Linkstar, a Globalstar Based Duplex Radio for Satellites In LEO - Architecture and Test Results

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30TH ANNUAL AIAA/USU CONFERENCE ON SMALL SATELLITES Pre-Conference Workshop
LinkStar
A Paradigm Shift in Satellite Communications

Why bother with Amateur Bands…?
**LinkStar Duplex**

**Product Features**

- No deployables
- 5.72 cm diameter circular patch for duplex
- Rapid acquisition

**Data rates**

- 9600 bps maximum
- SMS Uplink Messaging
- *LinkStar* intended to compliment traditional high speed radios
- *LinkStar* can serve as a primary radio depending project and product data requirements.
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

• Ground station over Internet Protocol (IP)

• Access your vehicle from anywhere!

• Piggy-backs on established 2 billion dollar network

• Low Cost
The "Gateway" Computer

Optional Stack IF Power Cape is NOT used

CBB-Serial Cape (See detail "B")

Power Cape (Optional)

Stack

Beagle Bone Black (rev C)

Stack

GSP-1720

TX RX

Data

Control

Antenna

Optional Connection to 6V solar panels

3-14v DC GND 5V GND

JST Battery Connector

DO NOT connect the Beagle Bone Black to the Space Vehicle Power Bus or any other power supply IF the Power Cape is used

5V

To Space Vehicle Power Bus OR Battery

GND
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!
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
<table>
<thead>
<tr>
<th>Feature</th>
<th>LinkStar</th>
<th>LinkStar-STX3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications Type</td>
<td>Duplex</td>
<td>Simplex</td>
</tr>
<tr>
<td>Data Rate</td>
<td>9600 BPS</td>
<td>36 Byte Packets</td>
</tr>
<tr>
<td>Input Power</td>
<td>~ 4 W</td>
<td>350 mW</td>
</tr>
<tr>
<td>Pointing Required?</td>
<td>Yes, ±40º</td>
<td>No</td>
</tr>
<tr>
<td>Internet Access in Orbit</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Coverage</td>
<td>~ 40%</td>
<td>Near 95%</td>
</tr>
<tr>
<td>Messaging</td>
<td>Uplink only - 35 bytes</td>
<td>Downlink only - 36 bytes</td>
</tr>
<tr>
<td>QuickSAT/VMS</td>
<td>Yes!</td>
<td>Yes!</td>
</tr>
</tbody>
</table>
QuickSAT/VMS

Flight and Health Management

with a Communications Framework
Packet Definition - EASY!

Define Parameters
QuickSAT/Designer, phpmyadmin, Existing Definitions

Build Packets
QuickSAT/VMS Packet Builder

View Packets
QuickSAT/VMS STX3 Viewer
Baseline Communications Scheme with LinkStar

FRNCS-P flight computer & QuickSAT/VMS

Other flight computers and radios can be used

LinkStar

QuickSAT/VMS or other server
- Direct VPN Link
- Data AES 256 Encryption
- SSH to console
Test Program

QuickSAT - Xen
The Problem

Need a **Safe AND Secure** embedded platform solution, without compromising **Performance**…

Security concerns in safety-critical systems are now paramount; and Aerospace & Defense, Medical, and Automotive markets are all demanding a solution.

…QuickSAT/Xen open-architecture hypervisor with unrestricted licensing of Xen provides **safety, security, and performance** on an embedded platform.
The Xen Hypervisor Environment

sci_Zone, Inc.
www.quick-sat.com
Ground & High Altitude Balloon Flight Test Program

- Key Tests:
  - QuickSAT/VMS Flight Management System Operations on DARPA Test System
  - Relay data from “Satellite” to the ground station
  - Add EIGHT Virtual Machines from the “Gateway”
  - Add One Virtual Machine from the Ground Station
  - Remove all Virtual Machines
Configuration for the Demonstration and for the High Altitude Test Flights
Results

- ALL Virtual Machines (VM) Installed and removed as planned
- Data transmitted to the ground station
- Command and Control of VM from ground station
Results

- Flight and LinkStar system data synced with the ground
- Data included signal strength, location, VM data
Future Missions

- DARPA High Altitude Balloon Test Flights
  - Flights in late August and October 2016
- Boeing RADSat Mission, February 2017
- New Mexico State University INCA Mission, 2018
TRYAD Mission
Terrestrial Ray Analysis and Detection

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

Featuring the \textit{LinkStar-HD} System!

Data rates up to 256 kbps!
Electrical Power System
- DHV solar cells
- Li ion batteries
- MPPTs, Current sensing, Bus switching, protection

Attitude Determination & Control System
- Sun sensors
- Magnetometers
- 3-axis rate gyos
- Novatel GPS
- 3-axis reaction wheels & magnetorquers
- Servo-controlled deployable fins for station keeping via diff. drag

Science Payload:
- Gamma Ray
- Scintillation Detector (UAH, NASA GSFC)

Command & Data Handling System
- (Embedded Linux, Beaglebone Black)
Next STEP - Join the Fun!

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