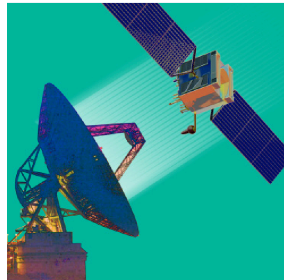


Working Group Discussion Summary

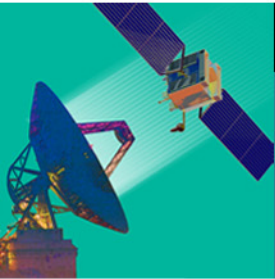
Ground System Architectures Workshop



Session 11F

Ground System Enablers and Future Small Sat
Development

*Catherine Venturini, Steve Mazuk, Adam Darley, The
Aerospace Corporation*

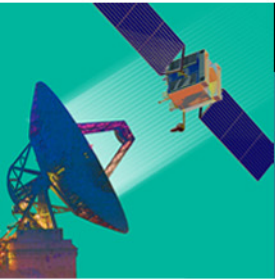


Introduction

- This report provides a detailed summary of the presentation notes and discussions during the GSAW Session 11F Working Group
- The Working Group agenda was as follows:
 - Welcome & Introduction
 - Presentations by Panelists
 - Mr. Austin Mroczek, U.S. Navy PEO Space Systems
 - Mr. Kyle Kemble, Air Force Research Laboratory
 - Mr. Erik Eliassen, Universal Space Network
 - Dr. Meagan Hubbell, NRO CubeSat Office
 - Dr. Marco Villa, Tyvak Nano-Satellite Systems, Inc.
 - Open Discussion/Group Participation

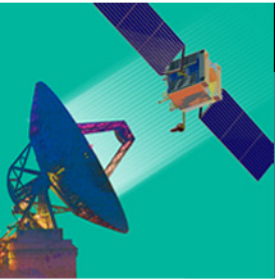


Notes from Presentations by Panelists



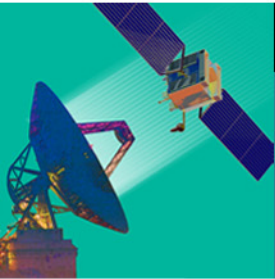
Mr. Austin Mroczek, U.S. Navy PEO Space Systems

- Cannot do large constellations of satellites of closely spaced satellites
 - Can't service many systems at once
- Frequency approval can take as long as the entire SmallSat development cycle
- Getting s/c data to users needs improvement
- Small satellite systems allow more users to control the system without overhead that is inherent in large systems
- Not building towards ground development
 - Ground is usually an afterthought – one-offs for each tech demonstration
 - Would need an established small satellite team to build
- TDRSS is available with some caveats, i.e., S-band, spread spectrum, return only
- ICE-CAP mission can close link to MUOS at limited duty cycle
- Thinks that existing ground infrastructure has not been extended to smallsats because it would difficult to train user of one-off systems



Mr. Kyle Kemble, Air Force Research Laboratory (AFRL)/RV

- See full presentation: http://gsaw.org/wp-content/uploads/2015/03/2015s11f_kemble.pdf
- CubeSats moving to more mature phase of capability
- Looking for the “killer app” e.g. space weather
- AFRL interested in
 - Missions: constellation support, high accessibility missions
 - Services: multiple access, access on-orbit communication constellations
 - Develop: SBIR efforts, demo “pointed” solutions
- Need flexibility with ground contacts
- Difficult to get contacts for VPM due to low priority on the AF system
 - Using Globalstar network
- Also experienced issues with frequency allocation for globalstar
- Highly interested in distributed systems
- GEARS-2 is going to use TCP/IP once it enters its “home zone”
- TechEdSat uses Iridium, can be used as a comparison with systems using Globalstar



Mr. Erik Eliassen, Universal Space Network

- See full presentation: http://gsaw.org/wp-content/uploads/2015/03/2015s11f_eliasen.pdf
- Large ground facilities are too expensive for CubeSat class missions
- Funding sustainment activities (ground systems) are very different from radical technologies (CubeSats)
- Cheaper access to space has driven demand for ground services
- USN compatible with CCSDS
- USN is working with radio providers
 - Erik suggests working towards a standard for radios, especially software defined
- AIAA is working on standards – minimal progress
- Can CubeSat missions levy requirements onto a ground system?
 - More automation, less focus on specific requirements



Dr. Meagan Hubbell, NRO CubeSat Office

- Prohibits growth
 - Inability to get data down lags behind capability of payloads
 - Again, frequency allocation
 - Disparity between ground stations
 - Would like dedicated launches
 - Finding CubeSat once they get to space
- Ground services needed
 - Dedicated launch
 - Talking to multiple satellites at once
 - Expensive dedicated ground systems make Cubesats less cost effective



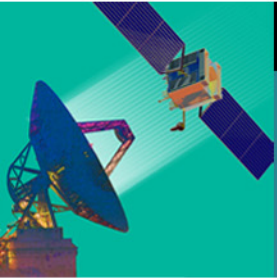
Dr. Meagan Hubbell, NRO CubeSat Office continued

- Future work
 - Using software from big systems is not cost effective
 - Looking at open source or existing software small satellite ground system
 - Common software architecture between government agencies
 - GENSO was most recent failed collaboration attempt. Utilized AX25 protocol.
- Should focus be on real time data flows, or store and forward?
 - Most CubeSats don't have capability for true real time flow
- MC3 network
 - UHF up, UHF or S-band down
 - Setting up more sites to improve coverage



Dr. Marco Villa, Tyvak Nano-Satellite Systems, Inc.

- See full presentation: http://gsaw.org/wp-content/uploads/2015/03/2015s11f_villa.pdf
- Standards won't be able to keep up with development
- Community and providers should meet in the middle to come up with tailored solutions
- Test software chain and RF separately
- Blur line between space and ground services
- Looking to utilize ubiquitous technology (e.g., internet) to enable agile spacecraft development
- Less is more for mission ops
 - data mining to keep cost down and focus on what is really important



Open Discussion/Group Participation



Open Discussion

- Are we still in the “Wild West” of CubeSats?
 - Solutions are so varied because too many systems are cobbled together because of lack of funding
 - Marco Villa’s counterpoint: Industry’s CubeSats can be very sophisticated. However learning programs still benefit from more traditional lower cost missions
- CubeSats have design difficulties due to lack of requirements such as orbit and launch environment
- Unexplored missions?
 - Small satellite constraints force alternative solutions
 - Almost every application has been explored in LEO
- Small satellites shift focus from the bus to the mission
- Small satellites don’t necessarily decrease operation cost
 - Can use adaptive scheduling with different ground facilities to reduce costs for an interplanetary mission



Open Discussion continued

- How to utilize a SmallSat as a high value asset is where missions can become constrained
- Look at the required data products to come up with a mission concept
 - Planet Labs vs Skybox
 - Skybox process data on the ground
 - Skybox doesn't require personal in the Mission Operations Center (MOC) unless there are anomalies
- Ground system deployment vs sustainment
 - Deployment can have a rapid turnaround time, but doesn't necessarily make the ground system more sustainable
- Publish information on ground station availability
 - Customers bid for time