

LinkStar

*An Integrated, Secure and Flexible Networked
Communications Architecture and Flight
Management System for Cubesats*

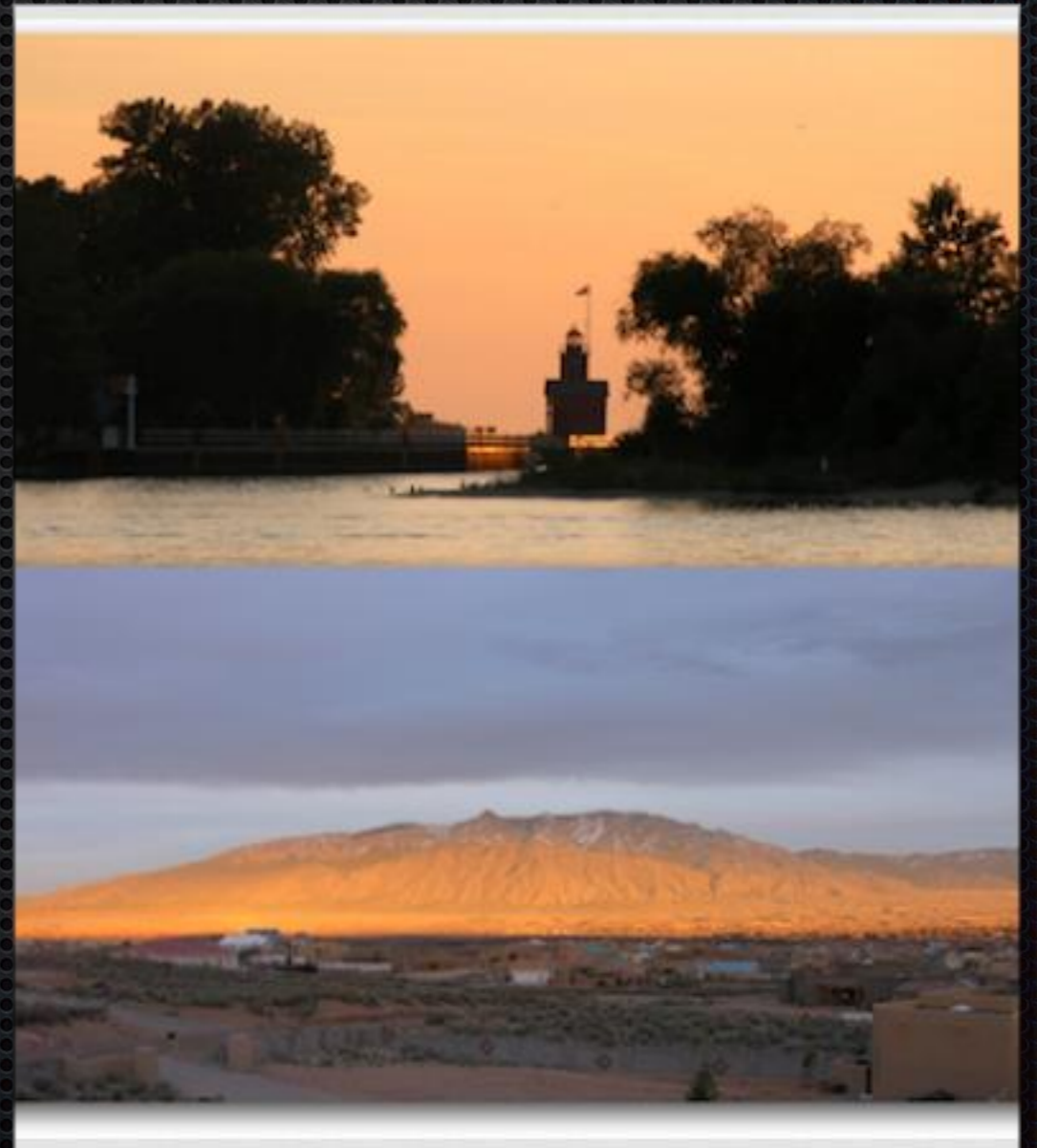
14th Annual Cubesat Developers Workshop
Andrew Santangelo
sci_Zone, Inc.

LinkStar

- Company Information
- The LinkStar Architecture
- QuickSAT/VMS
- Ground Communications
- Future missions...

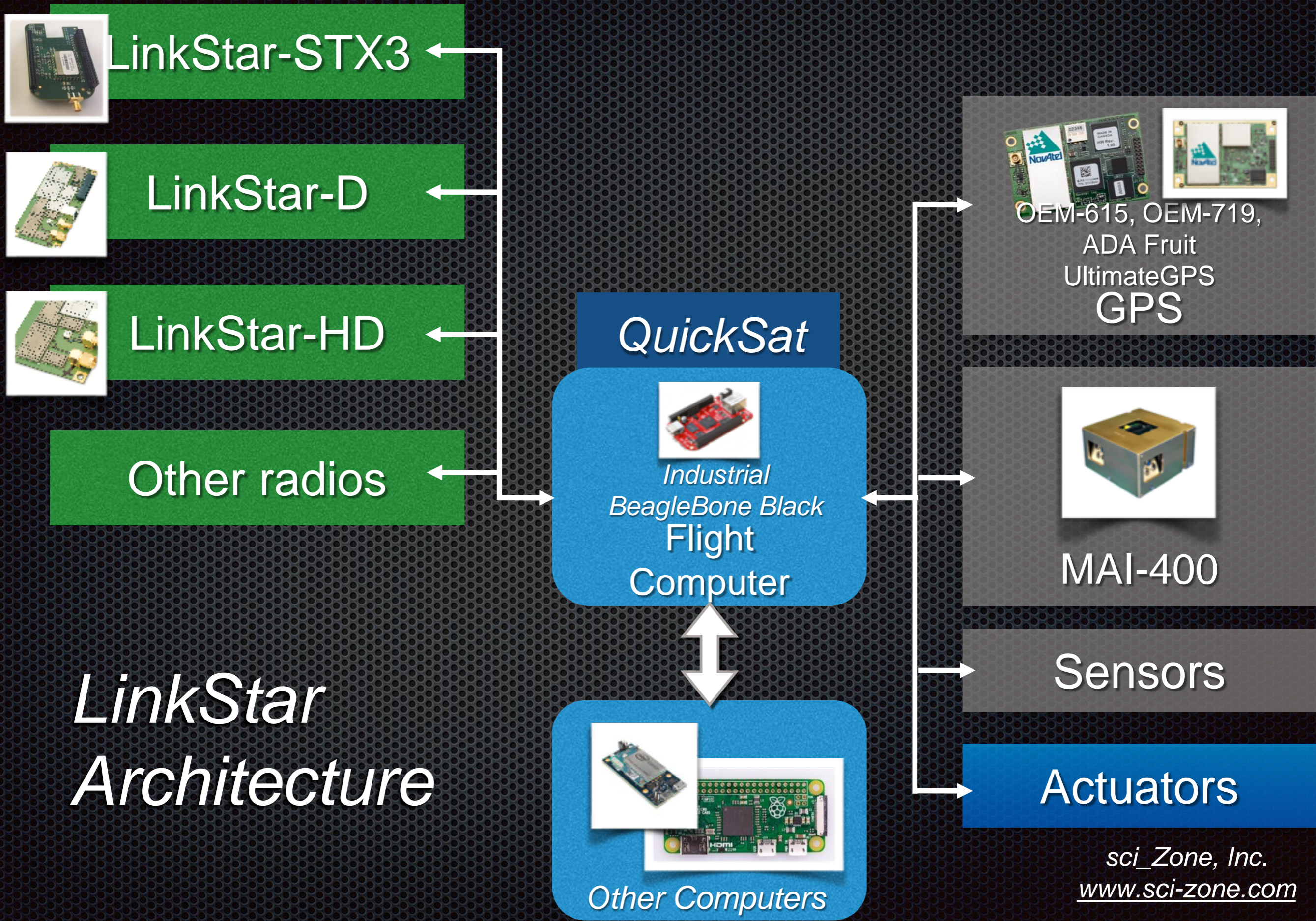
sci_Zone, Inc.

- Located in Holland, Michigan and Rio Rancho, New Mexico
- Core competencies: software development, satellite design, systems engineer, DO178B, and Flight Systems.
- Customers include GE Aviation, AFRL, DARPA, NASA, Boeing, USNA, Auburn University, and many more



LinkStar Architecture

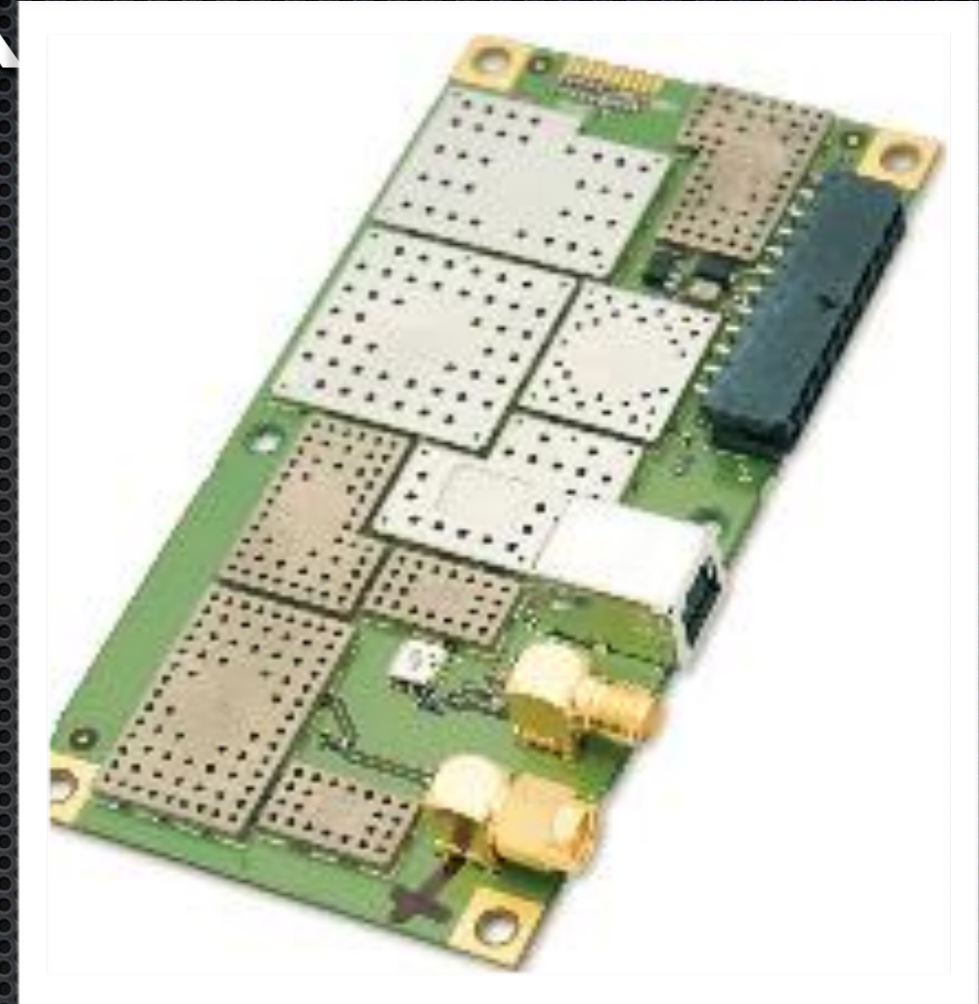
LinkStar: A Paradigm Shift



LinkStar Architecture

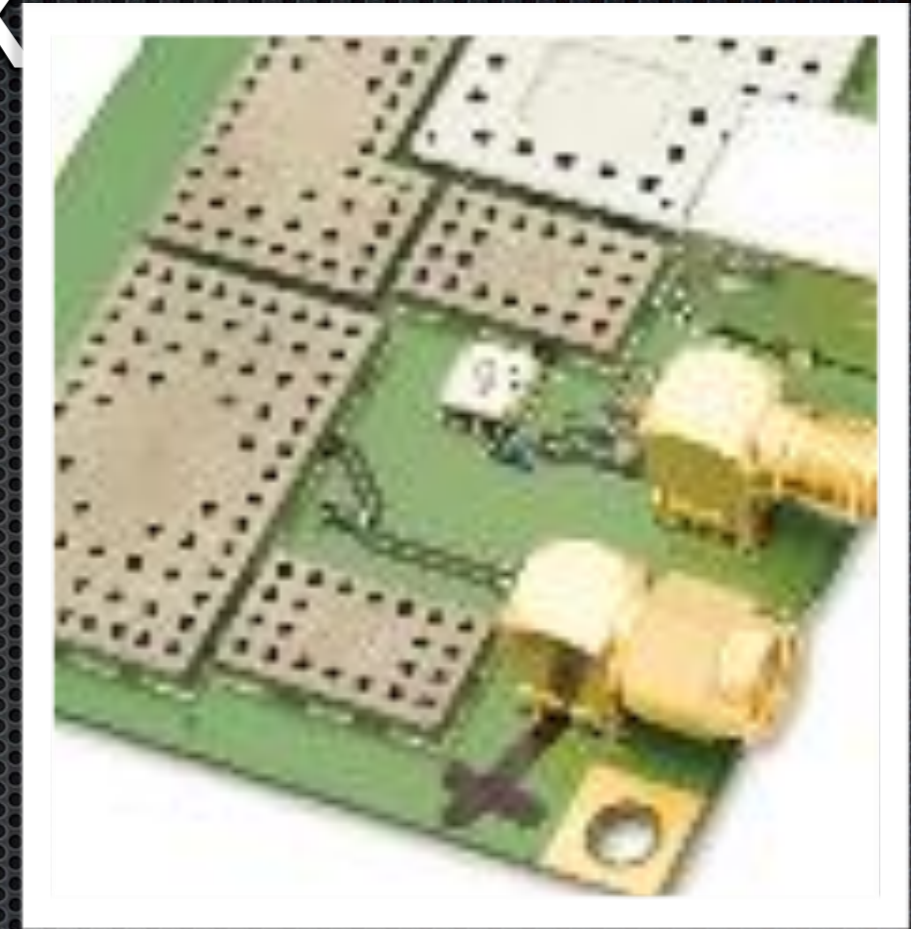
LinkStar-D Duplex Product Features

- No deployables
 - 5.72 cm diameter circular patch for duplex
- Rapid acquisition
- Data rates
 - 9600 bps maximum
 - SMS Uplink Messaging
 - *LinkStar* can compliment traditional high speed radios
 - *LinkStar* can serve as a primary radio depending project and product data requirements.



LinkStar-HD Duplex Product Features

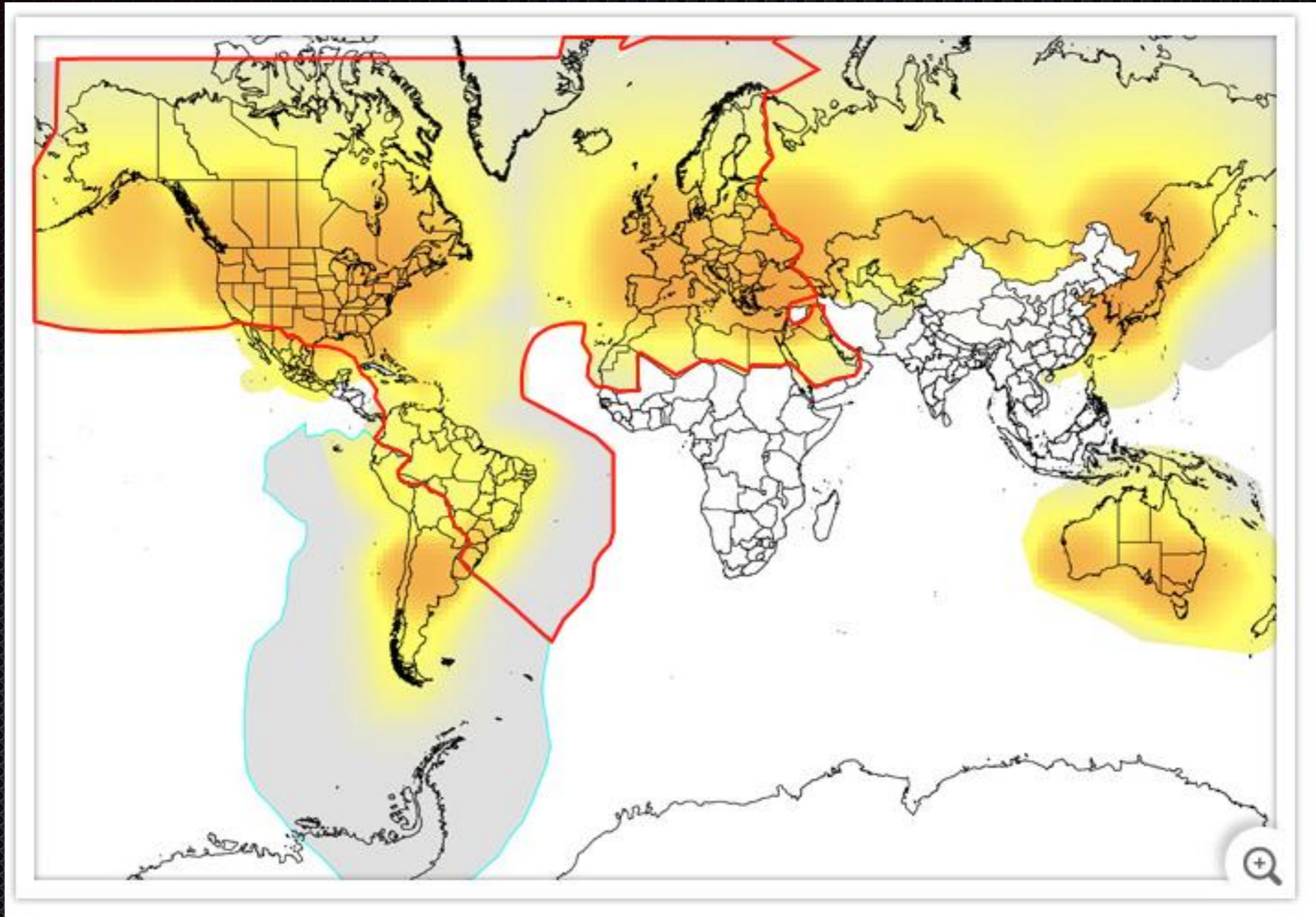
- No deployables
 - 5.72 cm diameter circular patch for duplex
- Data rates
 - 256 kbps maximum
 - SMS Uplink Messaging
 - Smaller form factor
 - sci_Zone custom board will support 1U form factor, USB connector, and UART for control



LinkStar-D, LinkStar-HD

Product Features

- Almost anytime, anywhere vehicle Telemetry, Tracking and Control
- Large, global coverage area
- Common FCC Satellite-to-Satellite License
- No Amateur bands
- No satellite to ground license required
- Globalstar will work with sci_Zone on obtaining FAA and FCC licenses
- Ground station over Internet Protocol (IP)
- *Access your vehicle from anywhere!*
- *Piggy-backs on established 2 billion dollar network*
- *Low Cost*



LinkStar Simplex Gen 3

Features

- Small form factor
- Power
 - 350 mW Tx power
- Dimensions
 - 28.7mm x 20.57mm x 4.13mm
- Electrical
 - Accepts 3.3 V to 12 V
 - TTL Data Protocol
- Near Global Coverage!

LinkStar-STX3 (alone and with cape)

Operating Temperature Range: -40 to +60 °C
Digital Power Supply Operational Voltage: 2.0 to 5.0 Volts
RF Power Supply Voltage: 3.0 to 5.0 Volts

Parameter	Test Conditions	Min	Typ	Max	Unit
TX output power	-40-85° C, Vcc=Vrf=3.3 volts, 50 ohm load	17.0	17.5	18.0	dB
Transmit mode supply current	-40-85° C, Vcc=Vrf=3.3 volts, 50 ohm load	315	325	350	mA
Active mode supply current	25° C, Vcc = 3.3 volts		2.3	2.5	mA
Standby mode supply current	25° C, Vcc = 3.3 volts		12	50	µA
Sleep mode supply current	25° C, Vcc = 3.3 volts		8	40	µA



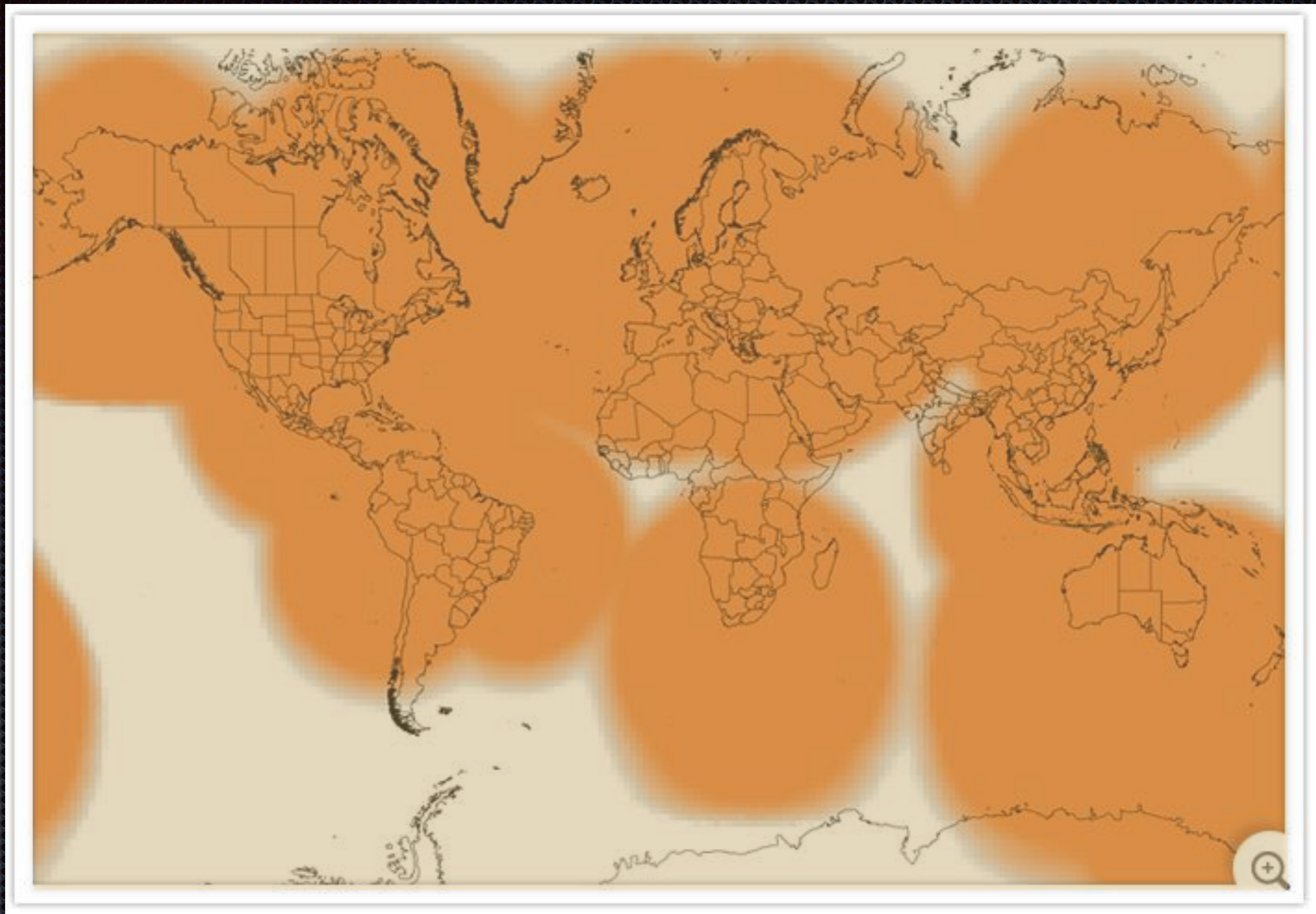
sci_Zone, Inc.

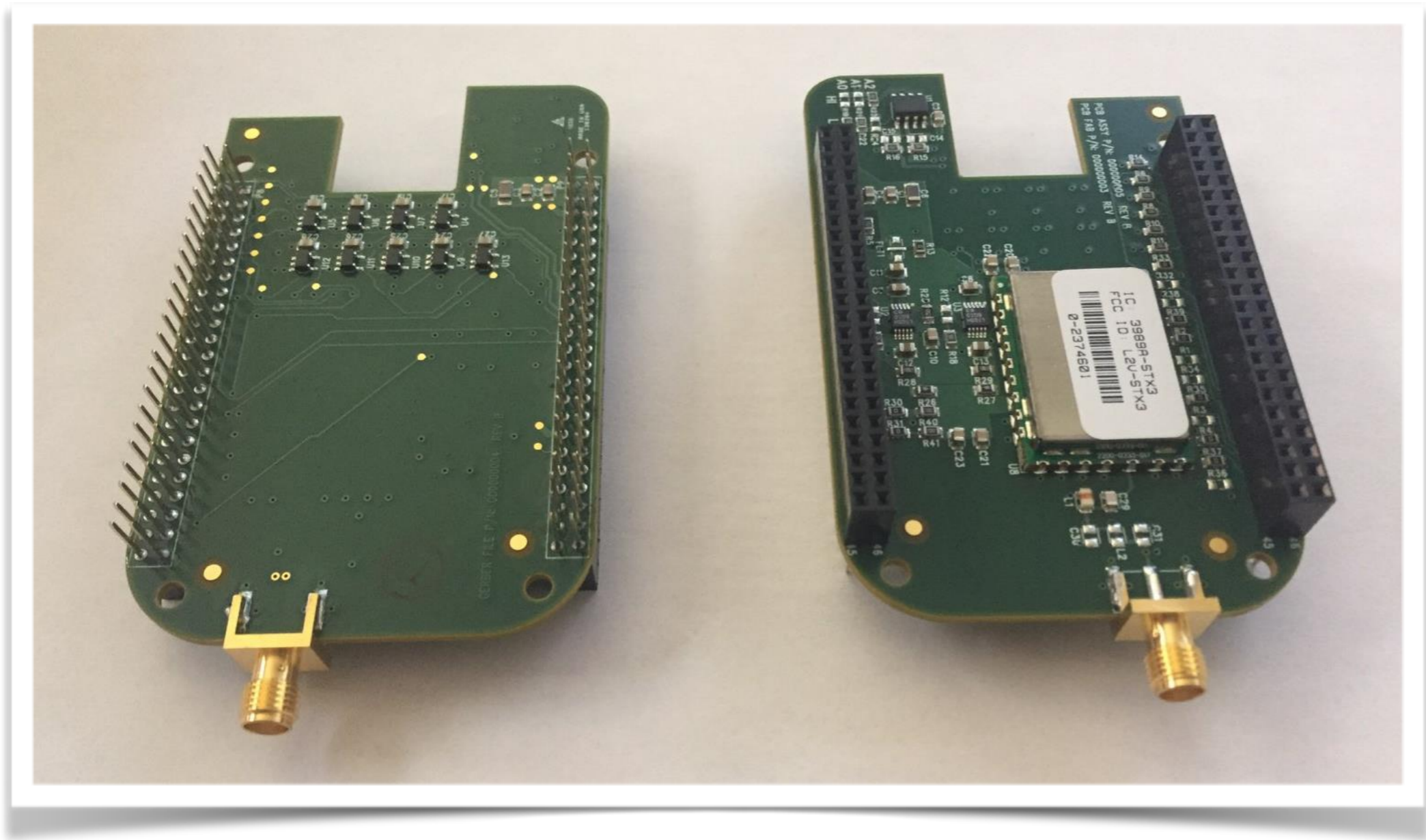
www.sci-zone.com

The *LinkStar-STX3*

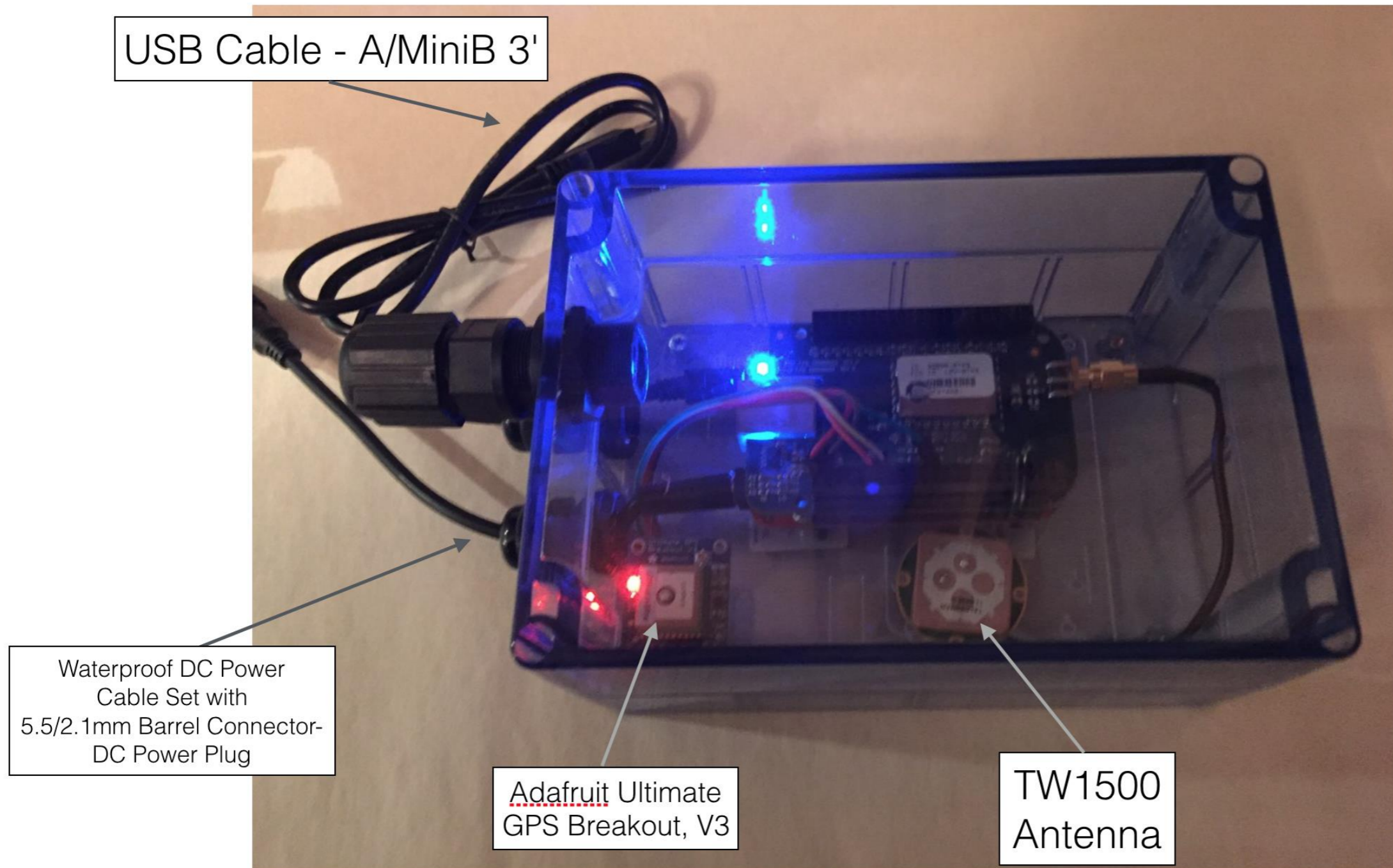
- Beacon payload data only
 - GPS
 - Battery life
 - Flight Data
- No control capability
- Full coverage U.S. for UAV, Near Space, Vessels, other vehicles
- Near global coverage in space



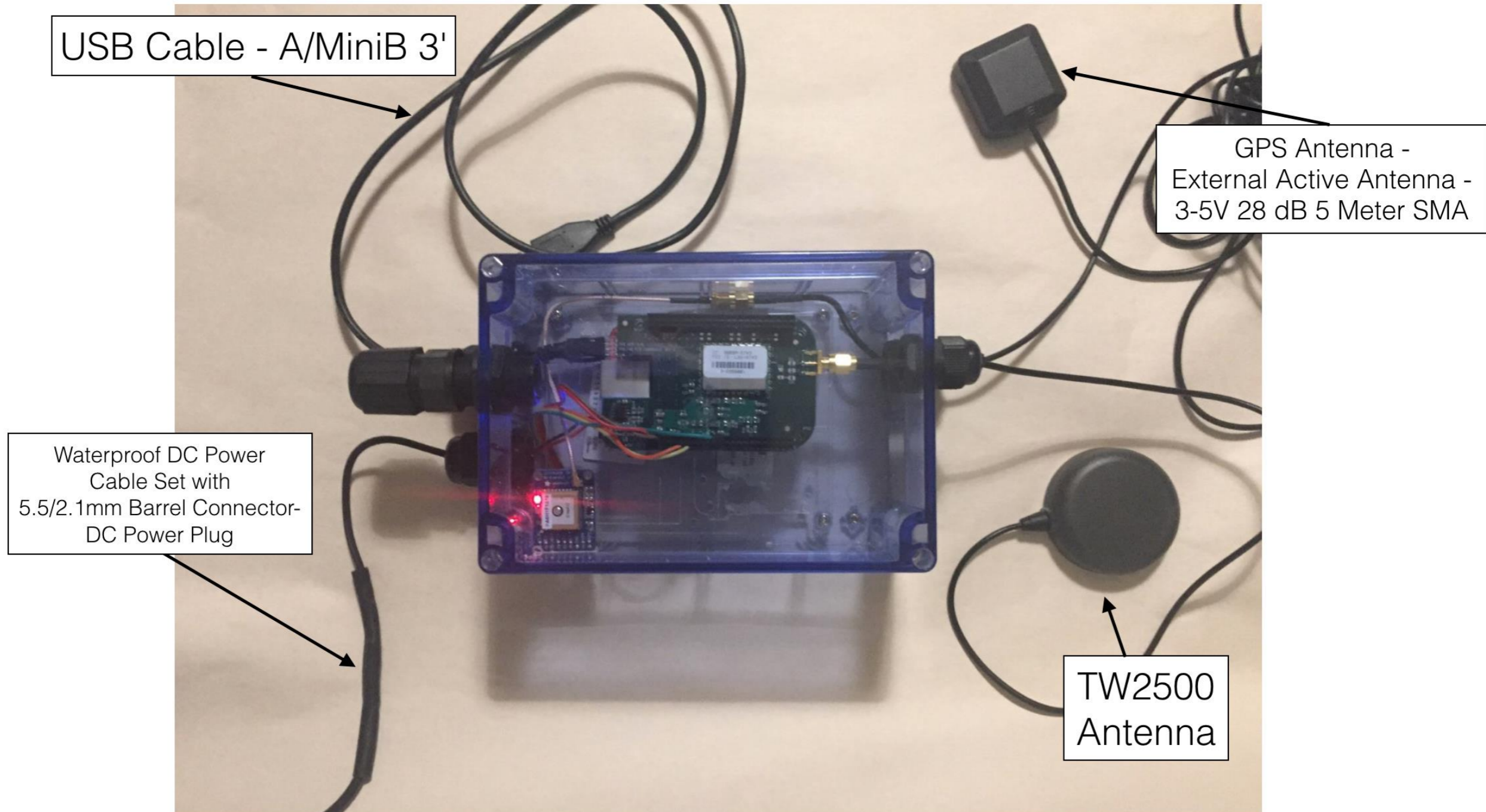




LinkStar-STX3, Mobile Unit, Internal Antenna Model Assembled and Operational

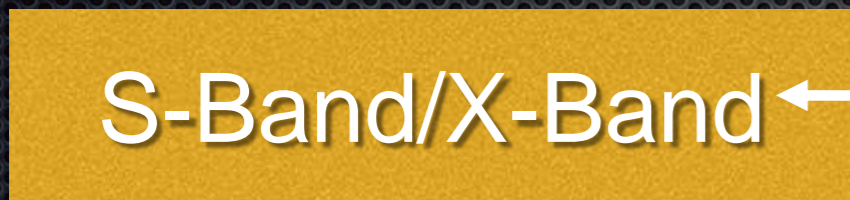


LinkStar-STX, Mobile Unit, External Antenna Model Assembled and Operational

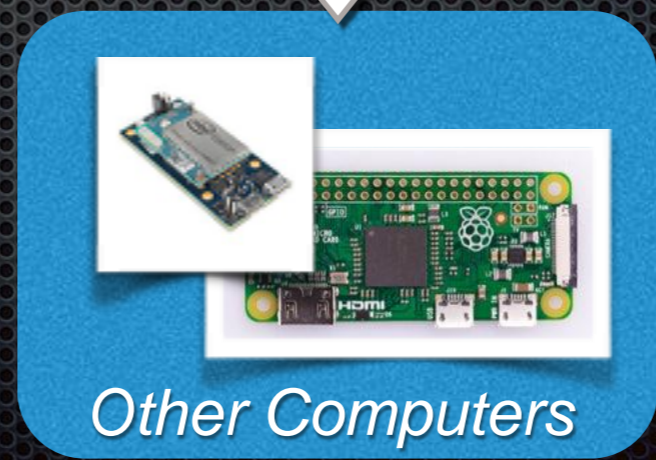


	<i>LinkStar-D</i>	<i>LinkStar-HD</i>	<i>LinkStar-STX3</i>
Communications Type	Duplex	Duplex	Simplex
Data Rate	9600 bps	256 kbps	36 Byte Packets
Input Power	~ 4 W	~ 4 W	350 mW
Pointing Required?	Yes, $\pm 40^\circ$	Yes, $\pm 40^\circ$	No
Internet Access in Orbit	Yes	Yes	No
Coverage	~ 40%	~ 40%	Near 95%
Messaging	Uplink only - 35 bytes	Uplink only - 35 bytes	Downlink only - 36 bytes
QuickSAT/VMS	Yes!	Yes!	Yes!

LinkStar-X Architecture



- Integrated ARM-53, FPGA
- QuickSAT Power Management
- Space rated. Can be used in "Deep Space": GEO and beyond
- 0.5U form factor
- 3-4W
- Watchdog timers and external signal reset
- Hypervisor



QuickSAT/VMS

Flight and Health Management

with a Communications Framework

QuickSAT/VMS

- Broad Use: *Aviation, Satellites, Cars*
- A complete Flight Management System
- Vehicle Health Management & Monitoring
- Vehicle Commanding Services
- Communications services
- Test/Monitoring interface
- Power Management
- Secure Hypervisor



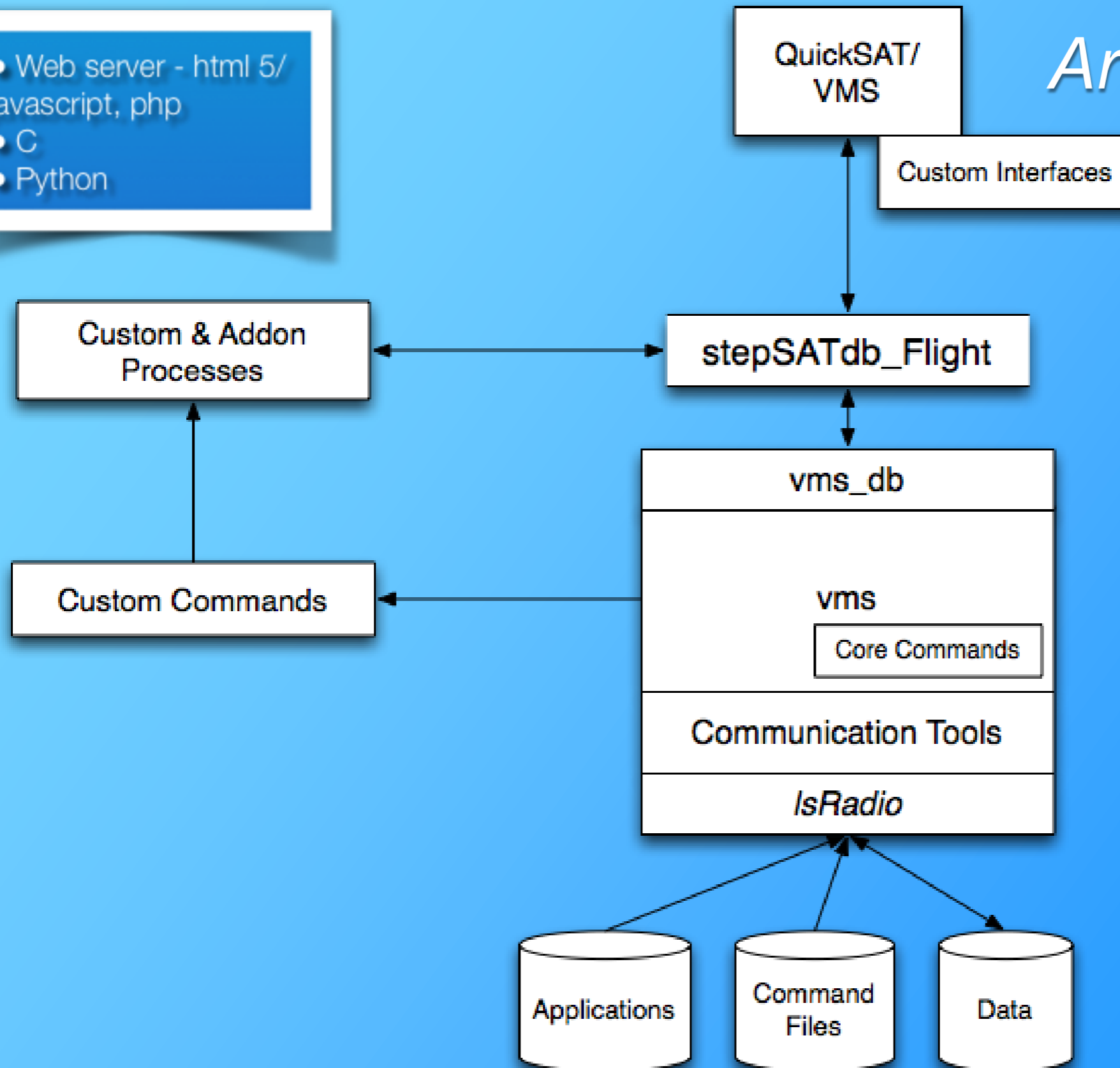
QuickSAT/VMS

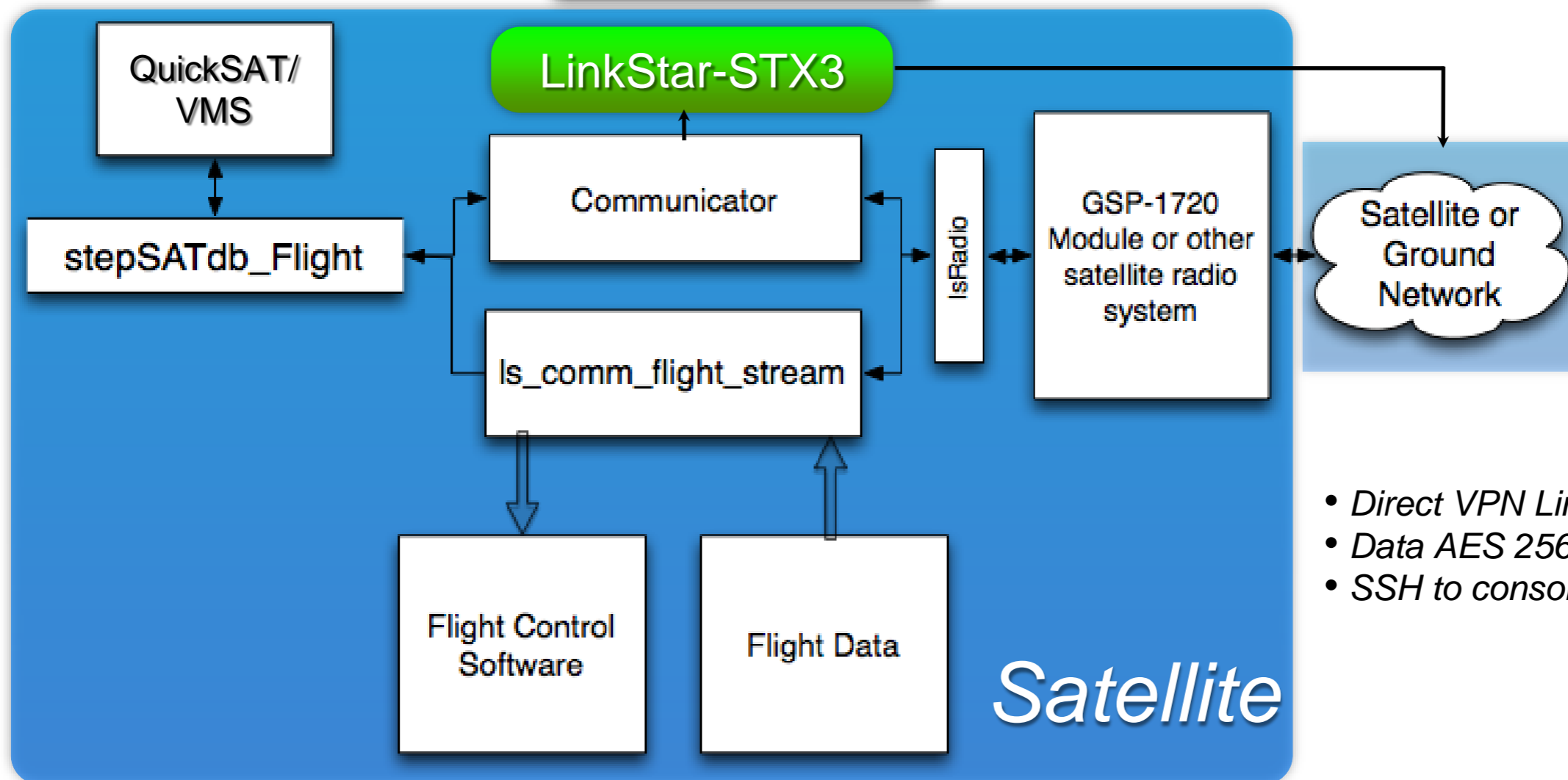
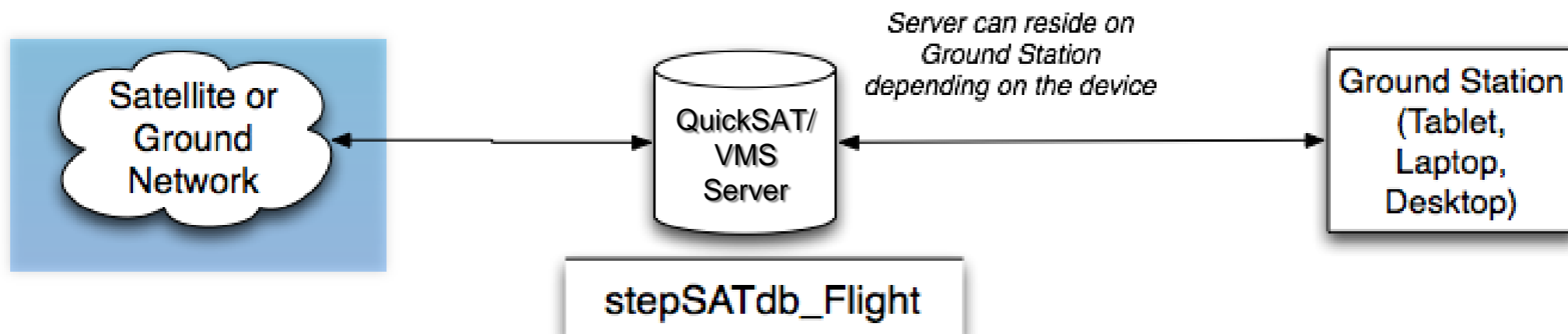


- Can serve as a stand alone ground station or part of an expanded environment
- Customizable
- Utilizes open source software where possible
- Works on a range of flight hardware
- Web based - PCs, Tablets, etc.
- Certified DO178B for Aviation

Architecture

- Web server - html 5/ javascript, php
- C
- Python





- Direct VPN Link
- Data AES 256 Encryption
- SSH to console



QS/VMS

Vehicle Management System

Identifier: RADSat Ground Station

Sessions

Update Location

Logout

Admin

Last DB Capture: 08/02/2016 @ 22:02:12
Current Recording Session: 86
Mission Phase: Ground Test
Mode of Operation: Ground Test
Current VMS Command: No Commands Pending

No Signal PRIMARY
Last Sync with FRNCS: 2016-08-02 22:02:08

Configuration »

Mission Operations - Operations »

Telemetry »

FRNCS Maintenance

Schedule

Comm

Operations

Ethernet Comm Status: Link Active

Serial Line Status: Link Not Installed

Gateway: FRNCS-P

FRNCS Software Status

Search:

ID	Name	Status	Stat
0	mcp	On Host - App Operational	100
VM1: Domain 1			
1	prime	On Host - VM Operational - App Stopped	100
VM2: Domain 2			
2	prime	On Host - VM Operational - App Stopped	100

Showing 1 to 17 of 17 entries

LinkStar Duplex Status

Phone Number: 2542191646
esn: 11601218333
Call Type:
Call Duration: 435
Call Number: #777
Provider: GSTAR USA
Service Available: YES
Service Mode: GLOBALSTAR
Call State: IDLE
Registration: YES
RSSI: 0
Roaming: NO
Gateway: 1

LinkStar Duplex Location

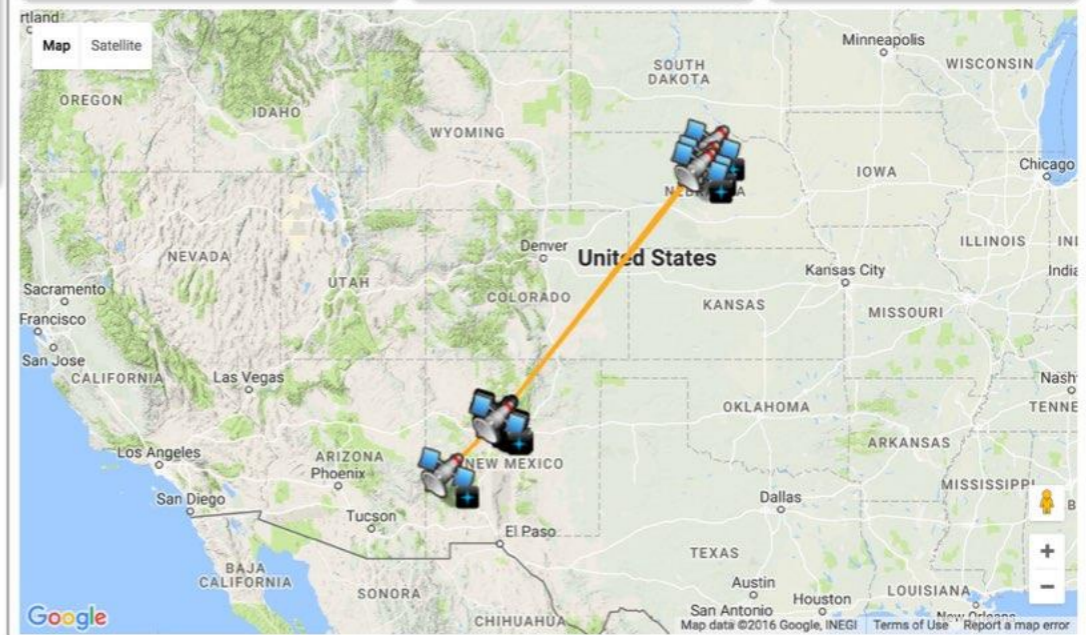
Last Read Position
Time of Day: 2016:216 03:01:06
Latitude (N): 035 Deg 16' 40"
Longitude (W): 106 Deg 37' 47"
Position Error: < 5 km

GPS Position

Latitude (N):
Longitude (W):
Altitude:
Heading:
H. Speed:
V. Speed:

VMS Map Settings

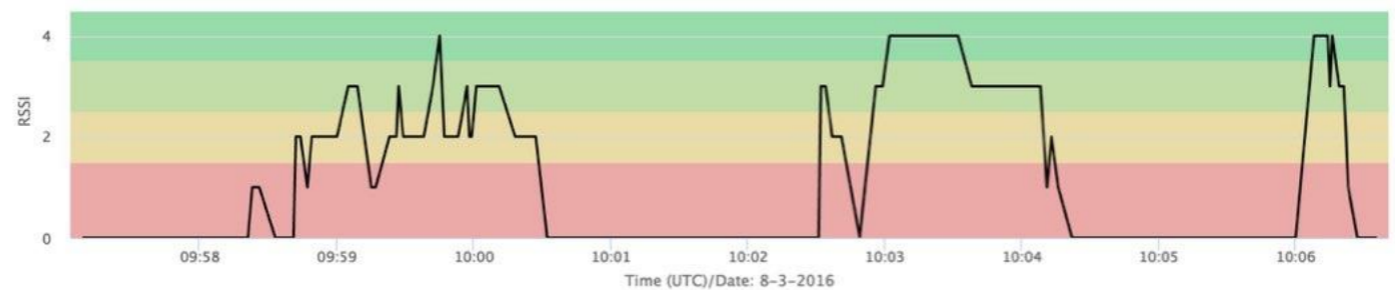
Error Circle:
Show Flight Path:
Prior Markers: 20
Source: LinkStar



LinkStar Duplex Historical Signal Strength

Plot Points: 200

Historical RSSI Signal Strength



QS/VMS

Vehicle
Management
System

Identifier: FRNCS-P/RADSAT

Sessions

Update Location

Admin

Logout

Last DB Capture: 06/30/2015 @ 02:59:54
Current Recording Session: 73
Mission Phase: Operating Mode
Mode of Operation: Mission Science/Operations
Current VMS Command: No Commands Pending

GSTAR USA



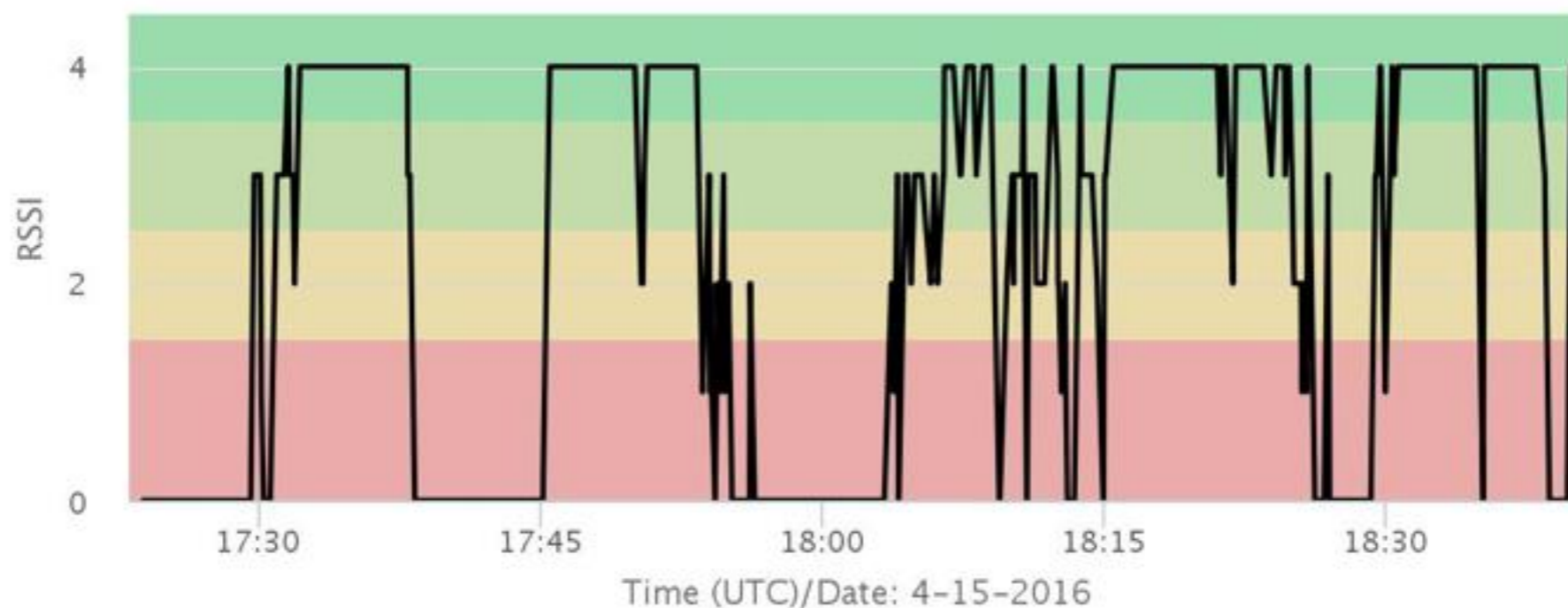
TEST



Last Sync with FRNCS:

06/30/2015 @ 02:59:54

Historical RSSI Signal Strength



Schedule

[CSV](#)
[Excel](#)
[PDF](#)
[Copy](#)

Search:

Event Date/Time (UTC)	Multiplier	Event Name	Status	User	Date/Time Completed (UTC)	Mode of Operation	Flight Leg	Mission Phase
2015-08-10 08:15:40	1	TEST	Pending	Admin	-	Mission Science/Operations	Primary	Operating Mode

Showing 1 to 1 of 1 entries

Command Log

[CSV](#)
[Excel](#)
[PDF](#)
[Copy](#)

Search:

Time of Command (UTC)	Command	Command State	Command Data
2014-04-23 02:16:55	REMOVE_VMAPP	Success	1
2015-02-17 21:43:57	REMOVE_VMAPP	Success	1
2015-02-17 21:55:58	REMOVE_VMAPP	Success	2
2015-11-18 20:00:14	REMOVE_VMAPP	Success	2
2015-11-18 20:01:27	ADD_VMAPP	Success	1
2015-11-19 09:39:46	ADD_VMAPP	Success	3

Showing 1 to 31 of 31 entries

System Message Log

[CSV](#)
[Excel](#)
[PDF](#)
[Copy](#)

Search:

System Message Time (UTC)	System Message
2014-04-23 20:23:20	Success - VM/App "prime_test_app00001" installed
2014-04-23 20:23:20	Command Success
2014-04-23 20:25:24	Success - VM/App "cosine_test_app00001" installed
2014-04-23 20:25:24	Command Success



QS/VMS

Vehicle Management System

Identifier: RADSat Ground Station

Sessions

Update Location

Logout

Last DB Capture: 08/04/2016 @ 13:09:48
Current Recording Session: 86
Mission Phase: Ground Test
Mode of Operation: Ground Test
Current VMS Command: No Commands Pending

GSTAR USA PRIMARY
Last Sync with FRNCS: 2016-08-04 09:58:34

- Configuration »
- Mission Operations »
- Telemetry »
- FRNCS Maintenance
- Schedule
- Comm - LinkStar/Duplex

LinkStar

Connection

LinkStar Duplex Settings

Save LinkStar Parameters → Save Parameters

LinkStar Connected: Data Port: /dev/ttyO2 Control Port: /dev/ttyO4 Max State Records Stored: 1000
Roaming Enabled: Poll Rate (sec): 39 "Number of Records"/download: 100 Dwell Rate (sec): 0

LinkStar Duplex Status

Phone Number: 2542191646
esn: 11601218333
Call Type: TIA_PPP_M
Call Duration: 254
Call Number: #777
Provider: GSTAR USA
Service Available: YES
Service Mode: GLOBALSTAR
Call State: CALLINPROG
Registration: YES
RSSI: 4
Roaming: NO
Gateway: 11

LinkStar Duplex Location

Current Position

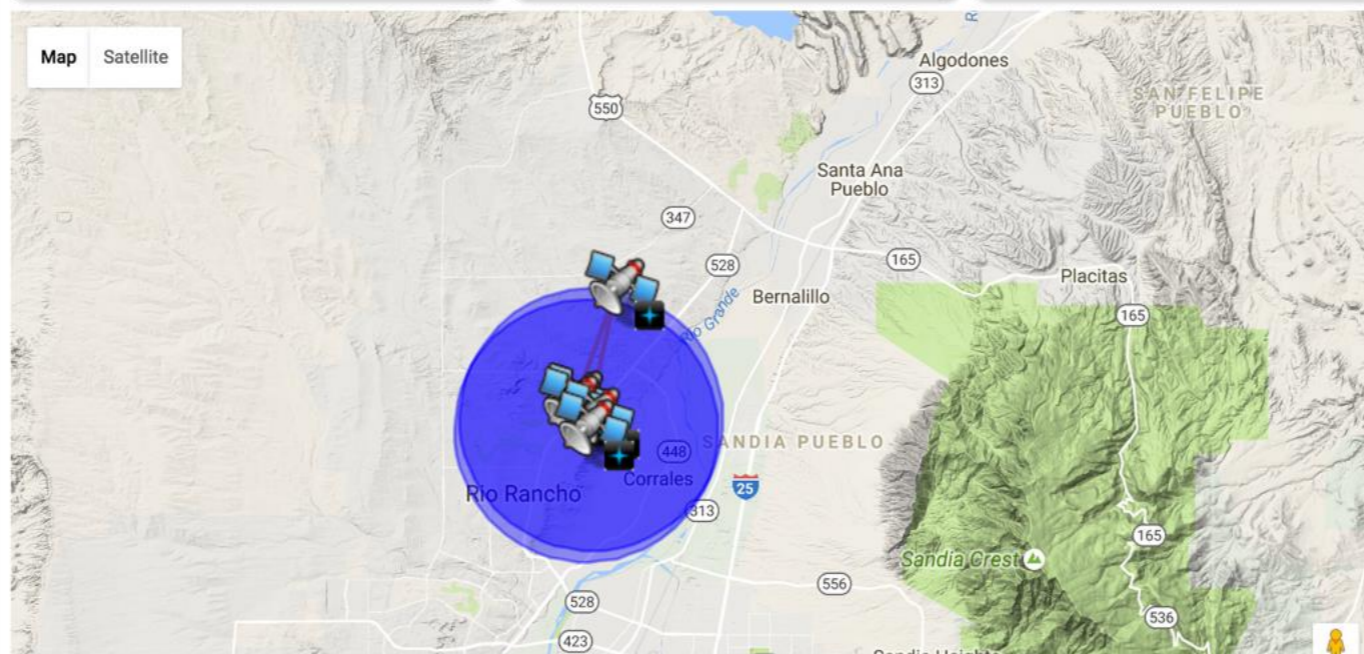
Time of Day: 2016:216 08:16:48
Latitude (N): 035 Deg 17' 17"
Longitude (W): 106 Deg 37' 48"
Position Error: < 5 km

GPS Position

Latitude (N):
Longitude (W):
Altitude:
Heading:
H. Speed:
V. Speed:

VMS Map Settings

Error Circle:
Show Flight Path:
Prior Markers: 5
Source: LinkStar



“Test Like You Fly!”

QS/VMS Vehicle Management System

Identifier: EarthScan Ground Station | Sessions | Update Location | HOL Ground | Logout

Last DB Capture: 12/06/2016 @ 14:09:43
 Current Recording Session: 1
 Mission Phase: Near Space Operations
 Mode of Operation: Mission Operations
 Current VMS Command: MCP.remove_vmapp; Command Data: 6

GSTAR USA | PRIMARY

Last Sync with FRNCS: 2016-09-06 21:48:36

Configuration - SW » Systems » Telemetry » FRNCS Maintenance Schedule Comm »

FRNCS-P

FRNCS Virtual Machines and Software

CSV Excel PDF

Search:

ID	Name	Status	State Code	State
VM0: Domain 0				
0	mcp	On Host - App Operational	100	Operational
VM1: Domain 1				
1	prime	On Host - VM Operational - App Stopped	100	Operational
VM2: Domain 2				
2	prime	GATEWAY Storage	80	FRNCS Stor
VM3: Domain 3				

Showing 1 to 10 of 10 entries

Parameters

for the application "prime"

ID	Param
1	Prime

Space Vehicle Profile

Space Vehicle Profile

EarthScan Mission

Configuration: Baseline Configuration
 Model Number: EarthScan NearSpace POD
 Date/Time: 2015-04-22 15:10:03
 Comments: EarthScan Payload Test Flight

Subsystem	Subsystem Mass (kg)
ADCS	0.00
Avionics	0.09
Experiments	0.00
Harnessing	0.00
Power	0.00

Showing 1 to 9 of 9 entries

Subsystem Mass Summary Chart

- ADCS
- Avionics
- Experiments
- Harnessing
- Power
- Propulsion
- Structure
- Telecom
- Thermal

Satellite Mass, Dry (kg): 0.14
 Mass Propellants (kg): 0.00
 Satellite Mass (Dry + Propellants, kg): 0.14

Select all Deselect all CSV Excel PDF Copy

Part Name	Part Number	Multiplier	Vendor	Mass	Avg Power (Watts)	Part Key
-----------	-------------	------------	--------	------	-------------------	----------

QS/VMS Vehicle Management System

Identifier: EarthScan Ground Station | Sessions | Update Location | HOL Ground | Logout

Last DB Capture: 12/06/2016 @ 14:07:07
 Current Recording Session: 1
 Mission Phase: Near Space Operations
 Mode of Operation: Mission Operations
 Current VMS Command: MCP.remove_vmapp; Command Data: 6

GSTAR USA | PRIMARY

Last Sync with FRNCS: 2016-09-06 21:48:36

Configuration » Systems - Management » Telemetry » FRNCS Maintenance Schedule Comm »



QS/VMS

LinkStar-STX3
Management
System

Identifier: 0-2357850

Sessions

Update Location

Logout

Admin

LinkStar-STX3 Status: Comm Enabled
 Current Recording Session: 1
 Time Last Packet Sent: 2017-01-08 05:28:40
 Last Packet Sent: 05:28:55,32,57.2543,097,03.9202,0.13,213.4,60.10,3,2
 Current VMS Command: No Commands Pending

GPS: DGPS Fix 3D Fix
 Current Time: 01/07/2017 @ 22:38:07

LinkStar/STX3 Software Systems » Telemetry »

LinkStar-STX3

Enable LinkStar-STX3

LinkStar-STX3 Messages

Current Packet View: 05:37:47,32,57.2639,097,03.9157,0.21,195.3,258.83,3,2

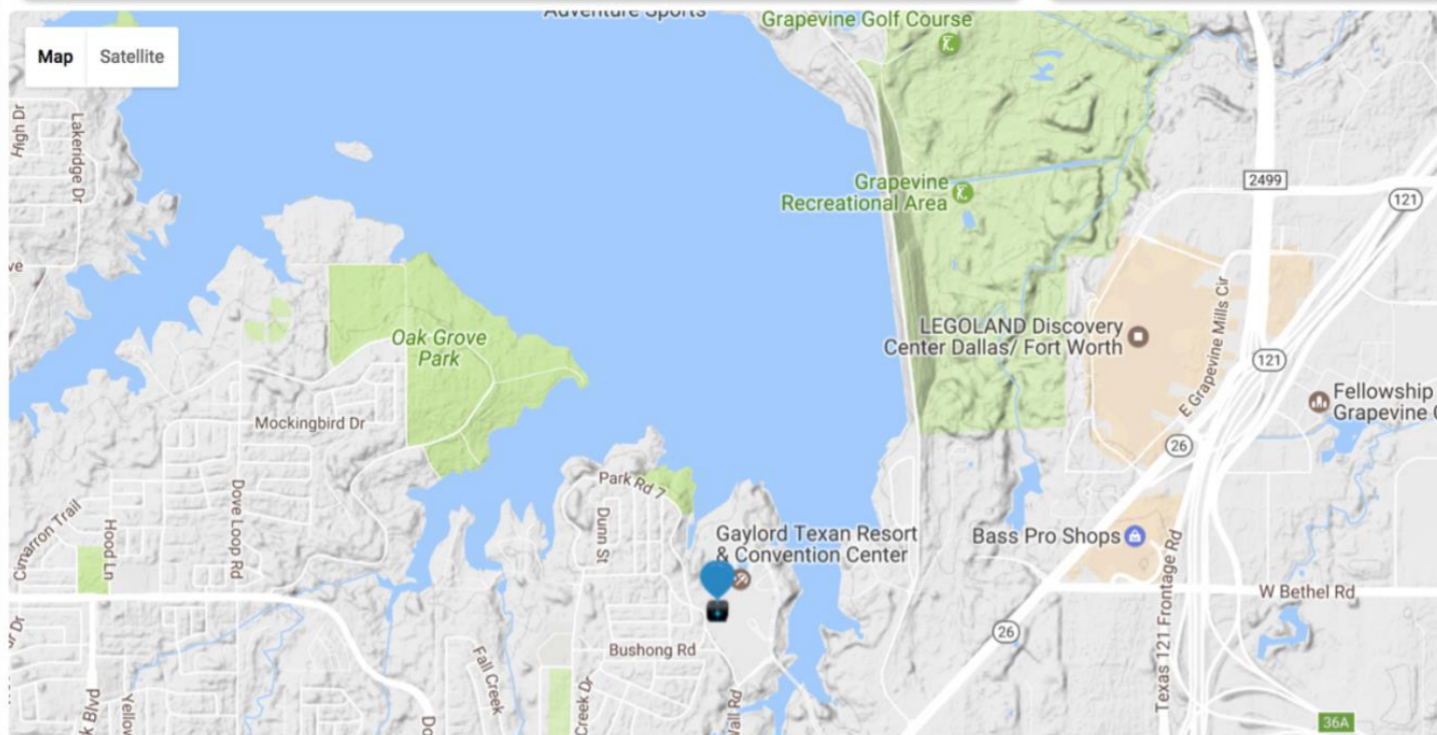
Last Packet Sent: 05:28:55,32,57.2543,097,03.9202,0.13,213.4,60.10,3,2

(sent @2017-01-08 05:28:40)

Heading: 258.8 Deg GND Speed: 0.21 kts Altitude: 195.3 m 641 ft
 Time (UTC): 2017-01-08 05:37:47
 Position: 32.954 Deg N 97.065 Deg W DGPS Fix 3D Fix

VMS/STX3 Map Settings

Show Flight Path:
 # Prior Markers: 5



LinkStar-STX3 Settings

Save LinkStar Parameters →

Save Parameters

Phone Number: 0-2357850

Provider: Globalstar

LinkStar-STX3 Installed:

Space Use:

#Message Timing:

10 to 19.9 min

Message Interval: 600

Alarm Enable:

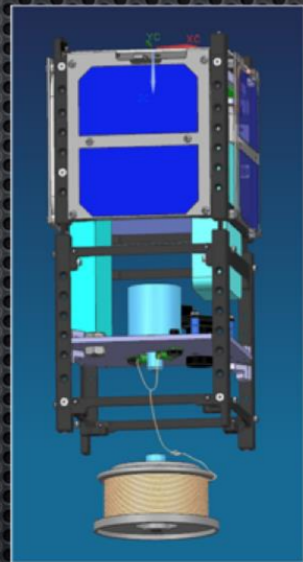
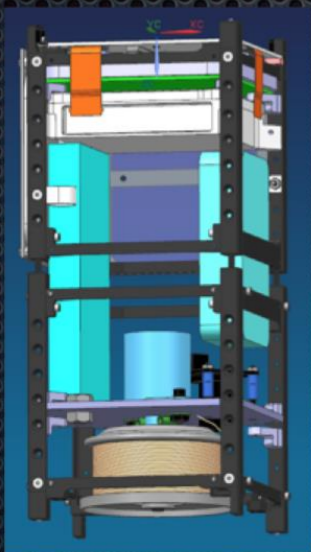
Alarm Interval: 300

Data Port: ttyO2

Maximum Packets Stored: 10000

Future Missions

- DARPA High Altitude Balloon Test Flights
 - Flight in May 2017
- North Dakota State University OpenOrbiter-1, June 2017
- Boeing *RADSat* Mission, Winter 2018
- New Mexico State University INCA Mission, 2018
- USNA NSat-2, 2019
- Carthage College
- University of South Alabama

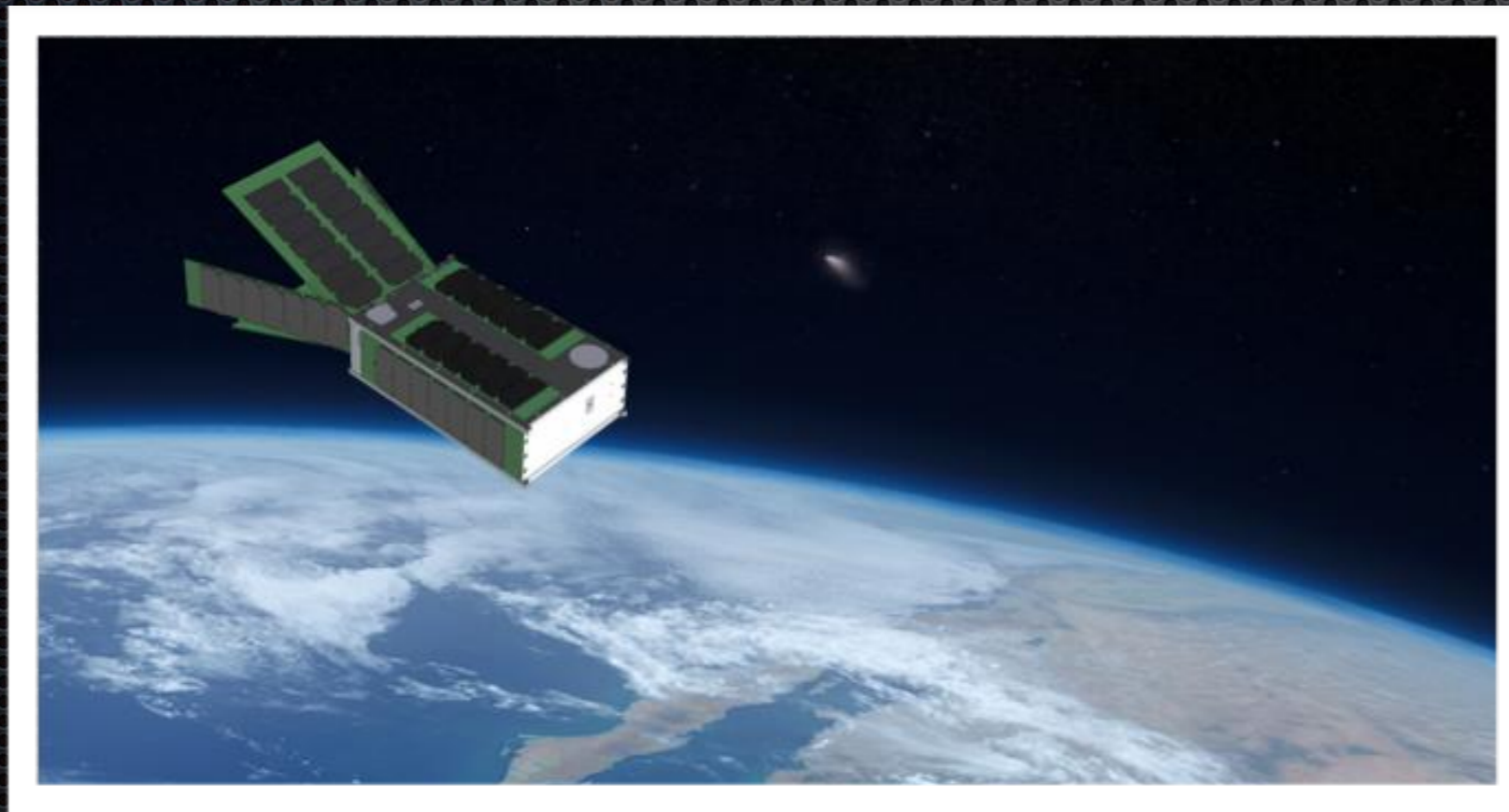
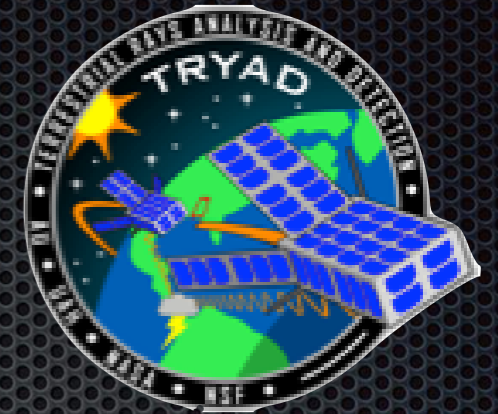


Auburn University

TRYAD Mission

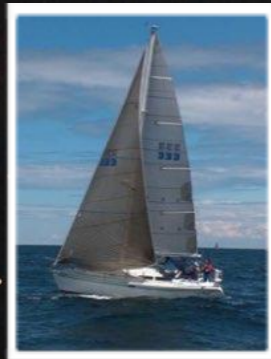
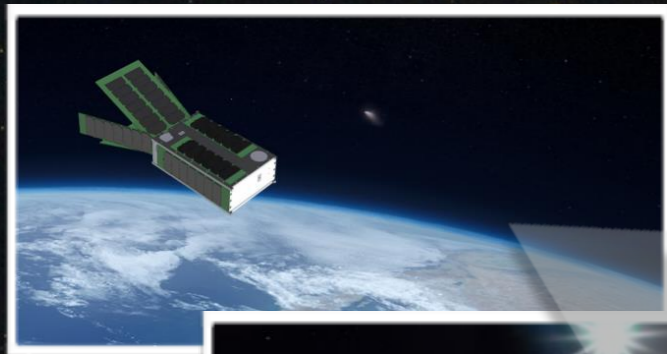
Terrestrial Ray Analysis and Detection

- Goal: To detect Terrestrial Gamma Ray Flashes in coincidence with ground lightning strike data and characterize the Gamma Ray beam geometries
- Two TRYAD 6U CubeSats at ~500km altitude, ~50° inclination.



Featuring the *LinkStar-HD* System!

sci_Zone, Inc.
www.sci-zone.com



Globalstar™
Satellite



Globalstar™
Ground
Station



sci_Zone™
Servers



*Customer
Mission
Control*

Next STEP - Join the Fun!

- ✦ email: andrew_santangelo@sci-zone.com
- ✦ web: www.quick-sat.com

The image displays several overlapping screenshots of the QuickSAT and QSVMS software interfaces. The top-left screenshot shows the 'ADCS' subsystem editor with a table of parts and their properties. The top-middle screenshot shows the 'Spacecraft Data' page with a 'Subsystem Mass Summary Chart' and a table of mass data. The top-right screenshot shows the 'Flight Plan' page with a map and various flight parameters. The bottom-left screenshot shows the 'Antenna' configuration page with a table of antenna parameters. The bottom-right screenshot shows the 'QSVMS' simulation results page with multiple line graphs and a parameter list.

Part Name	Part Number	Multiplic	Vendor	Mass	Avg Power (Watts)	TRL
Amp/MPL 1040 (S&S)	Amp/MPL-1040 (S&S)	1	ADCS/Spaceworks/FRL	0.20	0.20	8
Course Sun Sensor	25430	2	ADCS/Spaceworks/FRL	0.524	1.3	7
Course Sun Sensor	25430	1	ADCS/Spaceworks/FRL	0.524	1.3	7
MCU	IMU	1	Analog Devices/Memorex/SpaceWorks	0.36	1.5	8
RF/RF Receiver with Antenna	UTData	2	Design/SpaceAntenna/SpaceWorks	0.890	2.3	8
RF/RF Receiver with Antenna	UTData	1	Design/SpaceAntenna/SpaceWorks	0.890	2.3	8
RF Magnetometer	MAG 101	1	Southwest Research Institute	0.48	3.5	8

Subsystem	Average TRL
ADCS	10.00
Antenna	20.15
Experiments	3.64
Hardware	3.47
RF	8.85
Structure	42.90
Thermal	18.00
Power	3.91
Propulsion	49.70
Structure	9.29
Thermal	3.38

Parameter	Value
Carrier Frequency (MHz)	2.2
Transmitter Power (Watts)	10
Transmitter Line Loss (dB)	0
Transmit Antenna Diameter (m)	70
Transmit Antenna Beam Width (deg)	2
Antenna Efficiency	0
Peak Transmit Antenna Gain (dBi)	38.273
Transmit Antenna Pointing Offset (deg)	0
Transmit Antenna Pointing Loss (dB)	0
Peak Transmit Antenna Gain (dBi)	38.273
Equip. Isotropic Radiated Power (dB)	35.250
Propagation Path Length (km)	1001.8
Space Loss (dB)	170.194
Propagation & Polarization Loss (dB)	0
Receive Antenna Type	
Receive Antenna Diameter (m)	1.18
Peak Receive Antenna Gain (dBi)	2.716
Receive Antenna Beam Width (deg)	1.60