



## STRATEGIC PLAN

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## Foreword



“...Aside from the impressive technical accomplishment, there is no doubt that a successful mission by BLUEsat will likely encourage development in Australia by showing that universities can in fact put fully functional satellites into space. It will provide a successful example that will encourage political support and funding of similar projects, something that I feel is very important to Australia’s future. And of course, being a completely Australian satellite, the media exposure around its launch will boost awareness of Australian space projects amongst the general public.

There is a tendency for many people to incorrectly think of space projects as too costly and too difficult, a faulted paradigm that has hampered development of an Australian space program for much too long. Projects like BLUEsat will help correct this perception and bring space technology within the reach of the general public. Importantly, the technology and expertise needed to build the satellite are well within the capabilities of this dedicated student-led team and there is little doubt in my mind that you will achieve great success.

I therefore wish the BLUEsat team the very best in achieving their mission, and continuing to inspire Australians to become involved in space...I wish you every success.”



Andrew Thomas  
Astronaut Office, STS-114

## Executive Summary

*If you want to build a ship, don't drum up the men to gather wood, divide the work and give orders. Instead, teach them to yearn for the vast and endless sea.*

*Antoine de St Exupery*

BLUESat is an innovative low cost satellite being built by students at the University of New South Wales in Sydney, Australia. The satellite aims to give students experience in designing, building, testing and operating real space hardware. This plan shows how the mission is being achieved, and outlines the steps that remain to realise our goal.

Planning, experimentation and innovation have been occurring with the satellite since 1998. From those careful beginnings, midway through 2006 we have completely designed all the planned satellite systems, and have built prototypes of most of them. The tasks that remain integrate these components into the structure and test them under the severe conditions likely to be experienced in space.

Since 2000, BLUESat has also been progressing the non-engineering tasks that underpin our successful launch. As the construction of the satellite culminates, it is these areas that present the greatest degree of risk to successful launch. Foremost is negotiating a launch contract and raising the funds to pay for the launch. Insurance and regulatory compliance are also very important.

Achieving our mission will realise substantial benefits. The students who work on the project gain real space industry experience. The University will join the elite club of higher education institutions around the world which have successfully launched, and own, an operational satellite. Australia confirms that it can make a contribution to the global space quest. The payloads will benefit amateur radio operators across the globe and test cutting edge GPS modifications.

### **How will we get there?**

At present, BLUESat works on the likely scenario of paying for a launch with the Russian rocket company ISC Kosmotras. Funds for the launch will come from private sponsorship, State and Federal Government grants and the University of NSW.

The funds that remain to be raised are primarily for launch. BLUESat currently has the financial resources and expertise to finish the satellite, and offers the potential for an additional payload if a suitable payload candidate can be found.

Read on, and share our confidence and enthusiasm in BLUESat and its mission. We invite you to join with BLUESat in bringing space closer to Earth.

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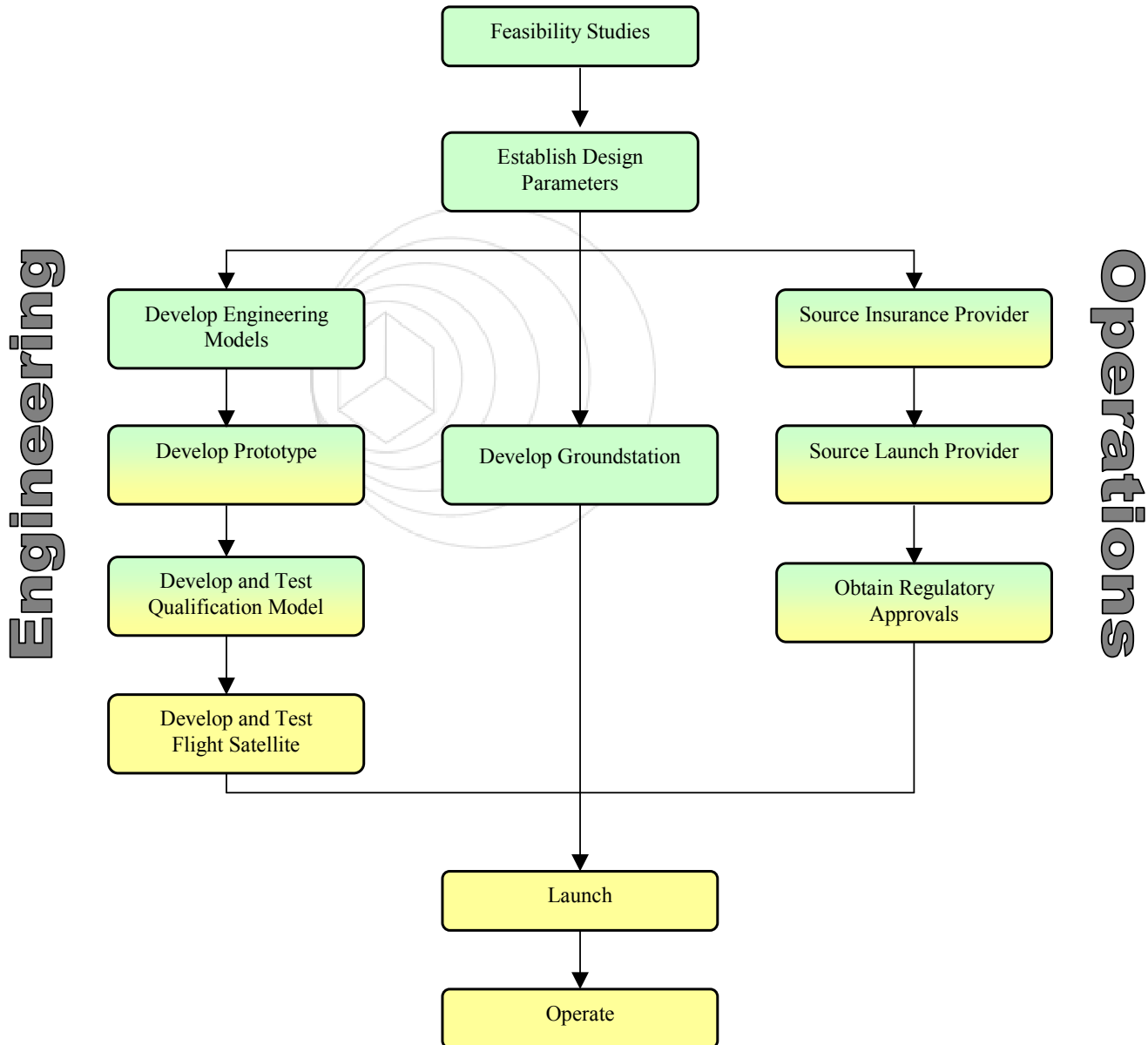
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## How To Build A Satellite

Building a satellite is a complicated process, and specialised terminology is used throughout this Strategic Plan where it is necessary. The flowchart below shows the essential steps required to construct our satellite, and reference to the Glossary will explain unfamiliar steps and processes. Those tasks shaded in green have been completed by BLUEsat, whilst those shaded in yellow remain to be done.



## What Will BLUEsat Do?

BLUEsat is primarily an educational satellite, designed to give students in Australia space experience which they could not obtain elsewhere. Therefore its mission has been chosen to offer low cost and minimum complexity, whilst at the same time offering enough of a challenge to inspire and enthuse the students who work on it.

Once in orbit BLUEsat will be a digital amateur radio satellite, which means that voice and data files can be uploaded to it by any amateur radio operator around the world, and can be downloaded over a different part of the world. This allows voice and data communication to and from remote areas without internet access. There are already several satellites which provide this service, but they are ageing, and new satellites need to be launched to replace them. Students from UNSW will continue to be the primary operators of the satellite whilst it is in orbit, continuing the educational focus through the full satellite lifecycle.

In order to support an amateur radio payload, however, BLUEsat must carry most of the hardware that makes up any functioning satellite: solar panels, rechargeable batteries, a programmable flight computer, an effective structure, radios and antennae. Building a satellite to fulfil an amateur radio mission is very similar to building a satellite to fulfil any other kind of mission – it is just the contents of the payload which change.

Therefore, whilst BLUEsat's formal mission is to provide useful amateur radio services, the purpose of this mission goes beyond simply increasing the amateur communication bandwidth. The over-riding purpose is to put up a fully functional satellite designed and built by Australian students.

## **BLUESat's Funding Environment**

We believe that the time is ripe for stakeholders to invest effort and funding in BLUESat. Recent developments in the global space industry and in the higher education sector in Australia have strengthened the case for low cost educational satellites such as BLUESat.

### ***Space Industry***

The space industry worldwide is becoming increasingly commercially focussed. This means that the numbers of people employed in the industry will rise and that companies that seize the advantages of the space age early stand to gain an enormous competitive advantage. Correspondingly, those which lag behind will find themselves on the wrong side of a widening technological gulf.

Recent developments which highlight commercial interest in space include:

- A valuation of the global space market in 2004 at \$83 billion, rising to \$130 billion by 2006.<sup>1</sup>
- The successful attempt at the \$10 million X-Prize for building a reusable space-plane by private US firm Scaled Composites.
- The \$25 million deal signed between Richard Branson's Virgin Galactic and Scaled Composites.

The potential impact of space-based resources such as remote sensing and instant data transfer is an issue which companies need to keep at the forefront of all strategic planning. BLUESat is a low-cost platform which attracts the innovative minds which will develop future space technology. Companies supporting BLUESat have the opportunity to tap this intellectual resource whilst at the same time supporting education and research into technologies which are of increasing benefit.

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<sup>1</sup> California Space Authority, 2004 California Space Enterprise Strategic Plan

### ***Higher Education Industry***

The higher education market in Australia is an increasingly competitive one. BLUESat presents UNSW with an opportunity to consolidate its position as the top science and technology university in Australia.

The global growth in the space industry and public excitement over recent achievements such as the winning of the X-Prize mean space technology education will be a key drawcard in attracting students over the next decade. UNSW currently has one of the most advanced satellite construction projects of Australian universities, but others, such as the University of Queensland and RMIT offer similar projects. Funding, marketing and publicising BLUESat has the potential to attract significant numbers of students to UNSW.

In addition, the global space industry provides jobs. These employers will look for students with theoretical competence, practical experience and the desire to learn. BLUESat provides the perfect complement to the suite of theoretical courses at UNSW in giving students this skill set.

Potential students may find courses elsewhere should UNSW be unable to offer cutting-edge space projects such as BLUESat.

## Background

In this section of the plan, we present the progress made on BLUEsat to date. For more information on the steps taken to reach our current level of development, please see the series of annual reports for the years 2000 to 2005 inclusive, available on our website.

### **1998 – 2000**

#### **Engineering Developments**

- Feasibility studies were conducted for the satellite.
- Early engineering modelling was carried out in conjunction with the feasibility studies.
- A preliminary design was selected, largely based around a modified AMSAT tray structure.
- A Sun-synchronous orbit was selected.
- Work on various subsystems of the satellite begins, largely through thesis projects.

#### **Operations Developments**

- The Business Development Team was introduced in 2000 with the aim of coordinating the operational (non-engineering) side of BLUEsat.

### **2001**

#### **Engineering Developments**

- The power system completed design of the solar array and procured all materials and workspaces needed to begin manufacture of the solar cells. Prototype batteries were also sourced in 2001.
- Work on the flight computer was outsourced to the School of Computer Engineering at UNSW, and design continued.
- A prototype model of the Groundstation radio system was designed, developed and tested. This included installation of antennae atop the School of Electrical Engineering.
- The structural prototype was completed.
- The testing and evaluation team designed the necessary experiments to fully test BLUEsat's space-worthiness and prepared the Testing and Evaluation Master Plan to guide future team members through the process.

## **Operations Developments**

- The key operations development for 2001 was the establishment of the BLUESat Steering Committee. The Steering Committee is the focal point for BLUESat's interaction with the University, academics and industry leaders.
- A Memorandum of Understanding ("MOU") was also signed between BLUESat and the National Space Society of Australia ("NSSA") to encourage mutually beneficial marketing of BLUESat's achievements.
- BLUESat increased its emphasis on training programmes, running a soldering workshop with renowned satellite builder Chuck Green of AMSAT.
- International connections were broadened as BLUESat hosted international visitors from IEAust and the Ukraine and additionally hosted the Honeywell Summer School.

## **2002**

### **Engineering Developments**

- The structural team prepared formal engineering drawings of their design, and adjusted the configuration of the trays to offer improved heat transfer capability.
- The solar cells were individually tested and characterised. Tests on lamination were carried out to determine the most suitable procedure.
- Flight computer development was brought back under the control of BLUESat. Specifications were completed in 2002.

### **Operations Developments**

- Discussions initialised with the Kosmotras launch corporation in the Ukraine.
- Thorough documentation was implemented for all components and subsystems.
- BLUESat attended the CRCSS conference.
- BLUESat attended the microsatellite conference at DNEPR in the Ukraine.
- Several new sponsors supported BLUESat with donations of materials and funding.

## 2003

### Engineering Developments

- Prototype boot loader was completed.
- Prototype radios for BLUESat were completed.
- Design of flight computer completed.
- Power system specifications completed.

### Operations Developments

- Groundstation officially opened.
- Cleanroom completed and officially opened. Resources to complete came primarily from in-kind donations from companies such as Arden, AES Environmental and Laserlite.
- Received first cash donation of \$10,000 from private sector.
- In kind sponsorship continued to grow through the year.
- BLUESat exhibited at CEBIT.
- BLUESat presented at the Central Coast Amateur Radio Club Field Day (largest amateur radio field gathering in the southern hemisphere).

## 2004

### Engineering Developments

- First prototype flight computer manufactured.
- Redesign of structure initiated.
- Design of second prototype flight computer.
- Space-grade solar cells purchased.
- JTAG boards are completed.
- Final power system design completed

### Operations Developments

- Research into legal and regulatory regime for BLUESat begun.
- ULSSD and BLUESat organisational structure optimised.
- BLUESat presented at Australian Space Development Conference.
- BLUESat again exhibited at CEBIT.
- BLUESat again presented at the Central Coast Amateur Radio Club Field Day.

**2005**

### **Engineering Developments**

- Revision 2 Flight Computer manufactured.
- Milling of redesigned structure
- Battery packs assembled
- Power board designed and routed
- Telemetry boards designed and routed
- Functional solar panels for earth use prepared
- Integration of systems into a “FLATsat” progresses
- Software development begins
- First data transfer to Groundstation through flight computer

### **Operations Developments**

- UNSW begins talks with Australian Space Licensing and Safety Office
- BLUESat participated in National Science Week (Commonwealth govt)
- BLUESat participated in Science Exposed (NSW govt)
- BLUESat again exhibited at CEBIT
- BLUESat again presented at the Central Coast Amateur Radio Club Field Day.
- Key sponsorship from Huber & Suhner finalised
- Key sponsorship from Master Instruments finalised

## **BLUESat To Launch: The Next Steps**

The timeline for BLUESat to launch cannot be stated with certainty. This is because BLUESat is purely run by volunteers, all of whom are working on a satellite for the first time. However, progress has accelerated over recent years and we are hopeful of having the satellite launched by 2010. Below, we identify briefly the major tasks that remain under four key focus areas of technical progress, funding, operations and industry relations.

### ***Technical Progress***

BLUESat will continue its steady progress to date towards a fully functional flight model.

The first step is to have a basic electrically functional satellite (the “FLATsat”) which demonstrates that all electrical hardware works correctly. The next step is to integrate the electrical hardware into the structure and begin environmental testing such as vacuum, vibration and thermal tests to confirm that the satellite is likely to survive in space. Finally, the entire satellite is built again, and transported to the launch site where it undergoes final testing before being launched.

Our current timeline calls for the FLATsat to be finished by the end of 2006.

### ***Funding***

Lack of funding is the key risk preventing a successful BLUESat launch. At the same time, experience has shown that cash donations will only occur in combination with measurable engineering progress. At the very least, a fully working FLATsat is required to demonstrate that we can build a satellite before we ask for cash sponsorship. At the same time, BLUESat has secured in-kind sponsorship from a number of organizations over the past few years which has allowed us to construct the satellite so far on a shoe-string cash budget.

We believe that the funding for launch can be obtained through the combination of mechanisms identified in the Financial Plan. We recognise that delays to development of the satellite are possible, and that funding timelines must be commensurate with satellite development proceeding to schedule.

## ***Operations***

BLUESat is set to work closely with the University, particularly through the steering committee, as launch approaches. BLUESat is a UNSW project and UNSW will have responsibility and ownership over the satellite, which is particularly relevant in the areas of the launch contract, insurance, and ensuring regulatory compliance. Publicity and marketing will also become increasingly important as launch approaches, and BLUESat will work closely with UNSW to maximise UNSW's return from its investment in the BLUESat project.

## ***Industry Relations***

BLUESat will continue to forge strong links with direct space industries, particularly through its relationship with the Australian Space Research Institute (ASRI), the NSSA and the network of former BLUESat members. These links gives BLUESat the credibility it requires to raise funds for launch.

BLUESat will also look towards secondary space industries, such as the Australian mining sector, as launch approaches with a view to working together to increase the technological edge of Australian corporations.

## **Organisational Structure**

BLUESat is divided into two teams: Engineering and Operations. These teams are further divided as shown in the graphic overleaf to allow logical progress towards the mission goals.

Both the Engineering and Operations teams meet weekly to discuss and review progress and form objectives for the coming week.

The greatest asset of BLUESat is the team of extremely bright, dedicated and enthusiastic people who on a day-to-day basis turn their attention to launching a satellite. Below is a description of the key roles in BLUESat.

### ***Elected Positions***

#### **President**

The President is a student responsible for overseeing BLUESat. The President communicates with the University and with external stakeholders to ensure all parties are fully informed about the project.

#### **Chief Technical Officer (“CTO”)**

The CTO is the chief student engineer of the BLUESat project. The role is primarily to monitor progress against the set milestones and liaise with the Executive to ensure that a complete satellite is ready for launch at the agreed launch date. The CTO works very closely with each Team Leader to ensure progress is continuing in each sub-team.

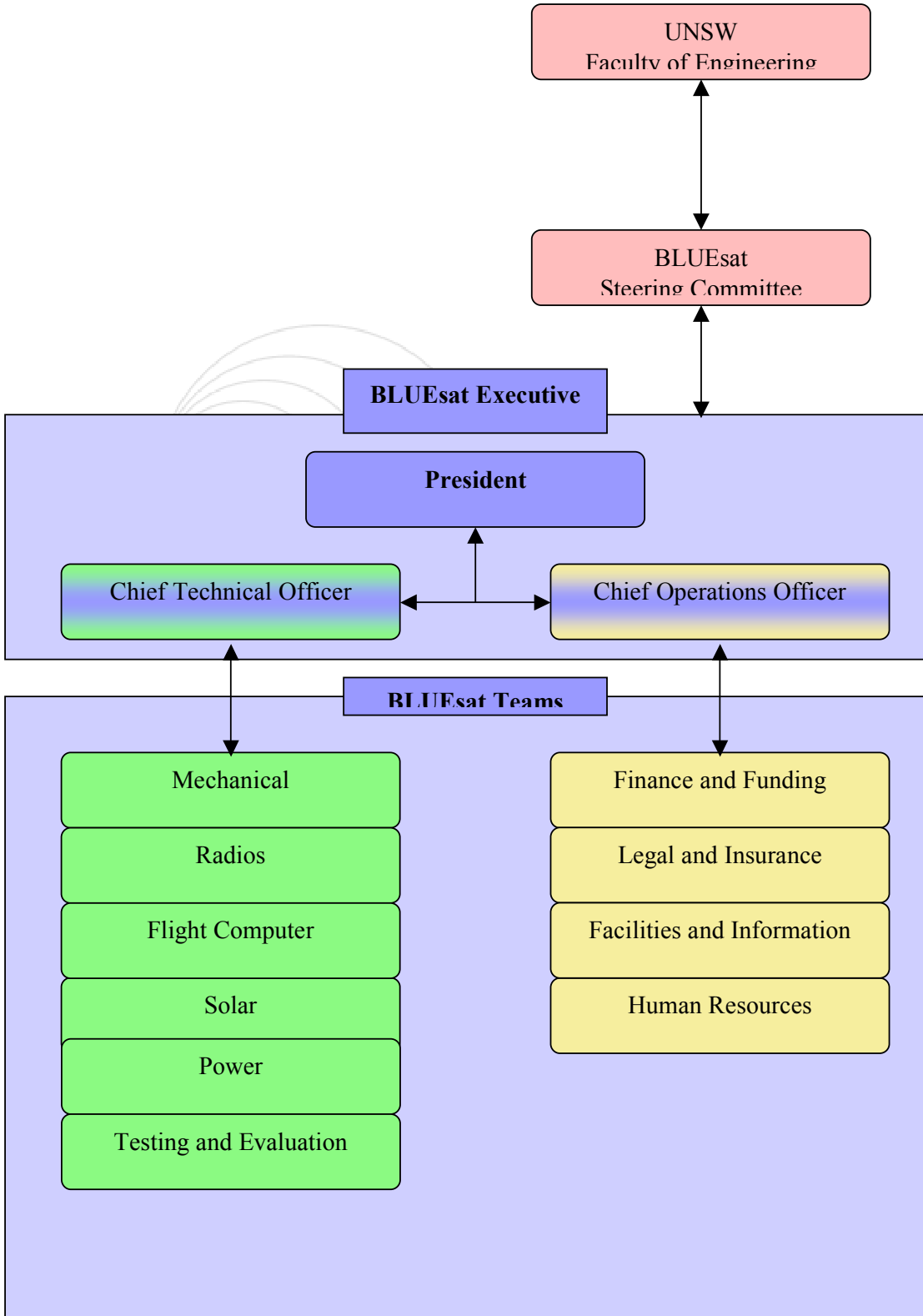
#### **Chief Operations Officer (“COO”)**

The COO is a student who oversees the non-engineering arms of the BLUESat project. The role is to monitor progress over all non-engineering tasks. The COO will also bolster the operations teams where required.

### ***Steering Committee***

The Steering Committee is a highly respected panel consisting of University staff, both academic and administrative, and industry representatives, who oversee BLUESat. The purpose of the steering committee, and its quarterly meetings, is to offer advice and direction for the BLUESat team leaders. Since the establishment of the Committee in 2001, it has significantly increased the focus and profile of BLUESat.

**BLUESat Organisational Structure**



## ***Engineering Teams***

### **Mechanical**

**Role:** The Mechanical Team is responsible for the design and manufacture of the satellite's structure. This includes the mechanical interface with the launch vehicle. The team works closely with the Testing and Evaluation Team, making modifications as directed by the CTO and other team leaders to produce an assembled satellite.

### **Radios**

**Role:** The Radios Team designs, constructs, tests and delivers the radio equipment for the satellite and the Groundstation.

### **Flight Computer**

**Role:** The Flight Computer Team produces the hardware and software which control the satellite.

### **Solar**

**Role:** The Solar Team produces the solar panels which power the satellite. Working with the Power Team, Solar is responsible for keeping the satellite powered throughout its design life.

### **Power**

**Role:** The Power Team is responsible for designing the way in which the solar panels supply useful power to the satellite. This includes battery charge and discharge and power allocation for the dark periods of orbit.

### **Testing and Evaluation**

**Role:** The Testing and Evaluation Team design and carry out the experiments on the satellite which subject it to anticipated conditions and evaluate its response. These tests are required by the Launch Provider.

## ***Operations Teams***

### **Finance and Funding**

**Role:** The Finance and Funding Team is responsible for the financing of the project. Their role covers project accounting, sponsorship, fundraising, grant applications and budget projections. It is the largest of the Operations Teams.

## **Legal and Insurance**

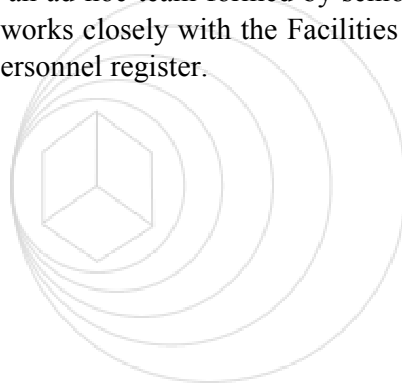
**Role:** The Legal and Insurance Team works closely with the University to ensure that all Australian and Foreign licensing requirements are met, and that the satellite is adequately insured to protect stakeholders.

## **Facilities and Information**

**Role:** The Facilities and Information team are responsible for maintaining the assets of BLUESat. Our software and hardware, as well as the Groundstation room and its associated antennae, are supervised and maintained by the Facilities and Information Team. The F & I team are particularly important because they allow many of the BLUESat members to work remotely with access to all electronic BLUESat information, including our unique Wiki-based knowledge database.

## **Human Resources**

**Role:** The HR team conducts recruitment drives at the beginning of each session. Presently, it is an ad-hoc team formed by senior members as recruitment is required. The HR team works closely with the Facilities and Information team to produce and maintain our personnel register.



## Financial Plan

The satellite requires two major categories of funding in order to successfully complete its mission. Firstly, funding and product donations are required for the BLUESat team to complete building the satellite. Secondly, funds are required to buy a launch for BLUESat. This section of the plan outlines the financial requirements for the satellite to completion and how these funds will be acquired.

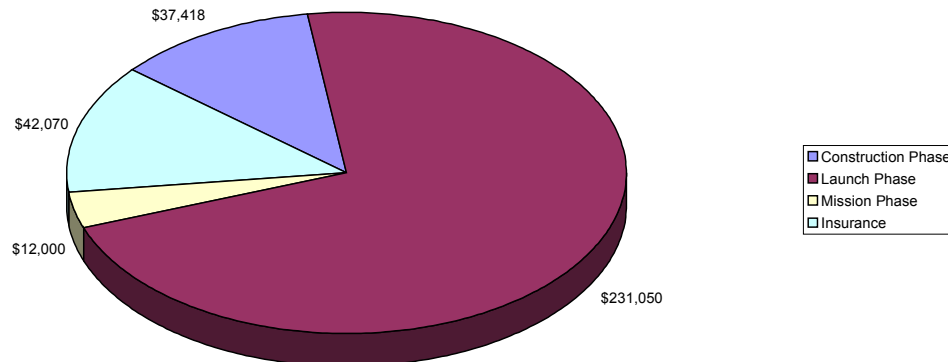
The funds required for the satellite are summarised in the table below.

<i>All values in A\$</i>	<b>Construction Phase</b>	<b>Launch Phase</b>	<b>Mission Phase</b>	<b>Insurance</b>	<b>Total</b>
<b>Best Estimate</b>	\$37,418	\$231,050	\$12,000	\$42,070	<b>\$332,538</b>
<b>Highest Estimate</b>	\$69,411	\$332,550	\$15,000	\$62,544	<b>\$479,505</b>

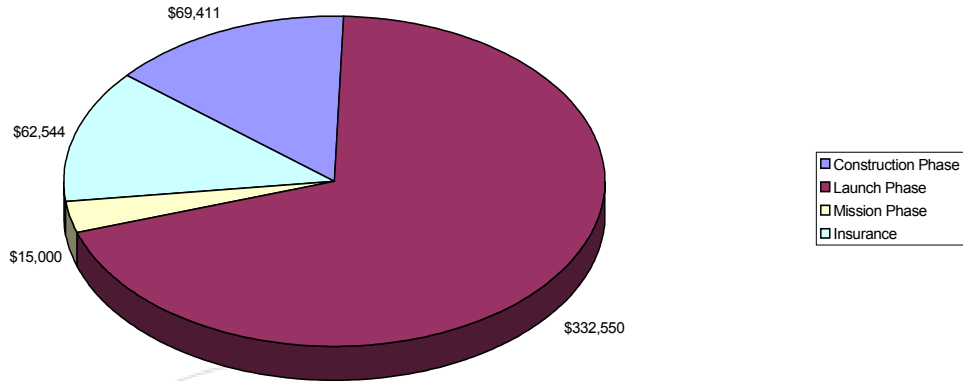
### ***Projected Budget to Completion***

The projections below are BLUESat’s best estimate of what we require, from the beginning of February 2005, to complete our mission. The budget divides financial activity into three phases, the construction phase, the launch phase and the mission phase. Insurance is a cost additional to these three, comprising approximately 15% of total cost.

**BLUESat Cost Breakdown  
Most Likely Cost Estimate  
\$322,538**



**BLUESat Cost Breakdown  
High Range Cost Estimate  
\$479,505**



### Construction Phase

The Construction Phase continues to the time that the satellite leaves UNSW completed on its way to launch.

The key activities in this phase are:

- Completion of all satellite hardware;
- Completion of all Groundstation infrastructure;
- Full documentation of the satellite for the Launch and Mission Phases;
- Testing and evaluation to the launch provider's satisfaction;
- Sourcing funding for the project; and
- Marketing and promotion of the project.

**The best estimate of costs for the construction phase is: A\$37,217**

**The highest estimated cost for the construction phase is: A\$69,140**

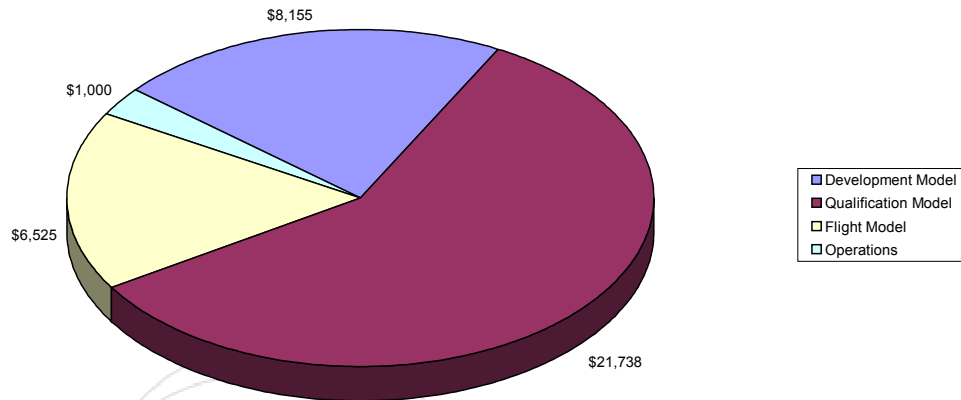
The key difference between these two costs is uncertainty in the cost of testing and evaluation. We have budgeted \$12,000 in the best estimate of costs, and \$22,000 in the highest estimated costs. The reason for the uncertainty is that the equipment used to test is highly specialised and space in the testing facilities is very expensive. We are, however, hopeful of being able to continue our good relationship with a number of testing facilities in Australia which will enable us to test the entire satellite for under \$5000.

The other cause of significant cost differences is uncertainty as to the extent of rework that will be required when the flight model is built, as this will depend on the test

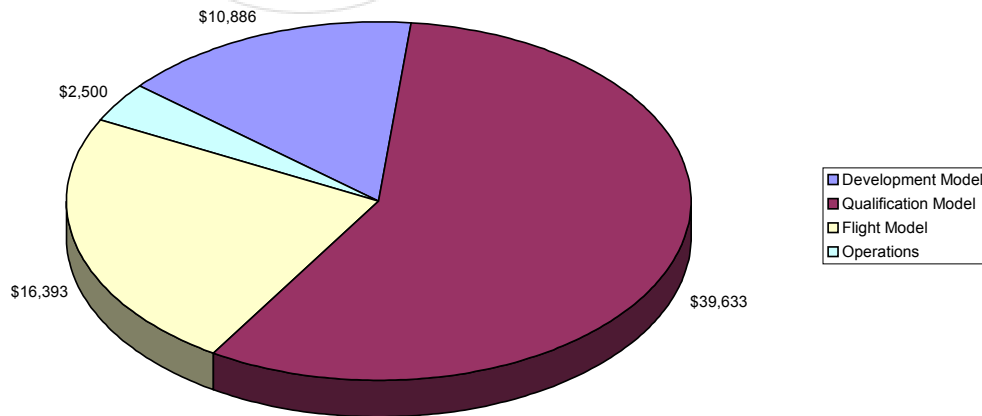
results from the qualification model. The best estimate of cost to build the flight model is two-thirds of the cost of the qualification model (without testing and evaluation), but in the high range cost estimate the high range cost of the qualification model (without testing and evaluation) has been used.



**Construction Phase Cost Breakdown  
Most Likely Cost Estimates  
\$37,418**



**Construction Phase Cost Breakdown  
High Range Cost Estimates  
\$69,411**



**Launch Phase**

The Launch Phase begins at completion of the Construction Phase and will be completed when the satellite is in orbit and first contact has been made with it.

Key activities in this phase:

- Transport of satellite from UNSW to launch site
- Insurance
- Licensing
- Travel for selected team members
- Launch purchase
- Launch Vehicle Integration
- Post Launch Monitoring

**The best estimate of costs for the launch phase is: A\$231,050**

**The highest estimated cost for the launch phase is: A\$332,550**

The largest portion of the cost in this phase is the fee paid for the launch itself. This is \$200,000 as a best estimate, and \$300,000 as a worst-case estimate. Because of the importance of this item, our method of estimating the launch cost is detailed below. A launch with the Kosmotras company has been selected, because they present the lowest cost commercially available launch, and so long as the funds can be raised, BLUEsat will be able to launch with them. There is, of course, the possibility that a subsidised or free launch will be available for some reason, perhaps by a sponsorship agreement, the need to test a new launch vehicle, or by the provision of educational space on a launch vehicle. BLUEsat will keep abreast of possible opportunities in this area, and evaluate each as they come to hand. For the purposes of financial planning, however, we work to cost estimates for launch with the Kosmotras company.

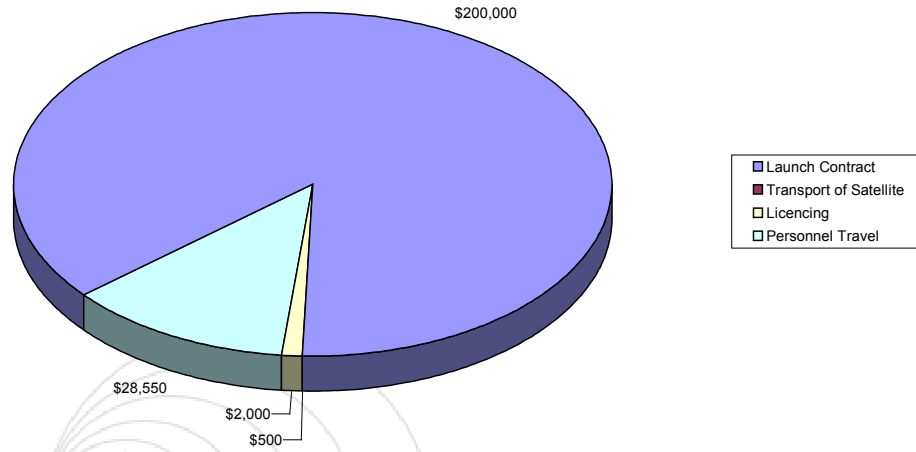
The table overleaf shows BLUEsat's estimated launch costs using the Kosmotras launch system. AMSAT's ECHO was a satellite launched in 2004 using the same launch provider, and weighing almost the same as BLUEsat. The launch cost for ECHO was approximately US\$120,000. Using the known weight of the satellite, the integration and per kilogram costs were estimated, the values of which are shown in the leftmost column of the table overleaf. These differed considerably from the prices quoted to us by Kosmotras in 2002, which are shown in the middle column. The difference can be explained by the highly negotiable nature of the launch market. In March 2005, BLUEsat again spoke with Kosmotras, and a figure of US\$12,000 per kilo with no integration cost was quoted. This value is shown in the rightmost column.

A conservative value of 0.68 has been used in converting between US and Australian dollars, to guard against high risk to the project from fluctuations in the exchange rate. To show the uncertainty surrounding this figure, and to reflect the approximate nature of the calculations in general, the calculated figures of \$186,784 and \$280,882 have been rounded upwards to \$200,000 and \$300,000 respectively.

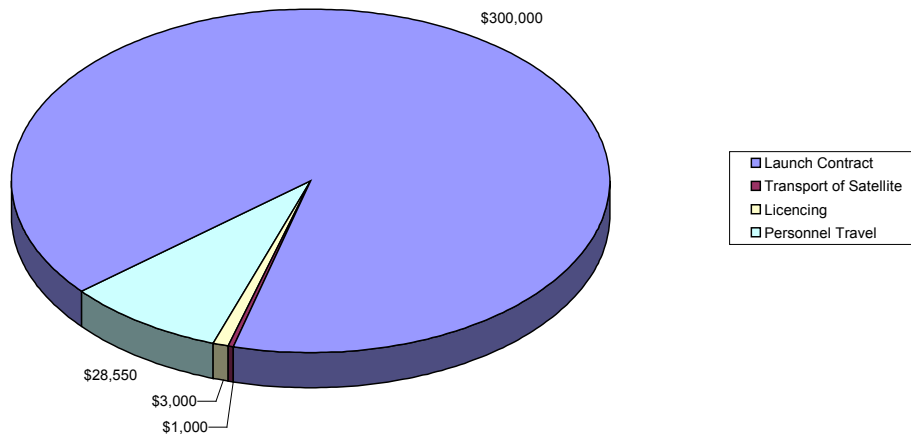
<b>BLUESat Launch Costs</b>				
<b>Estimate of Kosmotras Launch Costs from two sources</b>				
	<b>Echo Case</b> <i>rates deduced from known launch cost and weight of ECHO</i>	<b>BLUESat Case</b> <i>based on prices quoted by Kosmotras 2002</i>	<b>BLUESat Case</b> <i>based on estimated rates ECHO was charged</i>	<b>BLUESat Case</b> <i>based on prices quoted by Kosmotras 2005</i>
<i>Per kg cost (USD)</i>	\$8,500	\$11,000	\$8,500	\$12,000
<i>One off Integration (USD)</i>	\$25,000	\$70,000	\$25,000	\$0
<i>Satellite Weight (kg)</i>	11.8	12	12	12
<i>Weight Cost (USD)</i>	\$100,300	\$121,000	\$102,000	\$144,000
<i>Integration Cost (USD)</i>	\$25,000	\$70,000	\$25,000	\$0
<b>Total Cost For Launch (USD)</b>	<b>\$125,300</b>	<b>\$191,000</b>	<b>\$127,000</b>	<b>\$144,000</b>
<i>USD to AUD conversion</i>	0.68	0.68	0.68	0.68
<b>Total Cost For Launch (AUD)</b>	<b>\$184,264.71</b>	<b>\$280,882.35</b>	<b>\$186,764.71</b>	<b>\$211,764.71</b>

A breakdown of the launch phase costs by task is shown overleaf. Note that insurance, as a whole-of-project cost, is not included.

**Launch Phase Cost Breakdown  
Most Likely Cost Estimates  
\$231,050**



**Launch Phase Cost Breakdown  
High Range Cost Estimates  
\$332,550**



## Mission Phase

The Mission Phase begins at completion of the Launch Phase and will be completed when the satellite is no longer functional.

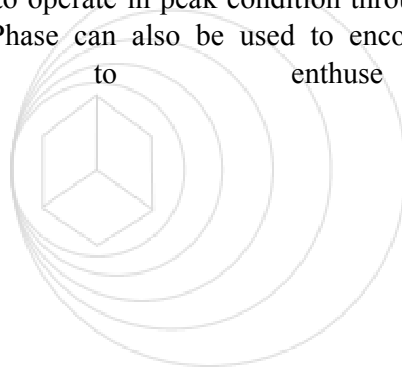
Key activities in this phase:

- Maintenance of Groundstation
- Continued liaison with Australian and International Space Societies to deliver maximum value from the mission.
- Formulation and delivery of the Operational Plan

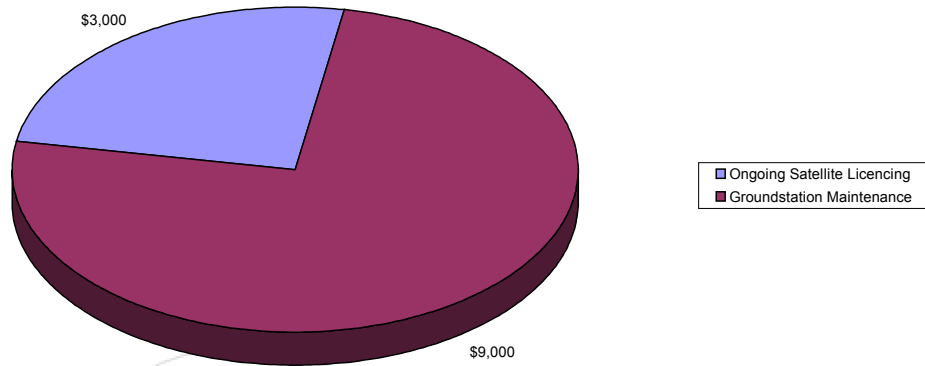
**The best estimate of costs for the mission phase is: \$12,000**

**The highest estimated cost for the mission phase is: \$15,000**

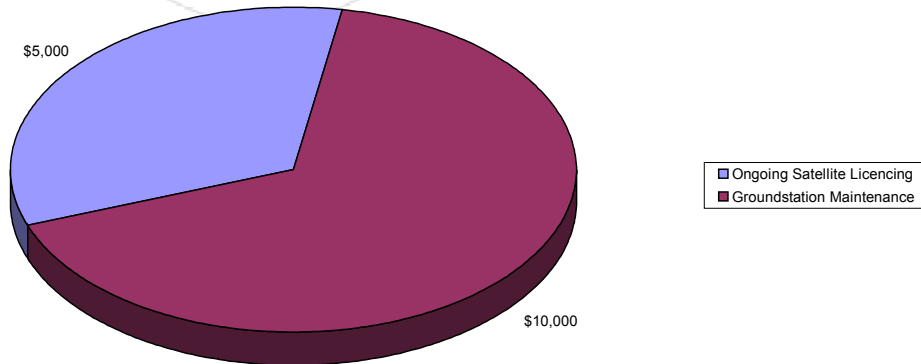
The mission phase is not to be neglected in the drive to launch BLUEsat. We have budgeted conservatively to ensure that the facilities to communicate with the satellite will continue to operate in peak condition throughout the satellite's life. Funding in the Mission Phase can also be used to encourage development of further space projects to enthuse and inspire.



**Mission Phase Cost Breakdown**  
**Most Likely Cost Estimates**  
**\$12,000**



**Mission Phase Cost Breakdown**  
**High Range Cost Estimates**  
**\$15,000**



## ***Projected Funding Sources***

This section details from where BLUEsat plans on obtaining the funding to complete the project.

### **Private Funding**

BLUEsat believes that it can secure one or two major sponsors who will provide the bulk of the funds required for launch. For a total contribution between them of approximately A\$250,000, the sponsors or sponsoring companies will have access to some of the brightest, most committed and forward thinking minds at UNSW. Companies in the mining and technology sectors are most likely to support BLUEsat.

BLUEsat will also continue to maintain its strong relationship with key industry sponsors who provide us with in-kind support and facilities. These sponsors are integral to the success of BLUEsat because they enable construction costs to be kept low. We do not believe there will be a conflict between the projected major sponsors and the existing minor sponsors, for the return proposed for their investment is quite different. The major sponsors will generally be companies looking to build intellectual capital, and they are offered the chance to target and employ BLUEsat personnel. The minor sponsors are predominantly manufacturers in the aerospace or electronics industries who are looking to expose their products to a new generation of engineers and advertise that their products have been used in space.

A final key source of private funding for BLUEsat is the amateur radio community. In 2004, \$10,000 was obtained through BLUEsat's exposure to this sector, who will realise substantial benefits from BLUEsat's launch.

An additional drawcard for all private funding of the satellite is that it presents taxation benefits for donors. As an educational, non-profit project, donations towards BLUEsat's construction or launch are tax deductible.

We have budgeted \$300,000 towards our launch from the private sector. We believe that the amateur radio community can raise \$50,000 of this figure.

### **Government Funding**

We also plan to obtain funding from the NSW and Australian governments. Whilst there are no specific grants targeted at exactly our mission, there are broader pools of finance for projects like ours which develop young Australians, encourage technology and space expertise and invest in Australia's intellectual capital.

We have budgeted \$80,000 towards our launch from Government grants.

## University Funding

### 1. U-Committee

BLUESat has a strong relationship with the U-Committee. Funds from this source in 2004 included a \$15,000 grant towards the flight computer which enabled completion of the flight computer. BLUESat hopes to win similar grants towards the launch costs of the satellite.

### 2. Faculty-Specific Support

BLUESat receives \$5,000 per annum from each of the Schools of Electrical Engineering, Computer Engineering and Mechanical Engineering and \$6,000 from the Faculty of Engineering itself. These funds are earmarked for satellite development – they buy the materials with which BLUESat builds the satellite.

Additionally, BLUESat receives computer equipment, a room to use as a Groundstation and a Cleanroom for fabrication from schools within the Faculty of Engineering.

BLUESat may also investigate the possibility of setting key performance indicators for the satellite and tying these to extra funding from the Faculty of Engineering. This will reward innovative and diligent engineering whilst assuring the Faculty that funding will be directly proportional to the amount of work BLUESat achieves.

### 3. Marketing Funding

BLUESat will also target the broader University's funding pool in 2005. BLUESat increases the prestige of UNSW, achieves mention in public newspapers and on radio, visits schools and societies and contributes in scientific circles. BLUESat is also a great educational tool for UNSW students outside the faculty of engineering as it presents significant legal, marketing and commercial tasks that students solve.

We have budgeted \$100,000 from the University towards completing the satellite and raising public awareness of the satellite.

## Technical Plan

BLUESat is a packet satellite (PACSAT). Its primary mission is to provide a packet-store-and-forward service to the worldwide amateur radio community. Its secondary mission is to test an experimental GPS algorithm developed by the Satellite Navigation and Positioning (SNAP) Group at the University of New South Wales.

The mechanical structure of BLUESat is based on a flight-proven AMSAT-NA design that has been modified and improved to better suit our needs. The structure is milled from aerospace-grade 6061 aluminium and comprises five rectangular trays. Each tray houses some of the satellite's subsystems and payloads. The trays stack atop each other to form the structure. Aluminium panels form the sides of the satellite, giving overall dimensions of 260x260x250mm.

Electrical power is provided by solar panels mounted on all six sides of the satellite. These solar panels are comprised of space-grade 21.5% efficiency gallium arsenide solar cells purchased from Spectrolabs. Power is distributed over time by two NiMH battery packs. Regulation and distribution of power is carried out by a custom designed power management system.

The communication systems comprise a set of Hamtronics receivers and transmitters, selected because they have successfully flown aboard several AMSAT satellites. However, they have had to be modified in each instance to make them suitable for space. The radios are controlled by the BLUESat flight computer which was designed in-house and is based around an Intel SA1100 microprocessor. Storage is provided by both unprotected and EDAC-protected SRAM, as well as flash memory. The flight computer will run an operating system based around the L4 micro-kernel.

Currently, the designs for the structure and the subsystems are complete and we will soon embark on manufacturing. After manufacturing of the structure and subsystems is complete, there are several major milestones that have to be met before BLUESat is ready for launch. The first milestone is to connect all the electrical subsystems together and verify that they function correctly as a whole. The next milestone will be to integrate the subsystems into the structure to produce a complete satellite. This satellite is the qualification model. The qualification model will then undergo vigorous testing in order to prove that the design is capable of surviving the launch and space environments. These tests include vibration testing to simulate the launch and radiation and heat testing to simulate the space environment. After the qualification model has successfully passed testing, a entire new satellite will be constructed. This satellite is the flight model of BLUESat that will be launched and the construction of it is the final engineering milestone. After light testing to ensure that the flight model functions correctly, BLUESat will be ready for integration onto the launch vehicle and the subsequent launch.

For the latest technical developments, go straight to our website.

## Legal and Commercial Plan

### ***Regulatory Regimes***

#### **Space Objects**

A significant regulatory regime underpins global coordination in outer-space efforts. All Australian space activities are regulated by the Space Licensing and Safety Office (SLASO), which operates pursuant to the Commonwealth *Space Activities Act* (1998).

Licences must be obtained for all objects launched into space by an Australian company, whether they are launched from Australia or externally. The essential conditions of the licence are that the company has adequate insurance, that SLASO is informed of the orbital parameters, payload and purpose of the satellite (and any alterations to that data as the satellite ages) and that the licence fee is paid. For educational institutions at the time of writing, that fee is \$100.

The technology used on the satellite may also be protected under non-proliferation of weapons treaties. If this is the case, export licences are required to take the satellite out of Australia. Import licences (and associated fees) may also be required in the state of launch.

Since UNSW will be the owner of the satellite at this stage, BLUEsat is liaising with UNSW to determine appropriate licensing. The SLASO regime is straightforward, but the import – export licensing is more complicated.

#### **Radio Frequencies**

We have already obtained the licences for the radio frequencies which BLUEsat and the Groundstation use. Nothing more needs to be done as far as licensing the radio frequencies BLUEsat will use, except to keep the IARU up to date with project progress.

#### ***Insurance***

Generally, insurance adds 10-20% onto the total cost of a satellite. BLUEsat's design, component and labour costs have been low, which would increase this percentage, but at the same time, it is unlikely BLUEsat will take out operational insurance cover as most commercial satellites do. The insurance cost has been estimated at 15% of the entire project cost, for cost planning purposes.

Insurance can be taken out for several discrete events:

- Insurance for satellite functionality
  - Transport to launch site
  - Launch
  - Operation
- Insurance against third party claims
  - Launch
  - Operation
  - De-orbit

It is likely at this stage that the only insurance that will be taken out is insurance during transport and against third party claims. This will have to be examined more closely, however, when the exact ambit of the launch contract is known. If this provides no redress against the launch provider in the event of a failed launch, or if this redress will be difficult to obtain because of international jurisdictional issues, then BLUEsat may require launch insurance.

Operation insurance is generally taken out only where the operation of the satellite is a significant source of revenue. This is not the case with BLUEsat.

### ***Property Rights in BLUEsat***

The key items of property in the satellite are:

- Property interest in the physical satellite
- Intellectual property rights in technology developed
- Ownership of the information that passes through the satellite
- Naming rights for the satellite

**Physical ownership** of the satellite implies responsibility to the Australian Government should disaster occur and someone elsewhere in the world be injured by the satellite. Under the Liability Convention, Australia would be liable to the signatory to whom damage was caused, and in turn the Government would sue the satellite owner for the damage. For this reason, the organization with ownership over the satellite will also be the organization in need of insurance (see above).

At present there is no commercially viable **intellectual property** created within the satellite, and there is no intention to create this, since it is a purely educational project. However, it is possible that this will be created during the remainder of the development or in the course of the satellite's operation. Agreement needs to be reached between the parties contributing to the satellite as to who will own any intellectual property stemming from it.

Ownership, and responsibility for, **information passing through the satellite** is also an issue. It is likely that UNSW will take no responsibility for information passing through the satellite. It is also likely that no offence can be created by information passing through the satellite, since the satellite is outside the jurisdiction of any State. There is still scope for debate however, such as over the rights of the BLUEsat Groundstation to record information that passes through the satellite. The standard IARU provisions prohibit the use of the satellite for commercial purposes, however, so commercial information is unlikely to be a significant problem.

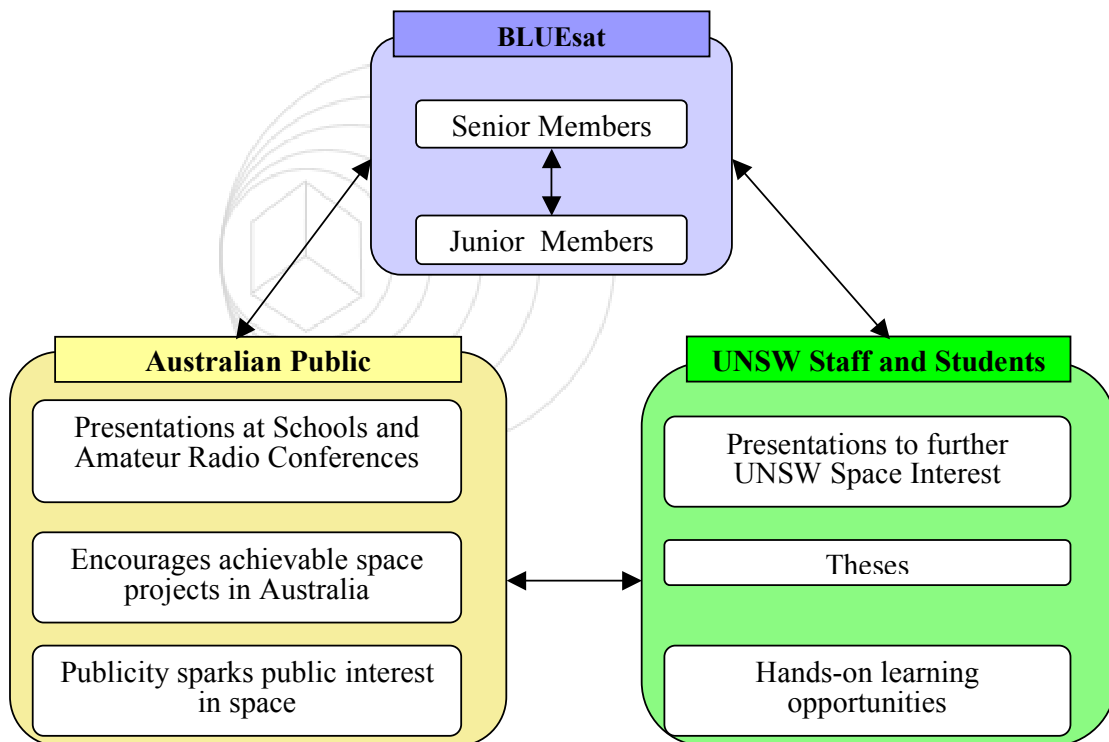
The **right to name the satellite** is a key sponsorship drawcard. At present, the name is simply a functional one, describing the capabilities, orbit and origin of the satellite in an acronym. As part of the broader sponsorship drive, the University's permission will be sought to permit the change of name of the satellite.



## Educational Aspects: BLUESat as Teacher

*“Show me, and I forget;  
Teach me, and I remember;  
Involve me, and I understand.”  
Chinese Proverb.*

BLUESat is first and foremost an educational satellite. Its aim is to promote successful use and understanding of space hardware. In order to do this, the BLUESat team conduct formal and informal educational programmes in conjunction with the construction of the satellite.



### **Teaching within the BLUESat Organisation**

An extremely thorough teaching programme takes place within the BLUESat team. New students are allocated to a team of their choice, and are assigned a mentor within that team, usually the team leader. Students working on engineering projects then spend about two months, depending on experience, becoming familiar with the history and collective experience of the BLUESat project and working on small practical projects to develop practical skills to the point where they can work on the satellite.

Students acquire valuable workplace skills by becoming part of a team focussing on a goal. Not only does the engineering have to be of the utmost professional excellence, but whole-of-project constraints have to be considered. The BLUESat engineers have to work with other disciplines in the team, such as those who are gathering the funding and regulatory approvals to make the project go ahead. The engineers also work to deadlines, develop project management and communication skills in a real world environment. Finally, BLUESat personnel have presented at a number of national and international conferences, giving presentation and communication skills as well as cementing contacts across the global space industry. The skills given by BLUESat are those in demand throughout engineering industries worldwide.

For those working outside the engineering aspects of BLUESat, it presents an ideal forum to apply the techniques learnt in classes. BLUESat needs real marketing, fundraising and management skills, and puts these into immediate practical application. Again, the BLUESat satellite project provides relevant, exciting experience for students, which is only available in very limited places around the world.

### ***Teaching within the University***

The educational value of BLUESat is not limited to those who are members of the team. BLUESat has become a component of the teaching programme of the Faculty of Engineering at the University of New South Wales.

Lecturers are closely involved with the project, through informal student links, through thesis supervision and formally through representation on the steering committee. This enables lecturers to develop examples and problems drawn from the BLUESat experience and add value to classroom teaching.

BLUESat also gives a broader spectrum of students in the engineering faculties practical projects on which they can apply their theory. The large number of theses written on the topic speak to the excitement generated by the project, and the desire among students to put their work to practical use as soon as possible.

### ***Driving Space Interest***

BLUESat will be the first amateur satellite built in Australia since 1966. BLUESat shows that it is possible for dedicated amateurs and students to work together and produce a working satellite. Such a role model for those to follow is of great value, and encourages others to build on our knowledge base for more advanced projects.



BLUESat speaks at space conferences such as the Australian Space Development Conference and has sent students to international conferences. BLUESat is also one of the few opportunities for Australian students to become directly involved in the burgeoning space industry. Australia has made great advances in areas such as data analysis of remote sensing data, and other “second-hand” space applications. BLUESat, however, presents the sort of “first-hand” challenge which fires imagination and enthuses people.



## The Way Forward

BLUESat is an unprecedented opportunity. For the first time since 1966 Australia is launching an amateur satellite. An Australian university is poised to join the elite international club of space-going universities. And more impressively, BLUESat is built predominantly by students.

The global space industry is maturing, with the achievement of the X-Prize in 2004 and expectations high for private space flight. BLUESat is working towards similar goals, giving Australian students an exceptional foothold on the space age.

A team of volunteer students have given tens of thousands of hours in thought, in design and in construction to realise the dream of making a craft that can circle the Earth, daily communicating with the Groundstation at UNSW and linking people with amateur radios across the world.

The design is proven. The engineering is sound. The time has come for those aligned with our lofty goals to help, to provide the funding and commercial backing which will push us towards the approaching stars.

To contact the BLUESat team, please visit our website:  
[www.bluesat.unsw.edu.au](http://www.bluesat.unsw.edu.au)

## Glossary

<b>AMSAT</b>	The worldwide Radio Amateur Satellite Corporation, an organisation aimed towards promoting, building and funding amateur satellites.
<b>BLUESat</b>	The satellite, and the group that builds it. The acronym stands for <b>B</b> asic <b>L</b> ow Earth Orbit <b>U</b> NSW <b>E</b> xperimental <b>S</b> atellite.
<b>CEBIT</b>	High level industry trade fair for information and communications technology.
<b>CRCSS</b>	Co-operative research centre for satellite systems
<b>Groundstation</b>	The Earth-based control point for the satellite, located at the University.
<b>IARU</b>	International Amateur Radio Union, which controls the radio frequencies on which BLUESat operates.
<b>JTAG boards</b>	Joint Test Action Group standard for production testing of printed circuit boards.
<b>Launch Contract</b>	The agreement between the Launch provider and the satellite owner, setting out the terms and conditions of provision of a rocket to take the satellite into space.
<b>Launch Provider</b>	The organisation which owns and operates the rocket to which the satellite is secured and which lifts the satellite into its orbit.
<b>Lexan</b>	The “Lexan Experiment” is a potential experiment on board BLUESat which tests a particular plastic (called Lexan) under space conditions.
<b>Operations</b>	The non-engineering aspects of BLUESat including funding, marketing and facilities.
<b>State</b>	In the sense of international law, this refers to a nation rather than an internal division within Australia.
<b>Steering Committee</b>	A group of University and Industry representatives as well as interested academics who guide BLUESat’s development
<b>Sun-Synchronous Orbit</b>	A path taken by a satellite around the Earth which completes a rotation approximately every hour and a half and covers most of the Earth’s surface. A sun-synchronous orbit crosses the equator at the same local time on each orbit.
<b>University</b>	The University of New South Wales, Sydney, Australia

## Addendum A: Technical Specifications

<b>Physical</b>	Dimensions	260 x 260 x 250mm
	Structure	Modular tray design
	Mass	11-12 kg
	Stabilisation	Passive magnetic stabilized
	Separation	Dependant on launch vehicle
<b>Power</b>	Solar cells	Gallium Arsenide cells 21% efficiency Average power 6W
	Batteries	NiMH batteries
<b>Communication</b>	Transmitter	2 Downlinks - 435Mhz at 9.6kbps
	Receiver	2 Uplinks - 145Mhz at 9.6kbps
<b>Command and Control</b>	Processor	StrongARM SA-1100 59-133Mhz processor speed
	Memory	16MB Flash memory 8MB Hardware EDAC Protected Static RAM 16MB Unprotected Static RAM
	Interfaces	I <sup>2</sup> C bus to telemetry subsystem GPIO ports
	Operating System	In-orbit re-programmable (L4 microkernel)
	<b>Payloads</b>	PACSAT
	FM Repeater	FM Bent pipe repeater
	GPS	Experimental GPS unit