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
**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
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!

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sci_Zone, Inc.

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

Flight and Health Management with a Communications Framework
Architecture

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

Custom & Addon Processes

QuickSAT/VMS

Custom Interfaces

stepSATdb_Flight

vms_db

vms

Core Commands

Communication Tools

IsRadio

Applications

Command Files

Data
Packet Definition - EASY!

Define Parameters
QuickSAT/Designer,
phpmyadmin,
Existing Definitions

Build Packets
QuickSAT/VMS
Packet Builder

View Packets
QuickSAT/VMS
STX3 Viewer

sci_Zone, Inc.
www.quick-sat.com
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
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
Gateway

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!
Linkstar Duplex Satellite Radio (real time command & telemetry)

PULSAR S/X – Band SDR Radios 300kbps/150Mbps (NASA MSFC, NEV)

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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