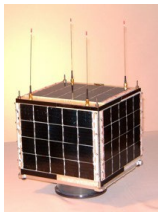
Microsat Design
What Do People Want?

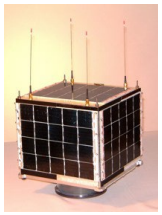


by
Rick Hambly, W2GPS

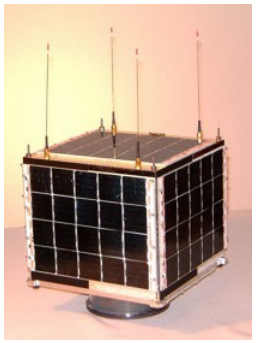
20th Space Symposium and AMSAT-NA Annual Meeting

Saturday, November 9, 2002, 08:15 - 09:00 CST
Lockheed Martin Recreation Area (LMRA), Bryant Irvin Road, Fort Worth, TX

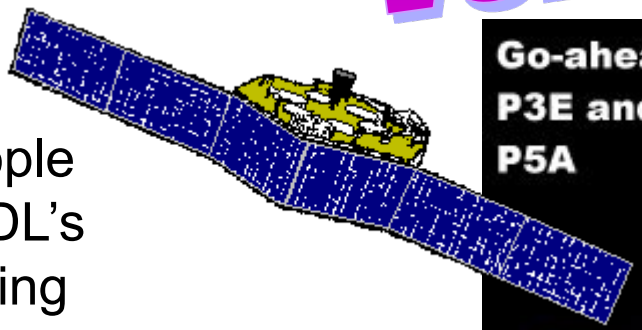
The Problem



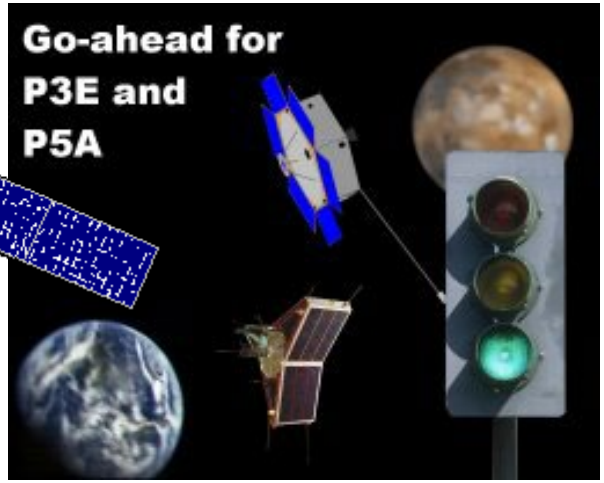
- I spent months of searching for qualified and motivated leaders and developers for AO-E's optional payloads without much success.



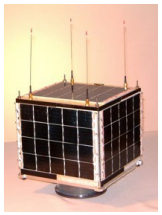
VS.



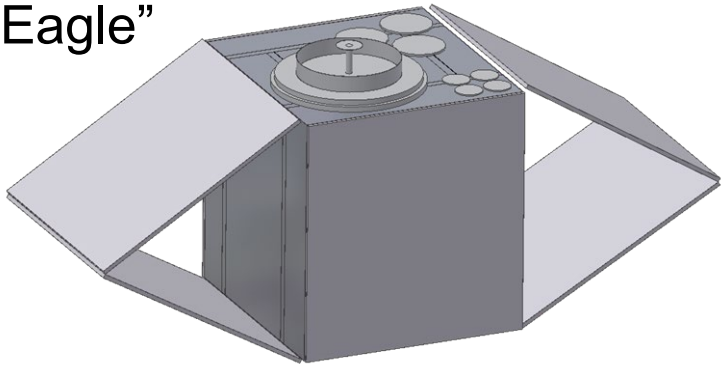
- I observed qualified people joining up with AMSAT-DL's Mars program and flocking to build CubeSats.



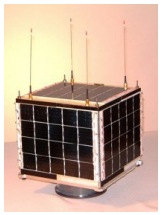
Background -1



- Jan 01: KA9Q's radical new proposal
  - Wideband digital communications pipe
  - Allows practical use of bands above 1GHz on LEO satellites
  - Eliminates Doppler tracking problems.
  - Endorsed by the AMSAT-NA Board.
- Jul 01: AMSAT-NA Project Committee met in Denver CO
  - Decide on design parameters for "Eagle"
  - Orbit similar to AO-40
  - Modes U/H, L/S
  - Little or no propulsion

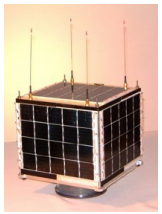


Background - 2



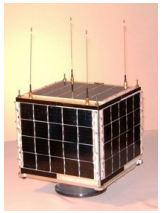
- Jan 02: AMSAT-NA approved building "Echo"
  - To be launched much sooner that "Eagle".
  - Would provide a successor to AO 27.
  - Basic systems to be built by SpaceQuest.
  - Optional systems to be built by volunteers.
- Apr 02: "Echo" launch schedule extended
  - Late 2003.
  - Gives builders more time for optional payloads.
- Oct 02: AMSAT-NA Annual Meeting
  - Many "Echo" components built.
  - No optional payloads being designed or built, yet.

The User Community

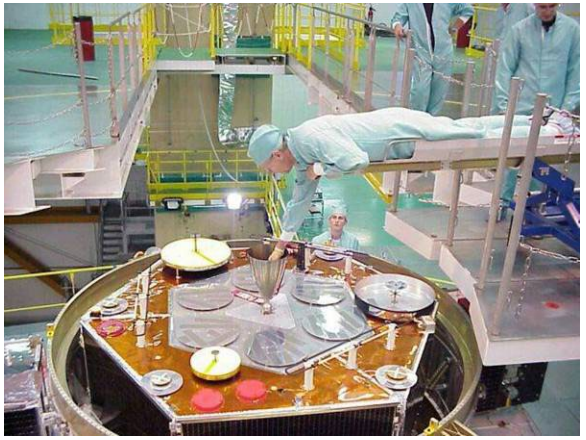


- EasySat Users
  - Simple antennas and one or two FM HandieTalkies
  - Generally pleased with AO E's core design
- Linear Transponder Users
  - Base stations with computer tracking
  - 2 meter and 70 cm beams on an Az El rotor.
  - Some have Mode U/S and/or Mode L/S.
  - Some are disappointment in AO-E - no Mode B or J linear transponder.
- APRS Users
  - 2 meter mobile and portable operation.
  - Some dedicated base stations with sophisticated software.
  - Dissatisfied with AO E because they want Mode B not J.
- Users with Limited Capabilities
  - Cannot set up home stations
  - Some compensate by becoming builders or by operating mobile/portable.
  - Would benefit from the KA9Q wideband system but many don't understand the concept.

The Builders - 1

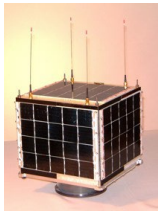


- Design, construct, test, launch, control and experiment with the satellites.
  - » Independent group of scientists, engineers technicians and others
  - » Build what they want, each using their own personal style.
  - » Some are idea people, others do conceptual design and others do post-launch analysis.



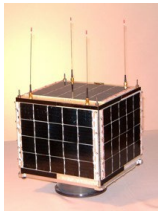
- Many do not even have a satellite station at home
  - » But when they do the stations tend to be sophisticated.
- Tend to work behind the scenes.
  - » Most don't check into nets or AMSAT-BB, don't operate satellites.
  - » Most visible at Board meetings and the Symposium.
- View their involvement as "professional" volunteers.
  - » Involvement sometimes a springboard for real professional activities.

The Builders - 2



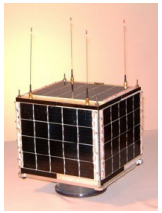
- What do the builders want?
  - Technical challenge + Recognition.
- AMSAT-DL's mission to Mars
  - Has builders lining up to get on the team.
  - It matters not that none of the people in the users groups will ever hear the signals from this spacecraft. It is a huge and worthy challenge, and that's enough!
- AO-E and "Eagle".
  - Limited enthusiasm.
  - These satellites pose relatively few interesting new challenges.
- An aging group.
  - They are a decade older than when they built the original Microsats.
  - Certain of their skills show signs of age, too.
- Young Builders
  - There are young builders - Small Satellites Conference at Utah State.
  - Many of them just haven't been introduced to Ham Radio.
  - They maybe get a license just to be able to fly their satellite.

General Membership



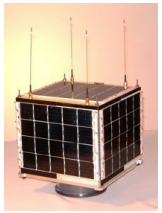
- General membership and other onlookers demand complete, honest, and timely flow of information.
  - This is especially true if the news is bad.
- When there is even a slight delay, the result is a perception that “they” are keeping something important from “us”.
  - This attitude is infectious and invariably negative.
- The Internet has enabled everyone to become an instant critic.
  - Some feedback is good, some degerates into tangents, some is downright counterproductive and some even exhibits blatant violations of the laws of physics.
  - Most of the builders ignore the feedback because S/N is so poor.
- Many of those who complain the loudest are not AMSAT members.

Technical Constraints and Other Challenges



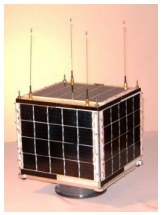
- Every year we can put more features in less space.
  - » Commercial interests have discovered the same thing
  - » No more free rides as ballast replacement.
- Software is becoming more important than ever.
  - » Modems using sound cards and DSP software.
  - » How many of us understand modern techniques of software development or the mathematics needed to grasp DSP and coding theory?
- Universities have recognized these facts and have changed their curriculums to accommodate.
  - » Joint CS and EE departments.
  - » Traditional skills essential to developing a satellite like RF, analog and digital design, are getting harder to find.

What's Wrong

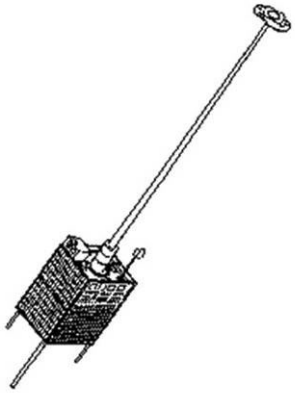


- AMSAT-NA Goals
  - Be responsive to the the average user.
  - Be realistic about what it will take to get at least one satellite launched soon.
  - Rebuild our image and membership roles.
- Realities that have, in the past, driven the development of our satellites
  - A real launch opportunity with a fixed schedule.
  - Desire of builders to build.
- Other challenges
  - Frequency spectrum envy from commercial, industrial, defense and other scientific users.
  - Regulatory issues such as space debris mitigation that could drive the cost of launching satellites beyond our reach.

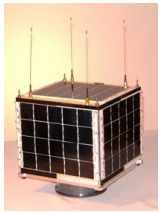
Recommendations for AO-E



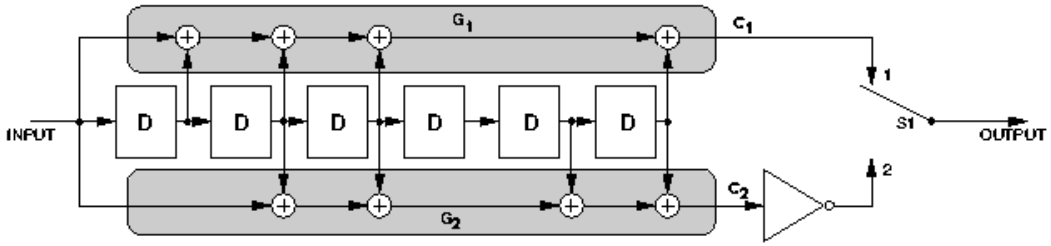
- Attitude Stabilization
  - » Gravity gradient boom (“moving parts” and pyros).
  - » System with three torque rods and a magnetometer (software + “magnetically clean” satellite).
  - » Momentum wheel (available from SST and Dynacon).
- Switch from Mode J to Mode B.
  - » Requires new 1-2 watts Tx and New Rx modules.
  - » Puts cross band interference and desense issues on the satellite.
- Add a Mode B (or J) Linear transponder
  - » Requires an AMSAT design and implementation.
  - » Mechanism to share antennas.



Recommendations for AO-E

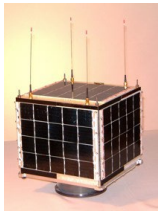


- Mode L/S transponder
  - » Must solve Doppler problem.
  - » Support development of wide band technology (KA9Q).
- Encoding of digital downlink channels.
  - » Compensate for noise and fading.
  - » Enhance link margin through coding gain.

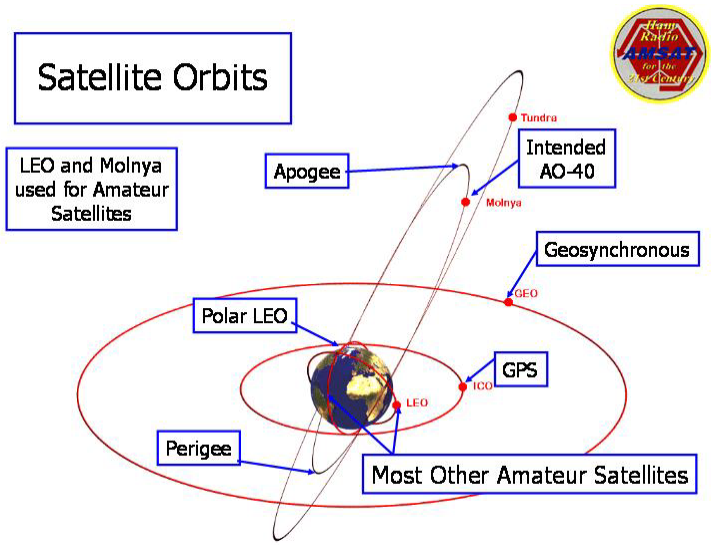


- New Operating System
  - » Open Source
  - » High Performance. Preemptive multitasking? File System?

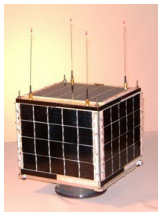
Recommendations for “Eagle”



- Achieve a favorable orbit regardless of the launch opportunity.
  - » Probably not a GTO orbit.
  - » Molnya orbit
  - » Geosynchronous orbit
  - » High Molnya orbit as used by the Sirius system .
- Put a motor on "Eagle" that is sufficient to achieve the goal or reaching the desirable orbit.
  - » **Cold Gas**
  - » **Monopropellant** (Hydrogen Peroxide, H_2O_2)
  - » **Bipropellant** (Mono-methyl hydrazine, MMH + nitrogen tetroxide, N_2O_4)
  - » **Solid fuel.**
  - » **Hybrid** (Vortex engine with Nitrous Oxide N_2O or cryogenic O_2 + Dioctyl Adipate Plasticizer, HPTB)



Cost

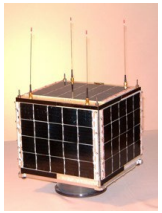


- Lack of available funding.
  - » Membership must be prepared to provide sufficient funding
  - » Can you afford 30 cents a day to support AMSAT?
- If you want AMSAT to produce the goods - then you must support AMSAT.
  - » AMSAT President's Club Core Donors program
  - » "If we were able to achieve an average donation of $10/month/member we would then have a viable satellite program."

Martha

Art, W4ART

Conclusion



- Builder Satisfaction
  - » We must fire up the imaginations of the builders.
  - » No amount of user satisfaction or fund raising will substitute for this!
- New Builders
  - » Our builders must be replaced!
  - » We need to cultivate a crop of new, younger, builders.
  - » Ask our experienced builders to act as mentors.
  - » Colleges and universities are our best hope.
- Service
  - » AMSAT-NA needs to serve the broad user community.
  - » Education, information, and activities that promote the feeling of belonging.
  - » Restore our membership rolls to the levels of a decade ago to help maintain financial vitality.