# Working Group Discussion Summary

# Ground System Architectures Workshop

Session 11F

Ground System Enablers and Future Small Sat Development

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AEROSPACE

# 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 Eliasen, 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 Eliasen, 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