Introduction to WSMR Dome Coupled Telemetry Sensor Arrays

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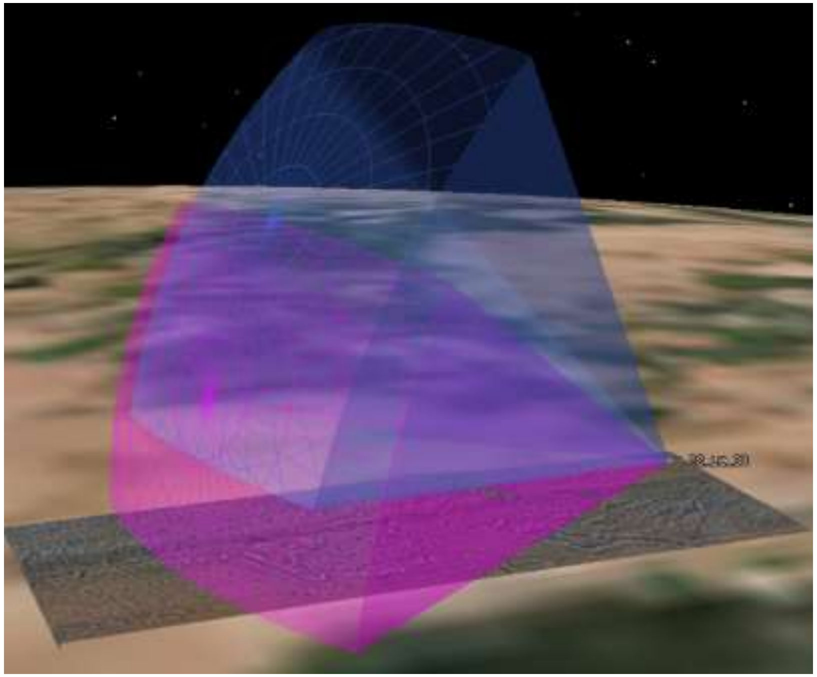
Introduction

This presentation introduces the WSMR Dome concept and provides a general description of initial testing results and projected capabilities. Existing WSMR TM architecture cannot readily support an object dense scenario without augmenting the number of traditional narrow beam trackers. The WSMR Dome approach addresses this issue by providing seamless TM coverage over expanded spatial volumes.

The WSMR Dome is comprised of groups of static arrays of antennas that can be used to cover multiple vehicles in a coverage zone. This approach is inspired by the current use and success of the Launch Area Van (LAV) systems at WSMR, which have proven that a non-tracking telemetry configuration is capable of effectively acquiring data from launch to impact.

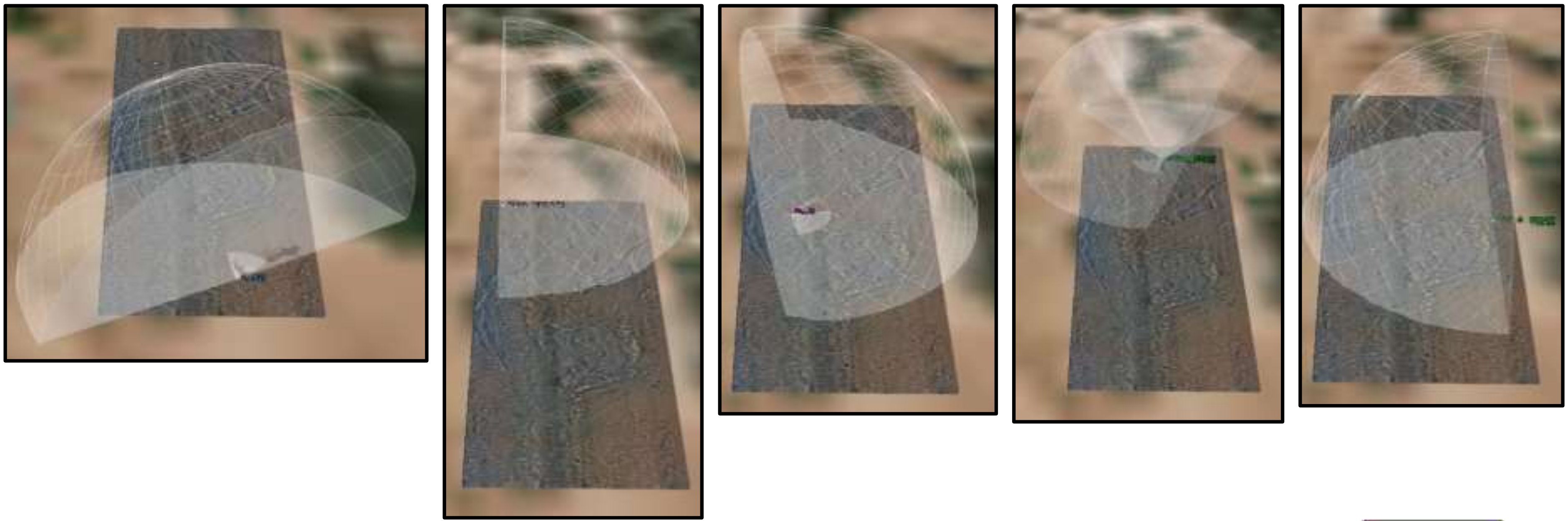
Background

- WSMR Dome is inspired by Launch Area Van (LAV) systems at WSMR
- The LAVs use two or more antenna horns to capture telemetry flight data
- Capable of collecting data from launch to impact ~80 miles
- TM receiver combiners are used to switch between two sources based on signal strength
- LAVs can only switch between two elements limiting the coverage to the beamwidth of two antennas



WSMR Dome Concept

- The WSMR Dome is comprised of multiple sets of antenna arrays deployed in strategic locations in order to provide TM coverage throughout the range

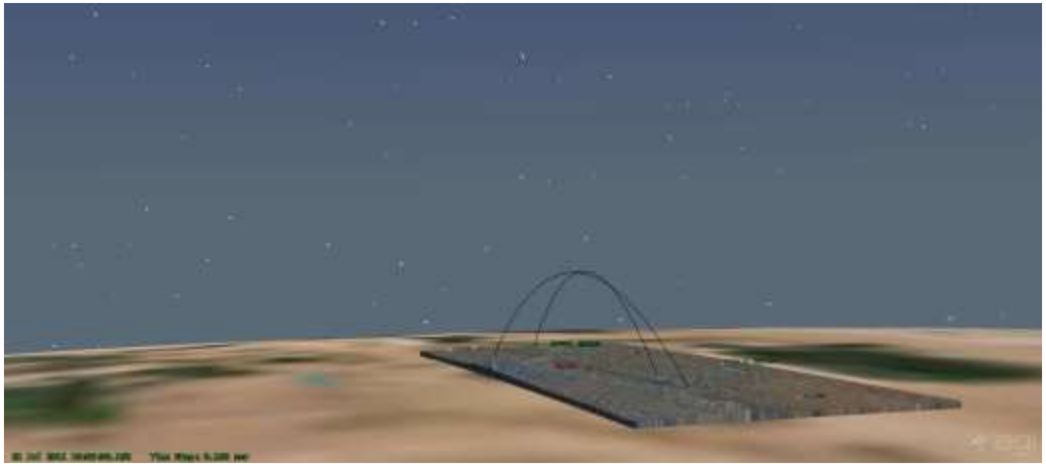


WSMR Dome Concept (cont.)

- Each antenna array consists of static horns that provide a large area of coverage and are tied to a “polling sensor”, which is capable of comparing multiple frequencies and separate vehicles simultaneously
- The “polling sensor” is used to measure the signal strength at each antenna element for any desired mission frequencies
- These measurements are compared to determine which antennas are receiving the highest signal to noise ratio per frequency
- The signals from the antennas chosen by the “polling sensor” are then routed to a bank of receivers that are configured for each mission frequency
- Source selecting at a central location creates an uninterrupted handoff between antenna array sets creating a continuous TM stream throughout missile flight

Simulations

- Using Systems Tool Kit (STK), a simulation was created to roughly model where the antenna arrays can be located throughout the range and what coverage each could provide
- These antenna models were derived from the LAV antenna performance and specs
- New models will be implemented as the system specifications are better defined



Benefits/Limitations of a Dome Architecture

Benefits

- Multiple frequencies from separate vehicles can be collected and processed simultaneously at low cost
- Increased operational and maintenance efficiency
- Augments current WSMR infrastructure to satisfy growing mission complexity
- Remote control facilitation
- Can be implemented as a mobile system
- External pointing data is not required
- Spatial diversity increases data quality
- Expandable architecture
- Can be used for frequency monitoring

Limitations

- Low gain solution cannot support long range or high altitude tests
- Increased network bandwidth requirements

Prototype Unit

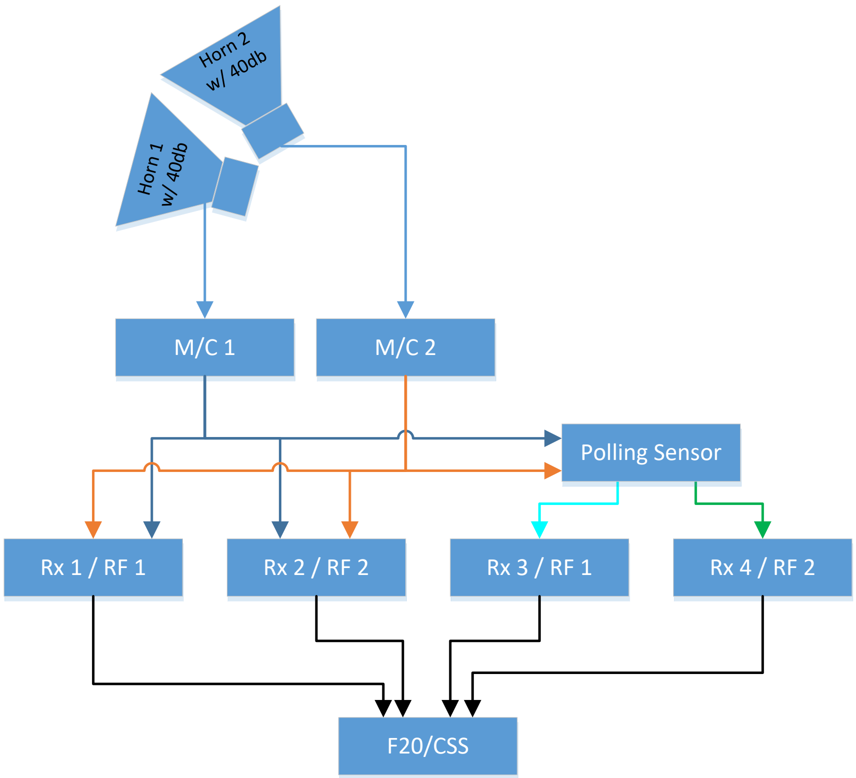
- Initial testing has recently begun using a prototype unit acquired in November 2016
- The prototype unit is capable of using up to six antenna elements to track up to two objects
- The unit can receive up to two frequencies per object, but can only track on one frequency per object

Initial Bench Testing

- The unit's RF switching capabilities were tested in a lab
- Four horn and two patch antennas were used to track two transmitters moving across the antenna fields
- This test was performed in both S and C Bands simultaneously
- The unit performed as expected
- Due to time constraints, only the conceptual switching capabilities were tested in the lab
- The unit was then installed in parallel inside the LAV to shadow a mission and compare performance

Field Testing

- A typical LAV mission was used to test the prototype under operational conditions
- The field test was configured to ensure that only the "polling sensor" performance was compared to the LAV
- The prototype was configured to track one object with two frequencies
- Both systems used the same antenna sources and similar receivers



Results and Discoveries

- The first field test for the unit yielded conceptual proof of antenna element switching in a mission environment. However, design flaws were exposed that will require some minor changes.
- The RF that was used as the primary tracking frequency experienced some drop outs causing the selection of the antenna element to be unclear to the "polling sensor". This created data gaps for the secondary frequency.
  - A frequency based selection as opposed to an object based selection must be implemented to avoid this issue and ensure scenario flexibility and reliability of every link.
  - This will require more processing capability in order to support more downlinks.
- The RF drop outs also exposed a weakness in the selection process. Currently the prototype uses only signal strength to make its antenna selection.
  - A signal to noise ratio (SNR) should be used in order to eliminate any antenna elements from being selected due to an elevated noise floor.

Path Forward

- Further testing and analysis of performance
  - Testing and mission shadowing can continue in a frequency selection type architecture
- Implement changes to prototype design
  - Frequency Selection process
  - SNR based measurements
  - Augment capabilities to twelve downlinks
- Create new simulation using more accurate antenna models
  - Not true 180° AZ x 90° EL array coverage
  - Finalize number of antenna arrays needed throughout range to support missions with suitable coverage and spatial diversity
- Acquire and assemble a fully functioning array and field it in a central location to maximize mission exposure
  - Expand number of systems to provide full WSMR coverage
- Potential candidate for CTEIP and/or Service I&M to mature and deploy the capability

Conclusion

The WSMR Dome is a low cost solution that can provide excellent augmentation to existing TM architecture. It will provide coverage that would easily handle typical and upcoming flight profiles and would minimize the amount of uprange support needed. The current prototype has provided a great starting point and upcoming testing should solidify a more complete solution to the WSMR Dome approach.

Questions?