

## HSMM-Mesh From Space

South Texas Balloon Launch  
Team  
BLT-26

## How We Did

- Goal: To determine the ability to make and maintain links over 2.4 GHz digital at long distances in harsh conditions
  - If Successful we would:
    - ◊ See the signal from the HSMM (WiFi) router
    - ◊ Show linkage of the balloon package into an active mesh
    - ◊ Be able to link to the balloon package
- Result: We were more than successful
  - We were able to see the HSMM signal throughout the flight and at a longer distance than expected
  - The balloon package stayed linked throughout the flight
  - A successful link to the balloon mini-server was achieved

## Beyond Expectations

- Other things achieved:
  - Good off-axis antenna data received
  - Active connection with the balloon package successfully toggled an onboard LED from the onboard web server
  - Path loss model was designed to be within -3.5 dB of actual measured performance
  - Mini-server capabilities and weaknesses were fully determined
  - Some video frames were downloaded

## How Was the Project Planned?

- The original concept came from independent team-member study
- These team members began focusing on specific areas:
  - Antennas
  - HSMM-MESH
  - Digital Video
  - Mini-server options
  - Payload & Weights
  - Ground Stations
  - Backup plans
- The team members worked together by:
  - Meeting for lunch or dinner over the course of a year
  - Communications via the BLT and HSMM remailer, telephone, and e-mail

## Assembly

- Component Development
  - Each focus area built their respective components
  - Debugging was usually done separately
- The goals for components were:
  - Lightweight
  - Rugged
  - Bulletproof
- Integration occurred at two separate pre-launch meetings
- Unexpected problems that arose and were solved:
  - Video stream/Server page addressing
  - Physical enclosures & power supplies
  - Groundstation focus and responsibilities

## Quality Assurance & Support

- Product Quality was assured by a rigid "Payload Master"
  - If at integration or launch something does not work, he mercilessly rips it out and tosses it on the ground saying, "This stuff doesn't work!"
- This year no team member had any equipment "Hit the dirt"
- Quality issues were rapidly solved via peer pressure...

## Key Lessons

### Thoughts for the Future

## What Went Right with BLT-26

- The HSMM-MESH software worked perfectly
- The mini-server worked as designed
- The analog video and audio worked well and the new camera was a big improvement
- The Groundstations were very functional
- The practice tethered launch on Field Day allowed the team to experience how all the components and people worked together

## What Went Wrong with BLT-26

- Ground operators had trouble doing both analog and digital simultaneously
  - Learned: Team “fell back” to the lead station doing analog and the backup station focusing on digital
  - This will be a standard configuration in the future
- The untested bi-amp experiment for the primary digital Groundstation failed
  - Learned: Antennas fail less than Amplifiers

## Findings

- The post launch analysis of the data led to a gain balance model that works extremely well
- The flight trajectory was very different from previous years. This led to suboptimal antenna performance. Diversity antennas will be used next time
- The package stayed in the mesh all the way to the manufacturers S/N ratio limit
- Webpage serving takes more than just a good mesh link due to dropped packets

## Findings

- A good estimate of required gain margin to serve web pages was determined to be about 20 dB (-70 dBm) above mesh link (-90 dBm)
- Digital video requires a larger gain margin than page serving, estimated at least 40 dB (-50 dBm)
- Antenna design is crucial, especially for the Groundstations; polarization and line losses hurt
- Power increases are not as valuable as antenna and system gain increases due to weight and batteries
- Aiming is very difficult on a digital signal due to the “all or nothing” nature. Having analog with the digital helps tremendously, and AZ-EL aiming based on GPS is next
- Full flight digital connections are within the realm of possibility

## Typical Screen Grabs



