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
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!

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
<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
“Test Like You Fly!”
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

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
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
Auburn University

TRYAD Mission
Terrestrial Ray Analysis and Detection

• Goal: To detect 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 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

Command & Data Handling System
- (Embedded Linux, Beaglebone Black)

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

Linkstar Duplex Satellite Radio
(real time command & telemetry)

PULSAR S/X – Band SDR Radios 300kbps/150Mbps (NASA MSFC, NEN)
Next STEP - Join the Fun!

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