CALL FOR APPLICATION

PhD Scholarship - Industrial Postgraduate Programme (IPP)

Company:	Thales Solutions Asia Pte Ltd
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Company Profile:	**Thales Group:** Everywhere it matters, Thales is there. In all its markets — aerospace, space, ground transportation, defence and security — our solutions help customers to make the right decisions at the right time and act accordingly. The combined expertise of our 65,000 employees, world-class technology, and operations in 56 countries have made Thales a key player in keeping the public safe and secure, guarding vital infrastructure and protecting the national security interests of countries around the globe. **Thales Solutions Asia:** Established since 1973, Thales has been present in Singapore for over 40 years and today employs over 600 people. Thales Solutions Asia is the legal entity that brings together the Aerospace, Defence, Security and Transportation domains. It has grown from strength to strength, building up industrial capability in avionics production & maintenance, repair & overhaul (MRO), enhancing its competencies in the fields of transportation & security and contributing to the local Defence and R&D eco-system.

S4TIN (Smart Small Satellite Systems Thales In NTU)
S4TIN is a joint laboratory between NTU, Thales Alenia Space and Thales Solution Asia. The partnership aims to leverage the rapidly growing nanosatellite and microsatellite segments of the global satellite industry which usually refers to satellites less than 100 kg. The lab brings together the world-renowned heritage of Thales Alenia Space in satellite systems, NTU's pioneering research in small satellite platforms and technologies, and the local research and technology capabilities of Thales in Singapore.
S4TIN supports the development of new flight-proven technologies for the micro/nano-satellite market. These technologies will first enable the development of prototypes and mission demonstrators and will become, in the future, basis of operational missions.

Thales Alenia Space

Thales Alenia Space, a joint venture between Thales (67%) and Finmeccanica (33%), is a key European player in space telecommunications, navigation, Earth observation, exploration and orbital infrastructures. Thales Alenia Space and Telespazio form the two parent companies' "Space Alliance", which offers a complete range of services and solutions. Because of its unrivaled expertise in dual (civil/military) missions, constellations, flexible payloads, altimetry, meteorology and high-resolution optical and radar instruments, Thales Alenia Space is the natural partner to countries that want to expand their space program. The company posted consolidated revenues in excess of 2 billion euros in 2014, and has 7,500 employees in eight countries.
www.thalesaleniaspace.com

Positions 1

Optimization of Satellite-based Data Collection & Communication systems for Maritime Applications

In the frame of S4TIN (Smart Small Satellite Thales In NTU) laboratory activities Thales Solution Asia, Thales Alenia Space and NTU are collaborating to develop the next generation of Systems for Maritime Surveillance from Space. To support the project, there is the need for researching in the following areas:

- Signal Processing: Waveform & Modulation scheme

analysis
- Data Processing for Signal De-collision
- Secure Communication Protocols
- Encryption methods for private communications

Signal Processing: Waveform & Modulation scheme analysis

The analysis of the signal should help the characterization of the Signal to optimize the RF chain and the processing unit provided by Thales Alenia Space.

Data Processing for Signal De-collision

The system is capable to improve the de-collisioning of AIS (Automatic Identification System) messages emitted by the ships in the field of View (FoV) of the Satellite directly on-board. However to improve the reception of messages figure, there is the need to post-process the data on ground as well. The thesis should focus on the optimization of post-processing through de-collisioning techniques a posteriori on ground. On this field it is necessary a bibliography analysis to determine the available algorithms and verify the applicability to the case. The research shall focus on the determination of the best algorithm, new or enhanced from the existing available and applicable.

Secure Communication Protocols

The System should be capable to retrieve and retransmit AIS - ASM (Application Specific Messages) encrypted messages for security and military purposes. The thesis should focus on the determination of the most appropriate communication protocols for this type of messages.

Encryption methods for private communications

The System should be capable to retrieve and retransmit AIS - ASM (Application Specific Messages) encrypted messages for security and military purposes. The thesis should focus on the determination of the most appropriate encryption method (hardware or software or both) to ensure that the transmission of messages is not threatened and correctly transmitted.
In addition to these fields, the candidate could determine smart usage of AIS signals (bending, deformation, …) for other purposes (atmospheric and environmental monitoring, military,…).

Positions 2	**Next Generation Attitude Control for Small Satellites for High Performance Remote Sensing from Space** In the frame of S4TIN (Smart Small Satellite Systems Thales In NTU) laboratory activities, Thales Solution Asia, Thales Alenia Space and NTU are collaborating to develop next generation small satellite technologies for High Performance Remote Sensing from. Due to the restrictions in mass, limited power and maneuverability, as well as constraints on the payload it can carry, acquisition of images from Space using small satellites poses several challenges. However, with advanced attitude control and image enhancement techniques, good quality images are achievable The objective of the thesis is therefore to research on the field of innovative control technologies (sensors and actuators) and algorithm adapted to small satellites, of nano and micro class, and to instruments with demanding acquisition modes as: TDI (Time Delay Integration), Video modes, High stability of the Line of Sight, High Agility,… • TDI is a detector concept, where multiple pixel lines are used to reconstruct a single line, the overall signal is roughly the sum of the signal of each pixel line. In this mode it is important to keep the satellite pointing the same areas on ground passing through the various lines pixel per pixel. • Video Modes, is a concept where the low earth orbit satellite keeps the pointing on a given scene to acquire a video while travelling along its orbit. • Stability of the line of sight is required for acquiring blur-free images. • Agility is linked to the possibility of the satellite to acquire images from one side to the other of the ground track in the minimum time in order to increase the satellite swath.
Positions 3	**Designing with Phase Change Materials for Satellite Thermal Management** Passive thermal control (TC) methods such as surface coatings, films, paints and blankets are commonly used for spacecrafts [Gilmore, 1994], in particular for small satellites, as active TC methods need additional electric power and hardware for implementation. It is however a challenge to base an entire design of thermal controls

subsystem for a satellite using conventional materials and approaches. Subsystems, such as power, ADCS, certain payloads, batteries etc., have stringent thermal requirements. If not fulfilled, these conditions put serious constraints on functionality of these units.

Researchers [e.g. Darcy, http://www.electrochem.org/dl/ma/200/pdfs/0305.pdf] are therefore looking into innovative ways to achieve necessary thermal management for critical subsystems. This project proposes to design a material scheme using phase change material (PCM) that can offer required function and flexibility.

Aims

1. To choose right phase change material/s for batteries and solar panels
2. To understand behaviour and problems associated with PCMs
3. To design and develop a double-wall composite with PCM to reduce thermal variations at least on one side of it independent of heat inputs to it.
4. To test and verify behaviour of such composites in extreme thermal environment.
5. .To investigate into their performance and suitability for satellite applications

Approach

To begin with, various commonly used PCM materials, their characteristics, and different material design options will be explored based on the literature review. Newer PCM options made available by the ongoing research will also the examined. It is expected that the final design will be a double-wall composites with a PCM sealed between them. Certain design features will be incorporated to improve heat transfer properties as desired, with an investigation on the interest of new fabrication processes such as 3D direct manufacturing. Properties of PCM and the effect of PCM degradation and swelling will be investigated. Different sandwich designs, suitable for subsystems such as batteries and solar panels will be conceptualized and analyzed. The manufacturing of the optimally designed scheme/s will be studied. Outgassing studies and the heat management tests will be conducted.
During the study efforts will be spent to consider also the

problems and the solutions for other applications where the PCM may be not sealed inside composite sandwiches, but for example inside a metallic cavity.
Thales, France, will offer support in terms of the specifications and spacecraft thermal requirements. It will also advise on space grade fabrication. Its unit at Cannes will facilitate specialty testing of typical schemes for battery and solar panels at their test facilities. All the generated values will be compared with existing thermal control schemes. The initial design work, coupon level testing and the rest of the project activities will be undertaken at NTU.
This unique product is likely to provide niche technique useful for both parties for capturing international market.

Positions 4

Shape memory alloy 3D printing

Motorized hinges are commonly used for spacecraft's deployable structures. These components should be very reliable and simple, in term of design and power system. TAS had used since many years, shape memory alloys in its mechanisms (rotating actuator for solar array's deployment, cylindrical cartridges for hold and release mechanisms...etc). The shape memory alloy's raw material is produced currently in cylinder profile or cube shapes and manufacturing of complex shapes is very difficult and costly, these aspects limits our capabilities of design and the performance of these components. It is however a challenge to base an integrated multi-functions design (thermal heaters, strain gauges and specific mechanical shape). These kind of subsystem have stringent thermal/mechanical requirements. If not fulfilled, these conditions put serious constraints on functionality of these subsystems.

Aims

1. To choose good material phase change (adapted to different moves: rotation, translation, flexion...) and adapted to space environment and additive manufacturing constrains.
2. To understand behaviour and problems associated
3. To design and develop adapted specific raw materials
4. To test and verify behaviour of such material during 3D manufacturing
5. To test and verify the mechanical and thermal

characteristics of such material. (strains, stiffness, homogeneity, compacity, geometrical tolerances, reproductibility…etc)

6. To investigate into their performance and suitability for satellite applications by manufacturing and testing real items

Approach

To begin, different SMA materials options will be explored based on the literature review; The characteristics of various materials commonly used and Newer SMA materials available by the ongoing research will also the examined. It is expected that the final design will be multifunctions, associating heating, motorization , insulating interfaces.... The design features will be incorporated to improve heat transfer properties as desired. performance analysis should be done for the different expected deformation (torsion, flection, expansion) to evaluate the best candidate for each of them, or the best one for all of them.
Manufacturing aspect should be evaluated to obtain the best quality of compacity and resistance.
Different designs, suitable for subsystems such as motorized hinges will be conceptualized and analyzed. The manufacturing of the different items will be studied. strains and stiffness tests will be conducted.
Thales, France, will offer support in terms of the specifications (mechanical, thermal and technological requirements). It will also advise on space grade fabrication. TAS wishes to share it's knowledge, in a co-engienering gait with NTU
Its unit at Cannes should facilitate some specific testing. All the generated values will be compared with existing flight mechanisms. The initial design work, sample level testing and the rest of the project activities will be undertaken at NTU.
This unique product is likely to provide technic essential knowledge for both parties to capturing new international market.

Positions 5

Localized surface plasmon enhanced Sb-based quantum structures for infrared photodetection

Infrared photodetectors have wide applications, such as biomedicine, defence, environmental monitoring, astronomy and so on. However, most infrared

	photodetectors operate at low temperature environment due mainly to the noise at high temperature. Sb-based detectors could operate at room temperature but the performance is not as good as required. Recent research on surface plasmon enhancement makes them possible for room temperature application. This project aims to develop localized surface plasmon enhanced Sb-based quantum structures for infrared photodetection. The detailed work includes fabrication and characterization of Sb-based semiconductor quantum structures, metallic structures for enhancement and integrated devices for infrared photodetection.
Positions 6	**Development of innovative industrialization procedures for minimization of costs and lead time in the development of nano and micro satellites** The nanosatellite and microsatellite market size is estimated to grow from USD 889.8 Million in 2015 to USD 2.52 Billion by 2020. Nanosatellites and microsatellites have proved to be a great opportunity for space exploration and research. These economically feasible small satellites are capturing the market rapidly. OneWeb is challenging the market by placing more than 900 150kg class microsatellites in orbit as from 2018 in less than 2 years, which means a satellite produced every 8 hrs. This short term planning and large production chain drags the overall cost of each satellite at less than USD 1 Million. S4TIN Satellites are expected to reduce their cost and speed up their development in order to maintain a share in the market over the next years. The research objective is to research and innovate the development and production chains applied to S4TIN projects.
Position 7	**Development of Spaceborne Antenna with high deployed/stowed ratio with the use of Shape Memory Polymers (SMPs)** In the frame of S4TIN (Smart Small Satellite Thales In NTU) laboratory activities Thales Solution Asia, Thales Alenia Space and NTU are collaborating to develop nanosatellites operational demonstration. Today Radar applciations are of high interest for Singaporean Government and the Industrial Environment. Thales Alenia Space is one of the leaders in Spaceborne radar. Three are the axes of research necessary to minimize the resources necessary for such

applications: Miniaturization of the electronics, miniaturization of the amplification chain and creation of antennas with the highest deployed/stowed ratio.
This research objective focuses on the latter.
Spaceborne Synthetic Aperture RADAR requires large antenna apertures in order to fulfill simultaneously the requirements on maximum PRF, Swath extension and sensitivity. The required large antenna aperture, with the related large stowed dimensions as well as significant mass, makes the installation of SAR payloads on mini/micro satellites quite difficult.
Among the many requirements, two key design drivers have been identified in i) low mass density, ii) large stowed/deployed ratio. Deployable reflectors which have been flown in orbit use mainly metal meshes as a reflecting surface, although stiffer surface versions have been also flown. Such are largely deformable shell reflectors and solid surface reflectors. New reflecting surface materials have been presented in past years. Among them the carbon fibers which reinforce a silicone (CFRS) elastomer. This type of the reflecting surface falls between the metal meshes and largely deformable shells according to the stiffness. The reflecting surface formed by this material has been called a shell-membrane. Or Shape Memory Polymers (SMPs). SMPs are typically polymers which can transform its shape from 1 state to another state once its glass transition (Tg) temperature is reached. Here in NTU a new prototype SMP has been developed which can now overcome the size limitations by using a skeleton approach. This SMP design now can have Tc at least 10 times better than conventional materials without any significant increase in density and mass of the SMP.
Starting from the available solution, and focusing the attention on the most promising ones, like CFRS and SMPs, the scope of the research activity is to investigate new materials and solution to be used for light weight deployable SAR antennas with high deployed/stowed ratio.