LinkStar-TRK, A Small Satellite Global Communications And Tracking System: System Design, Application And Test Flight Results From Low Earth Orbit

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sci_Zone

LinkStar-TRK

For Decentralized Identification, Global Tracking, And Communications

LinkStar-TRK **provides global tracking and messaging from small satellites in Low Earth Orbit through the Globalstar network to the user's desktop, mobile device, and tablet.**

Key Metrics:
- Find lost satellite
  - Get location to within1.0 m after 4-6 minutes of GPS activation
  - Receive message within 300 ms of transmission from ANYWHERE except poles in Low Earth Orbit

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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!
- Small vehicles…yet difficult to integrate.

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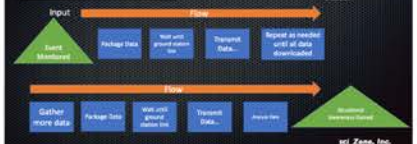
Value Stream Map: Limited Communications

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 raised.
- Delay in response to "situation"



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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

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The Solution…

LinkStar-TRK with optional *Grandview Artificial Intelligence/Machine Learning* and *QuickSAT/ Autonomy Modules*

- Autonomy APIs and Functions for Vehicle Health Monitoring, Perception and Planning
- Integrated computer (Raspberry Pi or Xilinx Zynq UltraScale+ MPSoC chip), communications interface, with optional GPS
- IC2, RS422, RS232, Space Wire, Serial, CAN, USB Interfaces, UART
- Support for CubeSat bus
- 0.5 U in size (10cm x 10cm x 5cm)
- QuickSAT/VMS environment for seamless control and software integration
- Optional Hypervisor for protection from malicious attacks.

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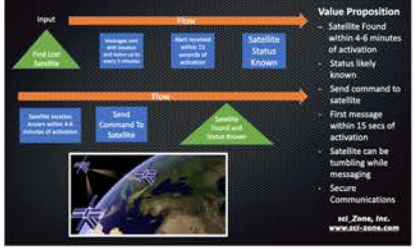
Value Stream Map: *LinkStar-TRK*



Value Proposition
- Satellite Found within 4-6 minutes of activation
- Status likely known
- Send command to satellite
- First message within 15 secs of activation
- Satellite can be tumbling while messaging
- Secure Communications

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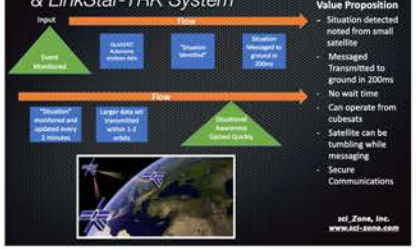
Value Stream Map: *QuickSAT/Autonomy & LinkStar-TRK System*



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

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Why Now?

- It can take 2 - 4 weeks to link up with a cubesat.
- Need to track and monitor large fleets of small satellites and cubesats.
- 50% of cubesats fail in the first 90 days! [1]
- Communications fail in 29% of cubesats in the first 90 days. [1]
- Computers failing in 21% of cubesats in first 90 days. [1]
- Need for Tactical Intelligence, Surveillance, and Reconnaissance Functions in cubesats
  - Low cost
  - Small
  - can be quickly deployed
- Need for on board, secure autonomous solutions
- Due to cubesat size limits on power, antenna size limiting data transmission rates
- Limited number of ground stations
  - Global communications vs only over select ground station
  - Example USSOCOM Mission: 4.36% Earth Coverage with five ground stations vs. >95% Earth overage with LinkStar-TRK

1- "Reliability of CubeSats – Statistical Data, Developers' Beliefs and the Way Forward", M. Langer, Institute of Astronautics, Technical University of Munich and J. Bouwmeester, Delft University of Technology, Small Satellite Conference 2016.

LinkStar-TRK Features

- Almost anytime, anywhere Asset Telemetry, Tracking and Control plus Health Monitoring
- Common FCC Satellite-to-Satellite License
- No satellite to ground license required - System FCC certified
- Ground station over Internet Protocol (IP)
- *Access your vehicle and asset from anywhere!*
- *Piggy-backs on established 2 billion dollar network*
- *Low Cost*

Globalstar

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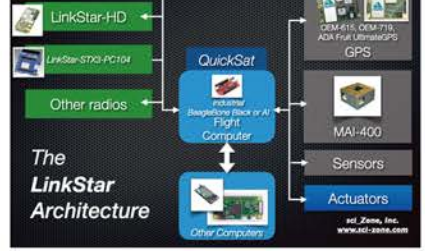

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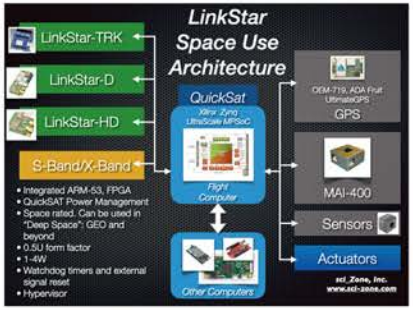

- Integrated ARM-53, FPGA
- QuickSAT Power Management
- Space rated. Can be used in "Deep Space": GEO and beyond
- 0.5U form factor
- 1-4W
- Watchdog timers and external signal reset
- Hypervisor

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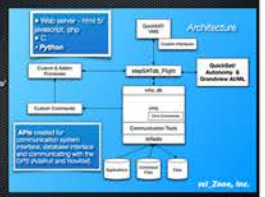
QuickSAT/VMS

- **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.



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Radio Interface

Message and GPS information

Radio messaging control and radio information

GPS signal quality information

OEM 719 Accepts SNR > 29 db

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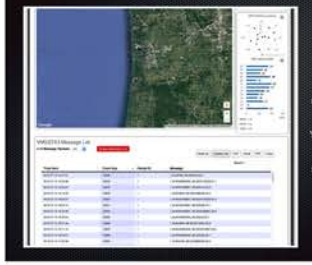
Screen Shots: *LinkStar-TRK*



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!

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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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Globally connected through ***Globalstar***

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Wide Range Of Other Uses…

- Aircraft messaging and tracking
- Support for Tactical Intelligence, Surveillance, and Reconnaissance functions
- Ground applications:
  - Utilities
  - Fire monitoring
  - Border security
  - Earth Quake sensors
  - Pipeline monitoring
  - Ship tracking and monitoring

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Up Next…***Spot-X***: Expanding Applications

- Hiking and Camping
- Boating
- Emergency Rescue
- Remote Communications
- Fire Fighting

Now sci_Zone is adapting Spot-X for Other Assets, Vehicles and Small Satellites!
- Two-way messaging with your satellite!
- >95% Orbital Coverage!
- Ties in with *QuickSAT, Grandview* and our *Autonomy Systems*

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Next STEP - Join the Fun!

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