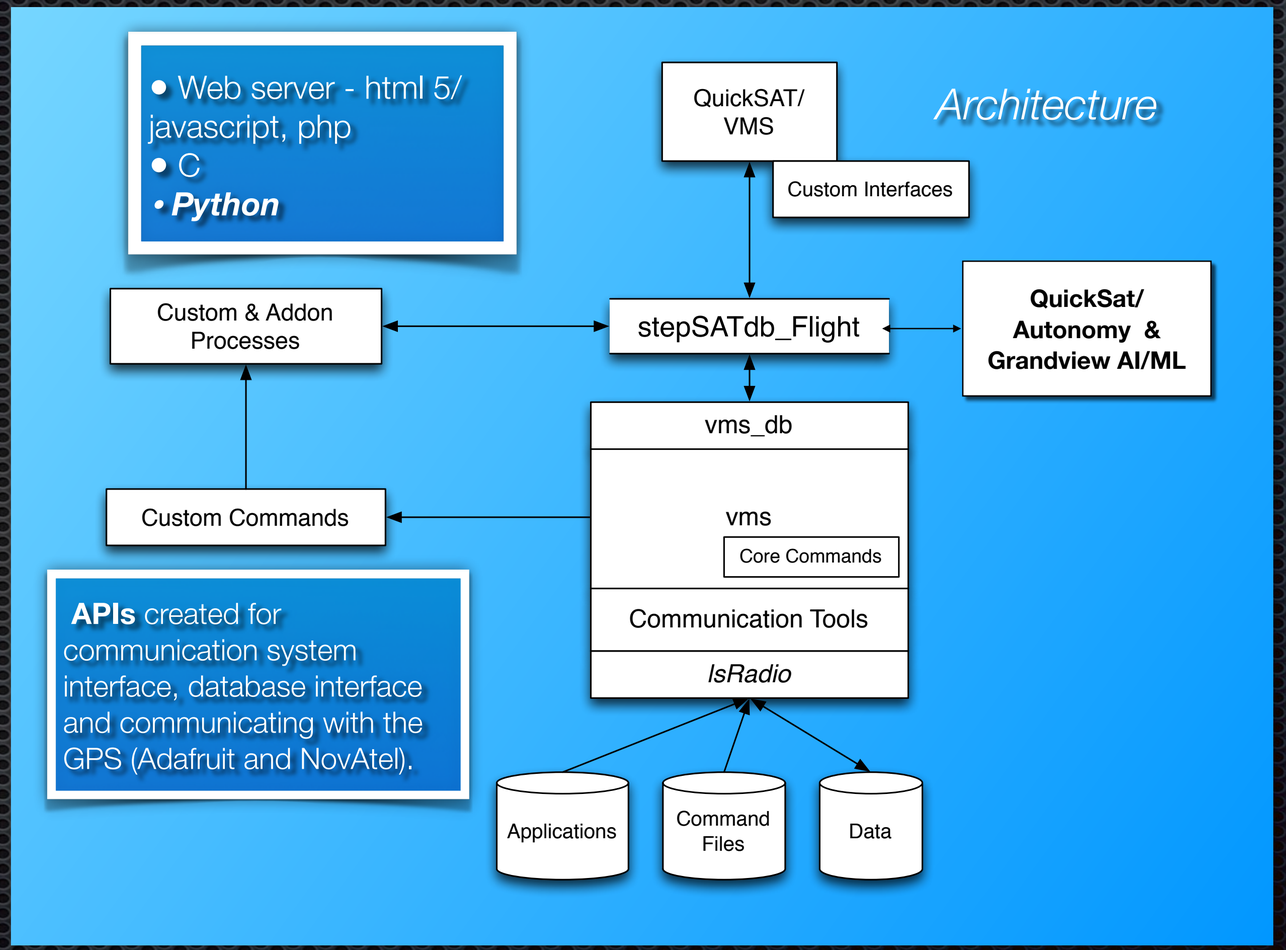
LinkStar-TRK/Spot-X Coverage area

- Uplink/Downlink: 140 bytes
- Communications via Laptop, Desktop computer or mobile device
- Management via *QuickSAT/VMS*
- *Operator does not need to package data*
- *QuickSAT/VMS* exchanges data via JSON formatted messages between the *LinkStar-TRK* board and the *Spot-X module.*



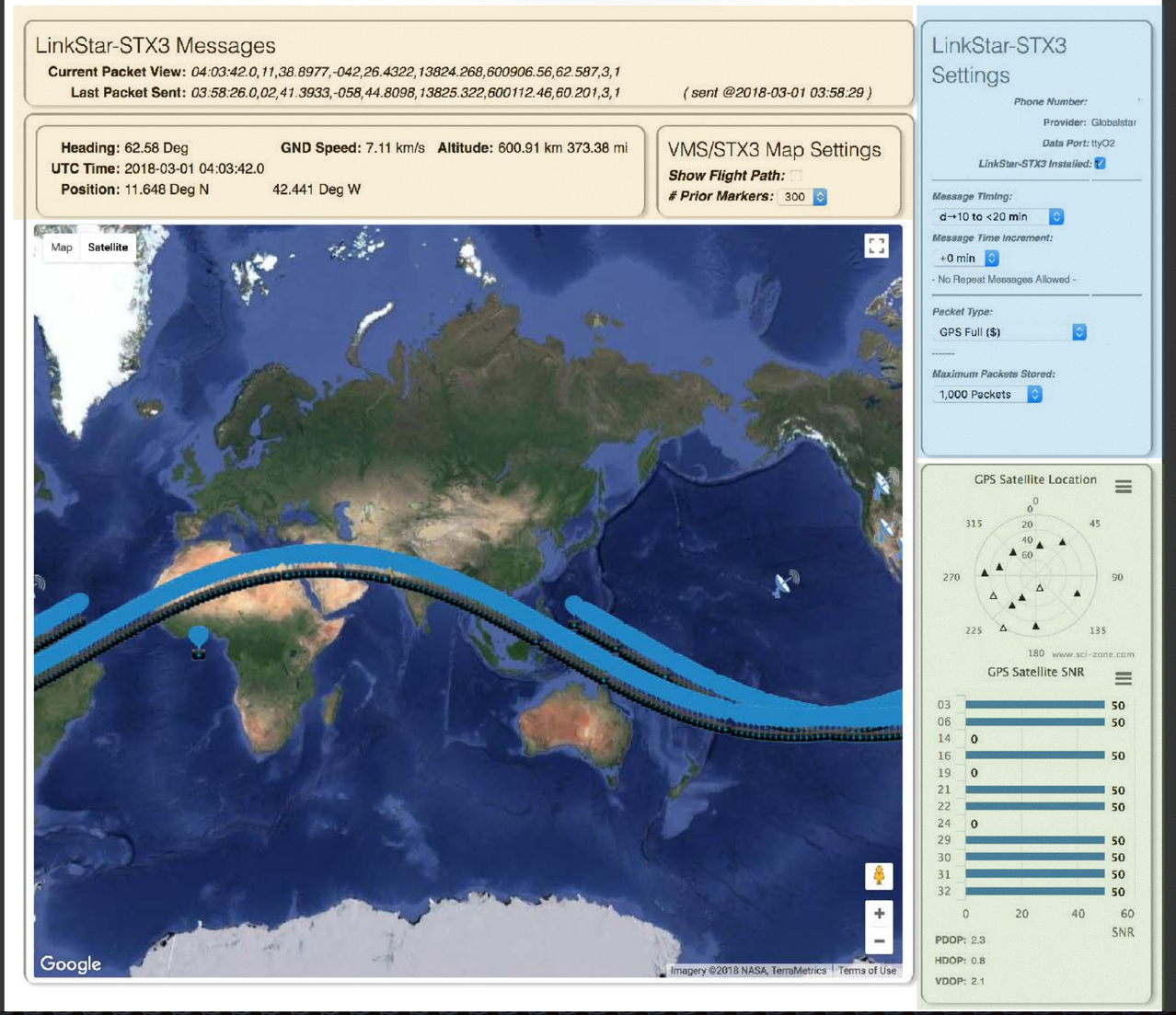
QuickSAT/VMS

- **Broad Use:** *Utilities, Shipping, Aviation, Satellites, Cars*
- Asset and Vehicle Health Management & Monitoring
- System Commanding Services
- Communications services
- Optional *Grandview Artificial Intelligence/ Machine Learning* and *QuickSAT/Autonomy* modules
- Test/Monitoring interface
- Can serve as a stand alone ground station or part of an expanded environment
- Customizable
- Utilizes open source software where possible
- Works on a range of vehicles and platforms
- Web based Interface - PCs, Tablets, etc.



Radio Interface

Message and GPS information

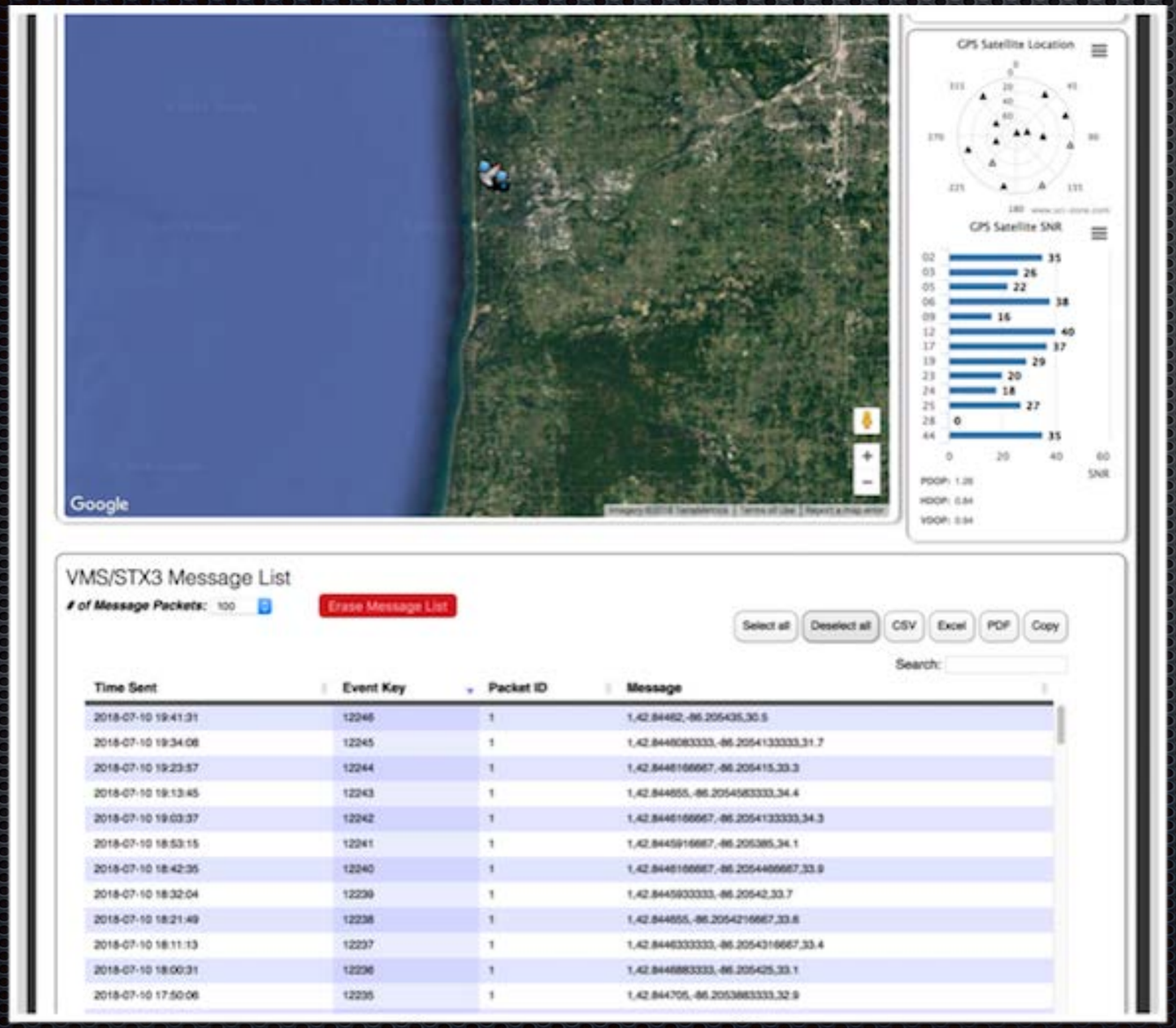


Radio messaging control and radio information

GPS signal quality information

OEM 719 Accepts SNR > 29 db

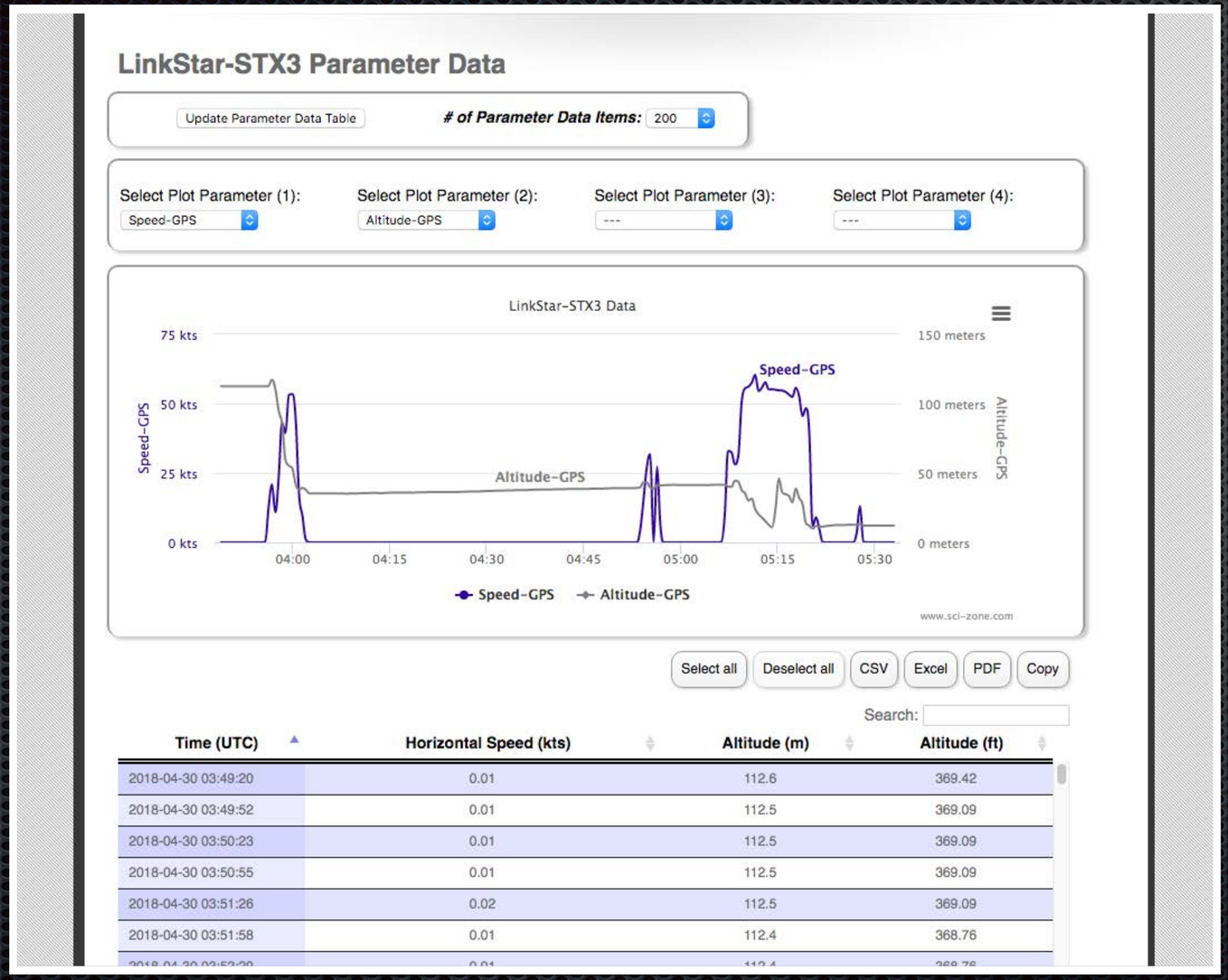
Screen Shots: *LinkStar-TRK/Spot-X*



You can also view how many GPS satellites you are tracking, where they are located and the strength of the signal.

You can view all the messages transmitted and save them to *CSV*, *Excel*, and *PDF* format files!

Plotting and Data Tracking with *LinkStar*



QuickSAT/VMS on the *LinkStar* radio system allows you to track your data, monitor it, and even generate plots!

Plots can be saved in JPG, PNG, PDF and SVG formats. Data can be saved in CSV, Excel and PDF formats.

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Next STEP - Join the Fun!

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