CubeSat High-Speed Downlink Communications Update

Bryan Klofas
SRI International
bryan.klofas@sri.com
CHDC Goals

• Maximize downlink bandwidth and contact time for science missions
• Lower cost and regulatory burden on PIs
• Establish open knowledge base of NSF-specific CHDC solutions
CHDC Description

• Provide high-speed data downlinks for future CubeSat NSF missions
  – Expandable to all educational missions in the future
• Open standards/interoperable
• Multiple Access
• Meetings:
  – Proposed at CEDAR 2009 by Chuck Swenson
  – Discussed at SmallSat 2009
  – AGU meeting in December 2009 and 2010

• [http://groups.google.com/group/cubesat-high-speed-downlink](http://groups.google.com/group/cubesat-high-speed-downlink)
• [http://mstl.atl.calpoly.edu/~bklofas/NSF_comm/](http://mstl.atl.calpoly.edu/~bklofas/NSF_comm/)
Outcome of last meeting

• Met at AGU last December
• John Malsbury is conducting a survey for NSF PIs about what they want out of this committee
  – jmalsbury@sparton.com
• Sara Spangelo is collecting information about available ground stations and spacecraft modulations
  – saracs@umich.edu
• Electromagnetic Spectrum Management group at NSF (Tom Gergely and Andy Clegg) submitted a proposal to place CubeSats on the agenda for the WRC-15.
  – 10 MHz band within 200 to 3000 MHz
  – Worldwide basis
  – Minimum regulatory burden

• Proposal was blocked by DoD, opposed by FAA, but had good support from NASA
  – Currently being improved by these organizations
• NTIA suggested placing CubeSats on the WRC-19 agenda, pending successful completion of feasibility studies

• Introduce a Study Question in ITU-R Study Group 7. Studies could eventually lead to an ITU-R Recommendation
## Current Frequency Allocations

<table>
<thead>
<tr>
<th>Award</th>
<th>Project</th>
<th>PIs</th>
<th>Type</th>
<th>Agency</th>
<th>Sponsor</th>
<th>Status</th>
<th>Downlink Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>RAX</td>
<td>Cutler/Bahcivan</td>
<td>Amateur/ISM</td>
<td>FCC</td>
<td>UMich</td>
<td>Granted</td>
<td>437 MHz; 2.4 GHz ISM</td>
</tr>
<tr>
<td></td>
<td>FireFly</td>
<td>Rowland/Weatherwax</td>
<td>Space Research</td>
<td>NTIA</td>
<td>NASA</td>
<td>Submitted</td>
<td>400 MHz</td>
</tr>
<tr>
<td>ARRA</td>
<td>FIREBIRD</td>
<td>Klumpar/Spence</td>
<td>Amateur</td>
<td>FCC</td>
<td>MSU</td>
<td>Coordinated</td>
<td>145 MHz, 19200 baud GMSK</td>
</tr>
<tr>
<td></td>
<td>DICE</td>
<td>Crowley/Swenson</td>
<td>Meteorological Satellite</td>
<td>NTIA</td>
<td>NSF</td>
<td>Not submitted</td>
<td>460 MHz, 1.5 Mbps</td>
</tr>
<tr>
<td># 2</td>
<td>CINEMA</td>
<td>Lin</td>
<td>Space Research</td>
<td>NTIA</td>
<td>NSF</td>
<td>Submitted</td>
<td>2.2 GHz</td>
</tr>
<tr>
<td></td>
<td>CSSWE</td>
<td>Li/Palo</td>
<td>Amateur</td>
<td>FCC</td>
<td>U Colorado</td>
<td>Coordinated</td>
<td>437 MHz</td>
</tr>
</tbody>
</table>
## Summary of Current Approaches

<table>
<thead>
<tr>
<th></th>
<th>Downlink</th>
<th>Spacecraft TX</th>
<th>Ground Station RX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RAX</strong> (STP-S26)</td>
<td>437 MHz, 9600 baud</td>
<td>AstroDev Helium</td>
<td>Icom 910</td>
</tr>
<tr>
<td><strong>FireFly</strong> (Elana4/CRS-2)</td>
<td>401 MHz</td>
<td>AstroDev Colony-2</td>
<td></td>
</tr>
<tr>
<td><strong>FIREBIRD</strong></td>
<td>145 MHz, 19200 baud</td>
<td>AstroDev Helium</td>
<td>Icom 910</td>
</tr>
<tr>
<td><strong>DICE</strong> (Elana3/NPP)</td>
<td>460 MHz, 1.5 Mbps</td>
<td>L-3 Cadet</td>
<td>USRP</td>
</tr>
<tr>
<td><strong>CINEMA</strong> (Elana6/OUTSat)</td>
<td>2.2 GHz, 1 Mbps</td>
<td>Emhiser</td>
<td>11m dish</td>
</tr>
<tr>
<td><strong>CSSWE</strong></td>
<td>437 MHz, 9600 baud</td>
<td>SX1231 (all-in-one chip)</td>
<td>Kenwood TS-2000</td>
</tr>
</tbody>
</table>
How to Help

- Comment favorably when the FCC puts out the CubeSat proposal for public comment
- Join the Google Groups
  - http://groups.google.com/group/cubesat-high-speed-downlink
- Monitor/participate in the work of the US Study Group 7 (Science Services)
  - https://www.ussg7.org/
  - Username: sg7User   Password: 4webAccess
Thanks

• Thanks for your time
• bryan.klofas@sri.com

• Backup slides provided by Tom Gergely
Frequency Allocations For CubeSats: Where Does it Stand

Tomas Gergely
Electromagnetic Spectrum Management Unit
National Science Foundation
tgergely@nsf.gov
703-292-4896

CubeSat Workshop
Cal Poly
April 22, 2011
Long Term Goal: Allocated or Designated Band(s) for CubeSat operations (command, control and data relay)

Conditions:

- Sufficient bandwidth to accommodate current and future uses
- Minimum of International Regulatory Obligations
- Uplink (Command and Control) and Downlink (Data Relay) in the same band or separate uplink and downlink bands
Roadmap

Two possible ways to approach the problem:

• Place Issue on the Agenda of a World Radiocommunication Conference (WRC-15 or WRC-19)
• Introduce a Study Question in ITU-R Study Group 7. Studies could eventually lead to an ITU-R Recommendation

These routes are NOT mutually exclusive. In fact, the first one would also require ITU-R studies, and the second could eventually lead to an Agenda Item
(Some) Difficulties

- No definition of pico or nanosatellites in the ITU. Not a trivial issue: CubeSats need to be differentiated from other satellites, so the appropriate regulations (or lack of them) can be applied to them and ONLY to them.
- No adequate explanation why they cannot operate in existing Space Research, Space Ops or Meteorological Satellite Bands.
- No reliable estimate of required bandwidth (worldwide).
- Some would prefer domestic regulations to precede ITU action.
- In the view of some, the issue is not mature for WRC action.
- Not an exhaustive list!
The Future Agenda Proposal Route


✓ Seeks up to 10 MHz of spectrum designated for use by picosatellite and nanosatellite operations, based on studies, described in a

✓ Resolution, that urges (mandates) the ITU-R to conduct studies to identify up to 10 MHz of spectrum for pico and nanosatellite operations,
  ✓ In the 200 – 3 000 MHz range
  ✓ while protecting existing services
  ✓ on a worldwide basis
  ✓ with minimum regulatory requirements
Where Do We Stand?

- The NSF proposal has been repeatedly revised (and improved) based on NASA, FAA and DoD inputs.
- In spite of which the RCS approved only a proposal to be submitted to WRC-19 on condition that an ITU Question be submitted to US WP 7B.
- Draft proposal sent to the FCC by NTIA (Feb 23, 2011).
- FCC submits proposal to the meeting of sub working group 3 of the WRC-12 Advisory Committee (WAC) – March 3, 2011.
- Proposal is strongly supported by Boeing, ARRL; but strongly opposed by Iridium, failing to reach consensus.
- At present the proposal is in the NTIA/FCC reconciliation process (the prospects for it to make it are not good).
The Study Question Route

- NSF introduced a draft “Study Question in the appropriate US ITU-R Working Party (US WP 7B) at the Meeting of March 24, 2011

- Requests for Revisions (Iridium and others)

- Revised “Question” submitted to April 21 meeting.

- If approved in the US, draft study question is sent to ITU as a US contribution
How You Can Help?


- The Nanosat proposal may be found in Attachment 2 of the above public notice.

- You may also write, expressing support to: Alexander.Roytblatt@fcc.gov

- Participate in the work of US WP 7B. See: [http://www.ussg7.org](http://www.ussg7.org)
  
  Username: sg7User; Password: 4webAccess
  
  Next meeting is May 26, 1:30 PM (see website for details)