Low Cost Conformal Transmit/Receive SATCOM Antenna for Military Patrol Aircraft

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Command: NAVAIR
Topic: N06-117, Low Cost Conformal Transmit/Receive SATCOM Antenna for Military Patrol Aircraft

PARCA Software-Defined Antenna™
(Pixel-Addressable Reconfigurable Conformal Antenna)
Packing more antenna capability into less footprint

PROBLEM STATEMENT
Navy aircraft with high data rate Beyond Line-of-Sight (BLOS) communications requirements need one or more high gain satellite communication (SATCOM) antennas. However, steerable high-gain dish antennas are bulky/heavy, can require large holes in the pressurized aircraft hull, and usually need a high-profile radome that creates aerodynamic drag. Therefore PMA 290, the P-8 Poseidon program, is seeking a low cost, conformal SATCOM antenna technology.

The PARCA Software-Defined Antenna™ is a conformal, reconfigurable, electronically pointed phased array antenna. Installed as shown as a pair of “saddle bag” panels, conformal PARCA shared apertures can support SATCOM links from L-band at 1 GHz to Ka-band at 44 GHz, electronically pointing high gain antenna beams.

WHO CAN BENEFIT?
High data rate SATCOM requirements are common to most Command and Control (C2) and Intelligence Surveillance and Reconnaissance (ISR) platforms such as the P-8 Poseidon and other electronic warfare and reconnaissance aircraft both manned and unmanned aerial vehicles (UAV’s).

PARCA software-defined antenna technology is also directly applicable to satcom-on-the-move (SOTM) communications for ground vehicles. The ability to electronically steer the antenna beam and vary its operating frequency allows satellites to be tracked from ground vehicles
moving on rough roads as well as aircraft maneuvering in flight. *Most military aircraft and many military vehicles can use this rapidly reconfigurable, low profile SOTM capability.*

Boeing is the prime contractor for the P-8 *Poseidon* and their Integrated Defense Systems group would be especially interested in this technology. Other Primes that could benefit from this technology include bidders for the Next Generation Jammer program, suppliers of radar threat warning systems, and ISR platform integrators. This includes Raytheon, Northrop Grumman, Lockheed Martin, L3 Communications, and EDO.

**BASELINE TECHNOLOGY**
Steerable high-gain dish antennas are bulky/heavy, can require large holes in the pressurized aircraft hull, and usually need a high-profile radome that creates aerodynamic drag. Further, either multi-band feeds or different SATCOM antennas are necessary to communicate in multiple frequency bands.

**TECHNOLOGY DESCRIPTION**
Microstrip transmission line technology is well known for low-loss transmission of radio frequency (RF) signals. PARCA uses movable pixels that rise above a contiguous ground plane to form reconfigurable transmission lines and antenna elements. By careful construction of these composite elements, millimeter-scale pixels with a uniform size and dimension can rapidly create a reconfigurable antenna. Agility in operating frequency, antenna pattern, beam direction, and gain is simply a matter of sending commands to the software-defined PARCA array.

**Pixel-Addressable Reconfigurable Conformal Antenna (PARCA)**
PARCA uses pixel-by-pixel physical reconfiguration of a radiating microstrip structure to provide antenna capabilities such as beam steering, beam shaping, operation at multiple frequencies and polarizations, and connections for multiple radios using a single reconfigurable antenna structure. Small conductive pixels in a grid pattern are actuated on/off. In their “off” state, the pixels are part of the ground plane. In their “on” state, adjoining conductive pixels over the ground plane create arbitrary feed structures and patch array geometries. Reconfiguration occurs rapidly (less than one millisecond) and high RF power levels can be handled. Antenna elements and transmission lines are configured, reconfigured, tuned and steered as needed under microprocessor control during an operational mission. Thus, a PARCA aperture can be shared between SATCOM terminals with different antenna requirements.

**Features, Advantages, and Benefits of Syntonics’ PARCA Antenna Technology**

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<th>Feature</th>
<th>Advantages</th>
<th>Benefits to Navy</th>
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<tr>
<td>Reconfigurable Frequency</td>
<td>Operating frequency can be changed anytime</td>
<td>Enhances mission effectiveness by providing versatility</td>
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<td>Shared aperture</td>
<td>One antenna system can cover all SATCOM bands</td>
<td>Simplified design &amp; configuration, reduced parts</td>
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<td>Electronically Steerable</td>
<td>Steering is faster than mechanical methods</td>
<td>Increased performance envelope for SATCOM operations</td>
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<td>Conformal</td>
<td>Radome can be essentially flush with aerodynamic surface</td>
<td>Reduced aerodynamic drag</td>
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CURRENT STATE OF DEVELOPMENT
PARCA is approaching TRL 4. Breadboard software-defined antenna panels are being built and tested. Experimental microstrip transmission lines and patch antennas implemented with pixelated elements have been built and measured. Transmission line experimental results are in good agreement with analytical results. Experimental pixelated patch antennas show performance equal to conventional patches plus a wide range of tuning options that enable fine adjustment of operational frequency and matching impedance. These results are also in good agreement with analytical results, inspiring confidence in the success of the Phase II prototype antenna panels.

Syntonics is seeking industry partners and Government programs that wish to develop specific PARCA implementations for new or upgraded satcom, jamming, and radar threat warning systems.
REFERENCES
NAVAIR is sponsoring Syntonics’ PARCA satcom antenna work on behalf of the P-8 Poseidon program:

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<tr>
<th>Position</th>
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<th>Phone</th>
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<tr>
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NAWCWD is sponsoring Syntonics’ PARCA jamming antenna work on behalf of the EA-18G Growler program:

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<th>Position</th>
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<tbody>
<tr>
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The ElectroScience Laboratory of The Ohio State University (ESL/OSU) is teamed with Syntonics for this project. ESL’s Compact Range for measuring antennas and scatterers from 300 MHz to 100 GHz is world-renowned. PARCA development is being led at ESL/OSU by Dr. Eric K. Walton, 614.292.5051, Walton.1@osu.edu.

ABOUT THE COMPANY
Syntonics designs, develops, and manufactures specialty military RF communications equipment and accessories, notably RF-over-fiber products and innovative antennas. The company was founded in 1999 as the first “technology transfer spin-off” from the Applied Physics Laboratory of The Johns Hopkins University (JHU) and is closely held. Syntonics’ Quality Management System, registered under ISO9001-2000 since 2002, ensures quality products on time, every time.

Syntonics has transitioned a number of products into military applications and now generate more than two-thirds of its annual revenue from those products. We are looking for interested acquisition programs for our FORAX RF-over-fiber communications systems and Handheld Tactical Antenna (HTA) products, while we would like to talk to interested parties for our FSS and UUV antenna systems.
Numerous products and technologies have been developed by Syntonics with initial funding from DoD’s SBIR/STTR Program

Syntonics’ FORAX™ RF-over-fiber communication systems connect tactical radios to distant antennas using a lightweight secure fiber optic cable. FORAX™ systems are used in the field and in military command centers around the world.

The FORAX-HARC (High Antennas for Radio Communications) system is being fielded in-theatre in 2009 by CENTCOM.

Syntonics’ Handheld Tactical Antennas are lightweight, rugged, low observables, and silent in use. They provide long-range communications for handheld and man-pack radios. Current models include SINCGARS, VHF, UHF, broadband LOS, and UHF TACSAT.

Syntonics’ patented frequency selective surface (FSS) multi-band antenna system packs more communications capability into less footprint for satcom-on-the-move (SOTM) and shipboard satellite terminals. Multiple independent, lightweight antennas are packaged within a single radome. Each antenna operates in its designated frequency band while tracking different satellites.

A multimode-mode antenna system for Unmanned Underwater Vehicles, in development by Syntonics for the Navy, supports SATCOM, line-of-sight, and GPS communications.