# The LinkStar-STX3 Architecture

## *A New Generation of Simplex Based Radios for Near Global Communications*

13th Annual Cubesat Developers Workshop
Andrew Santangelo
sci_Zone, Inc.

# LinkStar-STX3

- Company Information
- Background
- The LinkStar-STX3
- QuickSAT/VMS
- Ground Communications
- Future missions...

*sci_Zone, Inc.*
*www.sci-zone.com*

# 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 Glenn, Boeing, Pumpkin, DornerWorks and Leidos

***sci_Zone, Inc.***
***www.sci-zone.com***

# Background

*LinkStar: A Paradigm Shift*

# QuickSAT/Vehicle Management System (VMS)
*Multiple Options*

- S-Band radios
- Amateur Radios
- Iridium
- Ka Band
- “Newly invented” radios
- *LinkStar*...


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***www.sci-zone.com***

# The Foundation: *Globalstar*

- GlobalStar Constellation
  - 32 LEO Satellites (1400 km)
  - Provides global data and voice services for ~ 300,000 customers
- Used primarily for infrastructure/wildlife monitoring
  - Oil Rigs
  - Shipping Containers
  - Gas pipe-lines
  - Endangered animals
- *LinkStar* developed by *sci_Zone* for a range of applications
  - Data links via the GlobalStar network
    - Payload commanding
    - Data downlinks
    - Recovery tracking

Globalstar Be Heard.

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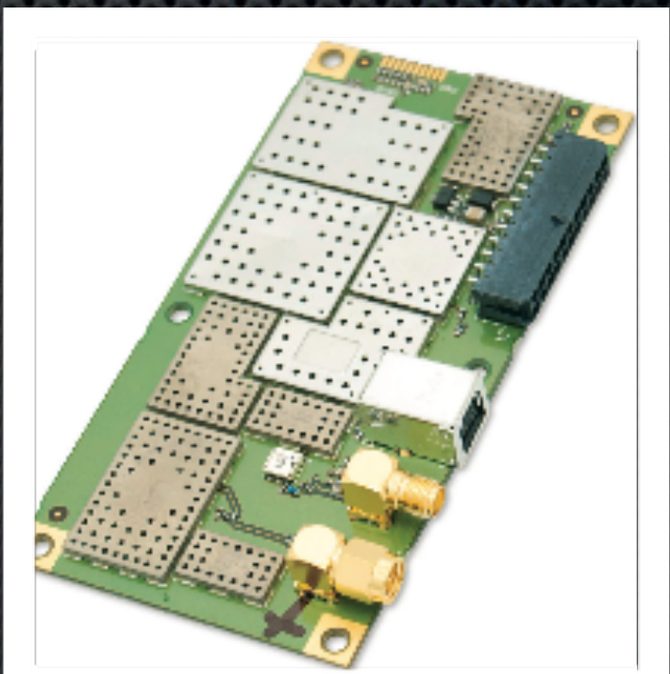
***www.sci-zone.com***

# *LinkStar* Duplex Product Features

- No deployables
  - 2.5 cm diameter circular patch for duplex
- Rapid acquisition
- High data rates limited
  - 9600 bps maximum
  - *LinkStar* intended to compliment traditional high speed radios
  - *LinkStar* can serve as a primary radio depending project and product data requirements.

# *LinkStar* Product Features

- Ground station over Internet Protocol (IP)
  - *Access your vehicle from anywhere!*
- Piggy-backs on established 2 billion dollar network
- Low Cost



| | |
|---|---|
| Operating Frequencies | Transmit: 1610 MHz – 1626.5 MHz<br>Receive: 2483.5 MHz – 2500 MHz |
| Maximum transmit power | +31dBm EIRP (passive antenna), +34 dBm (active antenna) |
| DC input voltage | +4.7V to 5.1V |

Power Consumption @5VDC input (estimated)

| State | Min | Typical | Max | Units |
|---|---|---|---|---|
| Shutdown | 0.0 | 0.65 | 1.0 | mW |
| Standby | 0.5 | 0.5 | 1.1 | W |
| Transmit | 2.2 | 3.65 | 5.0 | W |

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***www.sci-zone.com***

# *LinkStar* 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.

Globalstar Be Heard.

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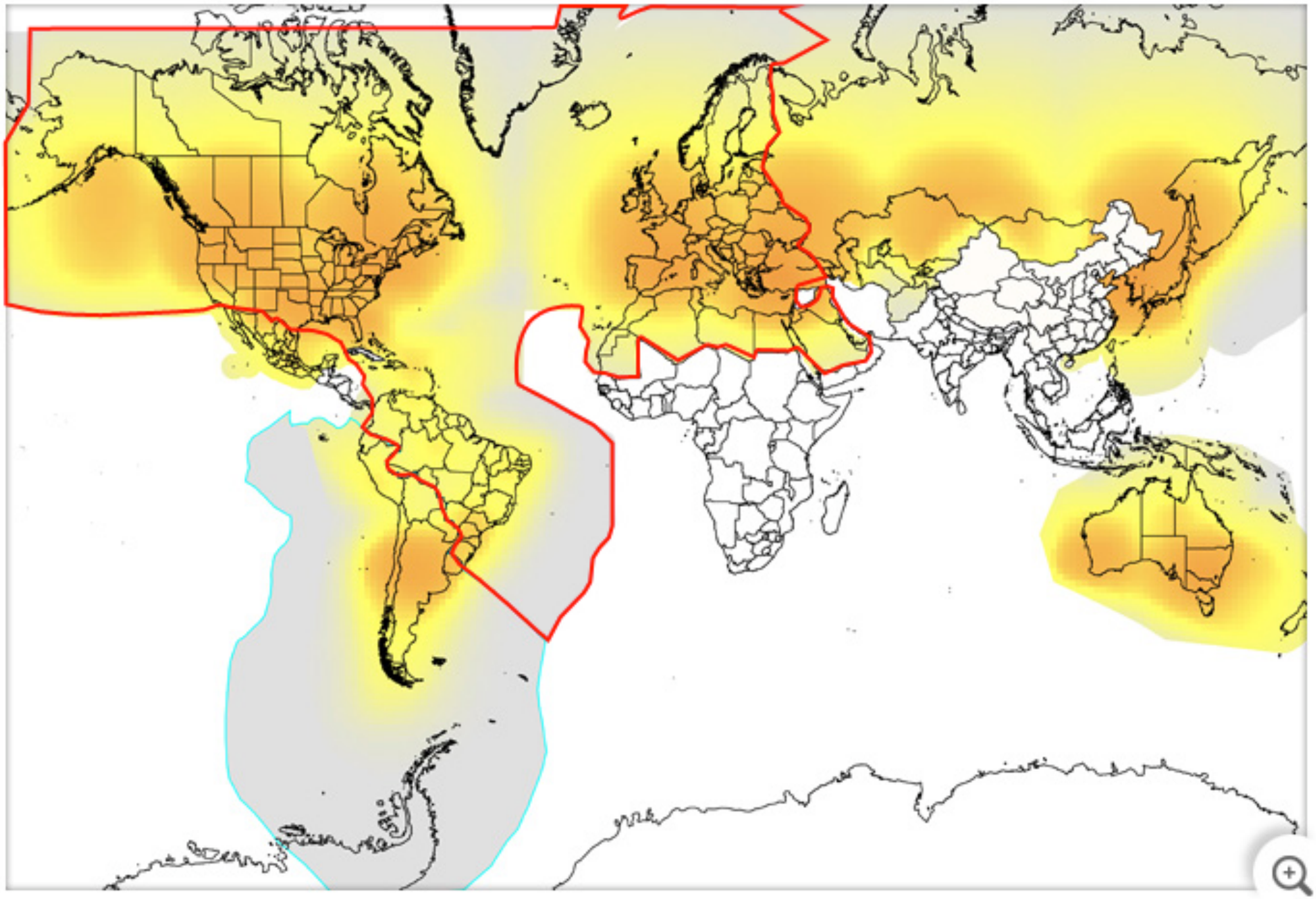

Globalstar Be Heard.

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www.sci-zone.com

# LinkStar-STX3

*A Simplex Radio*

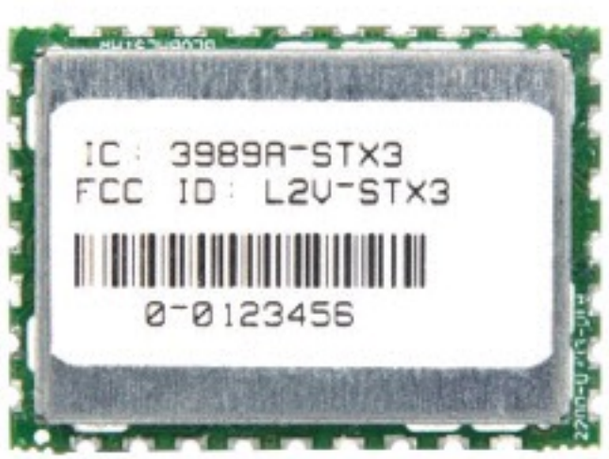
# *LinkStar* Simplex Gen 3 Features

- 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 | -40-85º C, Vcc=Vrf=3.3 volts, 50 ohm load | 17.0 | 17.5 | 18.0 | dB |
| Transmit mode supply current | -40-85º C, Vcc=Vrf=3.3 volts, 50 ohm load | 315 | 325 | 350 | mA |
| Active mode supply current | 25º C, Vcc = 3.3 volts | | 2.3 | 2.5 | mA |
| Standby mode supply current | 25º C, Vcc = 3.3 volts | | 12 | 50 | uA |
| Sleep mode supply current | 25º C, Vcc = 3.3 volts | | 8 | 40 | uA |





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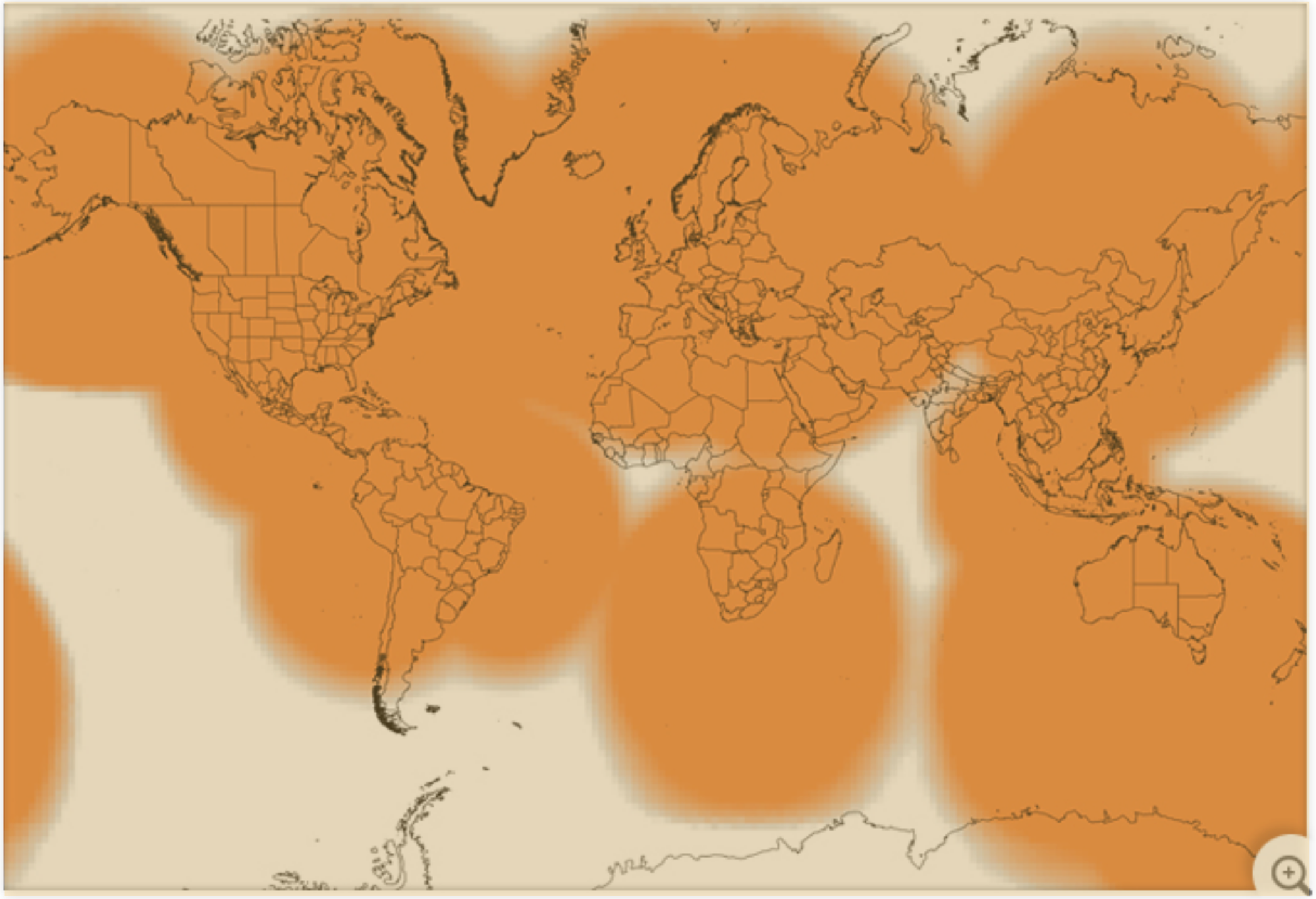
***www.sci-zone.com***

# 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

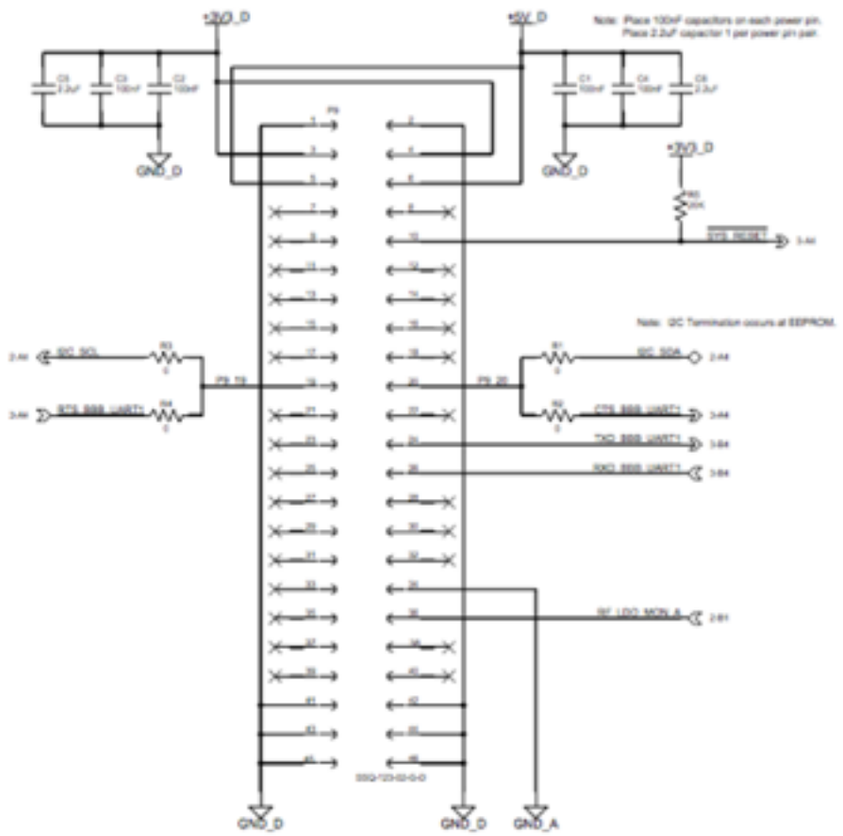


| | LinkStar | LinkStar-STX3 |
|---|---|---|
| Communications Type | Duplex | Simplex |
| Data Rate | 9600 BPS | 36 Byte Packets |
| Input Power | ~ 4 W | 350 mW |
| Pointing Required? | Yes, ±40º | No |
| Internet Access in Orbit | Yes | No |
| Coverage | ~ 40% | Near 95% |
| Messaging | Yes - up and down 144 Bytes | Downlink only |
| QuickSAT/VMS | Yes! | Yes! |

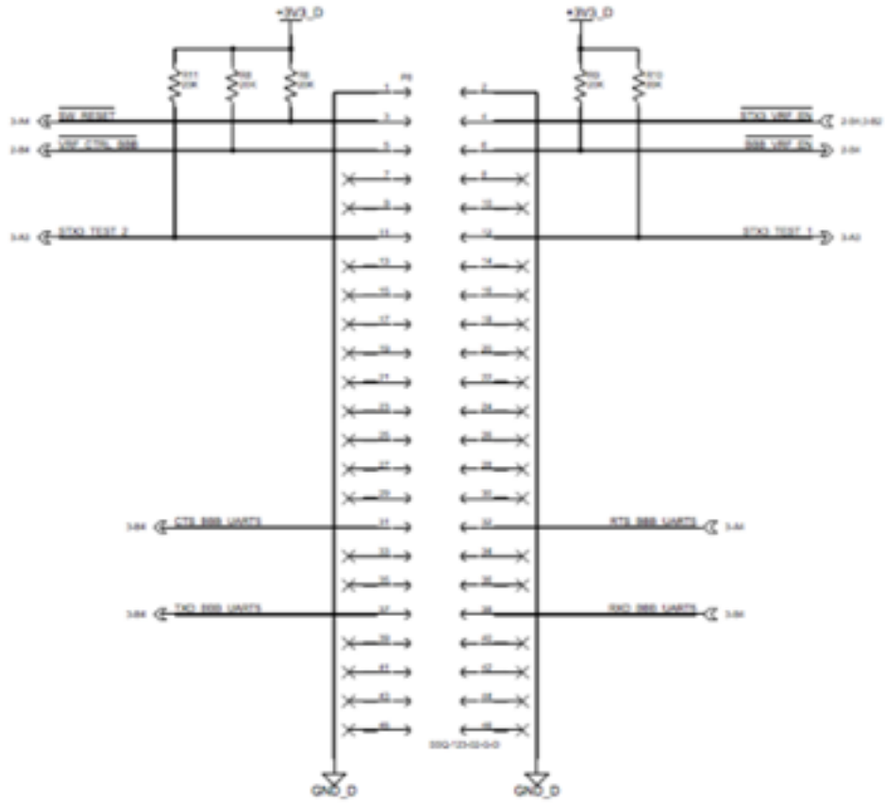
Notes:

1. Place the P8 | P9 connector footprint on the PCBA "Bottom", then install the part from the "Top".

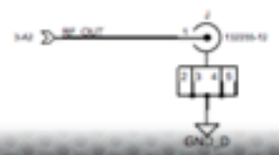
BBB P9 Interface



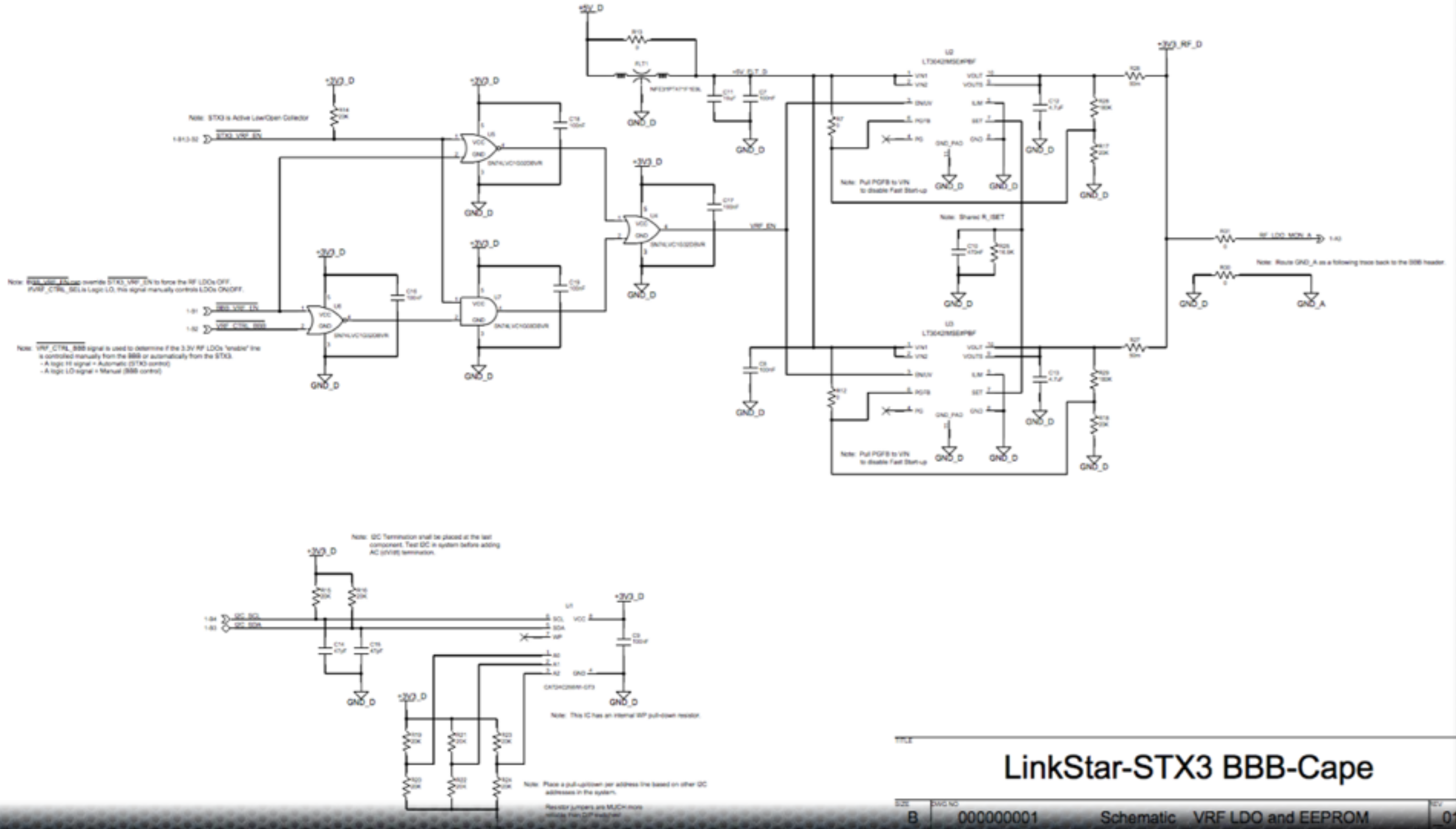
BBB P8 Interface



STX3 RF Antenna

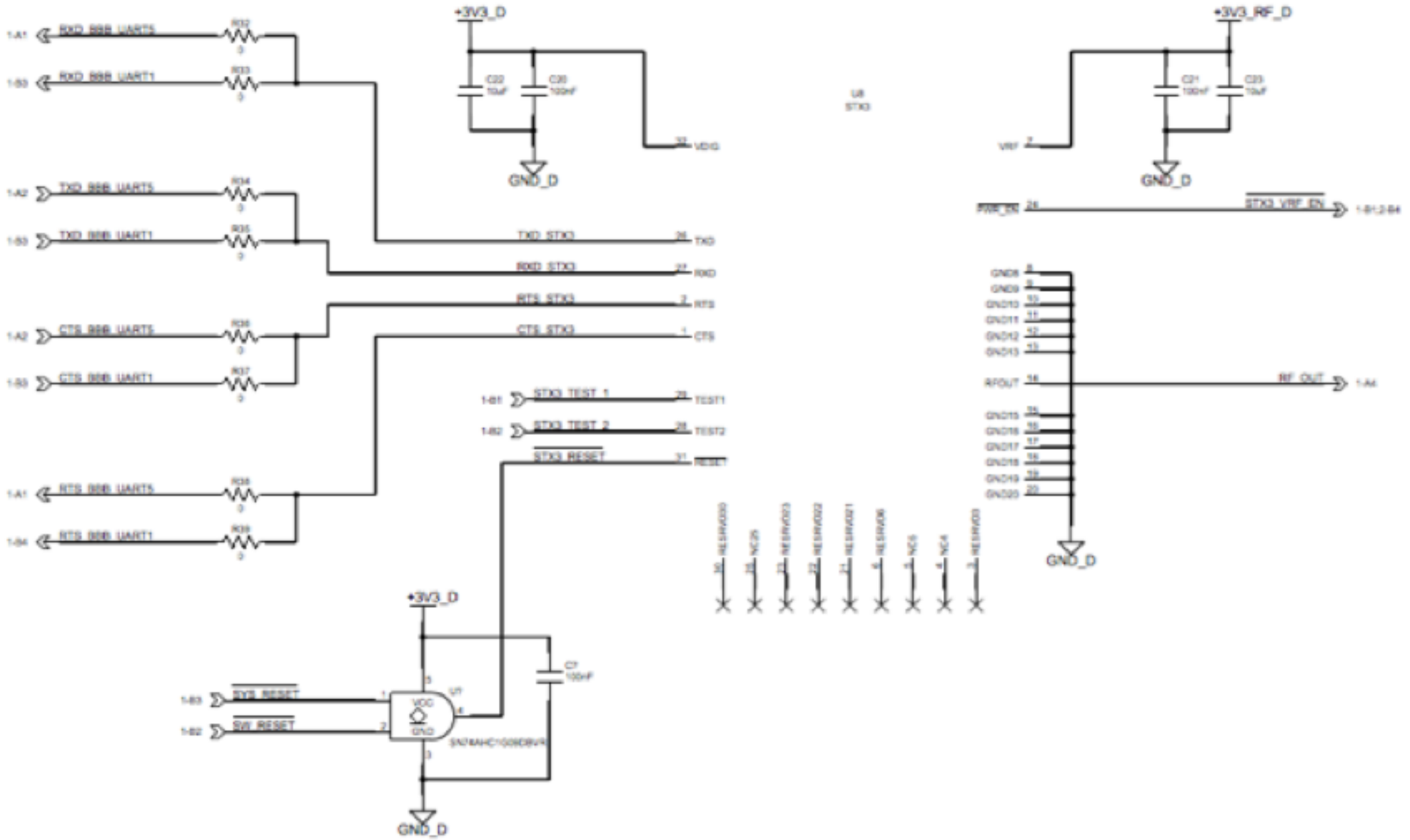


| | | | | |
|---|---|---|---|---|
| | LinkStar-STX3 BBB-Cape | | | |
| SIZE B | DWG NO 000000001 | Schematic Connectors | | REV 01 |




# LinkStar-STX3 BBB-Cape

| SIZE | DWG NO | | REV |
|---|---|---|---|
| B | 000000001 | Schematic VRF LDO and EEPROM | 01 |



# QuickSAT/VMS

*Flight and Health Management*

*with a Communications Framework*

# How It Began...

- sci_Zone commercialized QS code to support the GE Aviation Aircraft Health Management System Project.
- sci_Zone entered into an agreement with GE to use the open source QuickSAT APIs on their “Operational Ground Program” (OGP).
- **LinkStarAV**/Vehicle Management System (VMS) created as an expanded version of the OGP program.

# QuickSAT/VMS

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

# 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

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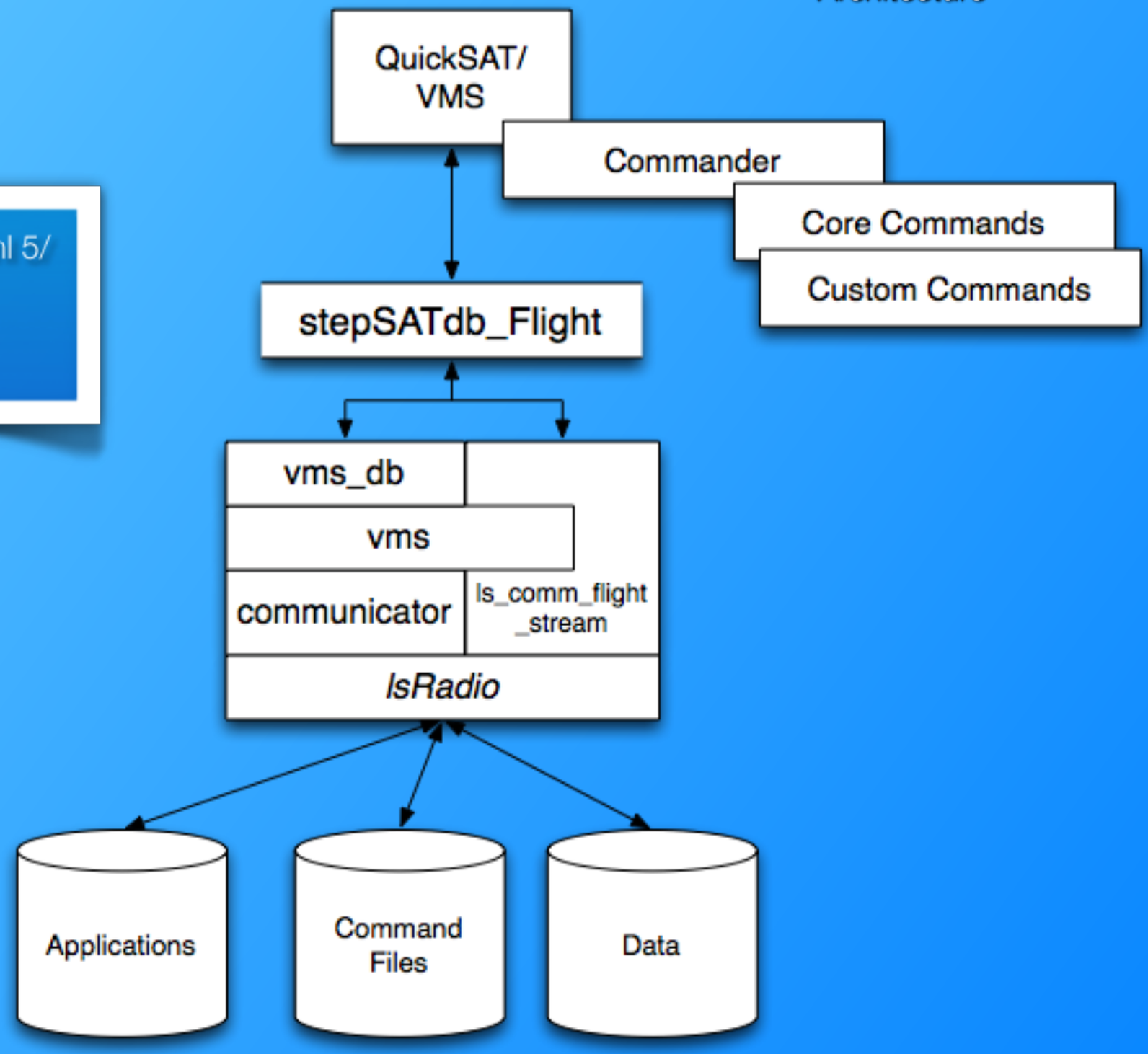
*Architecture*

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



QS/VMS
Vehicle Management System

Identifier: FRNCS-P/SHARC | Sessions | Update Location | Admin | Logout

Last DB Capture: 04/18/2015 @ 02:15:43
Current Recording Session: 72
Mission Phase: Operating Mode
Mode of Operation: Mission Science/Operations
Current VMS Command: *No Commands Pending*

GSTAR USA
Last Sync with FRNCS: 04/18/2015 @ 02:15:43

Configuration | Mission Operations | Live Parameter View | FRNCS Maintenance | Schedule | Server

FRNCS-P | Space Vehicle Profile

## FRNCS Virtual Machines and Software

CSV | Excel

Search:

| ID | Name | Status | State Code | State |
|---|---|---|---|---|
| VM1: Domain 1 | | | | |
| 1 | prime | GATEWAY Storage | 80 | FRNCS Stora |
| VM2: Domain 2 | | | | |
| 2 | prime | GATEWAY Storage | 80 | FRNCS Stora |
| VM3: Domain 3 | | | | |
| 3 | sine | GATEWAY Storage | 80 | FRNCS Stora |
| VM4: Domain 4 | | | | |

Showing 1 to 5 of 5 entries

## Parameters

for the application "prime"

CSV | Excel

Search:

| ID | Parameter Name | Units | Type | Description |
|---|---|---|---|---|
| 1 | Prime Number | n/a | INTEGER | Calculated prime value for the give |

FRNCS-P | Space Vehicle Profile

Space Vehicle Profile

## SHARC Mission

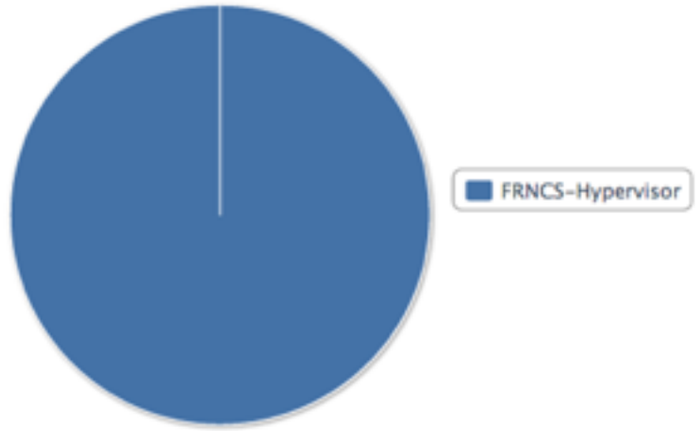
| | |
|---|---|
| **Configuration:** | Rev 4.0 SHARC |
| **Model Number:** | Version 4.0 |
| **Date/Time:** | 2014-10-09 01:42:39 |
| **Comments:** | SHARC is a 5U cubesat to be deployed from the ISS |

Search:

| Subsystem | Subsystem Mass (kg) |
|---|---|
| FRNCS-Hypervisor | 0.39 |

Showing 1 to 1 of 1 entries

Subsystem Mass Summary Chart




| | |
|---|---|
| **Satellite Mass, Dry (kg):** | 0.39 |
| **Mass Propellants (kg):** | 0.00 |
| **Satellite Mass (Dry + Propellants, kg):** | 0.39 |

Select all | Deselect all | CSV | Excel | PDF | Copy

Search:

| Part Name | Part Number | Multiplier | Vendor | Mass | Avg Power (Watts) | Part Key |
|---|---|---|---|---|---|---|
| BeagleBone Black, RevC | BeagleBoneBlackRevC00001 | 1 | | 0.03968 | 2.3 | BeagleBoneBlackRevC000011 |
| Cubieboard3 - Cubietruck | 800024001 | 1 | sci_Zone Inc | 0.1 | 5 | 8000240011 |
| FRNCS-P Bracket | SHARCFRNCSBracket-01 | 1 | AFRL | 0.2 | 0 | SHARCFRNCSBracket-011 |
| Global Star Duplex Antenna X2 | duplexantennaX2 | 1 | sci_Zone Inc | 0 | 0 | duplexantennaX21 |
| LinkStar Duplex Radio | LinkStar-0001-v00100001 | 1 | sci_Zone Inc | 0.05 | 2 | LinkStar-0001-v001000011 |

# QS/VMS

Vehicle Management System

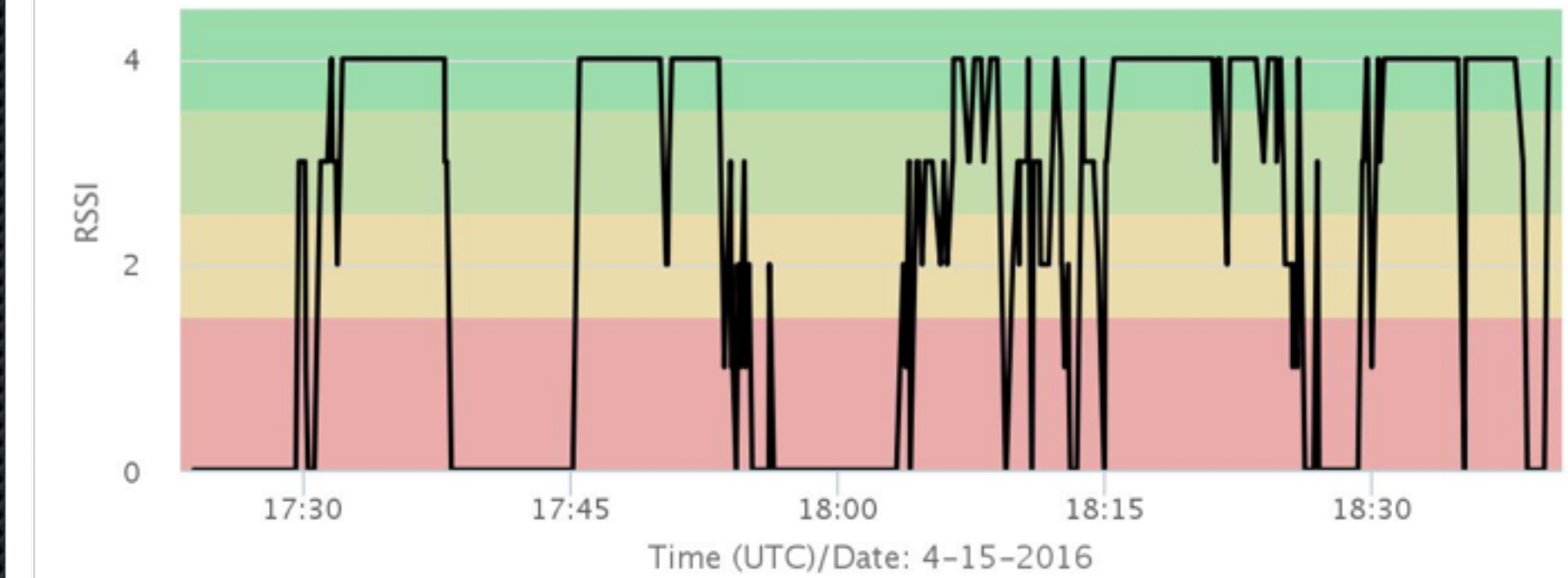
**Identifier:** FRNCS-P/RADSAT | Sessions | Update Location | Admin | Logout

**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



Operations | Support | LinkStar | Recording Sessions

**Ethernet Comm Status:** Link Active
**Serial Line Status:** Link Disabled
**Active Board:** Host_1

## FRNCS Software Status

Search:

| ID | Name | Status | State Code | State |
|---|---|---|---|---|
| VM1: Domain 1 | | | | |
| 1 | prime | GATEWAY Storage | 80 | FRNCS Storage |
| VM2: Domain 2 | | | | |
| 2 | prime | GATEWAY Storage | 80 | FRNCS Storage |
| VM3: Domain 3 | | | | |
| 3 | sine | GATEWAY Storage | 80 | FRNCS Storage |
| VM4: Domain 4 | | | | |

Showing 1 to 5 of 5 entries

## 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 |

## 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 |
|---|---|---|---|
| 2014-04-29 02:16:53 | 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 |

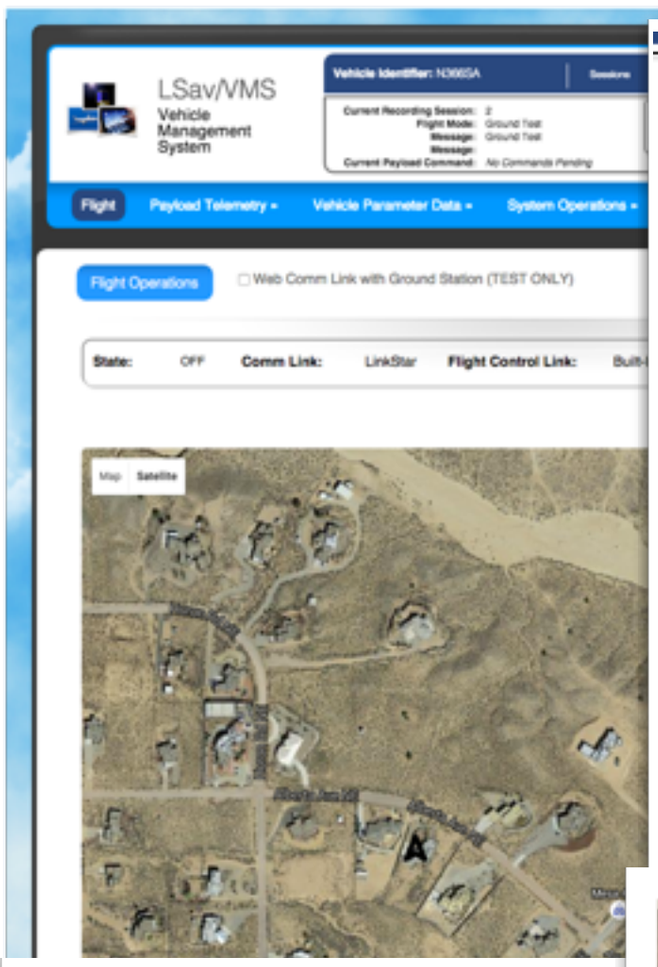
Showing 1 to 31 of 31 entries

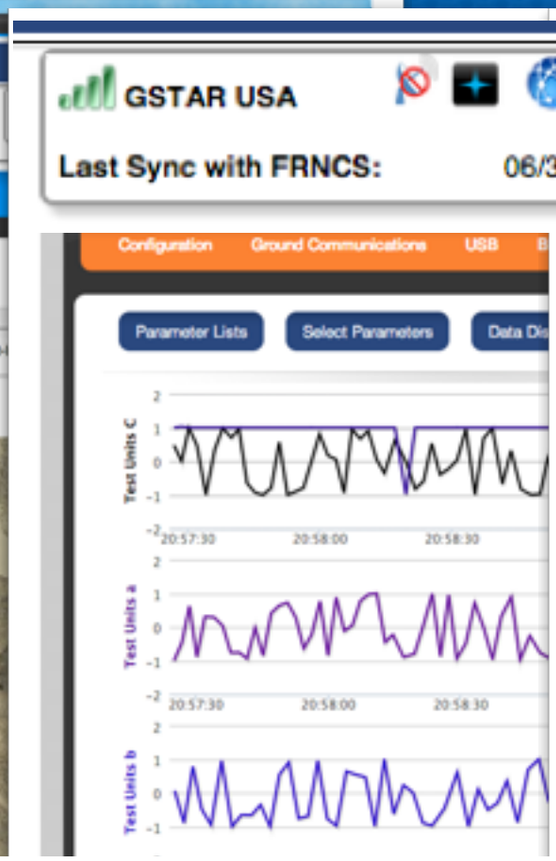
## System Message Log

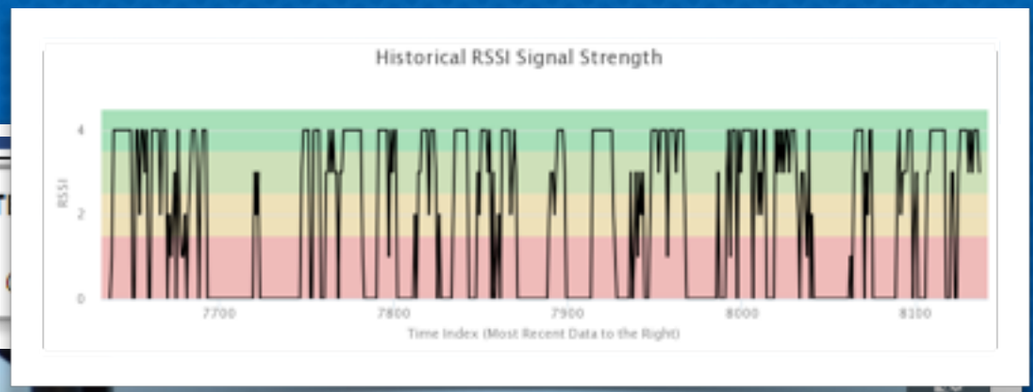
CSV Excel PDF Copy

Search:

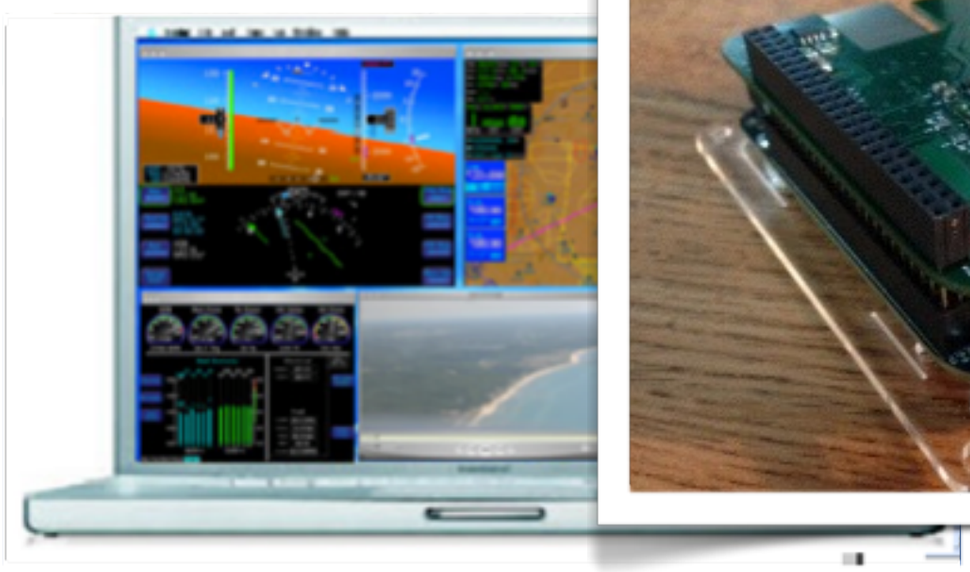
| System Message Time (UTC) | System Message |
|---|---|
| 2014-04-23 20:23:20 | Success - VM/App "prime_test_app00001" installed |
| 2014-04-23 20:23:20 | Command Success |
| 2014-04-23 20:25:24 | Success - VM/App "cosine_test_app00001" installed |
| 2014-04-23 20:25:24 | Command Success |

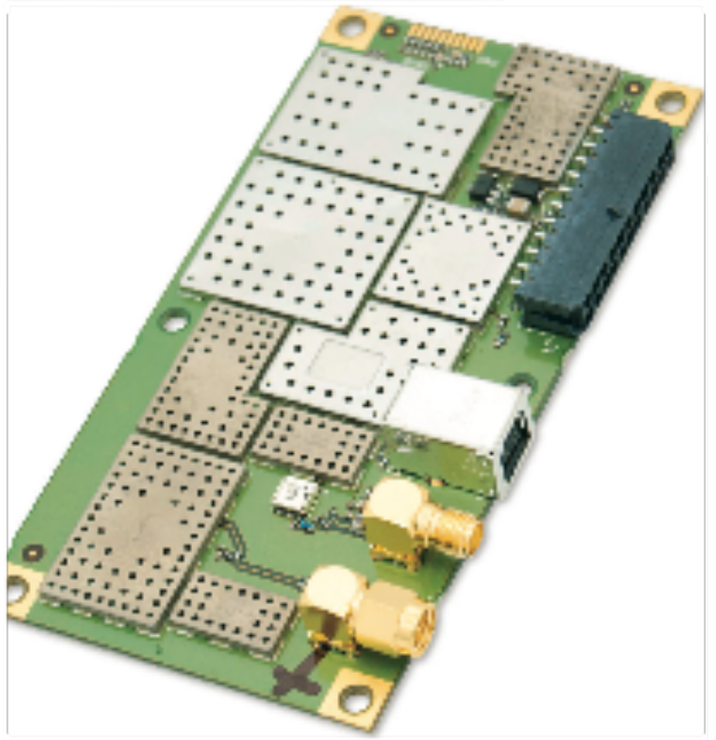








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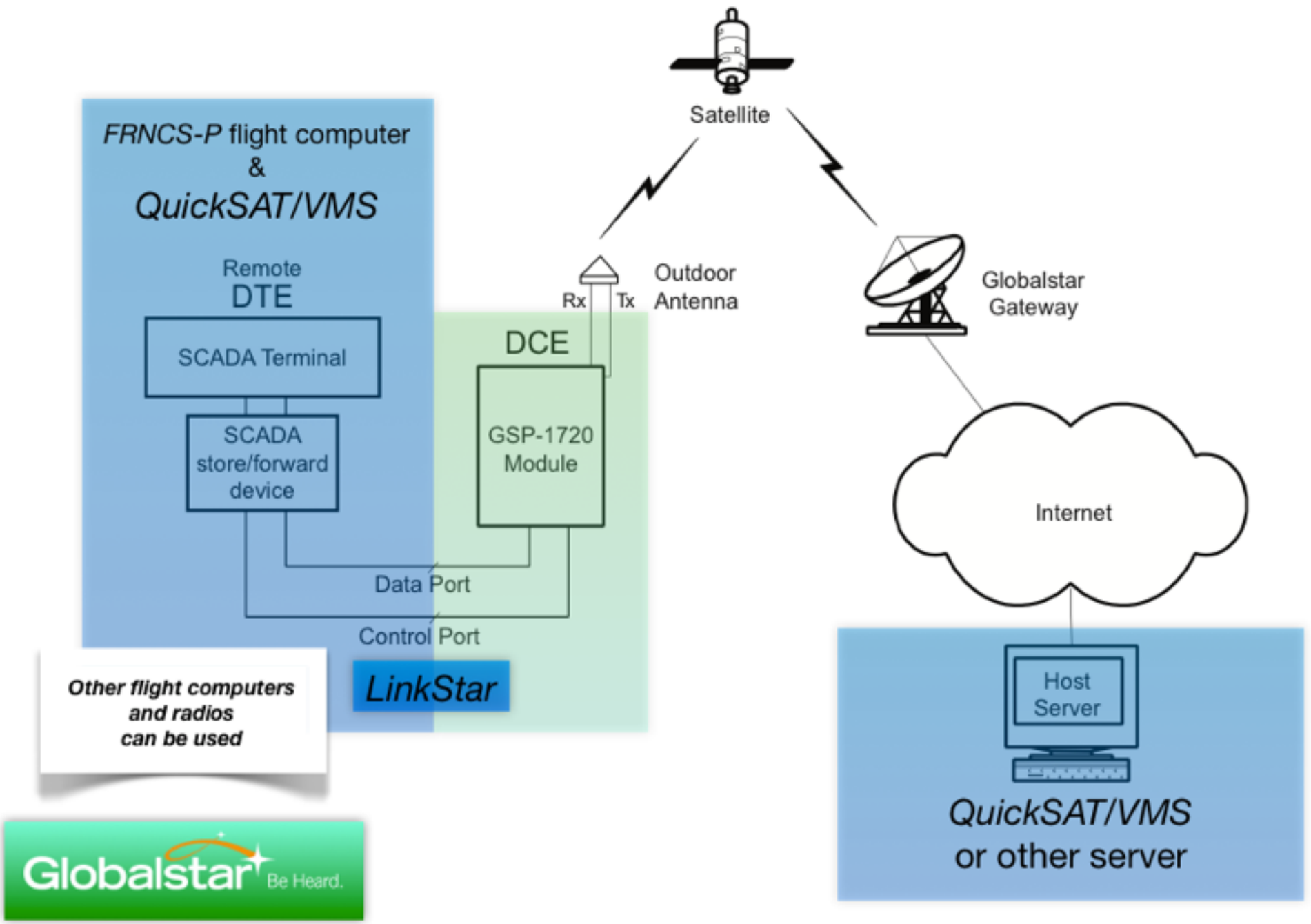
# Baseline Communications Scheme with LinkStar

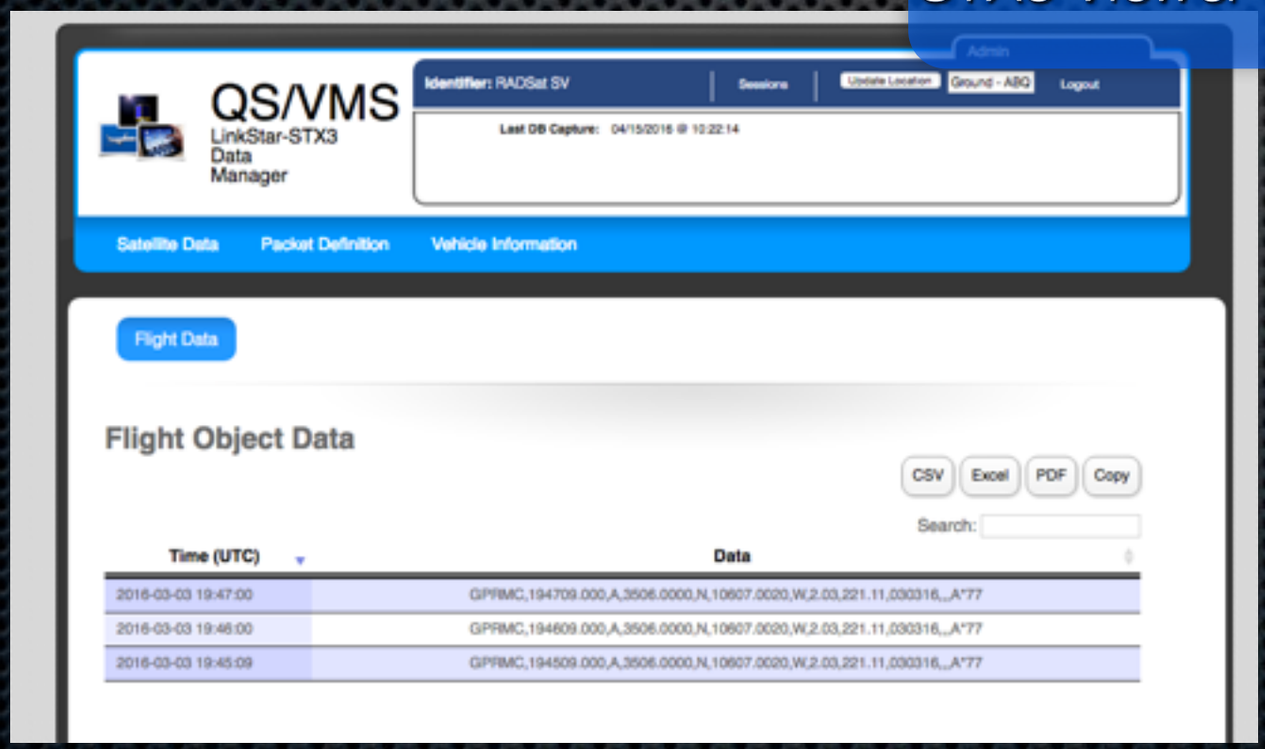


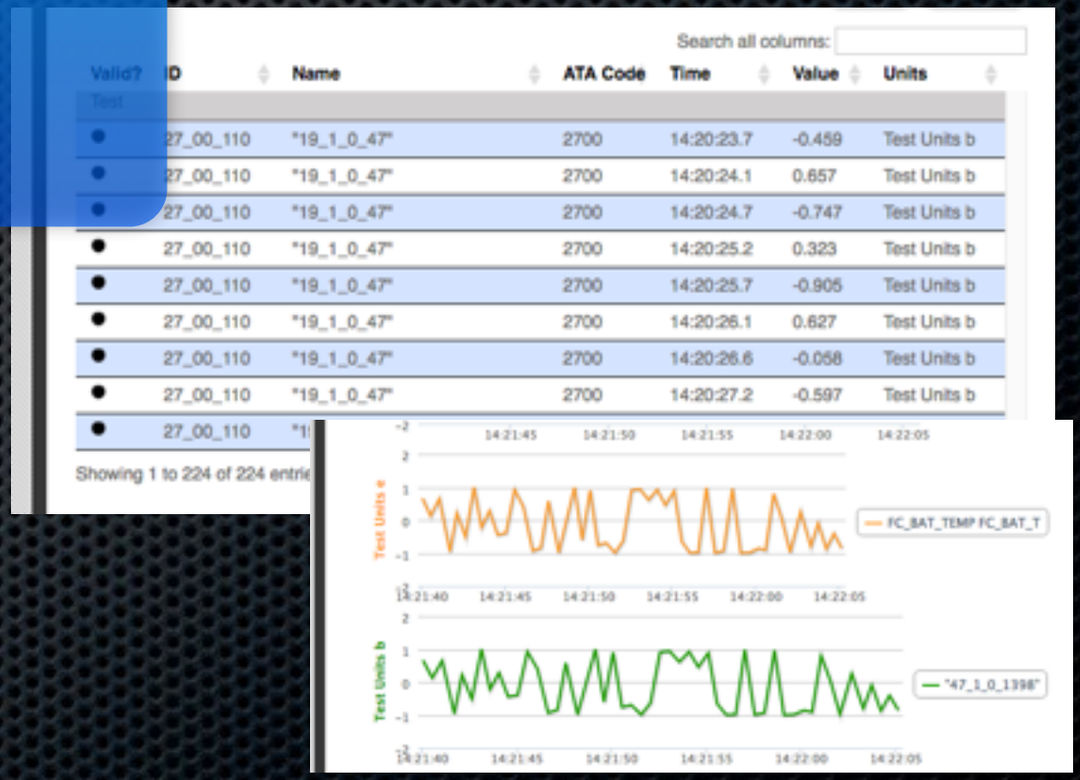
# Packet Definition - EASY!

**Define Parameters**
*QuickSAT/Designer, phpmyadmin*

**Build Packets**
*QuickSAT/VMS Packet Builder*

**View Packets**
*QuickSAT/VMS STX3 Viewer*

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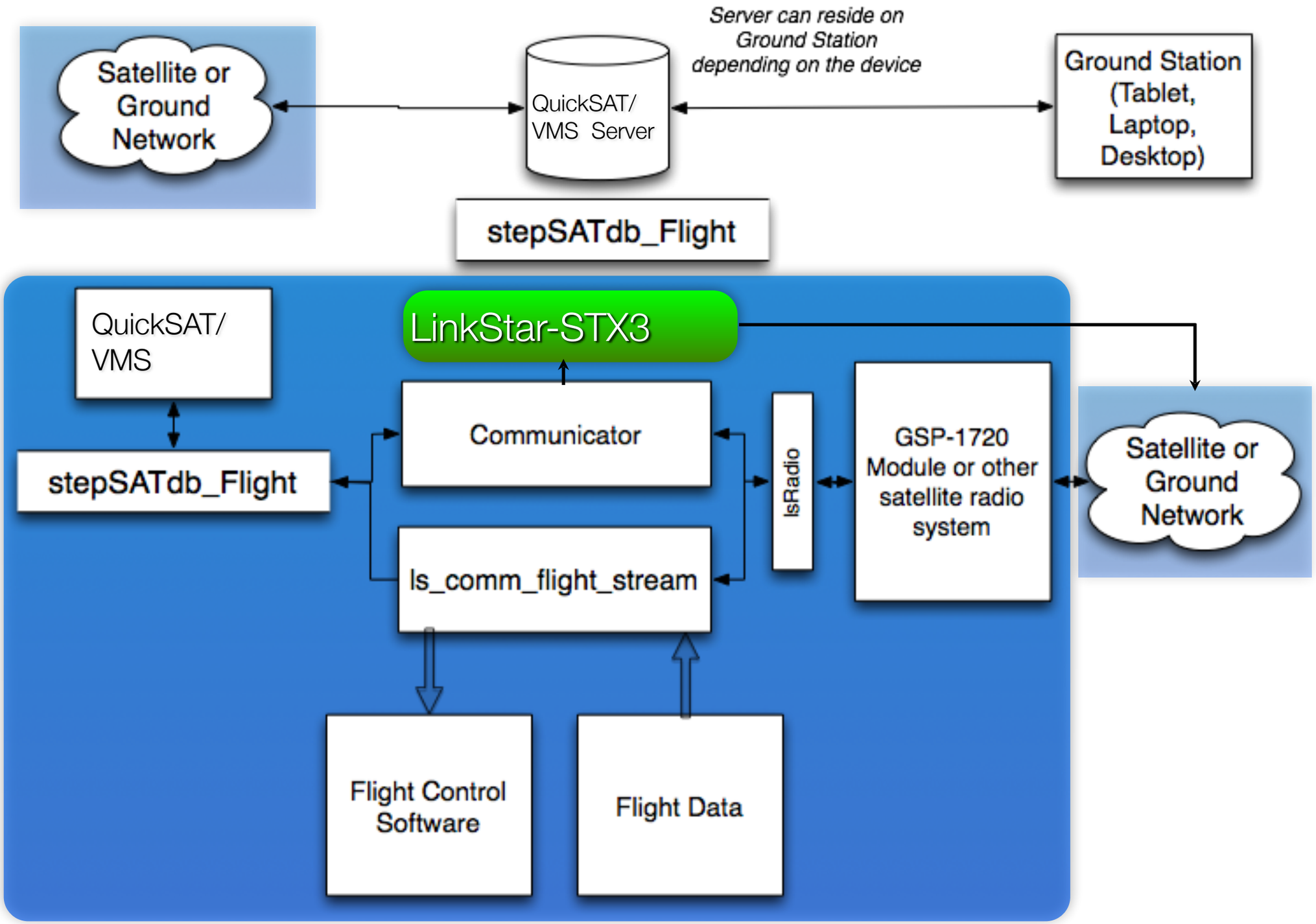
Satellite or Ground Network
QuickSAT/ VMS Server
Server can reside on Ground Station depending on the device
Ground Station (Tablet, Laptop, Desktop)
stepSATdb_Flight
QuickSAT/ VMS
LinkStar-STX3
Communicator
stepSATdb_Flight
ls_comm_flight_stream
IsRadio
GSP-1720 Module or other satellite radio system
Satellite or Ground Network
Flight Control Software
Flight Data

# Many ways to configure *LinkStar*

The heart of our communications system. Pick Simplex, Duplex or both!
Includes ARM-8 based flight computer system. Low power, but powerful and flexible. Allows your satellite to become a node on the internet!

*LinkStar* → QuickSAT/ VMS

"Vehicle Management System" - A complete flight management system - monitor, control, communications and commanding.

Monitor the health of your satellite on the ground or in space. Can also be used to control your satellite and serve as the core to your ground control system

+

Multicore and multiple boards, ARM based and linked together.

*FRNCS-M*

+

QuickSAT/ XEN

Our premier hypervisor environment - define virtual machines and payloads. Provides for a robust and secure environment

+

QuickSAT/ Designer

Design your satellite - and automatically configure both the satellite and your *LinkStar* radio!

*Add one or all these pieces to your LinkStar environment!*

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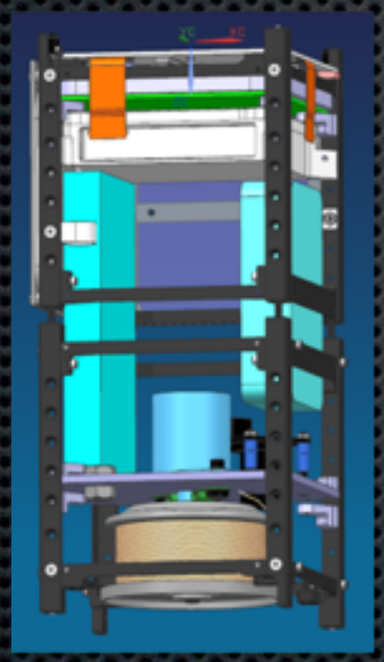
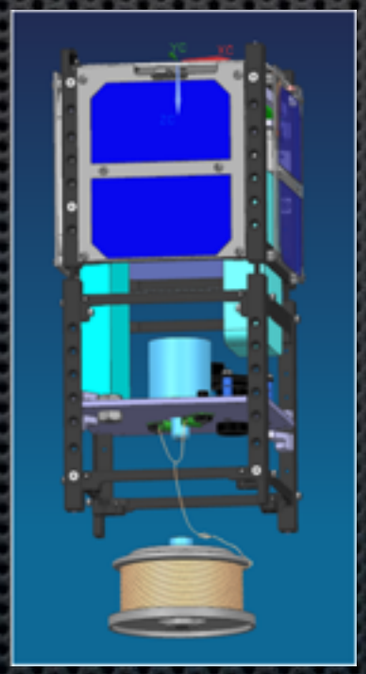
# Future Missions

- DARPA High Altitude Balloon Test Flights
- NASA UAV Project
- Boeing RADSat Mission
- And several Universities coming online...





# QuickSAT

Take your satellite from idea to flight!

## QuickSAT/Designer

*Design and Mission Planning from idea to flight!*

## QuickSAT/Xen

*Security, Reliability and Software Rad-Hardening!*

## QuickSAT/VMS

*Talk to your satellite!*

## LinkStar

*Communications for the Rest of us!*

## FRNCS

*ARM Computing for the Future!*

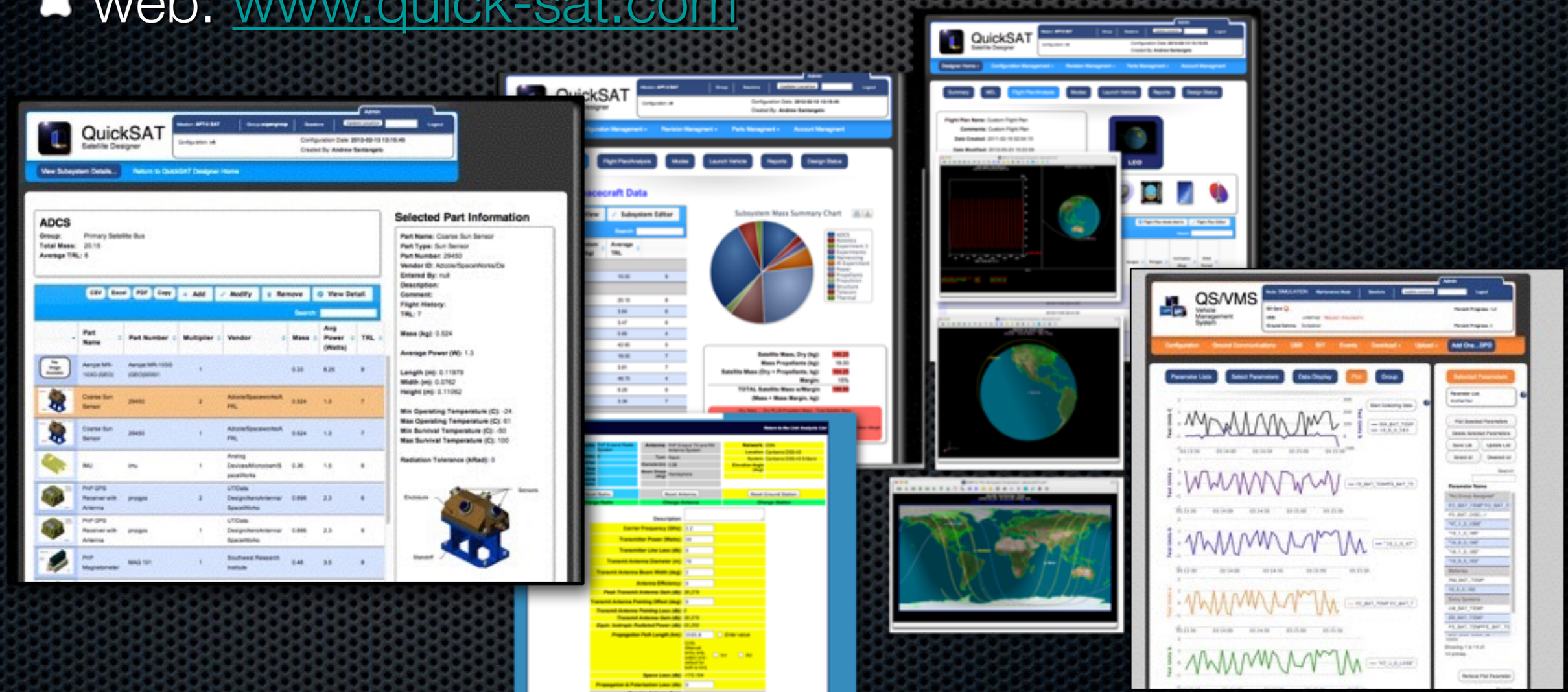


**sci_Zone, Inc.**

**www.quick-sat.com**

# Next STEP - Join the Fun!

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

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