

AMSAT UK OSCAR NEWS

The official journal of AMSAT-UK for all users of OSCAR satellites



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The Radio Amateur Satellite Organisation of the United Kingdom
(Affiliated to the Radio Society of Great Britain)

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Oscar News is usually sent to members 4 times per year (Dec. Mar, Jun, and Sep).
Articles and news items for inclusion in future issues will be very welcome. For the
time being please email: g3vzv.at.amsat.org

Front Page Illustration: Celebrating the 50th Anniversary of the first human space flight.
At 06:07 UTC April 12th 1961 Yuri Gagarin was launched in the Vostok-1 capsule for a single orbit
from Baikonor Cosmodrome.

From the Hon Sec's Keyboard!**HAPPY BIRTHDAY TO ME!**

I am reminded by the file number on this document, that this is approx the 50th "from the Hon Sec's Keyboard" that I have written, so pardon me for a trip down memory lane in the following few paragraphs!

I was rummaging in my loft a few days ago, looking through a box of old AMSAT-UK photos when I came across a copy of the letter written by our chairman, Martin Sweeting, G3YJO in the year 2000 to all AMSAT-UK members. Many of you will recall its contents, which had the message, if we can't find a new Hon Sec/Hon Treas to take over from Fred and Jenny Southwell then the future of AMSAT-UK looks bleak. I think it was a few weeks after this that I made my first trip to Fred and Jenny to gain an idea of what was involved in being the Hon Sec. So it must have been 1 Jan 2001, when I formally took over as Hon Sec, so not only is this my 50th Hon Sec Keyboard piece, but I think I can claim 10 years of Hon Secretary-ship! How time flies when you are enjoying yourself!

When I look back over those ten years, I do so with a mixture of emotions. One of them is sadness at the loss of quite a few friends who have passed away. I do not claim to know every individual member of AMSAT personally, but its always sad to receive notification of the loss of a member, whether I have known them personally or not. Most of the letters/emails I receive from those family members left behind, be they widows, sons or daughters, almost invariably indicate how much their loved one enjoyed his/her hobby and appreciated their membership of AMSAT-UK. If course this gives me a sense of responsibility, and also satisfaction that I was able to take over from Fred and Jenny when I did.

I shouldn't make light of the assistance I have had from many others, particularly the AMSAT-UK committee past and present. When I took over as Hon Sec, committee member Barry Sankey took over as Hon Treas. After about a year or so he asked to be replaced, as he found the job too time consuming given his busy day job and family commitments. After taking an old friend of mine, Stan Symons, G3DSS, to an AMSAT-UK Colloquium, I managed to persuade him to be our Hon Treas. Stan sadly went Silent Key a couple of years ago, and Jules Thompson stepped into the breach.

Looking back over the last ten years, I think some of the significant events/developments for AMSAT-UK have been:

The recent setting up of the on-line shop. Trade has been brisk, and Ciaran Morgan has done a great job over the last couple of years in finding new and useful items to sell.

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Letter from the Editor—Graham Shirville G3VZV

Welcome to ON 193! We seem to have been able to put together rather a bumper edition this time!

Of particular note is the fact that we have reports on FOUR UK CubeSat projects currently being developed. This is great news and hopefully this activity will spur the UK Space Agency and our politicians to quickly make the required changes to the UK Outer Space Act that will be needed for them to be launched as UK "birds".

The paper on STRaND is particularly interesting as it describes not only the satellite itself but also how the development team has been put together and how it works in practice. Essential reading for future CubeSat teams .

In addition to the four UK CubeSats it is also good to also be able to include brief details of two new cubesat projects from the AMSAT team in South Africa. We wish them good fortune as well.

Our thanks go to AMSAT in the US for permission to reprint, from their AMSAT Journal magazine, KA2UPW's article about the ARRISat telemetry and decoder. It will be good to hear the signals from this spacecraft hopefully soon.

No edition of OSCAR News would be complete without a plea from the Editor for the more articles. If you find this one a bit too technical then perhaps you could let us have a short report on your activities? We hear many stations working through the various satellites that are available to us and know that many others are busy downloading and decoding the telemetry. Why not share your experiences, both successful and unsuccessful ones, with fellow members of AMSAT-UK?

IAA Conference Report – Jan 2011 Rome

Graham Shirville G3VZV

This was a week long conference which concentrated entirely on small satellites – primarily CubeSats.

It was quite a marathon with over one hundred presentations crammed into the five days!

They were arranged to cover a wide variety of subject areas. From “ADCS Solutions” to “Launch Opportunities”, from “CubeSat Subsystems” to “Ground Station Networks”. One of the best segments was actually the

WHERE WE ARE AND WHERE WE ARE PLANNING TO GO
 “FROM NANOSATELLITES TO FEMTOSATELLITES”
 www.gaussteam.com

1ST IAA CONFERENCE ON UNIVERSITY SATELLITE MISSIONS AND CUBESAT WORKSHOP



last one “CubeSat subsystems – electric propulsion”. These were given late on the Friday evening but showed that now that attitude determination and control can be achieved on a CubeSat it is possible to experiment with micro-propulsion systems that could provide some reasonable dV numbers for orbit changes.

Of course this is mainly intended to deal with “debris mitigation” but it would be possible to use these systems to take a future Oscar CubeSat to a higher orbit to provide longer range amateur communications. One team was talking of a system that had a mass of 290gm plus 200gm of fuel. It would consume 13 watts and provide 200 micro-newtons of force.

These numbers would appear reasonable in the context of a 3U CubeSat and it was claimed that this sub-system

could raise the orbit by some 2000km over a period of only 13 days!

We were well represented with presentations about four UK satellite projects and a number of others about particular sub-systems and payloads that are being developed in this country.

Amongst the delegates and speakers were a fair sprinkling of radio amateurs and the contribution made by IARU in terms of frequency coordination was mentioned by many presenters.

There was a short FUNcube presentation combined with a FCD demonstration which attracted a lot of attention. During one of the refreshment breaks we were also able to demonstrate reception of UHF AX25 signals from an engineering model of the one of the student CubeSat projects on show at a nearby table. The student team was quite surprised to see how “wide” their signal was when it was shown using the Spectravue waterfall display!

Between the various presentations, quite a few CubeSat statistics were provided. The first was launched in 2003 and since then more than sixty have been launched and at least forty are still in orbit. Apparently there are at least 200 current projects, although it is not expected that all of these will reach a launch pad at any time soon. Eight different launch vehicles have been used so far and three more have CubeSats currently manifested.

The organisers have already set the dates for next year’s event. Again it will be at the end of January but it will be held in Brussels.

Two New CubeSats from the Southern Hemisphere



SA AMSAT is launching two satellite projects, both CubeSats but with totally different design approaches and time lines.

The first project will focus on providing a FM transponder that will be available on

most passes over South Africa and will have a short time line to launch.

The FM Transponder CubeSat which has been provisionally named KLETskous will be based on a standard available space frame and sub system with a locally designed payload. The project will be coordinated by Hannes Coetzee ZS6BPZ. SA AMSAT is inviting radio amateurs who have an interest in satellites to the project team.

They have also launched an innovative satellite project and are inviting the participation of South African Universities of Technology in the development and construction of a completely South African Amateur Radio experimental satellite. The objective of this satellite is to demonstrate South Africa's ability to engineer a satellite, employing the latest technology, and new innovations. In addition there are some feasibility projects for future commercial use.

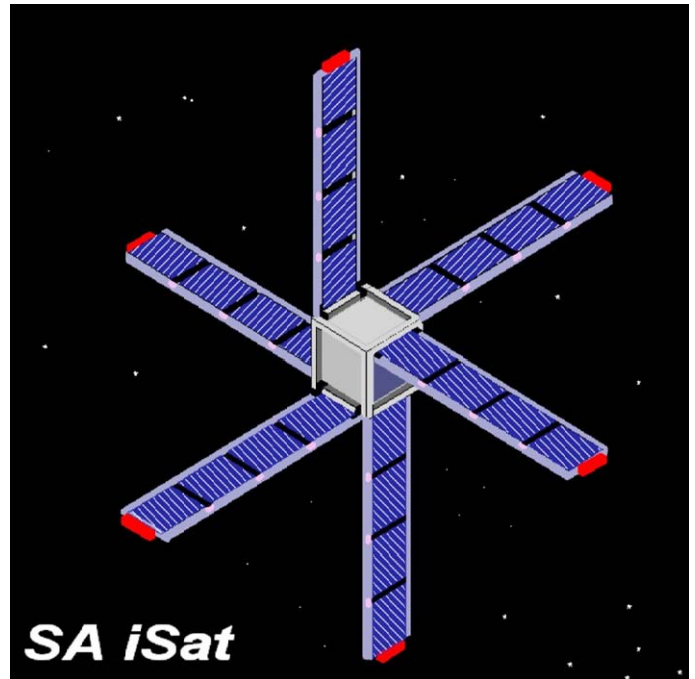
The name SAiSAT has been taken from the name imagination satellite, which was an earlier project to promote the concept of a South African Amateur Radio Satellite. This initiative resulted in two satellite projects, a basic CubeSat called "Kletskous", the Afrikaans for chatterbox and SAiSAT.

Kletskous is a shorter term project aimed for launch in 2012/3 while SAiSAT is a very involved project testing the limits of ingenuity and technology. SAiSAT is based on the CubeSat satellite. With many institutions participating in the CubeSat programme, the educational benefits are extensive. Students, through hands-on work, are given the opportunity to develop the necessary skills and experience needed to succeed in industry after graduation.

The CubeSat programme also benefits private firms and government by providing a low-cost way of flying payloads in space whilst creating important educational opportunities for future leaders of industry. This concept was clearly illustrated by the University of Stellenbosch SunSat success story that qualified engineers who were snapped up by Industry and which also resulted in the formation of the company SunSpace.

The reason for the decision to go the CubeSat route has only one dimension - financial. Launch opportunities are available at reasonable cost. However going the CubeSat route has restrictions including a very low power budget, very little space ~ 100mm square inside the cube, low mass specification, and the lack of opportunity for a platform stabilisation system.

SAiSAT overcomes these problems while still complying with the mechanical specification of the CubeSat format and by taking advantage of available launch opportunities and still supporting many projects on board.



SAiSAT will use fold out panels, a total of 24 in all, that support solar panel steering in order to capture the maximum energy available from the sun. The rear of the solar panels is free for project use. Potentially 24 projects depending on size can be accommodated. In addition the centre core of the Cube is still available for a large battery component. The power budget is to be evaluated but seems to indicate that a 12V DC 16 Ah supply can be accommodated which is very considerable for a small satellite.

It is further proposed that the outer rim of each panel is fitted with PCB tracks in the form of a coil. The fitted coils will have 4 main functions:

1. To generate additional power from the Earth's magnetic field.
2. To torque the satellite against the Earth's magnetic field.
3. To give orientation data to resolve the attitude of the satellite.
4. To take additional unused power from the batteries and elevate the satellite into an ever increasing orbit thus extending its usefulness and life.

Goonhilly satellite station in Cornwall is to become the UK's biggest centre for communicating with deep space missions.

Iconic Goonhilly Satellite Earth Station on Cornwall's Lizard peninsula might once again be set to play a "starring" role at the forefront of technology. The former BT Satellite Earth Station is now set to be upgraded and re-developed by a consortium, Goonhilly Earth Station Limited (GES), for use at the forefront of world-leading Radio Astronomy projects and Deep Space Network communications.

There are also plans to redevelop the Visitors Centre into an exciting new "Space" themed outreach centre. The plan has been almost three years in the making and was the brainchild of Ian Jones, Managing Director of the space sector company, Orbit Research Limited and now Chief Executive Officer of GES.

GES has worked closely with BT to develop the opportunity and a deal has been agreed, which includes GES taking a three-year lease on most Goonhilly antennas, including the four largest giant dishes, and an option to purchase the whole site for an undisclosed sum. BT will continue to occupy parts of the site. It will retain possession of some of the operational buildings, retain use of some of the smaller satellite dishes and will continue to employ about 50 people engaged in research, testing and other operations.



GES has identified and advanced exciting plans for the site to undertake a programme to upgrade the antennas which will enable deep space communication with spacecraft missions and to develop an exciting Space themed outreach centre. In addition, the GES partnership with Oxford University has enabled the scope of the project to include the delivery of ground breaking

radio astronomy work focused on the origins of the Universe.

Ian Jones said:

"Goonhilly is one of those amazing places that inspire people and has a pioneering heritage in international communications from the time when the first trans-Atlantic satellite TV broadcasts were made in the 1960s. Now we have plans to go one stage further and to use the antennas at Goonhilly to support space science missions to the Moon, Mars and beyond.

We plan to link up with the e-MERLIN Network operated out of Jodrell Bank creating an enhanced radio telescope network.

"As a child I can remember being inspired by the Apollo missions – my work as a satellite communication design engineer brought me here to Goonhilly to design, build and test mobile satellite communication systems. In the future I want Goonhilly to continue to provide inspiration to the next generation of scientists and engineers as we plan a challenging range of outreach and education initiatives for families, researchers and industry leaders. It is our vision that Goonhilly and the UK will continue to be recognized world leaders in Space science.

"Goonhilly can become a vital part of the rapidly-evolving story of the UK's space programme and an important source for skilled jobs in Cornwall. Space science is undoubtedly one of the technology sectors offering great opportunity for expansion in the years ahead."

One initial focus for the project will be to upgrade the site's antennas. This will enable a sustainable and cost effective means of ensuring their longevity and their continued practical but alternative use for Deep Space Communications work and Radio Astronomy projects. It will also enable both ground breaking science and the development of teaching opportunities for Oxford and other University undergraduates and graduates from the site. In addition, an exciting upgrade to the old visitor centre is planned, to transform it into an outreach centre promoting Space and Space science for visitors, including local residents and schools.

Antenna upgrade funding and funding for the outreach centre upgrades will be subject to support from both public and private sectors.

(Editor's Note: We understand that GES is planning to develop a number of replaceable "cartridges" that can be quickly installed at the dish focal point. They believe that it would be possible for one of these to be an "amateur" cartridge suitable for both transmitting and receiving. This would obviously be a tremendous asset for both terrestrial and satellite work at VHF, UHF and microwave frequencies in the future)

AMSAT-UK CubeSat projects - March 2011 Update

FUNcube

The FUNcube CubeSat project continues to progress well.

On the technical side a further Face to Face meeting of the development team is planned for mid March. The plan for the meeting is to thoroughly exercise all the software using physical boards or simulators. We also expect to be able to fully evaluate the full power performance of the transponder at the same time.

The current intention is to have the Flight Model of the satellite ready in time for limited display (perhaps remotely via a webcam in a clean room) during the Colloquium at the end of July.

In regards to the educational outreach we continue to develop the “back office” data warehouse facility and have produced an outline of the requirements for the front end GUI for schools and other users. We are developing contacts with the educational world and intend to find a person from that background to lead the outreach activities that will be made possible by the satellite.

The groundstation hardware requirements have not been forgotten of course. The “Pro” version of the FUNcube Dongle SDR receiver, also referred to as the FCD, is already being produced in limited quantities and has received a rapturous reception from both amateurs and professionals around the world. Supplies are unfortunately severely limited at the moment but the latest availability info can always be found at www.funcubedongle.com

Howard, G6LVB, the FCD creator has very generously agreed to donate a proportion of the profits of the sale of FCDs to AMSAT-UK, and we will be able to use this gift to further our aims, eg fund part of the launch costs..

It is planned that the “Education” version of this completely novel receiver, probably with limited frequency coverage, will be made available to schools and others at a significantly reduced price compared to the “Pro” version.

Work is also underway to evaluate and define the best sort of antenna and filter combination to use for this type of application. If you would like to become involved in this part of the project please contact Jim G3WGM who is the FUNcube Project Manager.

Currently we are actively investigating all possible launch possibilities which fit or nearly fit our ideal “profile”. In short, this means a Sun Synchronous circular polar orbit with an LTAN of around 10:30, an orbital height of between 500 and 650km and a launch

date of as soon as possible after August this year. We have already received some offers which are being further reviewed but generally, as reported elsewhere in this edition, it appears that there is a general shortage of such launch opportunities until well into 2012.

Up to date information continues to be available at www.funcube.org.uk

UKube

The UK Space Agency UKube-1 project is also going ahead with great speed. Again a launch date has not yet been finalised but the team is hoping that the spacecraft will be in space by the end of this year.

As mentioned in the previous edition of Oscar News, the UK Space Agency has agreed that this 3U CubeSat will carry a complete set of FUNcube boards so will be able to provide a second source of telemetry for schools on the ground. This will contribute the educational outreach sub-system for the platform. It will also retain the FUNcube amateur transponder functionality for use at weekends and in the evenings.

The FUNcube development team is taking on this extra work with enthusiasm and AMSAT-UK is, of course, delighted to have been given this unique opportunity.

A “CubeSat Workshop” was held in London on February 14th. This included a presentation on UKube. The three successful payloads will be identified by the second week of March and a CDR (Critical Design Review) of the whole project will take place in May.

It was reported that no definitive launch opportunity had yet been identified but that a number were under review.

The flight ready payloads will be needed by the end of July this year.

The mission will comprise one year of experiments with 2 axis attitude control followed by (at least) two further years of amateur mission when attitude control would not be so critical.

More news when it becomes available.

**Did you know that the
AMSAT-UK online shop at
<http://shop.amsat.org.uk> takes
all major credit cards AND
PayPal?**

STRaND: Surrey Training Research and Nanosatellite Demonstrator

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1. Introduction

STRaND stands for Surrey Training, Research and Nanosatellite Demonstration, and the aims of the programme are synonymous with the acronym. The programme was initiated out of a desire to:

- Give less-experienced Surrey Satellite Technology Ltd. (SSTL) engineers and Surrey Space Centre (SSC) researchers the chance to rapidly gain new skills.
- Develop innovative nanosatellite technologies with the possibility of commercialisation by SSTL
- Challenge the traditional SSTL approach and the processes that have developed in SSTL over the last 25 years, and perhaps most importantly
- To maintain the formal and informal links between SSTL and the Surrey Space Centre at all levels of both organisations.

The STRaND programme is intended to be a long-term arrangement between SSTL and the SSC, with STRaND -1 the first of a long line of STRaND nanosatellites. It builds upon a similar programme, a decade ago, which resulted in the highly successful SNAP-1 nanosatellite mission, launched in 2000 [1].

1.1. The STRaND Project and Goals

STRaND started out as a feasibility study and mission requirement exercise in the Mission Concepts team at SSTL, with the aim of answering the question: ‘what could SSTL do to leverage the explosion in miniature consumer-level technology that has occurred in the last 10 years?’. At the same time, SSC were developing an advanced CubeSat bus, so with input from the advanced space system research at the Surrey Space Centre, the result of the feasibility study and requirements exercise was an initial mission concept for a rapid, low cost technology demonstrator and requirements list, including a list of payload candidates, a component make/buy list, high level concept of operations (CONOPS) and mass, power and budgets.

The goals set for STRaND were graduated into three levels of priority, and covered all aspects of the programme, including programmatic, management and technical goals, found in Tables 1 and 2. The three levels of programme goal priority were primary, secondary, and tertiary. Only the primary set of goals need to be achieved for the mission to be a success.

Requirement Level	Mission Requirement	
Primary	Gain engineering experience for SSTL staff	
	Work closely with SSC to maintain ties with the university	
	Fly <i>something</i> and demonstrate an operational telemetry link	
Secondary	One or more of the payloads work	
	Rapid development and build time	
	Demonstrate the use of modern COTS for space applications by accepting an above-normal level of technical risk	
Tertiary	Remote inspection of a rocket body	
	Sustained outreach programme	
	Gain heritage of STRaND components for use in commercial SSTL missions	

Table 1. Mission Requirements

Requirement Level	Power Subsystem Requirements
Primary	Power core systems permanently
Secondary	Enable 1 operation per sunlit orbit section
Tertiary	Enable more operations per sunlit orbit section, or one operation during eclipse (implies successful deployment of solar arrays)
Attitude control system Requirements	
Primary	Detumble the satellite and point panels towards the sun
Secondary	Enable camera pointing for imaging the Earth and the rocket body
Tertiary	Detumble and achieve full 3-axis control within 1 hour
Payload Requirements	
Primary	Receive telemetry from a payload
Secondary	Take imagery from a payload and downlink it to a groundstation
Tertiary	Make use of all expected payload functions

Table 2. Subsystem Requirements

1.2. Evolution of Team

The feasibility study phase of the STRaND programme was initiated in February 2010. At the time the team consisted of an SSTL Mission Concepts Engineer acting as lead system engineer, and SSC Academic acting as Principal Investigator and an SSC Research Assistant acting as a nanosatellite technology and payload consultant. The feasibility analysis was concluded in April 2010, as the task was considered a low priority compared to business oriented tasks. The study phase culminated in a mission concept design review with senior SSTL engineers and senior SSC academics given the chance to decide on whether to proceed with the programme. The results of the feasibility study were prom-

ising and exciting and the programme was finally given a 'go'.

Any SSTL employee wishing to be involved with the STRaND programme had to be a volunteer. It is a condition of the programme that volunteers from SSTL and SSC use their own, free time for STRaND activities (such as lunches and breaks). There is a budget for hardware but no budget for man-power. This condition made finding willing volunteers a difficulty, however the first call for SSTL volunteers generated interest from at least 10% of the company, and a core team of six SSC academics and researchers.

Volunteers are expected to join the STRaND programme for their own benefit. In most cases, volunteers use STRaND-1 as an opportunity to learn new skills. Their responses included information on which skills the volunteer wanted to develop and so this was mapped to roles on the STRaND-1 mission. The programme is intended to be as inclusive as possible to maximise the benefit to SSTL and SSC. No volunteer was turned away.

The organisation of the team follows the standard Surrey practise of grouping by subsystem. However as the programme has evolved, this organisation was found to be restrictive, e.g. attitude/orbit and the on-board computer software were found to have much in common and it was more pragmatic to merge the groups. Therefore a new arrangement organised along skill sets rather than subsystems is being considered. This is a lesson that was learnt recently on the Astrium UK LunchSat project [2] and STRaND may follow a similar organisational structure as evidence that this is a more efficient structure, in general, for combined industrial/academic CubeSat/nanosatellite projects where the technical complexity of the satellite is constrained enough to allow engineers to be involved with multiple subsystems.

A similar move is also being considered with work package management. The STRaND mission was originally scoped out with work packages, as is standard industry practice. However this method was found to be restrictive and inhibited engineers' innovation to solve problems.

The STRaND team is currently transitioning to a more ownership-based system where engineers have the freedom to tackle tasks as they see fit, without being committed to a work package.

SSTL is a growing company with a growing workload. It is inevitable that during the course of the mission timeline there would be cases where volunteers would have to drop out of the programme due to increased commitments on commercial SSTL projects, as the amount of free time they could spend diminished. It is interesting to note that the rate of volunteer erosion is not constant, and a peak in erosion was seen approximately 5 months in to the project, however the team has

been stable for the last 3 months. This is analogous to the settling of a 'core team' which is standard SSTL procedure for satellite manufacture. The growth of the SSC STRaND team was more organic, and followed a more reactive process where volunteers were recruited as technical needs demanded. At the time of writing the ratio of SSTL engineers to SSC engineers involved on the project is approximately 3:2.

1.2.1. Stealth Reviewers and Mentors

The STRaND programme has been an opportunity to try a different approach to guidance and technical review than the standard SSTL (and indeed industry standard) approach of milestone reviews. The mission has a set of reviewers for each subsystem or volunteer, and the reviewers are expected to conduct reviews at random. This method was developed out of pragmatism as the reviewers are senior engineers with very little time availability. However, the system has additional benefits (one could say) in that volunteer engineers do not know when reviews will occur, so progressing the mission activities instead of preparing documents for review milestones. This also means that progress can be demonstrated regardless of when the next review takes place.

Stealth reviews have so far tended to be informal, irregular discussions. It is the close contact that enables the volunteers to avoid the need for formal review documentation, as the reviewer tends to be as up to date with recent events as the volunteer. This method of review is not designed or expected to be transferable to standard SSTL operation as it does not provide a satisfactory record of traceability. It is, however, ideal for the fast paced, innovation-rich and customer-less 'pathfinder' type missions that the STRaND programme is intended to produce.

1.2.2. Inter-team Cooperation and Knowledge Transfer

The Surrey Space Centre has developed expertise in embedded and miniaturised CubeSat technologies and standards that SSTL does not currently utilise. The STRaND programme is an ideal vehicle to start the transfer of this expertise into SSTL. SSTL benefits from increased understanding of very new technologies and how they can be incorporated in to existing SSTL heritage systems, and SSC benefits from greater visibility of their CubeSat projects within SSTL with the potential for industrialisation and commercialisation. On a related topic, SSC is a core participant of the amateur ground-station networking.

Although the transfer of knowledge is primarily from the University to Industry (as is expected), there are practical engineering skills that SSTL is helping SSC to gain. For example in SSTL solar array manufacturing expertise and antenna deployment mechanisms. Some engineering aspects of STRaND-1 are true collaborations (i.e. neither SSC nor SSTL are the prime developer). These are areas of collaborative research and de-

velopment where the experience gained is beneficial to both parties. Good examples of this collaboration on STRaND-1 include the development of bespoke Android software and the incorporation of AOCS, OBC and bus software on a single unit.

2 The STRaND-1 Nanosatellite

This section will discuss the STRaND-1 nanosatellite ideas and concepts and the hardware and software implementations that are currently base-lined. We will also discuss the launch and comment on the implementation of our programme as a whole.

2.1. Initial STRaND Concepts

STRaND-1 aims to combine both classical satellite design techniques from the microsatellite community with newer techniques and payloads towards an advanced concept nanosatellite. Challenging existing processes and traditional spacecraft design was also a key factor for both SSTL and SSC. The first STRaND satellite needed to be low cost, low mass, and high impact – as with the rest of Surrey’s satellite programmes. Therefore, the CubeSat standard was chosen to work on with the existing experience within SSC with a smart-phone payload.

Classical CubeSat design methods include the use of several existing COTS subsystems and components utilising I2C buses for satellite control. Purchased subsystems include the GomSpace on-board computer (OBC) or data handling (OBDH) unit utilising an ARM7 processor [3], the ClydeSpace electrical power system (EPS) [4] with 20 W/hr battery [5], and CubeSense [6] from the University of Stellenbosch.

New subsystems currently in development are a UHF/VHF transceiver (with the potential in later versions for S-Band with minimal redesign), deployable solar panels, power switches, nano-magnetorquers, nano-reaction wheels, a butane thruster, and a new CubeSat deployer called ‘S-POD’. Further firsts will include the latest attitude and orbit control system (AOCS) software .

After an extensive trade study, an Android-based smart-phone payload was selected for this mission. A smart-phone was chosen as it was the most advanced commercially available electronics device that contains many highly miniaturised and integrated components. These include orientation and acceleration sensors, highly integrated computing and memory devices, and open source software tools. If a smart-phone can be qualified for space flight, the potential for many new COTS components and sub-systems, found commonly in terrestrial systems, could be used to reduce costs and mass in satellite and space missions.

2.2. The STRaND-1 Satellite

The satellite bus itself utilises the PC/104 connectors for mechanical and electrical conformity to other commercial CubeSat subsystems within a classical 3U CubeSat structure as shown in Figure 2 along with Table 3.

PCB Layer	Developer
VHF/UHF Antenna & Deploy Switches	SSTL
Pulse Plasma Thruster Board 1	SSC
Pulse Plasma Thruster High Voltage Board	SSC
Clyde Space EPS 3U Board	SSTL/SSC
Clyde Space Battery Board	SSTL/SSC
GomSpace NanoMind ARM7 OBC	SSC
CubeSense (Sun and nadir imagers)	Stellenbosch
Payload Power Switches	SSC
Custom V/U Transceiver	SSTL
Payload Bay:	SSC
Custom Magnetorquer x 3	SSC
Custom micro reaction wheels x 3	SSC
Digi Wi9C High Performance Computer	SSC
Android smart-phone	SSC /SSTL
Screen Imager	SSC
GPSR (SGR05)	SSTL
Pulse Plasma Thruster Board 2	SSC
Butane Thruster	SSTL

Table 3. STRaND-1 PCB Subsystem Stack

The key operations of each subsystem are operated using the I2C bus with the NanoMind ARM7 OBC acting as a master. The attitude and orbit control system (AOCS) contains a number of sensors and actuators including nano-reaction wheels, nano-magnetorquers, SSTL’s SGR05 GPS receiver [7], 8 pulse plasma thrusters (PPTs), and a butane thruster. Except for the SGR05, each of these subsystems has been designed for STRaND and future CubeSat applications and missions within Surrey’s activities. The custom transceiver provides a UHF downlink and VHF uplink at 9.6 kbps using frequency-shift-keying (FSK) modulation at 1.6 W RF output power.

The nano-magnetorquer rods and nano-wheels are housed in the payload bay; and discussed in the next section. Pulse plasma thrusters developed through extensive research at Surrey Space Centre will also be flown in STRaND-1, and is discussed in detail in “Development of the μ PPT propulsion module for STRaND a 3U CubeSat” presented at the 1st IAA Conference for University Missions and CubeSat Workshop (Rome, 2011).

2.2.1. Payload Subsystems

The payload bay houses a number of advanced AOCS payloads as well as a COTS high performance computer (HPC) based on the Digi Wi9C embedded system and the smart-phone. The payload bay not only provides further total-dose protection for these components but also provides rigid mounting points for the nano magnetorquers, nano reaction wheels, SGR05, and GPSR antenna. The magnetorquer rods are 85 x 6 mm and made from a custom metal alloy. The three reaction wheels provide full 3-axis control and are a development of the momentum wheel flown on SNAP -1. These are shown in Figure 4.



To control the high performance computer (HPC) and smart-phone using I2C, an interface board is used to decode and command these payloads. The smart-phone is modified only at the power switch and uses a custom micro-USB connector which is soldered to the HPC. An additional C328A imager with lens is used to capture the phone screen and operations should further links fail. The smart-phone operates the Android 2.3 operating system (OS) which is primarily based on a modified Linux 2.6 kernel. The HPC also operates Linux 2.6 and can be connected via telnet and IP networking applications on both platforms. Other “apps” will include taking images/video footage, lossless compression algorithms, and operating the telemetry logging app (shown in Figure 5).

The aim of these applications is to assess the state of various components on orbit, from the light, magnetic and acceleration sensors to computational loads, as well as providing compressed data to be downloaded. Other applications will look at fault detection and recovery from single event effects (SEEs) using autonomous software agent middleware from previous Surrey Space Centre research [8]. The same agent middleware is also under way for controlling and communicating with other satellite subsystems; shown in Figure 6 as IP-networked devices.

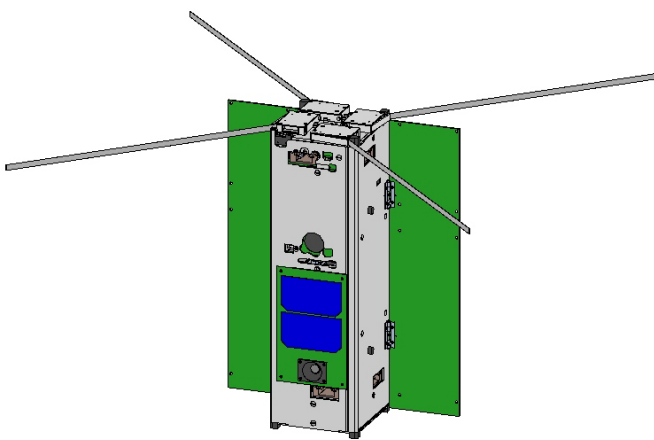


Figure 2 The STRaND satellite

The smart-phone has already undergone thermal-vacuum, and total ionising dose experiments as part of the rigorous ground testing expected with such a high risk payload. Thermal ranges swept between -10 to 70° C and vacuum tests were carried out at 10^{-4} mbar for 3

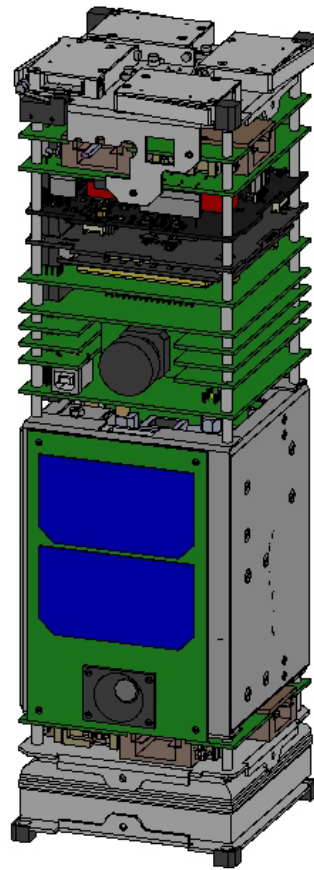


Fig 3 STRaND CAD Drawing

hours. Radiation results are currently underway and are being carried out at National Physics Laboratory (NPL), London, using a Cobalt-60 gamma-ray source. Further tests are planned in the coming months.

2.3. STRaND-1 Operations and Programmatics

Launch is a notoriously difficult segment of any CubeSat development, and STRaND-1 is no different. At the time of writing, no specific launch is officially planned for the satellite, although it is expected that a Q4 2011 launch is feasible. Subject to launch availability, the decision was made at the mission design phase that a circular orbit of 550km, sun synchronous inclination would be a reasonable assumption and any sizings or engineering trades would use this rule-of-thumb for the final orbit until a launch is secured. An early decision was made to only pursue low-Earth orbit (LEO) launch opportunities, due to radiation dose concerns in other orbits. Single-event effects (SEEs) will be mitigated using Surrey’s normal methods of memory washing

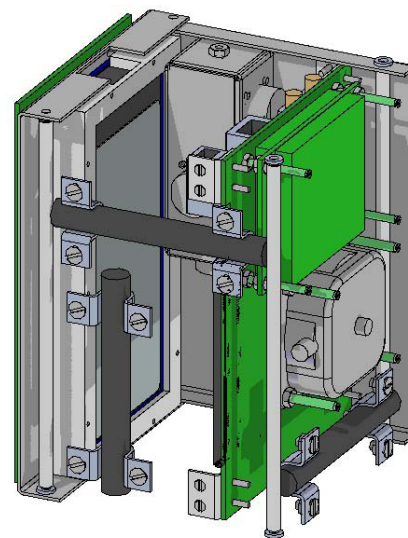


Figure 4. STRaND-1 Payload Bay

with error-detection and correction (EDAC) coding, and over-current protecting power switches to mitigate single-event latch-up (SEL).

The power budget analysis for STRaND-1 is also different to the standard process for SSTL. In SSTL it is standard practise to start with the mission requirements or any customer requirements in relation to payload duty cycle and to calculate from there the

required power sizings necessary to meet the requirements. STRaND-1 benefits from not having a set of commercial payload operation requirements, and so the problem was inverted. The power budget is now approached from the starting point of available solar cell area and then the available duty cycle for payload operations for every subsystem and payload is calculated.

Figure 7. Surrey Space Centre Ground Segment

The ground segment to be used is based-lined on previous groundstation activities in the GENSO Project with the European Space Agency (ESA) and can be found in Figure 7.

As the concept of operations for STRaND-1 is expected to be dynamic and reactive, flexibility in the operations schedule are key. There is no ‘nominal operations’ concept for STRaND-1 and so the power budget was calculated as a function of a set of core operations, ensuring that depths of discharge did not exceed 20% for any single operation per orbit. Additionally, none of STRaND-1’s payloads demand challenging pointing requirements, this allows the operator to control the attitude to maximise the power generation by ensuring that the angle between the sun angle and the solar panel normal vector is kept to a minimum.



Figure 5. SSC Telemetry Logging App

Mentoring on STRaND-1 is another aspect where the process is experimental and part of the innovation of the programme. In this case, the onus is very much on the volunteer to initiate the mentoring process, and decide on the appropriate level of mentoring. Assessment of the stealth review method is ongoing. A key finding so far is that the engagement of the reviewer is strong indicator of the effectiveness of the stealth reviewing. Some stealth reviewers are highly engaged with the volunteers and when this is the case the volunteer benefits greatly from the review sessions. This implies that there is a profile for the ideal Stealth reviewer, and they must have the time flexibility to allow for unannounced reviews and passion to remain interested in the volunteer’s progress. Further observations and collation of anecdotal evidence will feed into a more thorough assessment of the Stealth review process at the end of the mission.

Both SSC and SSTL have capped budgets for STRaND-1. This cap forces the team to be careful with component purchase, and also prevents STRaND-1 from being

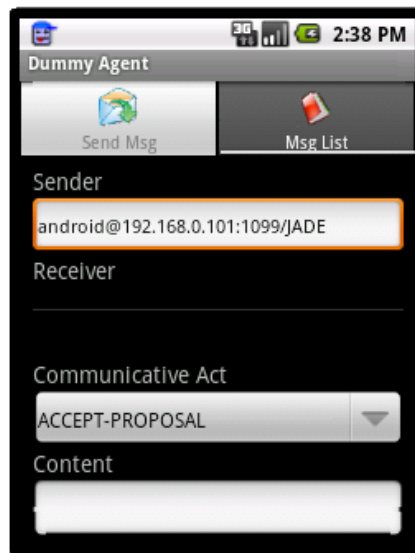


Figure 6. Agent Middleware Screenshots on the smart-phone

- built alternative?
- Can we build it better than what’s commercially available?
- Can we develop it in time?

a purely integration project only. Large expenditure decisions in SSTL on STRaND have followed a procedure that considers:

- Is the component mandatory for spaceflight?
- Can we build it ourselves?
- Is the cost of building it ourselves comparative to purchasing one?
- Is there the potential for commercialisation of a surrey-

Following this process of considerations, it was deemed more suitable to develop the following sub-systems in-house: antenna assembly and deployment mechanism, VHF/UHF transceiver, solar arrays, butane propulsion system, and launch deployment mechanism (project called ‘S-POD’).

SSTL and SSC are now on separate sites. Unfortunately, this means that co-location of the STRaND-1 team is not possible, but also given that STRaND-1 is a free-time project all the volunteers have separate roles and are collated with their colleagues on work-time projects. The situation has led to reliance on conventional tele-conference technologies, but also technologies that are still being rolled out in institutions such as Instant messaging, VoIP, and for more technical cooperation activities, virtual desktops. In some cases, even social networking websites such as Facebook and Twitter have helped communication during out-of-hours conferences. STRaND-1 has also attempted innovative information sharing techniques.

Online storage to share information between the two sites has been an experiment with varying results. Google Docs was assessed at the beginning of the project for the sharing of documents and imagery. However, the support for wider file formats such as CAD packages and diagram packages was not as mature as that for more common file types such as spreadsheets and text documents, and so an SSTL-hosted FTP site was set up instead.

The opposite finding was found for the sharing of software. STRaND software collaboration (non-Android) is hosted using GIT, a software revision control repository [9]. For wider collaborations with NASA and Google,

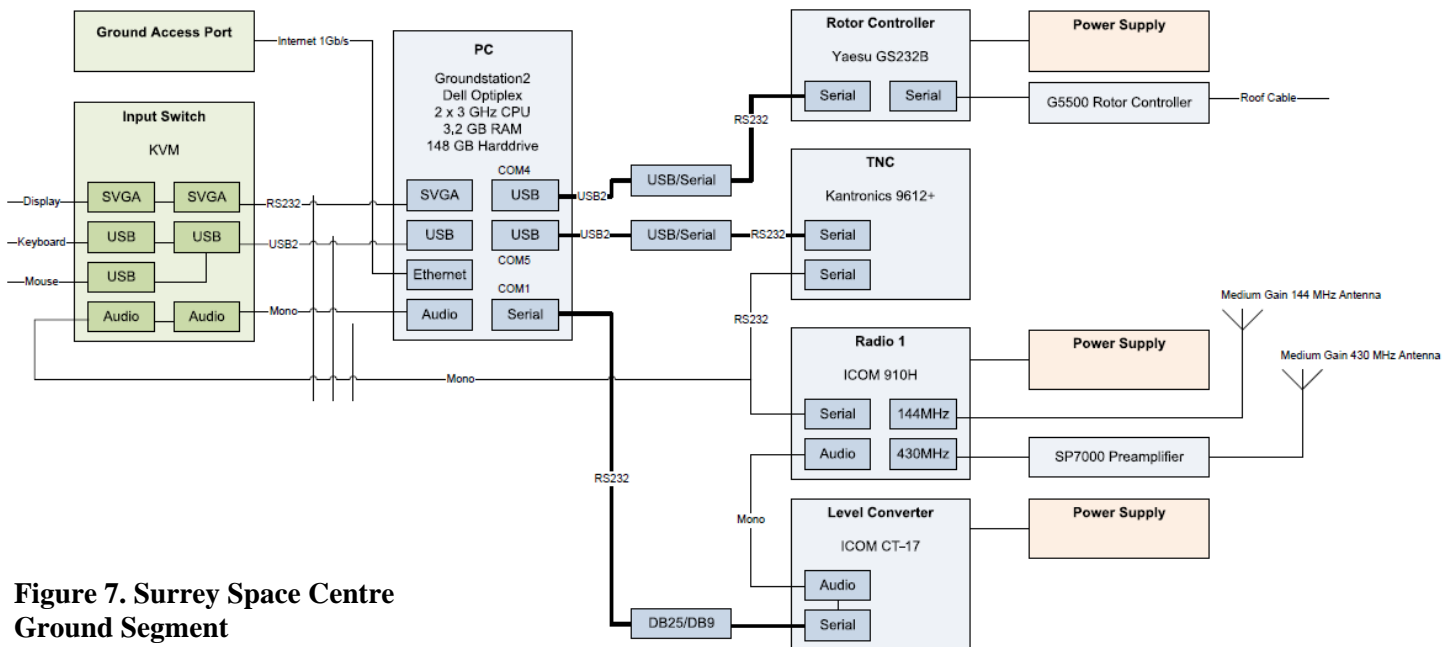


Figure 7. Surrey Space Centre Ground Segment

Surrey Space Centre founded a Google Code project called 'S-Android' for the sharing of source code pertaining to the smart-phone [10].

3. Conclusion

This paper has discussed many of the processes that both Surrey Satellite Technology Ltd. and Surrey Space Centre have been implementing to train new engineers, lever off University research, help fly novel payloads, and challenge industry concepts in managing spacecraft missions.

Unlike other nanosatellite programmes, STRaND chose a CubeSat to leverage existing expertise at Surrey Space Centre, but also to provide a standard design compatible with commercially available CubeSat subsystems. Both teams successfully work closely together using a variety of online software tools which gains improved visibility with each organisation which led to knowledge transfer and the development of new skills. Payloads include an advanced and capable attitude and orbit control system, a new high performance computer, a modern smart-phone with Android operating system, and a novel electric propulsion system and high performance AOCS – making this one of the most advanced CubeSat yet designed.

Acknowledgements

The authors would like to acknowledge the support from managers and volunteer colleagues in the STRaND programme from both Surrey Satellite Technology Ltd. and Surrey Space Centre. We all work hard in our own free time, and it couldn't be done without you.

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HAVEN'T GOT A CALLSIGN? - THEN THIS PAGE IS FOR YOU!

CLIVE WALLIS G3CWV

At the start of another New Year, a very warm welcome to all readers. 2011 promises to be a very interesting and eventful year for amateur satellite enthusiasts. A team of AMSAT-UK members are working hard on building our first satellite, FUNcube, which hopefully will be launched later this year.

Part of the FUNcube project is the ground station receiver which has been designed and developed by Howard G6LVB. Known as the 'FUNcube Dongle' this software defined radio (SDR) offers a simple and efficient means to receive and decode the FUNcube telemetry. There has been an unprecedented demand for this device, with batches of 100 selling out within a minute. Congratulations Howard, I'm looking forward to getting one!

At a recent CubeSat conference it was estimated there were about 250 projects being designed or constructed. Not all will make it into orbit, but there should be plenty of new satellites for us to enjoy in the months ahead.

FOR NEW MEMBERS!

If you have recently joined AMSAT-UK, you may be wondering what this page is all about. The aim is to cover Amateur Radio Satellite activities which do not require a transmitting licence. I have avoided reference to Short Wave Listeners (SWLs) and beginners in the title, as many non-licensed members are not beginners, and some may be scientists, astronomers, science teachers, or even space professionals.

The column is dedicated to the memory of the late Geoff Perry MBE, and takes its name from the title of a lecture he gave to the 1990 Amsat-UK Colloquium. Geoff was a science teacher at Kettering Grammar School. He founded the Kettering Group of satellite observers. They achieved international recognition for reporting the existence of the then secret Soviet Plesetsk launch site in 1966, and also made several other newsworthy discoveries.

Geoff was a frequent visitor to the AMSAT-UK Colloquium, where he presented papers about his activities. For further information see OSCAR News 141, February 2000, pages 41 - 45, and OSCAR News 146, December 2000, page 11. A lot of information about Geoff and the Kettering Group, including many photographs can be found on Sven Grahn's website. It's well worth a visit.

Sven was the Kettering group's first overseas member. <http://www.svengrahn.pp.se/trackind/getstart/oldcyts.htm>

SILENT KEYS

During recent months we have sadly lost two well known members of AMSAT-UK. Both were regular attendees at our annual Colloquium, when it was held at the University of Surrey.

Dr. David Clark G6XYA passed away in October. He was affectionately known as Nobby. I recall that he was interested in receiving signals from AMSAT-DL's P5A Mars probe and was experimenting with novel hardware for controlling a three metre dish. He planned to feed this with commands from Vincenzo Mezzalira's PIC/ TRACK satellite tracking system, running in linux. We had several discussions on this topic at the Colloquium.

John Heaton G1YYH died on Christmas Eve. I understand that he had been seriously ill for sometime, which had prevented him from attending the Colloquium.

John was a computer expert. His knowledge and abilities in this field were truly amazing. He usually brought his latest gizmo to the Colloquium and gave many informal and interesting demonstrations. I remember that on one occasion he installed new software on his computer in Manchester by using his laptop at the Colloquium. He then opened a virtual window in the newly installed software and proceeded to run other software in that window!

I shall always be indebted to John for introducing me to Ubuntu Linux (OSCAR news 179, September 2007). I make regular use of this operating system, and am reminded of John whenever I use it.

Our sincere condolences go to the families and friends of both AMSAT-UK members – they will be sadly missed.

SOUNDCARD TERMINAL NODE CONTROLLERS (TNCs)

In a recent posting Zack N8FNR asked a simple question, which generated several very useful replies. "Is there software to decode packet without a TNC? I would like to decode transmissions from the satellites but don't have a need to transmit and was wondering if such a programme exists."

Pete WB2OQQ responded "Yes, there is software available that can decode packet without a TNC, visit this site, I believe it will answer your questions. <http://www.kc2rlm.info/soundcardpacket/> "

Dave KB1PVH replied that he used AGWPE along with UISS. <http://www.sv2agw.com/ham/agwpe.htm> <http://users.belgacom.net/hamradio/uiiss.htm>

Craig N6RSX confirmed Dave's choice - Sure, UISS and AGWPE with a sound card interface like a Signalink USB or a homebrew interface. Works like a champ. <http://www.kc2rlm.info/soundcardpacket/>

Drew KO4MA suggested - "I use MixW to send and receive packet, and many other modes."

Henk PA0GUO added "After you installed MixW, you can test it with a mp3 recording at my website: http://www.pa3guo.com/ooreos_26nov2010_pa3guo.mp3

This is a recent recording of 1200 baud packet from O/OREOS, one of the new satellites. MixW should decode and show them all on the screen. Simply replay the mp3 and see if MixW can decode it for you.

Also I have two Youtube videos that demonstrate this on O/OREOS:
<http://www.youtube.com/watch?v=M4Ka-RVpEHU>
 (screen recording of MixW)
<http://www.youtube.com/watch?v=Qh6IH5vqw-Y>
 (shows also DK3WN software)

And finally, this is how MixW works on ISS packet: <http://www.youtube.com/watch?v=FSFVTN2KKog>

All these YouTube videos are best viewed (full screen) in HD quality.

Scott N1AIA suggested recording passes and decoding the .wav files afterwards with TrueTTY. "No need for a rig/soundcardinterface. It's a bit clumsy, but easy."

MixW and TrueTTY require registration & payment. Trial versions may be downloaded from -

www.g3vfp.org (G3VFP is the moderator of the Yahoo MIXW group)

<http://www.dxsoft.com/en/products/truetty/> or <http://www.qsl.net/wm2u/truetty.html>

OSCAR-11 REPORT

This report covers the period from 27 November 2010 to 09 February 2011. During this time the satellite has been heard from 01 December 2010 to 10 January 2011, and from 21 January to 30 January.

Excellent signals have been reported from stations located around the world, and good copy obtained from decoded telemetry frames.

The satellite is now transmitting during eclipses, although signals are weaker at those times. This indicates that there is still some capacity remaining in the battery.

The on-board clock is now very stable. It gained eight seconds during January. There is however a large accu-

mulated error of 308.54394 days slow. This was caused mainly by the clock stopping during eclipses, when there was also an unknown drain on the power supply. The units of the least significant digit correspond approximately to seconds (0.86 seconds actually).

The VHF beacon frequency is 145.826 MHz. AFSK FM ASCII Telemetry. The satellite is operating in the default mode, approximately ten days on followed by ten days off.

Reception reports have been received from Christian SWL-CHMY, Mike DK3WN, Campo PY5JAP, Ron WB0SOK and Horatio CX8AF. Many thanks for those and to everyone who posted reports on the general satellite status website.

At the present time, while OSCAR-11 is operating in a predictable way, I no longer need direct reports or files by e-mail. However, could all listeners continue to enter their reports on the general satellite status website? This is a very convenient and easy to use facility, which shows the current status of all the amateur satellites, and is of use to everyone. Reports around the expected times of switch-on and switch-off are of special interest, especially for times 12:00 - 17:00 and 22:00 - 07:00 UTC, to when the satellite is out-of-range in the UK . The URL is <http://oscar.dcarr.org/index.php>

An extended version of the latest OSCAR-11 report is available on my website, and new listeners to OSCAR-11 should read this for further information. The URL is www.g3cww.co.uk/oscar11.htm .

This page contains links to the report, a short audio clip to help you identify the satellite and a file of the last telemetry received. The website also contains an archive of news & telemetry data which is updated from time to time, and details about using a soundcard or hardware demodulators for data capture. There is also software for capturing data, and decoding ASCII telemetry.

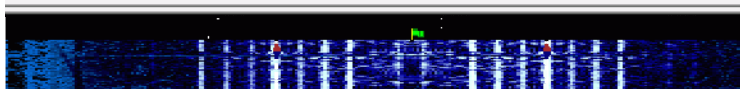
OSCAR-11 TELEMETRY

Figure 1 shows an excellent picture of UO-11 telemetry, sent by Mark DK3WN. The waterfall display at the bottom of the picture clearly shows the side bands which can be heard when you tune across the signal with a CW or SSB receiver. Mark uses the soundcard decoder programme MixW v2.19 to decode & display the

```

0000 0001 0001 0200 02 0300 03 0400 04 0500 05 0600 06 0700 07 0800 08 0900 09
1000 0111 0000 1200 0313 0002 1400 0515 0004 1600 0717 0006 1800 0919 0008
2000 0221 0003 2200 0002 2300 0124 0006 2500 0726 0004 2700 0528 0008 2900 00
3000 0331 0002 3200 0133 0003 3400 0735 0006 3600 0537 0004 3800 0839 0008
4000 0441 0005 4200 0643 0007 4400 0445 0001 4600 0247 0003 4800 0C49 0008
5000 0551 0004 5200 0753 0006 5400 0155 0005 5600 0357 0002 5800 0D59 000C
6000 0E61 5FC1 6200 0463 33 0564 44 0265 1E 0C66 20 0267 00 0168 00 0E69 00 0F
UOSAT-2          1 0032 04 00 4 020

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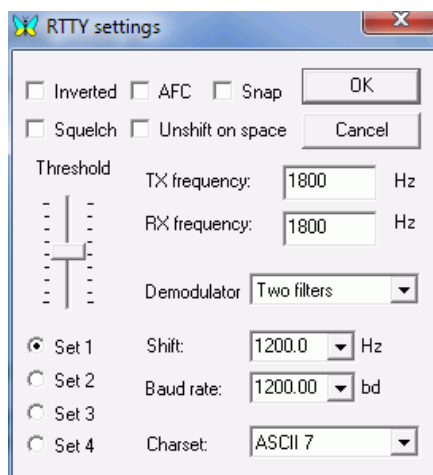


Figure 2. MixW Settings

data. Figure 2 shows Mark's settings for the programme, which may be helpful if you wish to try this excellent programme

< Tnx DK3WN >

LUNCHSAT PROJECT

In OSCAR News 186, July 2009, page 5, I reported on a CubeSat project being constructed by newly recruited graduates at EADS Astrium, Stevenage. During last year I visited the site and was able to see the satellite and its ground station.

The ground station is located in a building which is shared by newly recruited graduates for their personal research projects. The equipment which forms a typical amateur radio satellite ground station includes an ICOM -910H VHF/UHF radio and a computer running NOVA tracking software. The antennas are two crossed yagis for 145 & 435 MHz. respectively, situated on a convenient flat roof, and are controlled by a Yaesu G5500 rotator.

My visit coincided with a pass of HO-68, which we were able to track and hear the CW telemetry. Project leader Nick Fishwick M3ZIY has very kindly sent this introduction and latest progress report -

"LunchSat combines a graduate training initiative with a CubeSat project, allowing participants in the Graduate Development Programme of Astrium to gain experience in how satellites are developed. It is a unique project within space industry prime contractors for further dynamic education of new entrants to the space industry, which promotes both links to universities as payload providers and contributes to the award winning Astrium outreach programme.

CubeSats are miniaturized satellites, typically designed and built for research and the launch of scientific payloads. Crucially, they provide a simplification of spacecraft engineering concepts, providing new levels of accessibility for newcomers to the space industry, members of academia, other aerospace institutions and interested professional groups. Appreciation of the development of a whole satellite project is possible, due to the scaled-down development associated with a CubeSat compared to a standard project in terms of reduced size, lower costs and overheads.

Work on the LunchSat project is split into several 'subsystems', each addressing a separate area of expertise associated with the satellite. The graduates work on one or several of these, enabling knowledge building and experience across a number of disciplines. The project utilises the experience of senior engineers at Astrium and has recently presented a series of successful lectures in spacecraft systems engineering.

The LunchSat project was formed in 2006, when Astrium took delivery of a CubeSat kit based on the design of the recently successful Canadian CanX-2 micro-satellite. The satellite was assembled and a ground station commissioned at Stevenage by 2008. This year has seen the testing of hardware including the imager, and development of a second ground station in Portsmouth.

The ground stations now provide a listening post for receiving signals from LunchSat and other satellites. It comprises a large highly directional antenna system, signals from which are routed to a radio connected to a computer for their decoding. Both radio and antenna are controlled by computer to enable the tracking of satellites as they move across the sky. The facility will be used for school demonstrations and technical training in amateur radio, as it offers a powerful transmitter for suitably licensed operators.

The ADCS (attitude determination & control system) subsystem is designed to provide steering for LunchSat. Its primary requirement is to provide a known attitude that is stable enough to allow the mounted camera to take a clear picture of the Earth. A recent power budget analysis, using inputs from the existing CAN-X 2 system budget, has allowed the team to determine how much power can be achieved using the solar panels under different orbital conditions.

LunchSat houses an on-board computer which interfaces with the other subsystems and is responsible for telecommand and telemetry handling. Using this data, it will be possible to determine and control the attitude of the LunchSat micro-satellite, once in space. To ensure the CubeSat performs its intended function, modes have been established to govern its operation. A system-level testing programme is also being developed to prove the spacecraft is capable of fulfilling its mission.

LUNCHSAT PROGRESS REPORT

Members of the team have recently completed amateur radio training and are now licensed to transmit to passing satellites from the groundstations. The team has already engaged with schools and universities across the UK, and plan to connect with the astronauts aboard the International Space Station in an ambitious outreach initiative for next year.

The project has attracted considerable attention over the recent months, with visits from the former Science Minister Lord Drayson, former MP for education Sarah McCarthy-Fry, and the chief executive of the Science and Technology Facilities Council, Keith Mason. More recently, the team has presented papers about the project to the global space community at the International Astronautical Congress 2010.

In addition to the installed imager, the team are now developing plans for incorporating a secondary payload and are exploring the various launch options for the satellite. Both LunchSat payloads are to be integrated and tested in order to achieve flight-ready status in 2012.

The ground stations have been able to download images and meteorological data from the NASA Polar Operational Environmental Satellites, such as the view of Northern Europe shown in the photograph. For the latest developments from the project including photos, articles and interviews, check out the LunchSat blog at <http://LunchSat.blogspot.com> "

<Tnx Nick M3ZIY>

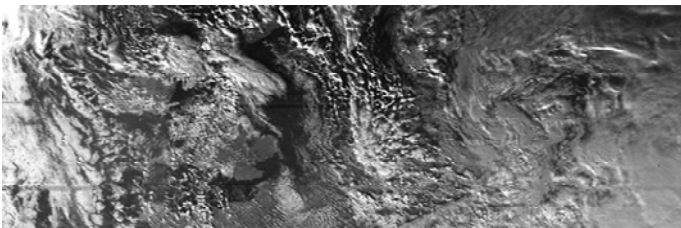


Figure 5. Received View of Northern Europe from a NOAA satellite

We shall look forward to hearing further news as work progresses. For those who missed the 2009 article, and are curious about the project's name, it recognised the fact that much of the work was done in the daily lunch break! -----

I am always pleased to receive comments, feedback, and requests for help from readers. Short items for inclusion in these pages are always wanted! A simple question can often be the basis of an article, which may be of interest to other readers (who didn't like to ask!). Your input can be by letter or e-mail. Please send it to the address below.

Clive Wallis, G3CWV e-mail g3cww@amsat.org
"Wychwood", Snailswell Lane, Ickleford, Hitchin, SG5 3TP

News shorts from various sources

The Falcon 9 Launch that took place in December 2010, placed the Dragon payload into LEO and also eight CubeSats. After these deployments the 2nd stage motor was fired again and this body is now in a 290x11000km highly elliptical orbit with a 34 degree inclination. Such a shame that there was no transponder riding on it. You can track "Falcon 9R/B" as object 37253

Arianespace are planning for six Ariane 5 launches this year from Kourou together with 2 Soyuz from the new facility there and the expected maiden flight of the Vega launcher.

ARRISat-1 was expected to be deployed from the ISS on February 16th but this now appears to have been delayed until a "late" July spacewalk. Signals were heard from ARRISat-1 by many amateurs around the world, when it was being tested from inside the ISS during the evening of February 10th 2011. It is currently expected that this transmit only mode will be rerun again on April 12th to commemorate the 50th Anniversary of Yuri Gagarin's flight.

The DNEPR launch from Yasny, carrying a number of spacecraft including Edusat and associated sub-payloads, has now been delayed until sometime in April.

According to NASA, the International Space Station, which has been orbiting at about 350km altitude over the past decade, will be boosted over the next few months up to a normal altitude of about 400km. Apparently this boost will be achieved by using the fuel and thrusters on the European ATV-2 vehicle Johannes Kepler. This vehicle is scheduled to be attached to the ISS for four months up to June 2011 and will "burn" 4500 kilos of fuel in the process. The plan is apparently related to the expected increase in solar activity and the increase amount of drag that occurs in very low orbits as a result.

—00—

Forthcoming meetings and events

May 14th AMSAT-DL Symposium and AGM-Bochum Germany—with additional EME activities

July 4/5th UK Space Conference—University of Warwick—sponsored by the UK Space Agency and will include a CubeSat workshop stream.

July 29-31st AMSAT-UK Colloquium—Holiday Inn Guildford. All the usual attractions plus hopefully sight of the Flight Model of FUNcube.

The FUNcube Space Model

by Jim Heck—G3WGM

Introduction. The FUNcube Space Model (FCSM) is not intended to be an exact replica of the finished satellite, more its intended to represent and illustrate some of the features of the 'real thing'. There are two versions of the FCSM. Mk 1 is the simplest, and has no antennas. Mk 2 has antennas, and requires some modifications to the Mk1 design. The main part of this article describes the Mk1, and the modifications are described at the end of the article.

Materials. You will need:

- 3mm thick Perspex or polycarbonate sheet, or similar
- A packet of 'Strip Strene' 0.188 x 0.188 inch (4.8mm x 4.8mm). These are available from many model shops or HobbyCraft shops, and come in packets of 4 strips each 35 cms long.
- suitable glue, Bostik, Uhu, etc
- a set of 6 paper panels, available for download from the FUNcube web site. (www.funcube.org.uk)
- a small quantity of matt black paint suitable for the Strip Strene
- a little, but not a great deal, of patience, and a steady hand!

Method.

From the Strip Strene rods cut four lengths each approx 9 cms long

From the Perspex (or similar) cut two panels each 96mm x 96 mm (these make to top and bottom of the model (+ and - Z)), and four panels, each 90mm by 90mm for the sides, (+ and - X and + and - Y). Its important that each of these panels is cut accurately and square, otherwise the model won't look very 'neat'

From each of the 96mm x 96mm panels remove a small square, 3mm x 3mm from each corner.

Take the 4 90mm x 90mm panels and using one length of the Strip strene as a brace at each corner, make them into an open ended cube. Note that the side panels should not, quite, touch each other (see pic). The resultant cube will be pretty fragile, so should be handled with care. Make the cube as nearly square as you can by eye.

Take the top and bottoms panels (96mm x 96mm) and glue them to each 'end' of the cube made in step 4 above. When doing this, you can adjust the cube so that it is exactly square. Allow the glue to set.

From the Strip strene cut four lengths exactly 100mm long. De-burr the ends, and paint one pair matt black.

Glue the four 100mm stripstrene rods to the edges of the cube formed by the +_X and +_Y panels. Ensure that the black rods are on the same side as each other. Note each rod should be approx 1mm proud of the +_Z panels. See picture.

Print the 6 paper panels using a colour printer. Ensure that the resultant image is the correct size (ie no scaling). Good results can be obtained by using glossy or semi glossy paper. Very carefully, using a sharp pair of scissors, cut the paper panels to size, including the 3mm cut outs from the corners of the + - Z ones. Its important that this is done carefully and accurately. You should check on the model that each paper panel will fit accurately to the relevant side.

Stick the paper panels to the cube in the appropriate place. Using a "Pritt Stick" (from WH Smith's and elsewhere) gives a good result. It is suggested that the glue is applied to the Perspex, as this ensures that no glue gets on the printed side of the paper. Make sure that the glue is applied to the edges of the Perspex, don't use too much to avoid 'squidging'! The position of the paper panels can be adjusted before the glue finally goes off. Ensure that the side panels are orientated correctly, ie Antenna deployer openings at the top.

You're done!

Modifications to make a model with antennas.

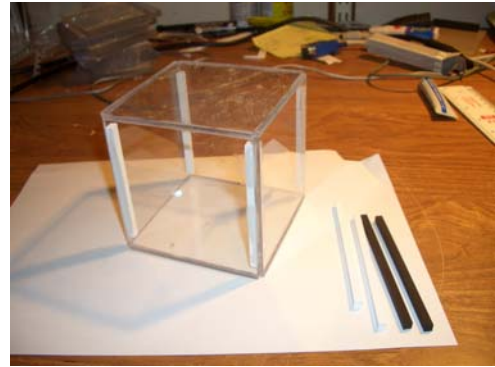
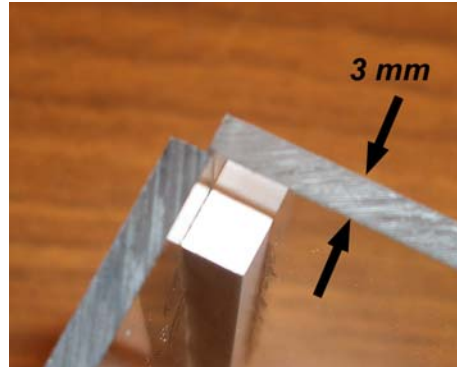
The antennas themselves are made from Strip strene 0.020 x 0.080 (.5mm x 2mm). They are thin and pretty flexible. Use two strips (each of approx 36 cms) to represent the two metre antennas, two half length strips (approx 18 cms) to represent the 70cms antennas. Note these lengths are not the same as the 'real thing' but serve to illustrate the antennas.

For the + Z axis Perspex panel, substitute 8mm thick perspex for the 3mm Perspex, and make the four side panels 90mm x 85mm.

Before gluing the cube together, drill 4 2mm holes in the 8mm sheet each approx 2 cms deep, and each 30mm from two of the corners .

Assemble the model as per above. After completion, locate the four holes in the top panel, and make a small hole in the paper sides, to allow the insertion of the 'antennas'.

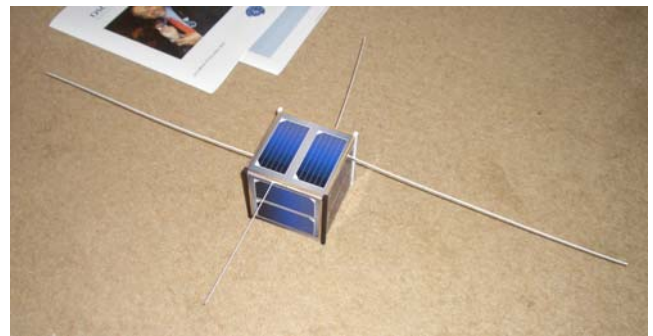
I am considering making a kit of parts available, if you are interested, please email me at g3wgm@amsat.org



Left. A packet of “StripStyrene” 4.8mm x 4.8mm square rods. The rods are approx 35 cms long. **Centre.** Showing a close up of the corner of the open sided cube stage. Note the 3 mm x 3mm ‘slot’ formed by the edges of the Perspex. These coincide with the 3 x 3 mm squares sawn out of the top and bottom panels. The outside square 4.8mm x 4.8 mm rods are glued into these slots. **Right.** The 10cms cube (actually approx 9.8 x 9.8 cms) ready to have the side rods (representing the elements of the structure which slide into the POD) glued on.



Left. Completed cube ready for paper sides to be glued on. Note the relative positions of the black and white rods.



A completed Mark 2 model.



Above. A completed, Mark 1 (no antennas) model. Note the antenna deployer openings near the top of the side, the socket for the ‘apply before flight plug’, near the bottom, and the Black and White parts of the structure for the Materials Science Experiment.

AMSAT-UK Shop

The AMSAT-UK shop is an important source of funds and every purchase from the shop helps to contribute towards the Satellite Building fund.

The currently available stock items available are:-

Elk 2m/70cm Log Periodic Antenna

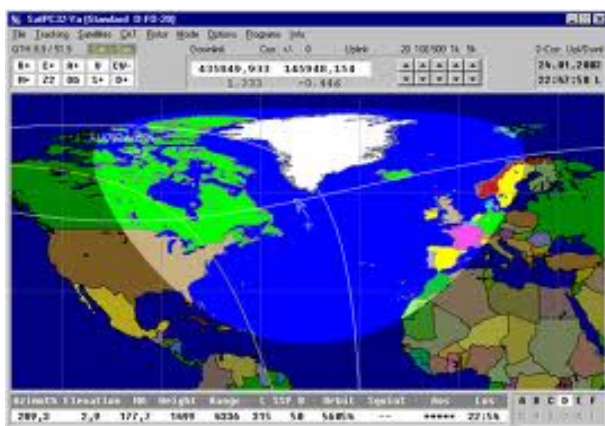
G7HIA Lindenblad Antenna Kit

G7HIA 2.4GHz Patch Antenna kit

G0MRF 2.4GHz Signal Sources

LVB Tracker – Motherboards, USB interface boards, full and partial kits.

SatPC32 and WiSP Software Licences.



Full details are now on the AMSAT-UK shop web site along with prices. Unfortunately, there are currently no books for sale – we are looking at this but suggestions are always welcome.

Suggestions from AMSAT-UK members are always welcome and a dedicated email address (amsat-uk-shop@amsat.org) is available for contact the shop. Please send the suggestions in and keep checking the website for updates and new items.

G7HIA Lindenblad Antenna Kit

We recently identified that there is a component missing from the G7HIA Lindenblad Antenna Kit sold since the Colloquium. I am in the process of arranging for this component (the lid for the junction box) to be posted to all those who supplied addresses on the order form. If you have not received yours by mid January 2011, please email me and I will follow it up as quickly as possible.

73 Ciaran M0XTD

OSCAR NEWS 200X ARCHIVE CD-ROM

Now available on CD-ROM – the last 10 years of OSCAR NEWS as digital searchable Adobe Acrobat PDF files! Read them on your desktop computer or view them on your Amazon Kindle, Apple iPad, Sony Reader or other mobile device.

The AMSAT-UK OSCAR NEWS 2000-2009 archive contains all 47 issues of OSCAR NEWS, the official journal of AMSAT-UK for all users of OSCAR satellites, published between February 2000 and December 2009. Containing more than 2000 pages of information about amateur satellites ranging from homebrew electronics projects to scientific papers, this archive offers an intriguing insight into the development of amateur radio satellites during a fast moving decade. These CDs are now available direct from the UK from the New AMSAT-Online shop at £14.99 plus shipping.



Go to the New online shop at <http://shop.amsat.org.uk>

Hint—you can also renew your AMSAT-UK Membership there at the same time !!

Satellite Tracking Apps For the iPhone, iPod Touch and iPad

Bill Ress W6GHZ

Well I did it! I had to get Apps too. I finally gave in and decided that I wouldn't get left behind the Apps craze. When I found out that the iPod Touch did everything the iPhone did but without the monthly cell phone subscription fees (it uses the free WiFi networks) and it runs almost all the Apps that the iPhone runs, my decision was to get the iPod. These same Apps will also run on the iPad. For me, the iPod Touch 8 GB was the thrifty (translation – cheap) way to join the App crowd.

So armed with my new Apps compatible device and seeing the constant Apple advertisements that tens of thousands of Apps were available, I naturally set out to see what satellite tracking Apps were out there. Well, there are a bunch, and at reasonable prices, starting with free and going up to a reasonable (\$24.95). So I downloaded six that were recommended and tried them out.

I need to point out that none of the Apps provide transceiver Doppler correction or will automatically point your antenna like those that run on the desktop. Recognizing that these Apps were “basic” satellite tracking programmes, I set out to see what differentiated them and which ones appealed to me. While the “i” devices are portable handheld computers most suited for field use, I find it very convenient for home use.

When I use the Apps, the first thing I want is to know when the satellite I'm interested in tracking will next come into view. Then, when the satellite is about to be in view, I'd then like to know the basic stuff like ground track, footprint, time to next AOS, elevation, azimuth and range. My evaluation focused on using it to track one satellite at a time but all can be configured to handle multiple satellites. I also looked at their features versus price, and just how intuitive they are to use, without having to go online to download the manual. We'll start with the ones that are FREE and work our way up.

Satellite Tracker (by Susan MacKay VK3ANZ – MacCon) FREE

While this programme is FREE, it offers all the basic features you need to select and track satellites in an uncluttered way. Setup is easy and intuitive. While there is no web site for online support, a very good “information” guide is included in the programme which takes you through setup and operation. This version of the programme doesn't include the satellite ground track and footprint (the upgrade for a fee version does).

Once you select your satellite(s) at setup and you select Tracking, your satellite(s) will be shown with the next AOS (acquisition of signal) time and the time to

AOS. Select your satellite and up comes a view of the track across your sky in a radar map along with AOS, LOS information and uplink and down link frequencies, if you entered them during setup. Further finger taps will give Future Passes for the time period you selected.

After entering the satellites up and down link frequency you'll be using, during the pass it will give you the Doppler offset for both up and downlink frequencies along with azimuth, elevation and range. Use of local or UTC time is selectable. An elevation filter is provided which will only identify passes that exceed your elevation entry. Another neat selectable feature is the “show held angle.” By holding the iPhone or iPod Touch parallel to your antenna and adjusting the elevation, your device will indicate the pointing elevation angle which you can align with the satellites elevation angle. It will remind you when the TLE file are out of date and asks you if you want to update them.

Satellite Tracker Plus by Susan MacKay – MacCon - \$1.99 (No online manual or support)

This programme has all the features of the FREE version but includes ground track and footprint, although the map response is “jerky” and cannot be expanded.

pxSat by Xavier Rouet -FREE (No online manual but a support email address is given)

This programme, although having the needed features and some other unique presentations, is not as intuitive as it could be. It also hung up a few times when changing screens, but this could just be an artifact of my iPod. But it's FREE and one might overlook some short comings.

It does have a smooth map operation with expanding capability but lacks the ground track I would like. The main screen does not show AOS or time to AOS. You have to drop down to a sub menu to get the information. I got into the overhead “radar” view and couldn't use intuition or an icon to get out. I had to read the Help section of the programme to find out that I had to rotate the iPod 90 degrees (to the horizontal and then back) to change the view from global to radar. I also managed to get into some truncated radar view by rotating the iPod 90 degrees which I couldn't figure out and the programme help section didn't address it.

On the main global view, the color display of Az and elevation (St) angles changes from blue to green when the satellite is in view. Doppler shift is shown as a relative velocity of negative miles per hour when the satellite is approaching and positive miles per hour when departing, but this wasn't helpful since it didn't show it in terms of frequency. While it wasn't my favourite, the price is right.

Satellite Ham Radio - HamSat (www.vosworx.com) \$4.99

While this programme has all the nice tracking features, it presents a 2D global map, and a unique 3D view, which is void of any information about the satellite, except ground track and footprint. I found the 3D view different from all the other programmes, but not useful. To get to the good features you have to navigate a few menus, but it's there. Double tapping on the satellite in the 2D or 3D view gets you to the menu of upcoming passes. It does not have advance/retard capability but does have Doppler frequency.

The programme help is good and covers all you need to operate the programme. A downloadable manual is available on their web site along with a support email address and a link to a YouTube video to help you install the programme.

GoSatWatch by GoSoftworks) \$9.99
www.gosoftworks.com

This programme is developed by Craig Vosburgh – W0VOS His web site provides extensive online support. On my iPod with 8 GB, at start up, I kept getting a “Low Memory Warning.” Removing a bunch of pictures and videos freed up memory but it occasionally came back. It's annoying but not a show stopper.

The global map screen is a little jerky and it doesn't have the expand view capability, but it does provide a ground track and footprint. A very nice feature that remains on all screens is the countdown timer in the top middle which shows the time to AOS for your selected satellite, so as soon as you open the programme you know how long until the selected satellite comes into view.

The programme is very intuitive. The main menu selects your map views, upcoming passes, your database of satellites and settings. The Passes menu selects the day's upcoming passes with AOS, LOS times, maximum elevation and finger selection of the alarm setting.

Once in the Passes menu, you select the pass you'd like to track and the overhead radar map is provided showing you the sky track. The global map view has a nifty satellite position advance/retard mode which nicely resets to the current time when you turn that mode off.. In the Settings mode you'll find another cute feature. Touching the “lock” icon puts the display in a mode which prominently shows the satellite name and a countdown timer to the next pass. The time can be adjusted to GMT or local time from the Location menu. On the negative side, there is no Doppler information, either relative or in frequency.

Pocket Sat3 by James Berry www.pocketsat.com

\$24.99

(Also available from the author is PocketSat3 LE (\$1.99) which only tracks bright satellites selected by the author. It doesn't track Amateur satellite but it will give you a feel for the programme before you spend \$24.99)

This was the “high priced” programme. So I wondered what you got that the others didn't have. Well, it has a lot of options in the Settings menu. In fact, for me there are too many. It has the best web site for support, including a manual. But, it performs the basic tracking functions just like all the others

I was disappointed that the screen which has the good stuff (AOS, LOS, time to AOS and maximum elevation, etc.) was the radar screen and to get to it you have to go through the Passes menu. Surprisingly, for the high price, you don't get Doppler information but it does have the smoothest global map movements, including expanding, of all the programmes evaluated.

Without a doubt, it has a lot of features, but for me it's too busy for my intended use. Compared to the other programmes, the value proposition isn't there. Even though I have downloaded it for the evaluation, I don't use it, except to go back occasionally to see if I overlooked something I really need. To date, I haven't found anything.

Conclusions.

No doubt I need to render an opinion, so here goes. I was surprised to find that all the programmes will meet basic satellite tracking needs as I defined them. They all downloaded the TLE data with ease and the AOS times were all within seconds. The differences are in the way they present the data, the number of features and options beyond the basic stuff and their ease of use. None of them had all the features I wanted in the way I wanted them presented so I ended up using two programmes: Satellite Tracker Plus and GoSatWatch.

The programmes evaluated (plus a few others) are available on iTunes where you'll also get some reviews to help with your decision process. Naturally, go the web sites for the programmes that have them and download the manuals.

(Editor's Note: to see Bill's Application Matrix go to page 31)

ARISSatTLM - A Software Demodulator and Telemetry Display Programme for the ARISSat-1 Satellite

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Abstract

ARISSatTLM is a complete software DSP demodulator and telemetry display programme for the telemetry from the ARISSat-1 satellite.

Introduction

ARISSatTLM is a graphical Windows programme for displaying telemetry from the ARISSat-1 satellite (formerly known as SuitSat-2). The programme is written in C, compiles with gcc, and is freely available under the terms of the GNU Public License (GPL).

ARISSatTLM includes C source code for the sound card routines originally written by Tony Monteiro, AA2TX, and a BPSK1000 software modem with digital signal processing source code originally written by Phil Karn, KA9Q. [1,2] Both were modified for use in ARISSatTLM. Karn's code was originally written for gcc on an Apple Mac computer, and required changes to compile under a similar version of the Cygwin gcc compiler for Windows. Similarly, Monteiro's code was written for a PC, but not written for gcc, and only minor changes were needed. ARISSatTLM provides some "glue," in the form of C code, to get the pieces to talk together. It also includes original code to display the decoded telemetry values. The software runs in real time on a 1 GHz Pentium III PC. It should be able to process prerecorded WAVE files on even slower machines.

ARISSatTLM configures the sound card to produce digital samples at 48000 samples per second with 16 bits per sample. This is the format that the BPSK1000 software modem expects. The bytes arrive from the sound card routines and are passed to the BPSK1000 software modem routines which extract the HDLC BPSK1000 frame. The BPSK1000 software modem routines then return the demodulated HDLC frames along with a length and a 32-bit CRC. These frames contain the telemetry values which ARISSatTLM then interprets and displays for the user.

Demodulated frames are also saved to a .CSV file on the local hard drive. The file will be named YYYY-MM-DD.CSV, where YYYY is the year, MM (or M) is the month, and DD (or D) is the date. Each frame is saved to the file by appending the file if the file already exists. This ensures that no received telemetry is accidentally overwritten. The frames are written to the file with one line per frame. Each frame starts with the date YYYY/MM/DD, a hyphen, the time (UTC) as HH:MM:SS, then

each (raw) byte of the demodulated frame is written as a decimal value. For example, a telemetry frame line starts as

```
2010/06/26-14:55:48,084,107,014,000,000,072,105, ...
```

and an experiment frame starts as

```
2010/06/26-14:55:44,069,049,066,053,054,159,000, ...
```

The .CSV file can then be imported into any number of common spreadsheet programmes for further analysis.

ARISSat-1 Frames

There are a couple different types of telemetry frames from ARISSat. The experiment frames contain data from the Kursk experiment, and the telemetry frames contain ARISSat telemetry.

ARISSAT-1 Experiment Frame

The transmitted frames are expected to alternate between ARISSat telemetry frames and numbered experiment frames. The order should be T, E1B1, T, E1B2, T, E1B3, T, E1B4, T, E1B5. The Kursk experiment runs on a schedule and the experiment frames will most likely be the same five frames during any given satellite pass unless the experiment has just completed. The ARISSat telemetry frames will each be unique. There will probably be less than a second of delay between frames, during which only HDLC flags will be transmitted, but it will take several seconds to send a complete telemetry frame. [6]

ARISSAT-1 Experimental Frame

Description	Size	Notes
frame ID byte "E"	1 byte	hex 0x45, ASCII letter "E" for experiment
Experiment number	1 byte	This will always be "1" for the Kursk experiment.
Experiment Block ID	1 byte	hex 0x42, ASCII letter "B"
Experiment Block number	1 byte	While still on the satellite, the experiment data is broken into five pieces for transmission. This byte is the piece number (1-5) as an ASCII character 1,2,3,4 or 5 (hex 0x31 to hex 0x35).
Mission Elapsed Time	4 bytes	Mission Elapsed Time when the IHU received this 2k of experiment data from the Kursk experiment.
Experiment data	varies	Experiment data is broken up into five pieces for transmission. Four pieces will be 512 bytes. The fifth piece will be 36 bytes. ARISSat will join the pieces together into a Kursk experiment data frame[4] and will save it as a file called KURSK-nnnnn.EXP where nnnnn is the Mission Elapsed Time when the Kursk experiment frame was received.

The ARISSat telemetry frames consist of a frame ID, a counter, a traditional satellite "Hi" message, a collection of telemetry bytes based on a C language structure named `ss_telem_t`, and a CRC32. The actual definition of the `ss_telem_t` structure and all of the fields contained within it can be found at the bottom of the `ss_types_common.h` header file on the SVN in the "firmware common" directory. Interested readers may also want to consult the `ss_stdint.h` file in the same directory. The `ss_telem_t` structure within the ARISSat telemetry frame is a byte for byte copy of contents of a `ss_telem_t` struct in memory on the satellite.

ARRISAT-1 telemetry frame

The `ss_telem_t` structure can be broken down into these major parts.

ARRISat –1 Telemetry Frame

Description	Size	Notes
frame ID byte "T"	1 byte	hex 0x54, ASCII letter "T" for telemetry
frame counter	4 bytes	4 byte integer counter
"Hi" message	22 bytes	The ASCII string "Hi, This is ARISSat-1."
<code>ss_telem_t</code> structure	290 bytes*	the <code>ss_telem_t</code> structure from the <code>ss_types_common.h</code> file
CRC32	4 bytes	CRC-32 as calculated by the spacecraft. Even though the demodulator software will verify the CRC to confirm a valid frame, we retain the CRC for end-to-end integrity checking.[5]

The size of the `ss_telem_t` structure (and thus the total size of the "T" telemetry frames) has changed numerous times during the development of the satellite. It is possible that the size will change again before the satellite is launched. The information here should be considered to be preliminary. The `ss_types_common.h` file on the SVN will have the latest version of the `ss_telem_t` struct.

Overview of the `ss_telem_t` structure in the ARISSatTLM frame

Description	Size	Notes
Mission time	4 bytes	Mission Elapsed time (in seconds). This counter can reset back to zero.
Mission mode	4 bytes	One of "Emergency Power", "Lower Power", or "High Power"
IHU Temperatures	18 bytes	Temperatures measured from the IHU
Power	75 bytes	Current consumption and ON/OFF status for different parts of the satellite
PSU Status	21 bytes	PSU statistics
PPT Status	18 bytes	Solar panel current, voltage, temperature, etc. There are six copies in the frame (one for each solar panel and PPT).
IHU Status	52 bytes	IHU, PSU, SDX, Camera ON/OFF status
Calc	8 bytes	Telemetry values calculated from raw counts by the satellite (voltage, current, temperature)

Each of above telemetry sections can be broken down further into individual telemetry values. Unlike many other spacecraft which have single byte telemetry channels, ARISSat telemetry values vary in size from individual bit flags up through eight byte numeric values.

IHU Temperatures Telemetry

Description	Size	Notes
RF	2 bytes	RF module internal temperature
Control Panel	2 bytes	Control panel internal temperature
Experiment	2 bytes	Experiment temperature
Bottom Camera	2 bytes	Bottom Camera temperature
Top Camera	2 bytes	Top Camera temperature
IHU Enclosure	2 bytes	IHU Box temperature
Battery	2 bytes	Battery temperature
PSU PCB	2 bytes	PCB inside the IHU Box
IHU PCB	2 bytes	PCB inside the IHU Box

In order to convert the raw temperature values from these telemetry channels into degrees Celsius, the raw value should be scaled using the `scale_thermistor_C()` routine in the `scale_therm.c` file. This function will perform a lookup in a table that correctly converts the raw value to degrees Celsius.

The four two-bit camera status indicators will have a value of three for ON and zero for OFF. However, they will only have the value of three if the camera was actually turned ON taking a picture at the exact instant when the telemetry frame was being created by the spacecraft. Because the cameras are being turned ON and OFF, the status bits might appear as OFF in the telemetry frames even when pictures are being taken.

PSU Status Telemetry

The PSU status telemetry is included for the ARISSat developers. These values are used for debugging purposes. ARISSatTLM does not currently display the PSU status telemetry.

There are six copies of the PPT Status telemetry in each ARISSat telemetry frame since there are six solar panels and six PPTs on the spacecraft. In each PPT status section there are two bytes that are logically split in half

Overview of the ss_telem_t structure in the ARISSatTLM frame

Description	Size	Notes
Mission time	4 bytes	Mission Elapsed time (in seconds). This counter can reset back to zero.
Mission mode	4 bytes	One of "Emergency Power", "Lower Power", or "High Power"
IHU Temperatures	18 bytes	Temperatures measured from the IHU
Power	75 bytes	Current consumption and ON/OFF status for different parts of the satellite
PSU Status	21 bytes	PSU statistics
PPT Status	18 bytes	Solar panel current, voltage, temperature, etc. There are six copies in the frame (one for each solar panel and PPT).
IHU Status	52 bytes	IHU, PSU, SDX, Camera ON/OFF status
Calc	8 bytes	Telemetry values calculated from raw counts by the satellite (voltage, current, temperature)

such that each four bit nibble contributes to a different telemetry value. This allows four twelve bit telemetry values to be transmitted in six bytes.

IHU Status Telemetry

* These values are repeated twice.

The IHU status telemetry is also included for the ARISSat developers. These values are used for debugging purposes. ARISSatTLM does not currently display the

Power Telemetry

Description	Size	Notes
Battery Status	12 bytes	2 bytes raw voltage; 2 bytes raw current; 2 bytes 2.5V reference; 6 bytes flight total net coulombs into battery
Battery History	12 bytes	6 bytes total charging into battery; 6 bytes total discharge out of battery
Camera Power	9 bytes	6 bytes total raw coulombs; 12 bits raw current value; four 2 bit status indicators for the four cameras
Experiment Power	8 bytes	6 bytes total coulombs; 12 bits raw current; 2 bits status
IHU	8 bytes	6 bytes total coulombs; 12 bits raw current; 2 bits status
SDX	8 bytes	6 bytes total coulombs; 12 bits raw current; 2 bits status
Power Supply 5V	8 bytes	6 bytes total coulombs; 12 bits raw current; 2 bits status
Power Supply 8V	8 bytes	6 bytes total coulombs; 12 bits raw current; 2 bits status
RF	1 byte	RF Power on/off
Spare	1 byte	Spare power on/off

IHU status telemetry.

These values were calculated on-board the satellite and converted from raw counts to human readable formats.

Source Code Availability

For those who are interested in the ARISSatTLM source code, it is available on a software repository ("the SVN") along with over three gigabytes of other ARISSat-1 material. Under Windows, the SVN can be accessed using the (free) TortoiseSVN software[3], or directly via https. Interested readers can start at <https://svn.sarpeidon.net/viewvc>. The ARISSatTLM files are in the `ground_station_software/ARISSatTLM` directory. Currently the ARISSatTLM software can be compiled with gcc 4.2.4, in which case the executable requires the `demod.dll` and `cygwin1.dll` files, or with gcc 4.3.4, in which case the `demod.dll`, `cygwin1.dll`, and `cyggcc_s-1.dll` files are needed by the executable.

ARISSat Telemetry for Everyone

In addition to the Windows version of ARISSatTLM, there is also a version for Apple computers (ARISSatTLM) that is being developed independently by Gilbert Mackall. We are attempting to keep the telemetry display pages as similar as possible between architectures. Both programmes use the exact same DSP routines for demodulating the audio signal into the HDLC frames and on-the-air performance is expected to be identical.

Those with mobile devices are not going to be left out either. We have plans for a web page on the www.arissattlm.org website which will contain (after ARISSat-1 is in orbit) a copy of the most recently received telemetry. There is a demonstration page at <http://www.arissattlm.org/mobile>. Currently this page is loaded with fictitious data, but it shows what the telemetry should look like when formatted for the smaller screens on mobile devices such as iPod touch and iPhone.

The Internet Telemetry Reflector



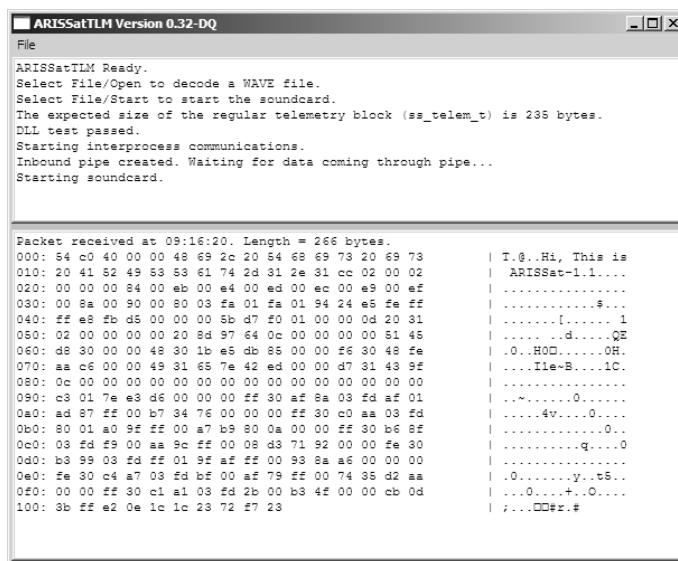
The mission patch for Yuri Gagarin's flight of Vostok-1—his radio callsign was KEDR. This is a Siberian Pine Tree and is the name that the Russians are using to describe ARISSAT-1

PPT Status Telemetry

Description	Size	Notes
Oscillator status	1 byte	Oscillator status
Crystal failed count	1 byte	Crystal failed count
Pin disturbs	1 byte	Flags if pin settings need to be changed
IHU forced reset count	1 byte	IHU forced reset count
SDX automatic turn on count	1 byte	SDX automatic turn on count
IHU recoveries count	1 byte	IHU recoveries count
Camera shutdown count	1 byte	Shutdowns due to low batteries
I2C wcol errors	1 byte	For I2C debugging
I2C overflow errors	1 byte	For I2C debugging
I2C bad message count	1 byte	Counts messages not formatted correctly
I2C bus idle resets count	1 byte	Counts resets due to lack of activity
I2C bus hang resets count	1 byte	Counts resets due to a stuck message
I2C bus reset sspcon	1 byte	SSPCON before bus is reset
I2C bus reset sspstat	1 byte	SSPSTAT before bus is reset
Command mismatch count	1 byte	Commands that were repeated to execute
PPT Poll Busy count	1 byte	Time to start the next poll and PPT is still being polled
PSU Reset reason	1 byte	The reset reason
PSU self-reset count	1 byte	Count of the number of times the PSU has reset itself

Description	Size	Notes
Panel Energy	6 bytes	Solar panel energy since last reboot
Panel Voltage	1 byte	Solar panel voltage
Panel Current	2 bytes	Contains 10 bit analog-to-digital converter output of the instantaneous current from this solar panel
Panel Temperature	12 bits	Solar panel temperature
Diode Temperature	12 bits	Diode temperature
Inductor Temperature	12 bits	Inductor temperature
FET Temperature	12 bits	FET temperature
Setpoint	1 byte	Solar panel current PWM setpoint
Age	1 byte	Indicates the age of the information from this PPT. A zero value indicates current information.
Corrupt count	1 byte	Count of corrupt packets from this PPT

Screenshot for Mac ARISSatTLM. Compare with Windows ARISSatTLM Telemetry As Text screenshot.



When the ARISSatTLM software is completed, demodulated frames will be sent to an Internet telemetry reflector. The reflector software will then combine all of the received telemetry frames, send telemetry frames in real time to anyone on the Internet who is interested using the Satellite Telemetry Protocol, update the www.arissattlm.org website with the latest telemetry, and update the telemetry archives.

Conclusion

Comments and criticisms on ARISSatTLM and the source code are welcome, as are bug reports and bug fixes.[7]

In this (earlier) version of ARISSatTLM the ss_telem_t struct was only 235 bytes. The ss_telem_t struct begins immediately after the ASCII "Hi" message. The Mission Elapsed Time starts at byte 0x01B in the hex dump. Note that the four bytes starting at byte 0x01B are "31 CC 02 00". As a four byte integer value this becomes 0x0002CC31, which converted to decimal is the Mission Elapsed Time of 183345 seconds (compare with "Telemetry As Text" screenshot below). The mission mode is the next four bytes are 0x00000002, which corresponds to "High Power".

The "^" and "v" characters indicate increasing or de-

creasing values compared to the previously received telemetry frame.

The layout for the telemetry values have been reformatted for display on smaller hand held devices.

References

- 1 Monteiro, Anthony. "Space Radio for Windows." Proceedings of the AMSAT-NA 26th Space Symposium. 2008.
- 2 Karn, Phil. "The BPSK1000 Telemetry Modem for ARISSat-1." Proceedings of the AMSAT-NA 28th Space Symposium. 2010.
- 3 TortoiseSVN is available at <http://tortoisesvn.net/>
- 4 The format of the Kursk experiment data frame is documented on the SVN at <<https://svn.sarpeidon.net/viewvc/suitsat2/Experiments/Kursk%20011509/Suitsat%202/Structure%20of%20experiment%20data%20frame%2B.pdf>>
- 5 Karn, Phil. "The Satellite Telemetry Protocol (STP)". 8/1/2010. <https://svn.sarpeidon.net/suitsat2/repos/ground_station_software/ARISSatTLM/Documentation/telem.txt>
- 6 The task of calculating the exact time to transmit a

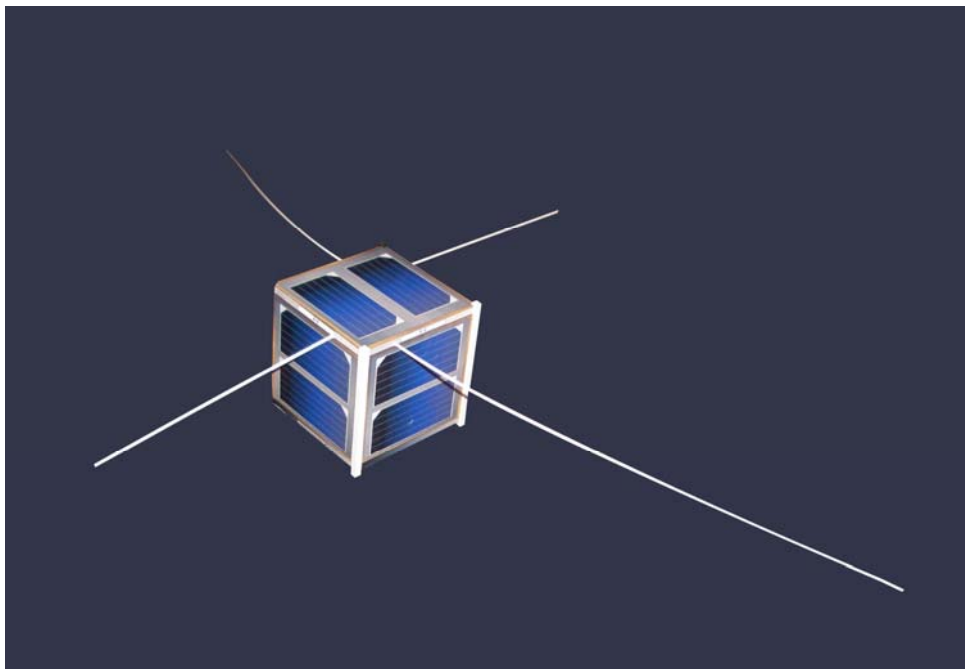
Screenshot - ARISSatTLM main window (Windows Version)

The screenshot shows a window titled "ARISSatTLM Telemetry As Text". It displays a grid of telemetry data. Key sections include:

- MET:** Mission Elapsed Time (sec) 183345, Days: 2, Hours: 2, Min: 55, Sec: 45. Mode: HIGH POWER.
- Battery:** Batt Voltage ^ 35.509, Batt Current ^ 0.000, PSU Vdd 5.054, 2.5 V Ref ^ 1FA, Charging Coulombs ^ 14023656, Discharging Coulombs ^ 32560987, Net Coulombs ^ -18537324, Battery is Discharging.
- Power Consumption:** Instant Total Flight, Camera = 0.000 36773901, Experiment = 0.000 20791898, IHU = 0.071 81947888, SDX = 0.243 22457807, 5 volt = 0.325 33303949, RF (8v) = 0.465 39805579.
- Status:** IHU ON, Camera1 OFF, Experiment OFF, Camera2 OFF, 5 volt ON, Camera3 OFF, 8 volt ON, Camera4 OFF.
- Temp:** IHU v 45, Top Camera v 28, PSU v 46, Bottom Camera v 28, SDX v 48, Control Panel v 28, Batt v 27, Experiment v 29.
- PPT 1-6:** Multiple sections showing Panel Energy, Panel Voltage, Panel Current, Panel Temp, Inductor Temp, FET Temp, Setpoint, Age, and Corrupt Count for different power points.

Calculated Telemetry

Description	Size	Notes
Battery voltage	2 bytes	Over the range -327.68 to 327.67 volts
Battery current	2 bytes	Over the range -4096 to 4096 mA (125uA/lb)
RF (8V) current	2 bytes	Over the range -4096 to 4096 mA (125uA/lb)
IHU Enclosure temperature	1 byte	IHU Enclosure temperature (-128 to 128 degrees C)
Control panel temperature	1 byte	Control panel temperature in degrees C



This is the Mk2 model of a 1U CubeSat with deployable UHF and VHF antennas created by Jim G3WGM. It is a close representation of FUN-cube - see his construction article on page 17

Live OSCAR Satellite Status Page

This web page was created to give a single global reference point for all users in the Amateur Satellite Service to show the most up-to-date status of all satellites as actually reported in real time by users around the world. Please help others and keep it current every time you access a bird. If you want to practice reporting without affecting the real data, please select the dummy-satellites AO-98 and AO-99.

Thanks and 73s,
 David Carr, KD5QGR --at-- dcarr.org, Site Development
 Bob Bruninga, WB4APR --at-- arnsat.org, USNA Satellite Ground Station

A reminder that probably the best website to track current activity on the OSCAR satellites is this one!

www.oscar.dcarr.org

Please remember to submit your own reports as well

Name	Transponder/Repeater active Telemetry/Beacon only No signal Conflicting reports ISS Crew (Voice) Active						
	Feb 17	Feb 16	Feb 15	Feb 14	Feb 13	Feb 12	Feb 11
ANDE-2		1					1
[A] AO-7	1	1 2 1 1 1 1 2 1	2	1 2 1 1 2 1 1 2 1			3 4 2 1 1 2 1 1 1
[B] AO-7	2 2 3 2 3 1 1 2 1		2 2 1 3 2 2 1 4 1 1	1	1 2 3 3 3 2 1 2 2 1 1 1		
[B] UO-11	1 1 1 1 1 1 1 1 1	2	1 1 1 1 1	1 1 1 1 1	2	1 1	
RS-15			1				
AO-27	1 1 2 1 1 1 2 2 2 1 1	1 2 2 1	1 2 2 1	2 1	2 1	1 2 1	4 1 1 1 2 1 1
FO-29	1 1 1 4 1 1 1 1 1 1 1 1	1 1 1 1 1 2	1 2 2 1 1 1	1 2 2 1 1 1	1 2 2 2 2	1 1 1 1 2 2 1	1
NO-44	1		1		1		1
SO-50	2 3 1 1 1 1 1 1 2 2 2 1	1 2 2 2 1	1 2 2	1 2 2 1	1 2 1 2	4 1 3 1	
AO-51	1 1 1 1 1 1 1 1 1 1 1 1	2 2 1 5 1 2 2 2 1	2 1 1 3 5 5 1 1 2	1 1 2 3 1 2 4 1	1 1 2 2 2 1 3 3 1 4 3 2 1 1		
VO-52	1 1 1 1 2 1 1 1 1 1 1 1	1 3 1 1 3 1 4 1	1 1 2 2 1 5	2 2 1 5 2	2 1 2 1 1 2 1 1 1 2 1 4 2 2 1 3 3 1		
SO-67					3 2 1 3	1 1 3 1 3 1	
HO-68	1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1	1 3 2 4 1	2 1 2 1 1	
Delfi-C3	1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 2 1 1	1 1 1 1 1 1	1 2 1 1 1 1 1 1 1 2 2 1	1	
ISS-FM		1 1 1			1		1
ISS-DATA	2 2 2	1 2 1 1	1 2 5 1 1 3	2 3 1 1 1	1 2 2 1 1 1 1 1 2 1	4 1 1 1	
ISS-SSTV			1				

[Download a 9/03/10 snapshot of the report database \(more than 128,000 reports\)](#)

Hon Sec's Keyboard—continued from page 3

Publicity. Trevor Hawkins took this over several years ago, and has done a great job. AMSAT-UK is frequently mentioned in various amateur radio publications, thanks to his efforts.

The move of the Colloquium from the University of Surrey to a nearby Holiday Inn. The facilities provided by the Holiday Inn are much superior to those at the University (except, perhaps for the lecture theatre).

Oscar News. About two years ago we made a decision to go from A5 black and white to A4 full colour. We have had some very favourable comments, and the quality of production is now much superior. I think it is very important that we maintain Oscar News at the highest possible quality, as it's the main instrument of communication between our geographically dispersed membership. There has been a marginal increase in cost of producing the colour version, but this has been offset by the reduction some years ago from 6 to 4 issues per year.

Website. When I took over, this was run by Richard Limebear, and when he decided to leave the committee, it fell to me to revamp it. I was happy to do this, as at the time, I was learning about web site design. But I soon realised that to maintain the content up to date was no mean task, and I was delighted when John Heaton took over as our webmaster some 4 years ago. Very sadly, he passed away on Christmas Eve 2010, so we now have something of a gap to fill, but steps are being taken. Watch this space. It is very fortunate that John's work colleagues have agreed to keep our website active for a time while we make new arrangements.

On line membership - makes my life much easier!

FUNcube. I can't recall when this was first discussed by your committee, it must have been over three years ago when we were notified by the Radio Communication Foundation of the legacy which has made this project possible. I think of all the developments/changes over the last 10 years, this is undoubtedly the most exciting and challenging!

Nostalgic trip down memory lane over! Suffice it to say that I have not regretted taking on the Hon Sec's job, although at the time, I did wonder what I was taking on!

Membership Renewals

A big thank you to all who have renewed. It does make a big difference to me if people renew promptly, especially if they do so by post. About 15% of people renewed by post (so far) this year, the remainder have done so on line. I think the number renewing by post is down on last year. (Don't worry if your cheque hasn't yet been presented, it soon will be! I tend to do them in bulk as it's faster and easier that way.)

A big thank you to all who made an extra voluntary donation, we have raised well over £600 this way, which will all go to help AMSAT-UK's efforts to advance the amateur space programme.

I do know that one or two people found the on-line system difficult/impossible to use. If you haven't been able to make it work for you this year, please have another go next year. Unlike previous versions (which were hand coded by yours truly) this version is outsourced (on a rather budget package, to keep overheads down). It does lack some of the functionality that I would have liked (eg remembering who you are and your address). There is a version that does this, but the cost is something like 5 times what we are paying now, and would significantly increase our overheads if we were to use it (and you would have to remember your login details!).

If you were a member of AMSAT last year, and have not renewed, then you should find a reminder in this edition of Oscar News. If there is a reminder in your envelope, and you HAVE renewed then please accept my apologies, and drop me an email. The insertion of the reminders is a manual process, and I do not claim to be infallible.

If you joined as a new member some time in 2010, then if you joined after 31 July 2010 your subscription will carry over into 2011, so you have nothing to pay now. If you can't remember when you joined, then please email me at g3wgm@amsat.org, and enquire.

OSCAR NEWS

The last couple of editions of Oscar News have been edited by Graham Shirville and I. We have sort of agreed to take it in turns. Graham has been the 'lead' on this edition, and I was the 'lead' on the last. We use a programme called Microsoft Publisher to do the layout, which although a little fiddly, is quite handy for doing things like putting text round pictures etc. (Much easier than MS Word!). One downside is that the files it produces are quite large, so it is difficult to send back and forth by email. We have been using a system called DROPBOX; a free utility that synchronises folders over the internet. Much easier than ftp'ing, and DROPBOX is free with 2 Gb storage. The files aren't that big! It works really well, and there is a bonus in that it saves a copy of your files 'in the cloud' as a backup available via a web based interface. I recommend it. Someone suggested using it for the exchange of TLM files, or even the output from receiver programmes like Spectraview.

We are always very grateful for any material for publication, and these can be sent to g3wgm@amsat.org. We also are keen to receive other comments as to the layout, content, and suggestions for future articles. Additionally, if you would like to assist with the editorial task, please feel free to get in contact; but do be aware, that we do aim to get the copy to the printer on time (not that

we always succeed!), so like all volunteer work, if you volunteer and do nothing, that's worse than not volunteering!

The cost effective size for Oscar News is 20 pages. This brings us just below the cheapest postage rate in the UK, 100 grams, and many other places. If we go more than 20 pages, then we go to the next level of postage, and incur significantly more postage costs. For the last few editions we have been more than 20 pages, but we have always concluded that if we have the material, then we should publish it, rather than keep it over for the next edition.

FUNcube and the FUNcube Dongle

See elsewhere in this edition of Oscar News for more detail on the progress of FUNcube. This has got to be one of the most exciting AMSAT-UK projects of all time, IMHO. We are very grateful to all the developers and others who are putting huge amounts of work in their own time. Our next significant developers face to face (F2F) meeting is scheduled for the end of March. I will put an update of what we achieve on the FUNcube web site (www.funcube.org.uk) as soon as I can after the meeting.

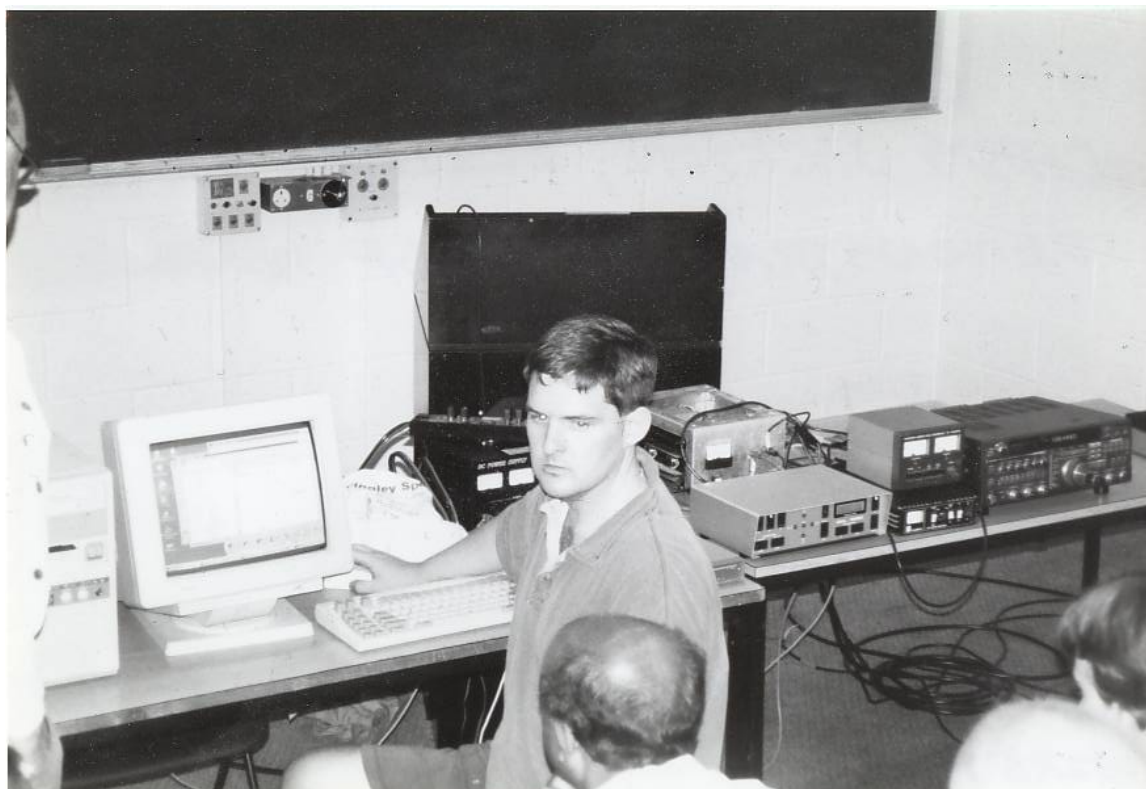
Also see elsewhere in this Oscar News for information on the FUNcube dongle, and also www.funcubedongle.com. The success of this part of the project is almost entirely due to Howard Long, G6LVB, and we should congratulate and thank him for his efforts. It was always the hope that we would have a cheap easy to use ground station for FUNcube. The early success of his design is evidence that it will have in place before the launch a cheap, reliable, flexible

ground station receiver for FUNcube. Already people are receiving signals from amateur satellites using early production versions of this novel receiver. It has even been used for EME!

I think it is a huge feather in our cap to be asked by the UK Space Agency to supply a set of FUNcube boards for their first satellite, UKube - a 3U cubesat. We are uncertain of the proposed launch date, but we understand that they are hoping for a launch before the end of 2011. There is no truth in the rumour that there is a race between FUNcube and UKube to be the first in space! Indeed we have held discussions about the pros and cons of being on the same rocket as UKube!

We are still slightly 'light' on the educational outreach side. Richard Limebear, G3RWL, has kindly agreed to coordinate the educational outreach effort, but although we have had several people expressing an interest, we don't seem to have made very much progress. I suppose if the truth be known, we are not certain at this stage exactly what we should be doing, but it would be good to have some material in place before the launch. IMHO, after the launch it will catch the eye of educators, and we want to try and be prepared as soon as we can.

73 Jim Heck, G3WGM,
g3wgm@amsat.org
Hon Sec AMSAT-UK
19 February 2011



Easy Question:

Who is the guy facing the camera?

Difficult Question:

Who is the guy looking at the screen with the bald head?

Answers to g3wgm@amsat.org

Pic: W2RS

Parameter	Satellite Tracker	Satellite Tracker Plus	pxSat	Satellite Ham Radio	GoSatWatch	Pocket Sat3
Intuitive	1	1	0.5	1	1	1
Convenient Display of Key Parameters	0.5	0.5	0.5	1	1	1
Map Ground Track	0	1	1	1	1	1
Map Footprint	0	1	0	1	1	1
Map Scrolling	0	0	1	1	1	1
Map Expand	0	0	1	1	0	1
Frequency Doppler Shift	1	1	0	1	0	0
Elevation Filter	1	1	1	1	1	1
Easy TLE Downloads	1	1	1	1	1	1
Antenna EL Indicator	1	1	0	0	0	1
Time Select	1	1	0	1	0	1
3D View	0	0	0	1	0	0
Satellite Advance/Retard	0	0	0.5	0	1	0
Programme Help	1	1	0.5	1	0	0
Online Manual	0	0	0	1	1	1
Features/Options	0.5	0.5	0	0.5	0.5	1
Ranking	8	10	7	13.5	9.5	12

Satellite Tracking Apps Features Matrix

(continued from p22)

My un-scientific and biased ranking criteria goes like this. 1 indicates good or included. 0.5 indicates poor. 0 indicates not included or very poor. For "time select", a 0 indicates time is local time only. My caveat – if I gave a 0 to a feature, it's because it wasn't there or I couldn't find it.

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- ✓ English Voice Guide
- ✓ SOS Function
- ✓ 170Hz Tone
- ✓ DTMF Encoding Function
- ✓ CTCSS/DCS Scan (Digital/Analog)
- ✓ Bright Flashlight Illumination
- ✓ Band can be set freely on the same Channel VHF TX/2M/70cm or UHF TX/400MHz
- ✓ Built-in FM Radio (76-108MHz ISM)
- ✓ Wide/Narrow Bandwidth Selection (25kHz/12.5kHz)
- ✓ Priority Scan, Add Scanning Channel
- ✓ High/Low Power Selection
- ✓ Channel Name Edit and Display
- ✓ 56 Groups CTCSS/100 Groups DCS
- ✓ Multi Step Frequency (300.350/100.250/50.050/50K)
- ✓ Multi Scan
- ✓ VOX Transmission
- ✓ Transmit Chirp/Voice Prompt
- ✓ English/Chinese Transmitting ID/EEP Prompt
- ✓ Auto/Manual Keypad Lock
- ✓ Wire Clone, Programmable By Computer
- ✓ Stopwatch Function
- ✓ Low Voltage VOICE prompt
- ✓ Busy Channel Lockout

Supplied accessories:
 1.3Ah Li-Ion Battery Pack (5W)
 Intelligent Base charger (110V-240V & 12V in input)
 Belt-Clip
 Dashboard Antenna
 Head Strap
 Handbook

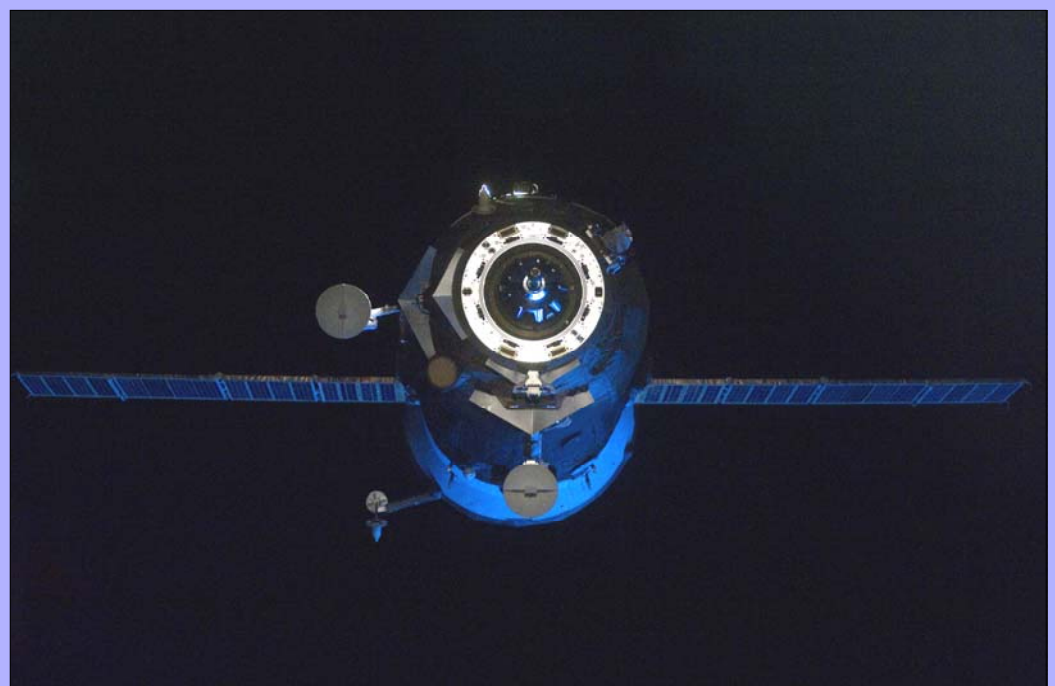
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Sergey Samburov RV3DR is seen testing the spacecraft before it departed from Moscow for the launch at Baikanour

ARRISat-1 as seen inside the International Space Station on February 10th 2011 being moved around by Russian Cosmonaut Dimitry Kondratyev. The VHF port of ARRISat, which is normally connected to a Kapton protected 1/4 wave monopole was connected to one of the external antennas that exist on the Station. The grab handles provided by AMSAT-UK for this project can be clearly seen in this photograph!



The Progress M-09-M cargo carrier arriving at the ISS with ARRISat-1 safely on board