AMSAT's Phase IV (lite)?

Is this ground hog day or amateur radio?

Bob McGwier, N4HY, AMSAT Vice President of Engineering (or am I Bill Murray?)

In AMSAT, it is déjà vous all over again. We have been working ***SLOWLY*** on Eagle for years, trying to find a way to get it into space. We have done a complete redesign of Eagle. We have put it into a space frame that makes mechanical sense and will allow us to address the many issues of delivering the SERVICES we want to deliver to our users as well as all of the new users we wanted to attract. We have a paper design of a fantastic digital communications system. It is designed to carry digital voice or digital video (depending on the size of your ground antenna). We call it the advanced communications payload rather than digital payload to help everyone distinguish it from our previous digital communications endeavors. We have assured ourselves of having power in all seasons and times of the year. This is provided by the fold out solar panels you see depicted in Figure 1. We have a solid complement of linear transponders provided by software defined radio transponders (hey, I am the boss after all!)

Figure 1 Eagle Model, 1/2 Scale

We were planning on providing 60% efficient 50 to 100 kHz wide linear transponders based on the use of this software radio transponder in addition to brand new devices and the good work of N2UO, KK7P, KD6OZH, WA6HTP, G6LVB, AB2KT, and N4HY. We have a new receiver design, new transmitter design, new transponder design. In other words, we have an RF team doing work on our satellite projects unlike we have had on previous Phase 3 birds. We are even considering providing an SMS text messaging service!

Matt Ettus, N2MJI, of USRP and GnuRadio fame, is the principle investigator on the advanced communications experiment. The communications engineers helping AMSAT met in San Diego, hosted by Franklin, N6NKF.

Figure 2 Matt Ettus, N2MJI and Phil Karn, KA9Q ACP at San Diego design meeting

We were fully prepared to spend $1,000,000 U.S. on solar panels to make this happen as well as $250,000 to $500,000 on the propulsion system we would need. We were going “all in” on this for AMSAT.

This summer, AMSAT’s Executive VP, went to the “Ride Share” conference. This is a conference specifically addressing the small community of people who want to share rides with others. An earthquake happened in AMSAT’s world view. First, a little history. It has been a goal since AO-13 went into orbit to consider building a geostationary satellite for AMSAT-NA, engineering lead, Jan King, W3GEY. We called this program Phase IV. The artist’s conception for Phase IV is seen in figure 3. The goal was to put a fully stabilized satellite into geostationary orbit. We had all sorts of wild ideas about how to do things. In possible the single most difficult piece of mathematics I have ever done in applied mathematics to engineering, I derived the equations governing the viscuous fluid suspension and control of magnetic particles in a fluidic momentum controller. This was done with Lou McFadin, W5DID who had the original idea. I was his “math geek” to figure out the control equations and to decide if it was possible.

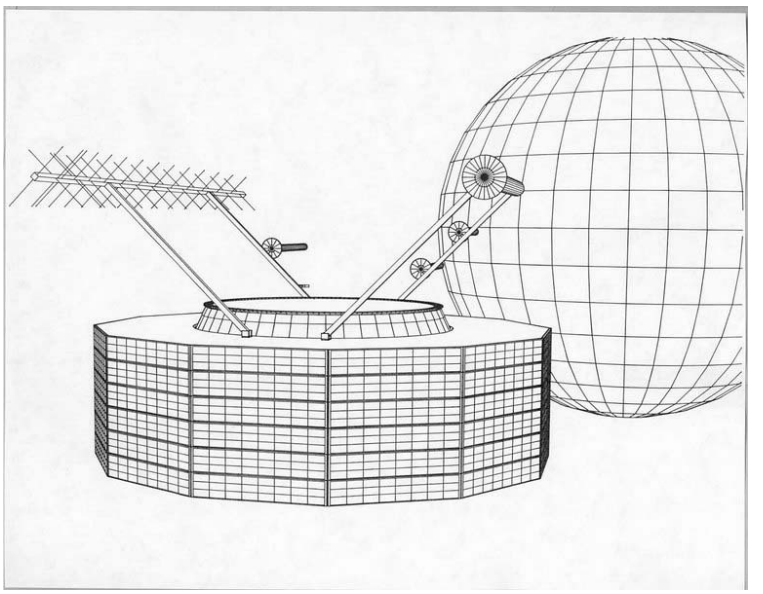

Figure 3 Phase IV (WD4FAB drawing)

One of the things that is readily apparent when you put a spacecraft into geostationary orbit and the rotate it very slowly (as in once per day, DOH!), you have one side in the sun and one side point at dark cold space for long periods of time. The thermal gradient across the spacecraft is huge. As such, we had to buy and use heat pipe technology to balance the temperature across the spacecraft. In another piece of clever engineering, we made ourselves the support mechanism for the primary payload so it would be easier for us to get a "free ride". In figure 4, these two major features, heat pipes and support structure are readily apparent in the Phase IV model.

In the end, Karl Meinzer, DJ4ZC and AMSAT-DL said to us "come on guys, get real" and join us on Phase 3D. We did and AO-40 was born. Our Phase 3 program has been remarkable. That several top notch scientists and technologists could build such systems and have them work is remarkable.

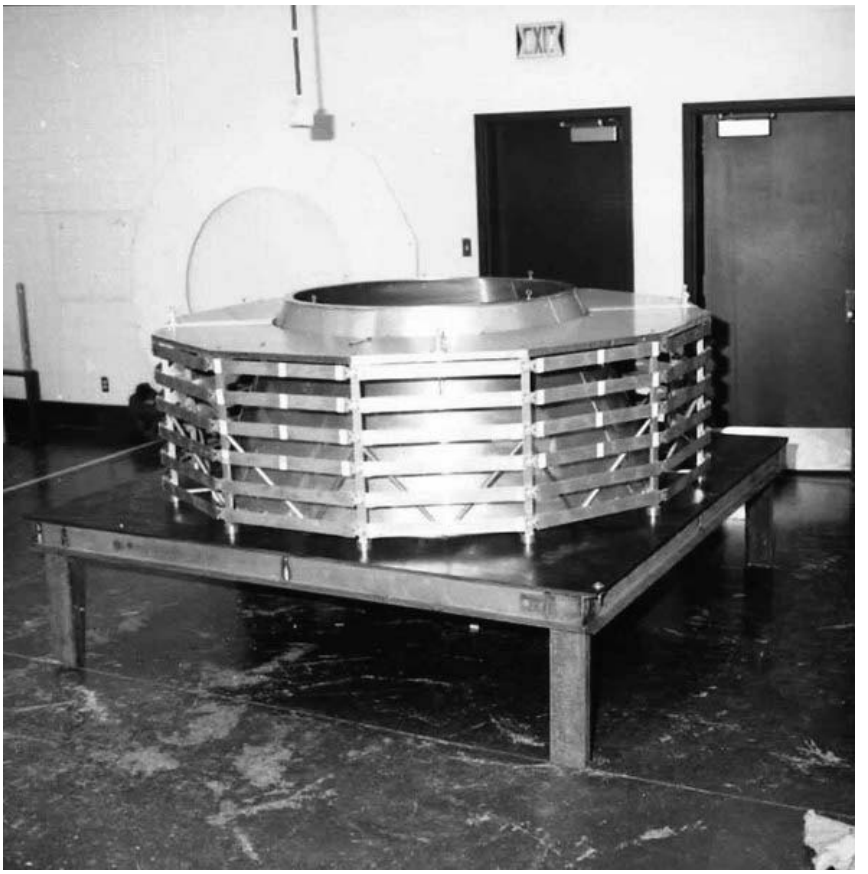

Figure 4 Phase IV model, heat pipes and support visible

Figure 5 shows the first design meeting for Phase 3D (AO-40) after we gave up on Phase IV. Yet with AO-40, the Phase 3 expansion era clearly came to an end. We did use experience garnered in building phase IV as will be readily apparent in the following.

Figure 5 Phase 3D Design, Marburg, DL, 5/90

And this led eventually to AO-40, a true monster.

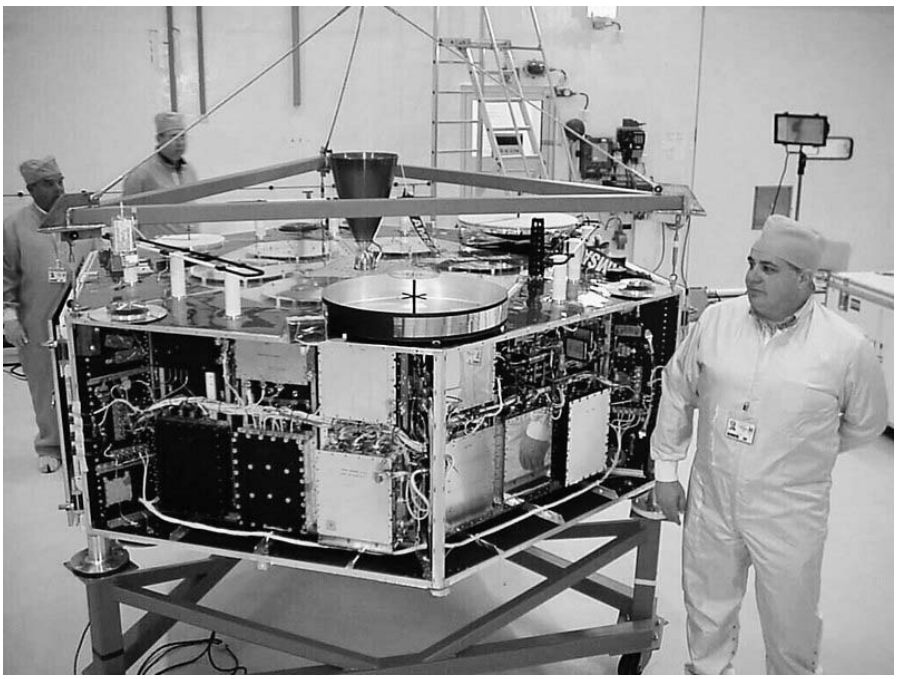

Figure 6 AO-40, over 500 Kg at launch.

The AO-40 spacecraft used the heat pipe technology and was intended to have fold out solar panels. We also used the structure technology experience from Phase IV. Our structure carried the primary payload, PANAMSAT-1 into orbit above us! We have had some serious engineering successes in AMSAT. But no one will claim that AO-40 is an unqualified success. The motor, readily apparent in figure 6 blew up after its first burn, forever changing our view of ourselves, these large missions, and our ability to do this kind of engineering. Eagle was to be a simpler Phase 3 spacecraft and then Karl, DJ4ZC, decided to do Phase 3E.

which is essentially a copy of AO-13 but testing new technology for his Phase V goal of sending a spacecraft to Mars.

As I said earlier, Lee, KU4OS, AMSAT-NA's EVP, went to a conference. At this conference Intelsat told the audience it was selling rides to worthy payloads. Rick Hambly, W2GPS, our president knows a just retiring executive from Intelsat. He just happens to be a neighbor of Rick's and a ham! He has been helping us prepare our request. We have had meetings with Intelsat to prepare for the formal request.

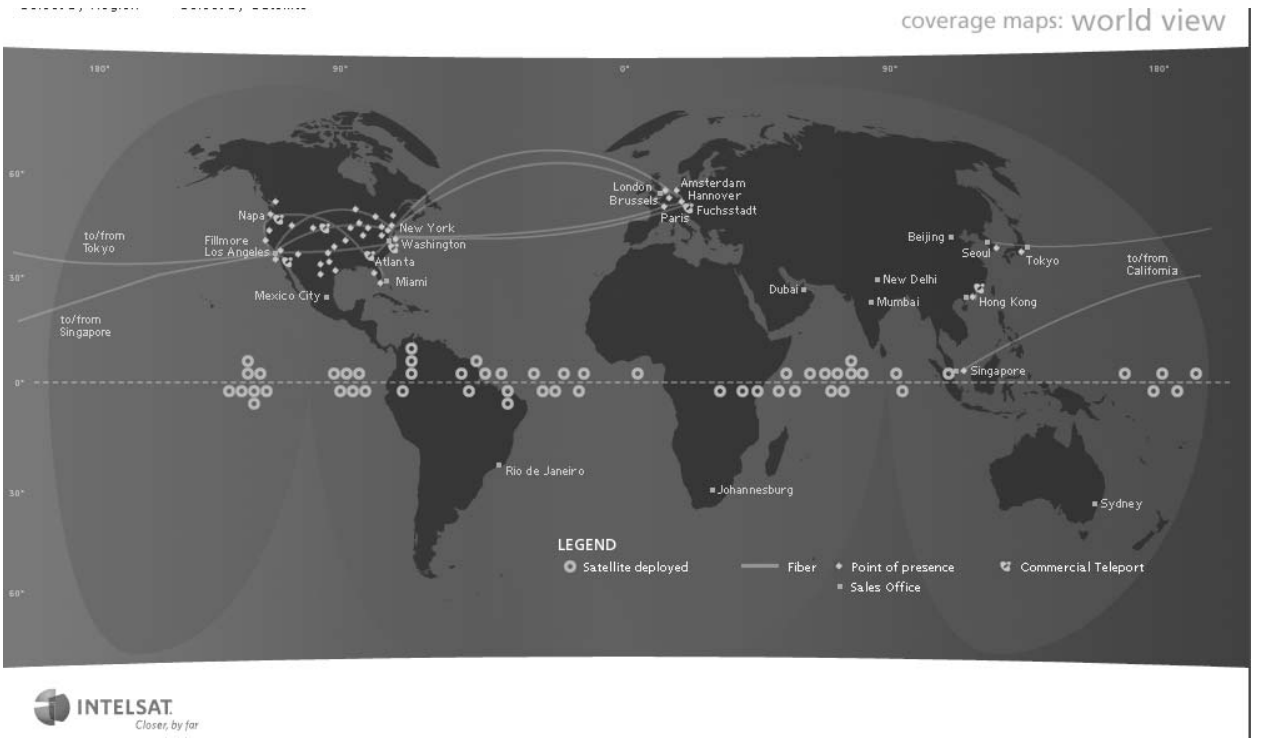

Figure 7 Intelsat view of the world

What can we do with a picture like this in our minds? I could have told you this story without all of those incredible photo's of our engineering prowess, some successes, some failures. Probably our greatest successes came in areas the typical user could not possibly care about. They just want it to work so they can use it. Take all of the incredible engineering you see in figures 1-6 and a lot of the people and thank them for their efforts, look back at the "glory days" because, they are not needed. Intelsat has one THOUSAND watts of excess generation power generation capacity at the beginning of life. This is aimed at 300 watts of excess capacity at the end of life after fifteen YEARS of solar degradation. They have a huge amount of extra room and lift capability on the rockets they ride, so it would be good for them for all sorts of engineering reasons to have us ride and use that capacity. So what do we need to do. Let's see, they will provide us a place on the bottom, nadir pointing (earth pointing) side of their spacecraft and we ride and stay there forever. So what does this mean? We have no need for solar panels. We have no need for a motor. We have no need to care about mechanical balance to fire the rocket motor. We simply fly our RF and control electronics. They provide us with enough territory for our package that we can put very good antennas on the outside of our package. What does this buy us? Geostationary means never having to say you are sorry. We never apologize for being out of view. Once it is up, the user points their antenna at it and forget the antenna rotators forever. Once it is up, the user can use it the first day they give us power. Because there is no major commissioning and no motor to burn. Intelsat will burn their motor to go to geo. They provide us with attitude control. So we need no magnetorquers or gas jets or momentum wheels or

attitude sensors. The complexity of our spacecraft just falls away as if by magic. The magic of a good ride on someone else's platform and we provide RF and services.

Which rides do we want? You see those orange dots in figure 7. Those are the ones we want. We want to build a long term mutually beneficial relationship with Intelsat. Because if we do, and we get these rides, we will not only change AMSAT, stop for a moment and ponder. We will change all of amateur radio forever. It will quite literally never be the same.

AMSAT will want to provide local emergency ARES teams with ground terminals, the red cross, etc. We will NEVER be off the air because a hurricane, earthquake, terrorist attack, etc. brought us down. Point the lower power consumption terminal at the satellite and talk. MARS will be completely revitalized. Imagine every foreign deployment having a MARS station where we have to get new authorizations to conduct MARS communications through these satellites. ARRL could provide LIVE digital television broadcasts around the world. So could RSGB, etc. Our SMS text messaging service will operate on something like a PDA attached to a little RF gizmo with low power and small antennas and operate over most of the planet. Now you know WHY we need ALL of those dots on the Intelsat map. After a short time, we will be full on our first system. We need to have a plan to go forward with an increase in our system capacity on every possible Intelsat launch for the foreseeable future.

If you think you have ever seen me excited before, forget it. Nothing compares to this. I want to be the AMSAT engineering leader that helped give amateur radio a rebirth by making this happen.