LOOKING FOR SMALLSAT TECHNOLOGY? ASK GODDARD!

NASA's Goddard Space Flight Center brings years of expertise in small satellite technology development and mission planning to the SmallSat community. Through NASA's Technology Transfer Program, members of the public can license patented technologies for their own use, saving valuable time and resources. Instead of starting from scratch, companies can incorporate Goddard technologies into their mission design, freeing up resources for other parts of the mission. Below, please find a list of featured technologies. To learn more about these licensing opportunities, or if you have questions about specific technology needs, please contact Goddard's Strategic Partnerships Office at techtransfer@gsfc.nasa.gov.

SPACECUBE

SPACECUBE V2.0 PROCESSOR CARD, ENGINEERING MODEL
SpaceCube is a cross-cutting, in-flight reconfigurable Field Programmable Gate Array (FPGA) based on-board hybrid science data processing system. The goal of the SpaceCube program is to provide 10 to 100 times improvements in on-board computing power while lowering relative power consumption and cost.
Patent Number: 9,705,320

SPACECUBE DEMONSTRATION PLATFORM
This fault-tolerant framework allows for recovery from radiation upsets. It is reconfigurable from the ground while in orbit. It can be used to produce fault tolerance technologies and serves as a generic data processing solution for space-based applications.
Patent Number: 8,484,509

SPACECUBE V2.0 FLIGHT PROCESSOR CARD
This flight processor card leverages six years of heritage SpaceCube designs while advancing the technology one more step. The processor architecture is designed to be better suited to handle radiation upsets than its predec-es-sors, and it is built for a longer life cycle.
Patent Number: 9,549,467

SPACECUBE V2.0 MICRO
This technology is a subset of the SpaceCube v2.0 Engineering Model, Mini, and Engineering Test Unit designs. It is a Single Board Computer (SBC) intended for systems requiring low power and a very powerful data processor.
Patent Number: 9,851,763

SPACECUBE 2.0 FLIGHT CARD MECHANICAL SYSTEM
SpaceCube 2.0 is a family of high-performance reconfigurable systems designed for spaceflight applications requiring on-board processing. The SpaceCube 2.0 Flight Card Mechanical System is inherently adaptable and configurable for various configurations.
Patent Number: 10,681,837

SPACECUBE V2.0 PROCESSOR WITH DDR2 MEMORY UPGRADE
The improved version of the card assembly extends the life and design of the processor and provides even greater memory throughput to support the next generation of instruments.
Patent Number: 10,667,398

SPACECUBE V3.0 FLIGHT PROCESSOR CARD
SpaceCube v3.0 features the radiation-tolerant multi-core T2080 pro-cessor and the radiation-tolerant Kintex UltraScale FPGA. The SpaceCube v3.0 Flight Processor Card meets the industry standards in lightweight systems specifications.
Patent Pending

SPACECUBE V3.0 RADHARD MONITOR
The SpaceCube v3.0 RadHard Monitor is an FPGA IP that is responsible for providing monitoring to the SpaceCube v3.0 processor card for sin-gle-event upsets and other faults.
Patent Pending

SPACECUBE V3.0 MINI EVALUATION BOARD
The Evaluation Board is designed as a breakout and test platform for the SpaceCube v3.0 Mini. It breaks out several debug and communication interfaces, as well as a large amount of General Purpose I/O to common standard PCB connectors.
Patent Pending

SPACECUBE V3.0 AUTOMATED TEST SUITE
This technology provides automated testing of the functionality of the SpaceCube v3.0 hardware. Individual functional tests are collected into a test suite that are run automatically.
Patent Pending

SPACECUBE V3.0 FMC+ ASTM CARD
The FMC+ ASTM Card provides a way to perform tests on the SpaceCube v3.0 Processor Card.
Patent Pending

OTHER HARDWARE

MINIATURE RELEASE MECHANISM OR DIMINUTIVE ASSEMBLY FOR NANOSATELLITE DEPLOYABLES (DANY)
NASA's DANY technology uses spring-loaded metal pins, a reliable burn-through mechanism, efficient bracketing, and a circuit board to reliably stow and release deployables on command. Using DANY, stowed deployables are securely fastened using the spring-loaded locking pins.
*Patent Number: 9,546,008*

RADIATION HARDENED 10BASE-T ETHERNET PHYSICAL INTERFACE
This Ethernet solution combines a custom circuit and a front-end field programmable gate array (FPGA) design to implement an Ethernet Phys-ical Interface (PHY) in compliance with IEEE 802.3. The custom circuit uses available radiation-hardened parts and handles the electrical interface between standard differential Ethernet signals and the digital signal levels in the FPGA.
Patent Number: 9,680,527

Photo Credit: NASA/Amy Klarup
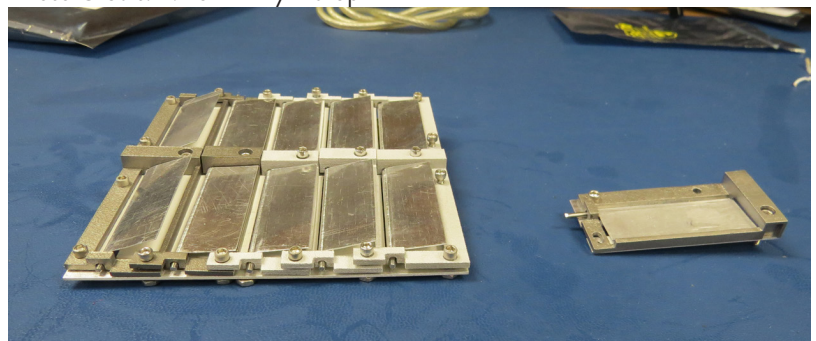
CUBESAT FORM FACTOR THERMAL CONTROL LOUVERS

The thermal control louvers use passive thermal control to significantly improve the internal thermal stability of small spacecraft, creating a difference of several watts in dissipated heat between open and closed louvers. The modular design can be produced in large quantities and swapped into various sized plates to tailor the thermal control to each spacecraft's needs.
Patent Number: 9,862,507

CUBESAT COMPATIBLE HIGH RESOLUTION THERMAL INFRARED IMAGER

The thermal infrared imager has high quantum efficiency, broad spectral response, and ease of fabrication. It is small and compact, making it ideal for the CubeSat platform.
Patent Number: 10,306,155

DELLINGR 6U CUBESAT

The Dellingr CubeSat design is more reliable than previous CubeSat designs. It is cost effective and more robust in terms of volume and power than older designs.
Patent Number: 9,938,023

SMALLSAT ATTITUDE CONTROL AND ENERGY STORAGE

By replacing reaction wheel ensembles with reaction spheres, this technol-ogy reduces the overall size and net power consumption of conventional three-axis attitude control systems.
Patent Number: 10,053,242

DEPLOYABLE BOOM FOR CUBESATS

The deployable boom for CubeSats is a rigid boom over 50 centimeters in length when deployed that houses a three-axis magnetometer. It is stowed on one side of the CubeSat with a double hinge system.
Patent Number: 10,717,548

NOVEL ANTENNA CONCEPT FOR CUBESAT PLATFORMS

By integrating the antenna into the structure of a CubeSat, the need for extruding antennas, packaging considerations, and a deployment mecha-nism are eliminated. The resulting antenna has reduced weight and volume, as well as increased dependability.
Patent Number: 10,361,472

ULTRA COMPACT STAR SCANNER

This innovative approach fuses the rapid advancements in miniaturized high-speed electronics with the ultra-compact freeform optical design from NASA efforts to create the next generation of stellar scanner instruments.
Patent Pending

SMALLSAT COMMON ELECTRONICS BOARD (SCEB)

Will be an evolution to a previous design concept that involves the devel-opment of a Command and Data Handling (C&DH) design within less than a 1U CubeSat form factor using a combination of robust rad tolerant components and COTS components. This SCEB design will utilize a next generation rad tolerant reprogrammable FPGA device that will give a great deal of design flexibility. The expectation is that this device will outperform the TID/SEE radiation ratings of reprogrammable COTS FPGA devices currently available in the market and be the centerpiece of a next genera-tion C&DH board design.
Patent Pending

SMALLSAT COMMON ELECTRONICS BOARD (SCEB) COMPLEMENT BOARD DESIGN: MEMORY CARD

The innovation is a miniaturized memory board that has up to 96 GB of NAND Flash memory along with either a radiation tolerant FPGA or a set of three commercial FPGAs. The memory board is designed to interface with the standard subsystems of Goddard's Modular SmallSat Architecture (GMSA).
Patent Pending

MINIATURIZED ASTROMETRIC ALIGNMENT SENSOR

The technology advances satellite capabilities for astrophysical mea-sure-ments, which are necessary for formation flying, relative navigation, and virtual telescope capabilities. The Miniaturized Astrometric Alignment Sensor makes it possible to measure a spacecraft's altitude and orientation with respect to known stellar objects.
Patent Number: 10,657,371

ION CONTROL SYSTEM

The electric propulsion system is suitable for small satellite attitude control, precision orbit control, constellation formation management, and extended low-thrust maneuvers.
Patent Pending

SELF-REGULATING CURRENT CIRCUIT

This technology utilizes a switching regulator to provide high-efficiency power conversion. The Self-Regulating Current Circuit simplifies the de-ployment of a circuit as circuit resistance associated with wire and inter-fac-es are negated due to the self-regulating circuit. The entire circuit can be miniaturized and can still provide relatively high constant current needed for nickel chrome based deployment devices.
Patent Number: 10,742,115

SILICON OXIDE COATED ALUMINIZED POLYIMIDE FILM RADIATOR COATING

This technology uses all the exposed surfaces on the six sides of a CubeSat as radiators. All the internal components are thermally coupled to the radiators. The technology lowers power demand and eliminates the need for voluminous heat regulation.
Patent Pending

SOFTWARE

THE CORE FLIGHT SYSTEM (CFS)

The cFS is a flight software framework with a layered architecture that builds on best practices from previous missions and works in tandem with mission-specific applications.

THE NASA OPERATIONAL SIMULATOR FOR SMALL SATELLITES (NOS3)

NOS3 is a suite of tools that caters specifically to small satellite missions and helps shorten development timelines.

SCIENTIFIC PAYLOAD TECHNOLOGIES

CUBESAT COMPATIBLE HIGH-RESOLUTION THERMAL INFRARED IMAGER

The thermal infrared imager has high quantum efficiency, broad spectral response, and ease of fabrication. It is small and compact, making it ideal for the CubeSat platform.
Patent Number: 10,306,155

OCCULTER FOR CUBESAT CORONAGRAPH

This technology is designed to minimize noise from the coronagraph that can interfere with data collection and analysis. It has applications in solar research and photography where the goal is to image a dim object near a bright one.
Patent Number: 9,921,099

A BROADBAND, COMPACT LOW-POWER MICROWAVE RADIOMETER DOWN CONVERTER FOR SMALL SATELLITE APPLICATIONS

The system includes a fundamental local oscillator source composed of a broadband tunable frequency synthesizer as well as a crystal oscillator. The synthesizer employs a harmonic doubler to expand frequency coverage.
Patent Number: 10,659,094

DEPLOYABLE SYSTEM FOR CUBESAT ELECTRIC FIELD INSTRUMENT (CEFI)

CEFI is a 3-axis electric field instrument with six rigid booms packaged into a less than 1.5U CubeSat volume.
Patent Pending

DIRECTION OF ARRIVAL ESTIMATION SIGNAL OF OPPORTUNITY RECEIVER

This transceiver technology for small satellite and CubeSat platforms enables maximization of antenna gain in a specific direction to receive desired signals and suppress signals from other directions.
Patent Pending

MARES

MODULAR ARCHITECTURE FOR A RESILIENT EXTENSIBLE SMALLSAT (MARES) COMMAND AND DATA HANDLING (C&DH) HARDWARE

The MARES (formerly DellingrX) C&DH hardware will be an evolution to a number of previous design concepts that involves the development of a C&DH design within less than a 1U Cubesat form factor using a combination of robust rad tolerant components and COTS components. This device will outperform the TID/SEE radiation ratings of reprogrammable COTS FPGA devices currently available in the market and be the centerpiece of a next generation C&DH board design that combines the use of COTS parts with some core rad tolerant components that can be integrated with other board designs to expand design functionality.
Patent Number: 17,023,505

CUSTOM APPLICATION SPECIFIC INTEGRATED CIRCUIT FOR DETECTOR CONTROL AND DATA ACQUISITION

The Wide-Field Infrared Survey Telescope (WFIRST) will have the largest near-IR focal plane ever flown by NASA, with a total of 18 4K x 4K devices. This project has adopted a system-level approach to detector control and data acquisition where 1) control and processing intelligence is pushed into components closer to the detector to maximize signal integrity, 2) functions are performed at the highest allowable temperatures, and 3) the electronics are designed to ensure that the intrinsic detector noise is the limiting factor for system performance.
Patent Number: 10,502,622

GODDARD MISSION SERVICES EVOLUTION CENTER (GMSEC) APPLICATION PROGRAMMING INTERFACE (API) 4.5

This architecture is a comprehensive flight and ground system architecture that spans the full mission lifecycle. Software components use the GMSEC Architecture API to connect to a middleware software messaging bus that in turn is responsible for message routing and delivery. This software release contains major enhancements to previous releases of the GMSEC API, including greater reliability and enhanced usability.
Patent Pending

DELLINGRX SMALL SATELLITE SPACECRAFT BUS ARCHITECTURE

This architecture will enable future challenging and harsh environment mission architectures currently being proposed by NASA scientists, especially those pursuing planetary missions. DellingrX tailors balancing/scaling of programmatic and technical risks for Class-D missions. The architecture reduces SWaP while increasing flexibility and robustness by tightly integrating electronics and software for core subsystems and standardizing interfaces for more mission unique components.
Patent Number: 62,966,249

SPACECUBE MINI SOLID STATE DATA RECORDER (SSDR)

This technology is a miniaturized CubeSat-Sized (3.5" x 3.5"), high-reliability solid-state data recorder (SSDR) designed for CubeSat/SmallSat applications and instrument electronic boxes in varying harsh radiation environment orbits. This SSDR is schemed for harsher radiation environments while still providing high density and throughput data storage in a miniaturized form factor that is essential for SWaP constrained CubeSats and SmallSats.
Patent Number: 63,249,869

SOFTWARE DEFINED RADIO WITH PARALLELIZED SOFTWARE ARCHITECTURE

This architecture is a unique software design that implements software defined radio procession over multi-core, multi-CPU systems in a manner which maximizes the use of CPU resources in the system. The software treats each processing step in either a communication, navigation modulator, or demodulator system as an independent threaded block. Each threaded block is defined with a programmable number of input or output buffers and are implemented using POSIX pipes.
Patent Pending

Photo Credit: NASA/P. Black

GODDARD'S STRATEGIC PARTNERSHIPS OFFICE CAN HELP YOU:

- License NASA technology
- Apply for a Startup NASA license
- Request NASA software for your mission
- Enter a Space Act Agreement
- Learn more about SBIR/STTR programs

Email techtransfer@gsfc.nasa.gov *for more information!*
Interested in learning more about Goddard's Small Satellite Project Office? Visit their website at: https://smallsat.wff.nasa.gov/

GODDARD TECH TRANSFER
www.nasa.gov