PARCA

(Pixel-Addressable Reconfigurable Conformal Antenna)

Packing more antenna capability into less footprint

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Command: NAVAIR / NAWCWD
Topic: N06-040, Ultra-Wide band Antenna (UWBA) for Electronic Attack Aircraft

PROBLEM STATEMENT

Current airborne tactical jamming systems must select jamming transmitters and antennas to cover the expected enemy system frequency ranges prior to a mission. Once airborne, they are unable to adapt to changes in an enemy environment. Advances in transmitter technology now allow multi-octave coverage from a single high-power amplifier. However the physics of conventional antennas have limited the frequency range and require specific antennas for specific missions.

The Naval Air Warfare Center Weapons Division (NAWCWD) is developing ultra wide-band (UWB) antenna technologies to address this limitation and to extend the performance of the next-generation jammer for the Airborne Electronic Attack (AEA) system on the EA-18G aircraft. The objective UWB antenna system will dynamically adjust its operating frequency, beam width (i.e., gain), and polarization while transmitting 2 kW power levels from a platform that can maneuver with the agility of a first-line fighter.

WHO CAN BENEFIT?

The Navy is designing the next-generation jammer for the Airborne Electronic Attack (AEA) mission and the new EA-18G "Growler" aircraft. Initial operational capability is planned for 2015. The next-generation jammer program is managed by the Naval Surface Warfare Center, Crane Division (Tom Dalheim) and the program of record for the next-generation jammer is the EA-18G, managed by NAVAIR PMA-265 at Patuxent River Naval Air Station. Syntonics anticipates the Navy's (classified) requirements for the next-generation jammer will require more capability and agility in the amplifiers and antennas.

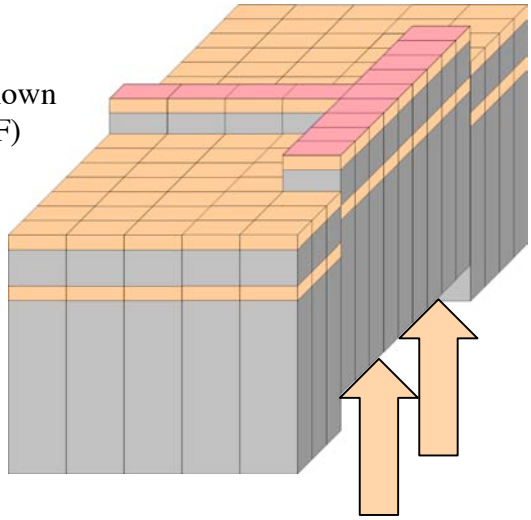
Reconfigurable antenna technology for the AEA mission is also directly applicable to sat-com-on-the-move (SOTM) communications from airborne and ground vehicles. The ability to electronically steer the antenna beam and vary its operating frequency allows different satellites to be tracked from ground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

BASELINE TECHNOLOGY

Conventional antennas — ridge waveguide horns for high frequencies and dipoles for low frequencies — are currently employed to meet the various mission scenarios. Current antennas cannot reconfigure, so many different antennas are necessary and antennas must be changed for different missions. Multiple antenna designs require additional support, inventory, and maintenance in standard operations.

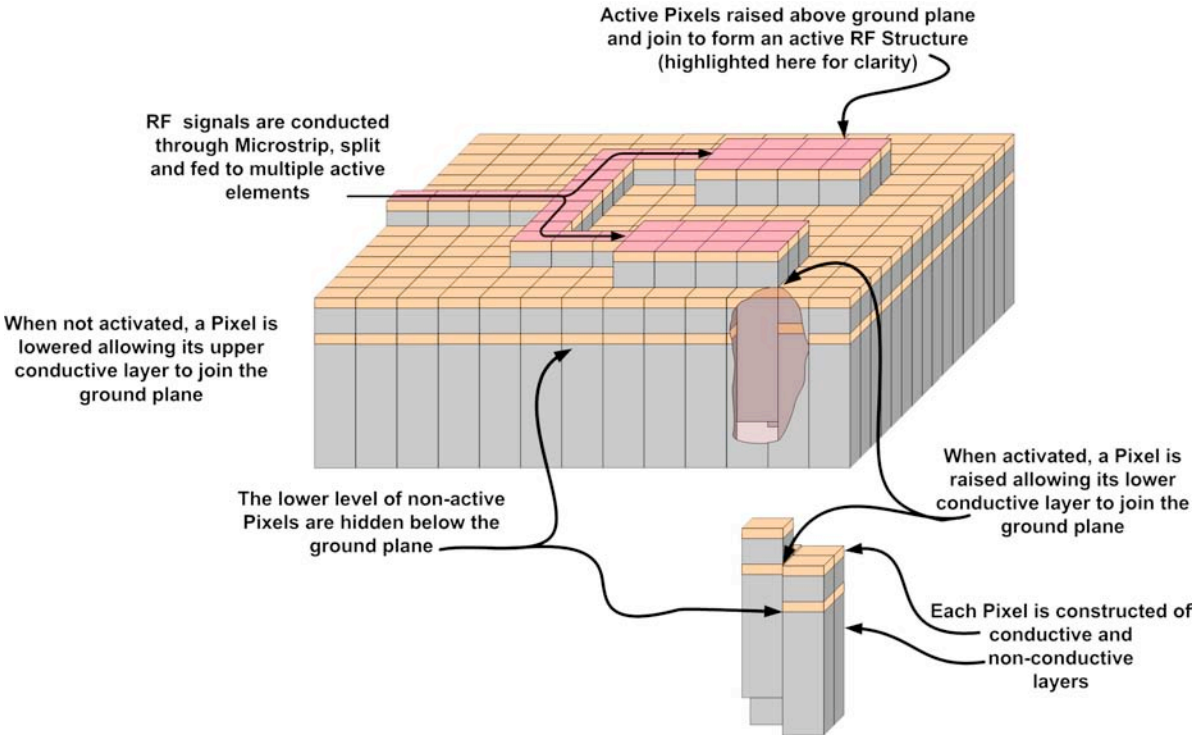
TECHNOLOGY DESCRIPTION

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. Changing frequency, antenna pattern, beam direction, or gain is simply a matter of sending commands to the PARCA array.



Pixel-Addressable Reconfigurable Conformal Antenna (PARCA)

The PARCA concept uses pixel-by-pixel physical reconfiguration of a radiating 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 "paint" arbitrary feed structures and patch array geometries. Reconfiguration occurs rapidly 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. The antenna system will be significantly more versatile than the existing antennas while packaging 50 percent more communications capacity into the same footprint.

For example, a system operating up to 18 GHz would use pixels with a diameter of ~ 1.65-mm. In a configuration with approximately 100,000 pixels making a square with sides of 0.5-m (20.5-in), the PARCA panel would be approximately 20-mm (0.8-in) thick with an estimated weight of 5.4 kg (12 lbs). This antenna would provide approximately +40 dBi gain at 18 GHz or +15 dBi gain at 1 GHz.

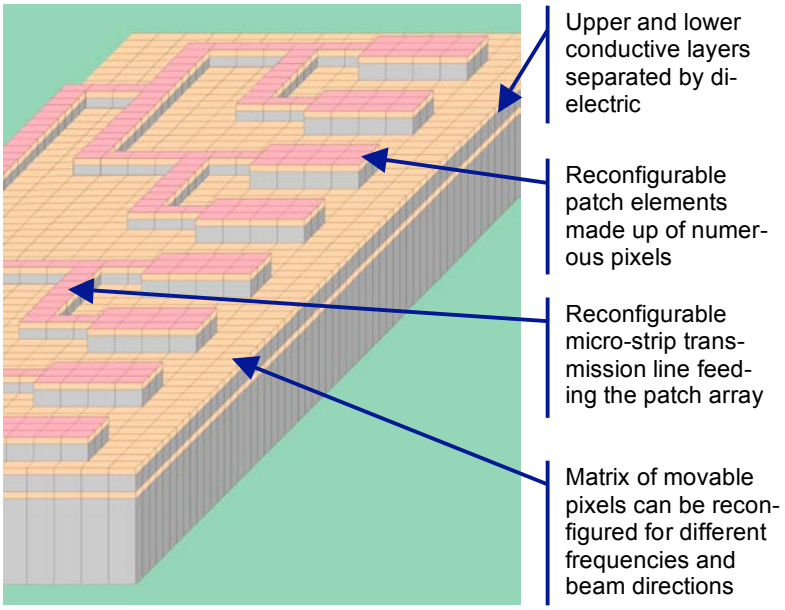
Features, Advantages, and Benefits of Syntonics' PARCA Antenna Technology

Feature	Advantages	Benefits to Navy
Reconfigurable frequency	Frequency band can be changed mid-mission	Enhances mission effectiveness by providing versatility
UWB frequency capability with continuous coverage	One antenna system can cover all operational scenarios	Simplified design & configuration, reduced parts
Electrically steerable antenna array	Steering is faster than mechanical methods.	Increased performance envelope for antenna operations
Multi-mission capability	Adaptable to new mission profiles and identified capabilities.	Improved life cycle costs and cost effective upgrades

The key benefit of the PARCA antenna system is that it can replace the many fixed-capability antennas that are currently used — and changed between different missions — with one or two arrays. Other EW or communications systems could employ a similar upgrade strategy while specification on new systems is also a consideration.

CURRENT STATE OF DEVELOPMENT

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, with good performance over the 500 MHz to 18 GHz range. 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.



TECHNOLOGY AVAILABILITY

The ALQ-99 is rapidly nearing the end of its serviceable life. PARCA antenna technology can be available in time for the Airborne Electronic Attack (AEA) mission and the new EA-18G "Growler" aircraft in 2015. Syntonics is actively seeking a partner with strong credentials in airborne jamming pods and/or satellite communications terminals. We are also actively seeking funding to develop a lightweight, multi-band SOTM antenna system.

TRL	Required Tests, Demos, and next steps	Target date	Estimated Funding required	Organizations to be involved
3	Demonstrate electromagnetic performance; demonstrate pixels	2008	(Already funded)	NAWCWD
4	Demonstrate Phase II PARCA prototype antenna	2009	(Already funded)	NAWCWD
5	Demonstrate full-scale prototype antenna	2011	Consult Syntonics	PMA-265, AEA Prime, PMA-290
6	Demonstrate full-scale pre-production antenna	2012	Consult Syntonics	PMA-265, AEA Prime, PMA-290
7	Flight demonstration of pre-production antenna integrated with next-generation jammer	2013	Consult Syntonics	PMA-265, AEA Prime, PMA-290, Boeing

8	Conduct Qualification Testing of production antenna	2014	Consult Syntonics	AEA Prime, Boeing
9	Operate production antennas on next-generation jammer	2015		

REFERENCES

These NAWCWD personnel are monitoring this PARCA "jamming antenna" project:

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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

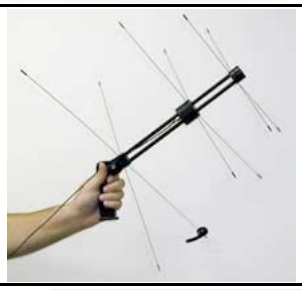
Syntonics designs, develops, and manufactures specialty military RF communications equipment and accessories, notably RF-over-fiber products and innovative antennas. The company was founded in 1999 as the first "technology transfer spin-off" from the Applied Physics Laboratory of The Johns Hopkins University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

BSI REGISTERED
ISO 9001:2000
FM 69168

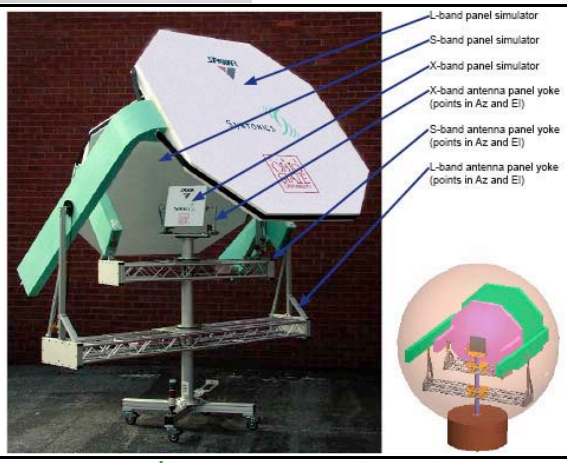
Syntonics has transitioned the following products into military applications and now generate more than 50% of its annual revenue from transitioned products. We are looking for interested acquisition programs for our FORAX RF-over-fiber communications systems and Handheld Tactical Antenna (HTA) products, while we would like to talk to interested parties for our FSS and UUV antenna systems.

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.

Syntonics' Handheld Tactical Antennas are lightweight, rugged, low observables, and silent in use. They provide long-range communications for handheld and manpack 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. Successful testing of prototype FSS antennas in early 2006 substantiates this technology is at TRL 6.



A dual-mode antenna system for Unmanned Underwater Vehicles, in development by Syntonics for the Navy, supports both satcom and line-of-sight communications.