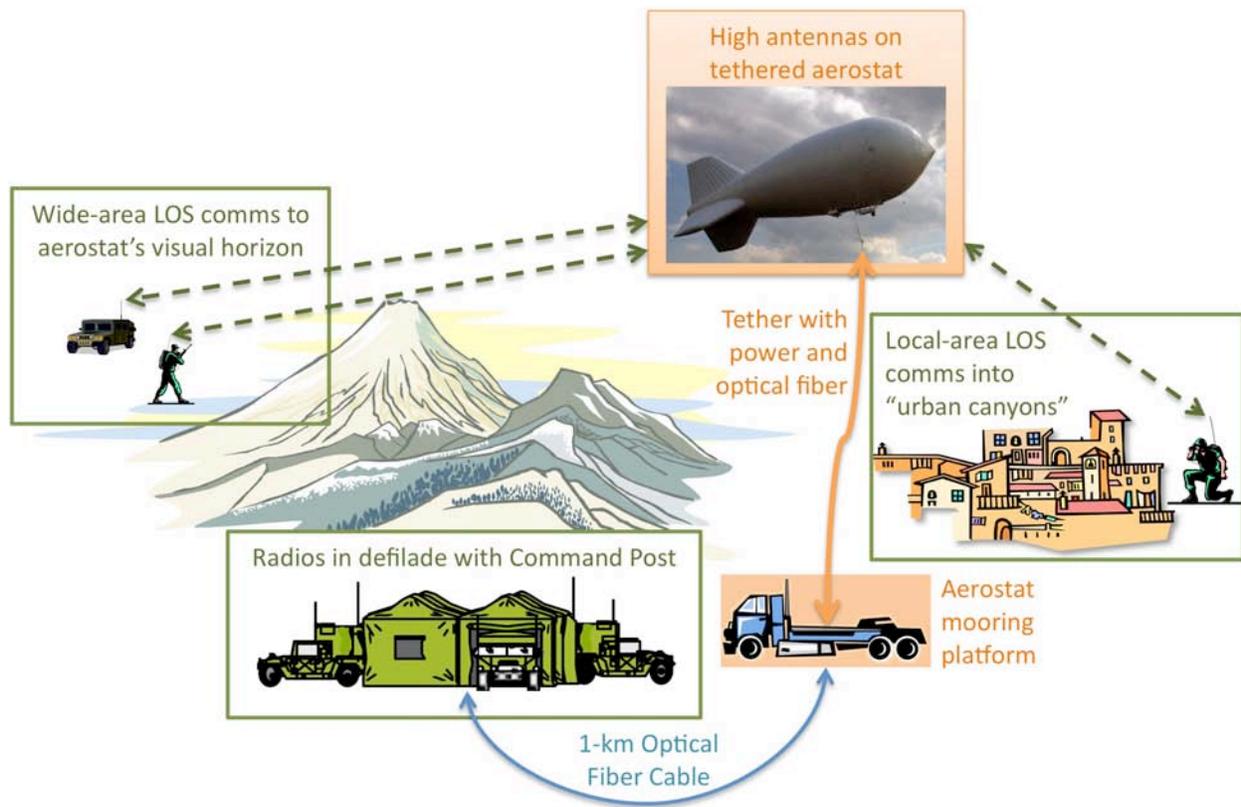


White Paper on “High Antennas for Radio Communications” (HARC)

Any aerostat can become a tall antenna tower for radio comms over long distances and rugged terrain.

Deploy HARC for tactical, emergency and disaster recovery communications.



January 2010

••• This White Paper may be exported •••

1. FORAX-HARC Overview

The FORAX-HARC system enables persistent, inexpensive wide-area radio communications using aerostats.

This White Paper explains how the lightweight FORAX-HARC™ payload enables any aerostat to become, in effect, a tall antenna tower for radio communications over long distances and rugged terrain. The FORAX-HARC payload is used for:

- Tactical communications
- Emergency communications
- Disaster recovery communications.

Commanders can communicate out to the aerostat's visual horizon and talk over terrain and down into valleys that are otherwise denied line-of-sight communications. Radio relay links can operate with the radios safely in the operations center; only the antennas are on the high-flying aerostat.

Syntonics' FORAX™ (Fiber Optic Remote Antenna eXtension) RF-over-fiber communication technology connects distant antennas to their radios using optical fibers. FORAX transports RF signals over distances up to ~100-km if necessary. FORAX has been installed around the world in mission-critical 24x7 operations since 2005.

FORAX-HARC enables almost any radio operating at VHF/UHF/cellular frequencies to take advantage of High Antennas for Radio Communications (HARC). Multiple radios on the ground share one optical fiber in the tether to connect to their antennas on the aerostat via a lightweight electronics payload. The FORAX-HARC system has two major components:

- **A ground-based Radio Interface Unit (RIU)** is collocated with the radios in an operations center. An optical fiber runs from the RIU to the AIU via the aerostat's tether.
- **A lightweight Antenna Interface Unit (AIU)** is installed on the aerostat along with lightweight antennas, also supplied by Syntonics

Several FORAX-HARC systems were delivered to the Army and deployed forward in 2009. Long-range VHF (SINCGARS, 30-88 MHz) communications using a FORAX-HARC system were successfully demonstrated at the Yuma Proving Grounds, AZ in October 2007 on the PTDS aerostat. VHF and UHF (EPLRS, 420-450 MHz) communications were demonstrated at Fort Dix, NJ in June/July 2009. High UHF data rates were successfully demonstrated at Fort Carson, CO in October 2009 on a RAID aerostat (shown above) and again at Camp Dawson, WV in December 2009.



1.1. General FORAX Features and Benefits

FORAX RF-over-fiber communication systems enable users to position their radios without regard to the antenna location. For example:

- FORAX connects antennas on an aerostat to multiple radios on the ground.
- FORAX moves highly visible, emanating antennas — “aiming stakes” for an enemy — away from the command post (CP), reducing radiating emissions and enhancing the electronic covertness and survivability of the CP.
- FORAX connects distant antennas to radios inside a Secure Compartmented Information Facility (SCIF), penetrating the SCIF perimeter with benign optical fibers.

FORAX changes communications doctrine as it relates to radio/antenna separation. FORAX allows antenna to be positioned away from the command post and, where applicable, to be moved off “Radio Hill.” This decreases risk to personnel and costly equipment, decreases time for CP set-up, and lowers maintenance reaction time. It also lets users position their antennas where they want them, without the current short tether of a coaxial cable. FORAX can play a vital role in Operations Centers of all sizes and in other tactical and air traffic control programs. Initially developed for the U.S. Special Operations Command, features and benefits of this RF-over-fiber technology include:

Feature	Benefit
Long Connections	» Radio and its antenna can be located up to 10 km apart using single mode fiber; greater distances are possible.
Easy Routing	» RF signals are carried on lightweight, flexible, rugged, optical cables » Multiple radios can be carried on a single fiber optic cable » Geographic diversity in RF signal routing becomes easy
All frequencies, all modulations	» FORAX™ products handle all modulations including HF, SINCGARS, HAVE-QUICK, UHF MILSATCOM, EPLRS, VHF and UHF LOS
EMP/EMI Immunity	» Lightning, electromagnetic pulses, or RF interference cannot propagate over, or influence the signals on, optical fiber cables » Radio equipment is opto-isolated from antenna

1.2. Specific FORAX-HARC Features and Benefits

FORAX-HARC technology was first developed for the U.S. Army’s Persistent Threat Detection System (PTDS). In brief:

- **High antennas improve line-of-sight (LOS) radio coverage** by enabling long distance communications and communications relay over mountainous terrain or down into congested urban areas. Using lightweight antennas installed in a specific configuration on the aerostat, multi-radio problems with co-site interference are avoided.
- **Aerostats can inexpensively carry high antennas.** Aerostats provide a tall, quasi-permanent radio tower. Aerostats are unmanned platform with relatively low acquisition and operating costs as compared to other operational approaches to providing wide-area LOS communications.

- **FORAX-HARC connects multiple ground-based radios to high antennas on the aerostat** via a single optical fiber in the aerostat’s tether. Leaving the radios on the ground enables immediate access for radio maintenance and crypto key loading. All radio controls are at the User’s fingertips.

A number of six-radio FORAX-HARC-PTDS systems, each handling four SINCGARS and two EPLRS radios, have been delivered to the U.S. Army.

- Figure 1-1 presents a notional system diagram of the FORAX-HARC-PTDS system. The Radio Interface Unit (RIU) is located within 1-km of the aerostat’s mooring platform and connected by a tactical optical fiber cable supplied by Syntonics.
- Figure 1-2 shows the same system’s Radio Interface Unit (RIU) in its military-grade shock-mount transit case with UPS, supplied by Syntonics.
- Figure 1-3 shows the lightweight FORAX-HARC-PTDS Antenna Interface Unit (AIU) that flies on the aerostat connected to multi-element antennas.

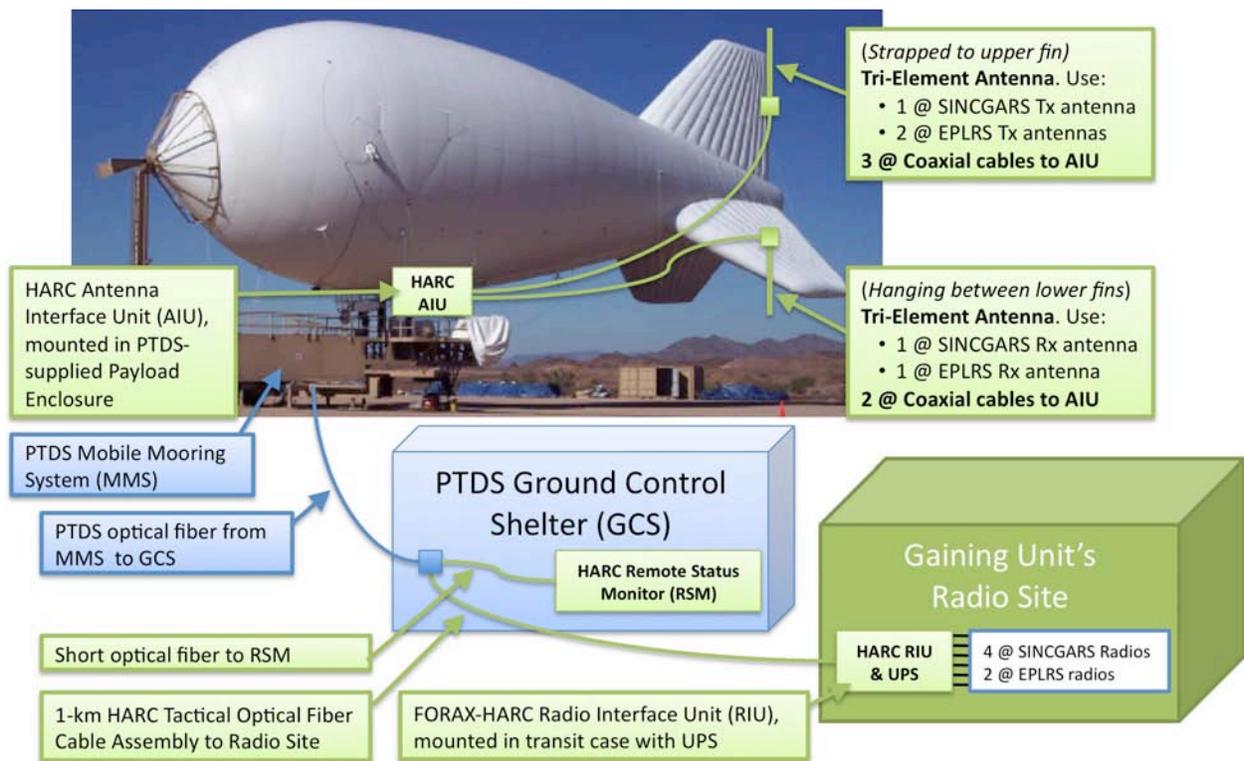


Figure 1-1. Notional system diagram of FORAX-HARC-PTDS system

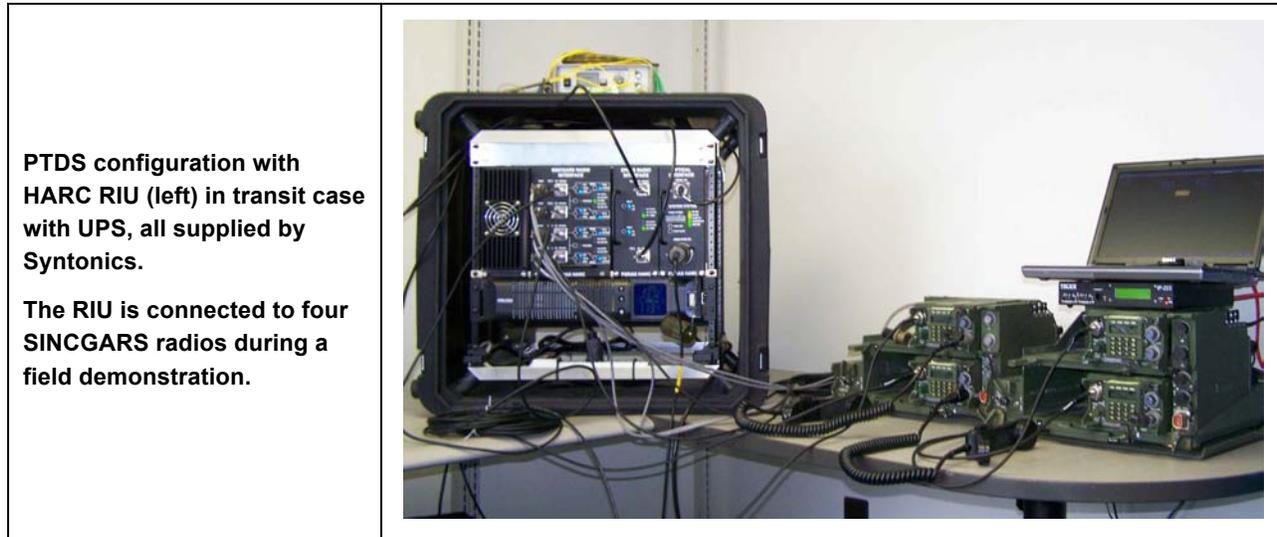


Figure 1-2. PTDS RIU

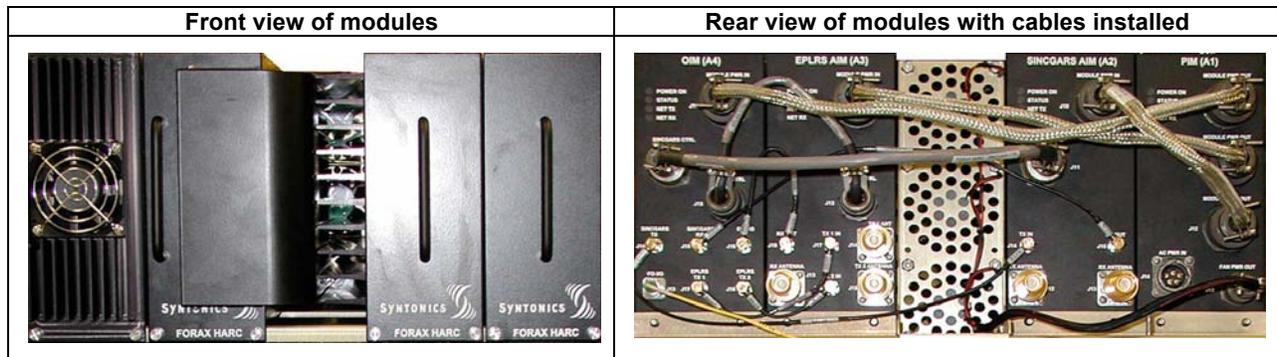


Figure 1-3. Lightweight PTDS AIU

1.3. Conclusion

Any aerostat can become a tall antenna tower for radio comms over long distances and rugged terrain. Communication and communication relay links can operate with the radios safely in the operations center; only the antennas are on the high-flying aerostat.

With a lightweight FORAX-HARC payload, an aerostat can be used for tactical communications, emergency communications and disaster recovery, and military exercises. Using HARC, commanders can communicate out to the aerostat’s visual horizon and talk down into “urban canyons” and valleys that are otherwise denied line-of-sight ground communications.

2. Syntonics LLC

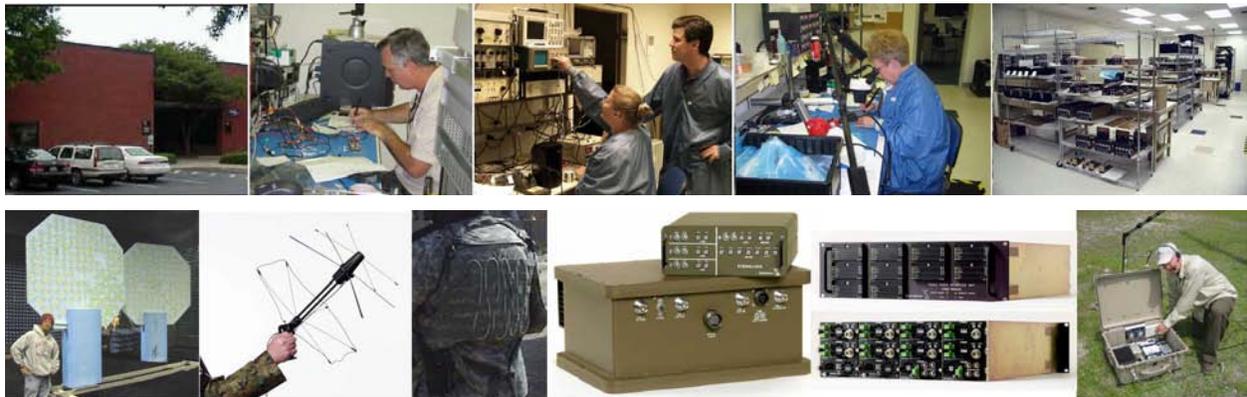
Syntonics develops innovative RF communications equipment that meets unique requirements.

Syntonics (www.SyntonicsCorp.com) designs, develops, and manufactures specialty RF communications equipment that meets unique military requirements. Most Syntonics products trace their origins to a communication technology project originally sponsored by the U.S. Department of Defense.

Founded in 1999 and based in Columbia MD, Syntonics is a well-qualified supplier of radio communications accessories:

- Syntonics' Quality Management System is registered to ISO 9001-2008.
- Defense Contracts Audit Agency (DCAA) approves Syntonics' accounting system.
- Defense Security Service (DSS) administers Syntonics' security clearances; our facility and most of our engineering staff are hold clearances.
- National Security Agency (NSA) administers Syntonics' COMSEC account.

Since developing the first FORAX systems for a U.S. military sponsor, Syntonics has continued to develop the technology and expand the FORAX product line. FORAX now meets the tactical and operational needs of a wide range of military and "first responder" communicators. FORAX™ RF-over-fiber communication systems have been installed around the world in mission-critical 24x7 operations since 2005.



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Thank you for your interest and taking the time to read this White Paper. If you have any questions or would like to arrange a field demonstration, please contact Bruce Montgomery or Ray Madonna at Bruce.Montgomery@Syntonics.com or Ray.Madonna@syntonicscorp.com or call 1-US-SYNTONICS (1.877.968.6642).