Space is a relatively recent playing field for mankind, and one we have yet to fully discover even today. We are at the very beginning of a new frontier; the future of space is still full of untapped potential, and that potential feeds into the development of an abundant market for space-based technologies. According to NASA, the Space Station program involves more than 100,000 people in space agencies and 500 contractor facilities across 37 U.S. states and in 16 countries. Those numbers don’t even cover the growth in aerospace design processes, manufacturing automation, the use of the Internet of Things (IoT), and the numerous ways to implement engine efficiency improvements.

According to Frost & Sullivan, the total aerospace manufacturing market is predicted to grow by 65.8% from last year into 2020, with the revenue share of savings growing to $2.82 billion by that year. This indicates a healthy demand for the development of many of the technologies and components for satellites,

Key Points
- There is a healthy market for aerospace technologies
- Predicted growth of 65.8% by 2020
- Includes satellites, antennas, navigation systems, imaging
antennas, space-based navigation, imaging, and measurement. These technologies are prominently needed in regions where there is an established or rapidly growing production of aircraft components, such as in North America, Europe, and Latin America. The space-based market is becoming a less conservative market, employing numerous more manufacturers, suppliers, and other services than ever before.

According to the European Patent Office, communication satellites make up the biggest chunk of the market for space-based products at $7.3.6 billion. Navigation satellites make up $1.23 billion of this market. Space-based technologies developed at the University of New Mexico relate to these expanding market areas. According to the European Global Navigation Satellite Systems Agency, navigation systems are expected to grow to an estimated 8 billion devices by 2020 with a 6% annual growth between 2015 and 2020. The optical imaging market will be worth $1.75 billion by 2020 based on a Markets and Markets press release, and the global antenna market is expected to reach $11.31 billion by 2020 at a growth rate of 9.27% between 2015 and 2020 according to Mordor Intelligence.

TECHNOLOGY BREAKTHROUGH

The following space-based technologies, developed at the University of New Mexico, provide significant benefits and advancements in the areas of satellites (including CubeSats and nanosatellites), antennas, space vehicle navigation, thermal management, high-resolution imaging, and fluid velocity measurements.

Rapid Design of Deployable Antennas for CubeSats (STC Ref. 2016-081)

This technology is a novel methodology for the rapid preliminary design of deployable antennas for CubeSats. Coupled electromagnetic and structural design problems are easily addressed by allowing designers to select and compare various antenna topologies against multiple deployment approaches on the basis of desired performance requirements. A graphical representation of antenna performance as a function of geometry is produced using a set of two-dimensional plots and eliminates designs that do not meet all requirements before selecting an optimal solution to be modeled.

Technology Benefits:

- Easily addresses coupled electromagnetic and structural design problems of current antennas
- Allows users to compare different antenna types or a single antenna with several different folding schemes
- Applications for CubeSats, micro- and nano-satellites

Intellectual Property: Filed PCT Application: PCT/US17/30464
Reconfigurable Filtenna (STC Ref. 2012-068)

A new reconfiguration technique for frequency tunable antennas has been developed, with the objective of changing the antenna’s operating frequency without incorporating active components in the antenna radiating surface. This can be done by integrating a reconfigurable band-pass filter within the feeding line of the antenna. The antenna can tune its frequency based on the filter's operation. This integrated antenna-filter combination, with filtering and radiation performance, is referred to as "filtering antenna" or a filtenna.

Technology Benefits:

- Integrates both the band-pass filter and the antenna within the same antenna substrate, which allows easier, more efficient and more compact integration
- A prototype for the reconfigurable filter and the reconfigurable filtenna has been fabricated and tested
- Negative effects of the biasing lines on the antenna behavior are minimized since they no

Intellectual Property: Issued Utility Patent 9,653,793

A Modified Quadrifilar Helix Antenna (STC Ref. 2017-016)

Researchers have developed a new method for creating a quadrifilar helix antenna using 3D printing. This technique provides a way of accurately miniaturizing the length of a quadrifilar helix antenna while maintaining circular polarization. A conical shaped ground plane is also implemented for a more compact structure. This technology shows that 3D printing technology can be used in the area of antenna design in order to facilitate the fabrication of volumetric radiating structures.

Technology Benefits:

- Allows for lower resonant frequency of the quadrifilar helix antenna without increasing the number of turns and arm spacing
- Antenna gain and radiation efficiency remains acceptable even with miniaturized structure

Intellectual Property: Filed Utility Patent 15/706,483
Dual-Matrix Composite Embedded Conductors (STC Ref. 2015-099)

A deployable high-performance antenna for CubeSats. This new antenna has been designed in a way for it to operate at Ultra High Frequency bands (UHF). The antenna can also be scaled to operate within other frequency spans. In addition, a unique structural concept, using dual-matrix composites, allows the antenna to be packaged into small volumes. The antenna is capable of satisfying size constraints by being compactly folded during launch and deployed successfully once in orbit.

Technology Benefits:

- Vibration tests showed that antenna natural frequencies are significantly higher than environmental forcing frequencies
- Advanced antenna ideal for ultra-high frequency and high-gain performance
- Prototype has been developed and was subjected to structural and electromagnetic testing to verify simulated performance
- Suitable candidate for deployment on top of a 6U CubeSat

Intellectual Property: Filed Utility Patent 15/148,584


A novel mechanism to measure both absolute and relative attitude of a vehicle. This mechanism introduces an Intra-cavity Phase Interferometer (IPI) method using an active bidirectional mode-locked laser that provides both a measurement of all three attitude rotation vectors (“pitch”, “yawn”, and “row”), and a measurement of the vehicle’s position relative to earth using information of its local magnetic field.

Technology Benefits:

- Lightweight with low power consumption
- High sensitivity inertial and position measurements using a single detection mechanism
- Absence of dead band and associated nonlinearity in the inertial response
- Applications in guidance, navigation and control systems (GNC systems); satellites and satellite navigation


www.stc.unm.edu
Metal-Carbon Composites for Enhanced Thermal Conductivity for Demanding or Critical Applications (STC Ref. 2006-043)

This technology provides a carbon nanotube composite matrix which improves thermal conductivity and heat dissipation compared to existing commercially available material. Carbon nanotubes can be organized in a random or specific alignment to fit the needs of the application. Because the melting point of carbon nanotubes (> 2000°F) far exceeds traditional metals, the composite provides a material that can withstand higher temperatures and is able to conduct heat at an accelerated rate.

Technology Benefits:
- Provides increased heat tolerance and increased thermal conduction/heat dissipation
- Applications in integrated circuit (IC) boards, electronic circuits, and aerospace systems

**Intellectual Property:** Issued Utility Patent 7,998,367

A Rotating Point-Spread Function (PSF) Design for Three-Dimensional Imaging (STC Ref. 2013-075)

A new technique has been invented that yields a 3D point-spread function with the ability to rotate with changing defocus while still keeping its transverse shape approximately constant over several waves of defocus. This new innovation also offers a broad spatial frequency response with 100% power transmission. This approach may also be generalized for other azimuthally symmetric, monomial phase aberrations.

Technology Benefits:
- Enhanced, highly-sensitive transverse and depth resolution in a snapshot mode
- 3D imaging capabilities of air-to-ground and space-to-space target recognition and remote sensing system
- Generalizes readily for encoding spherical aberration

**Intellectual Property:**
- Issued Utility Patent 9,350,977
- Issued Cont-in-Part Patent 9,823,486

www.stc.unm.edu
Researchers have developed a novel joint spatio-spectral algorithm for edge detection of MS and HS images. The algorithm, which is named Spectral Ratio Contrast (SRC), is designed as a dedicated MS/HS edge detection algorithm. The algorithm fuses a given spatial mask with the spectral band ratios from a given edge signature into a non-separable, three-dimensional spatio-spectral mask. This technology also utilizes the concept of the spectral ratio contrast to estimate similarity and discontinuity in a HS/MS image.

**Technology Benefits:**
- Generates improved edge map useful for HS/MS image segmentation
- Provides great potential for compressive sensing and data acquisition
- Applications in space-based imaging and image analysis, remote sensing, radiometers, and compressive spectral sensing

**Intellectual Property:** Issued Utility Patent 8,649,607

---

Researchers have developed a solid state electro-optical method and apparatus for measuring the velocity of any free stream flow. The mechanism is extremely simple without moving parts. It can be sealed with no secondary pressure outlets or mechanical links where contamination might be an issue, and it can be built in an inexpensive and compact fashion to a high level of redundancy for applications such as space exploration or the primary loop of a nuclear reactor, where field service is impossible or undesirable.

**Technology Benefits:**
- Can be sealed with no secondary pressure outlets or mechanical links
- Inexpensively and compactly built to a high level of redundancy for many applications
- Applications in space explorations, aerospace measurements, and velocity measurement of fluid flows in any pipe or channel

**Intellectual Property:** Issued Utility Patent 8,567,259
Structure Function Monitor to Detect and Measure Atmosphere Turbulence
(STC Ref. 2005-039)

This technology is an atmospheric Structure Function Monitor (SFM) that measures the phase structure of a wavefront at the pupil of an imaging system. The phase SFM provides detection and detailed measurement of turbulence in the atmosphere. Atmospheric turbulence principally perturbs wavefront phase and far less perturbs the amplitude. The phase is the more significant measure of turbulence. Additionally, by measuring the phase perturbations and correcting them, a perfect image can be reconstructed in the presence of blurring caused by atmospheric turbulence. The SFM detects and measures atmospheric turbulence, and provides phase corrections necessary to reconstruct near diffraction limited turbulence-blurred images.

**Technology Benefits:**

- Designed to directly measure the amplitude and phase of an electromagnetic wave at the aperture (the pupil) of an imaging optical system
- Can detect and characterize turbulence for avoidance purposes and enhanced fidelity in information delivery
- Applications in detecting wake turbulence, wind shear, and microbursts

**Intellectual Property:** Issued Utility Patent 8,103,045

CONTACT INFORMATION

STC.UNM is currently exploring commercialization options for these exciting emerging technologies. For more information, please contact Arlene Mirabal, Marketing Manager, at amirabal@stc.unm.edu or (505) 272-7886.