

WHITE PAPER — HARC-TD^{*}: Tethered Small UAS Developed and Optimized as a Communications Relay Platform

1.0 Executive Summary

Persistently hovering up to 75-m (250-ft) above ground level (AGL) in all weathers, winds of 30 mph, and with a service ceiling of 5500-m (18,000-ft), the tethered HARC-TD system provides highly expeditionary, persistent communications range extension for combat net radios, MANET[†] radios, civilian radios, EW payloads, ISR payloads, etc.



Having been engineered from inception as a communications range extension platform (“Think of it as a persistent, field expedient antenna tower”), HARC-TD can fly payloads for almost any conceivable radio needed for tactical or Humanitarian and Disaster Relief (HADR) missions.

HARC-TD integrates these mature technologies:

- Syntonics’ HARC comms range extension payloads are TRL 8
- Lockheed Martin Procerus Technologies’ (LMPT) Group 1 Indago small Unmanned Aerial System (sUAS) and its camera payloads are TRL 9
- Syntonics’ RF-quiet powered tether subsystem is TRL 8.

Any vehicle or generator can power the system (< 400W). Deploying and recovering in a few minutes, the system requires minimal user training and flies itself with no user inputs.

The HARC-TD system has been flying since Summer 2018 at DoD events sponsored by USSOCOM, JSOC, WARCOM, and AFSOC. Last year, HARC-TD was successfully demonstrated at TRIDENT SPECTRE 2019 (Little Creek, VA) and CyberQuest 2019 (Fort Gordon, GA). In 2020, “Early Adopter” customers include AFSOC and the Special Operations Group of DHS/Customs and Border Patrol.

HARC payloads have been fielded by DoD for more than a decade on tethered aerostats using Combat Net Radios with Type 1 encryption. Those HARC systems have been fielded in CENTCOM’s AOR continuously from 2010 by the Army’s Program of Record *Persistent Surveillance Systems-Tethered*, managed by PD Aerostats.

^{*} HARC-TD = High Antennas for Radio Communications - Tethered Drone

[†] Mobile *Ad Hoc* Networking, e.g., radios by TrellisWare Technologies, Silvus Technologies, Persistent System, etc.



Figure 1. The tethered HARC-TD system provides persistent communications range extension. The product roadmap calls for operation from moving vehicles, >>30 mph winds, and ops at 100+ m AGL.

2.0 Persistent Comms Range Extension using HARC-TD

HARC-TD has these key features:

- **Packs in a single footlocker (< 95 lb. total).** The entire footlocker can be jumped/carried, or the small individual cases can be jumped/humped/dumped (that is, humped in rucks or dumped in water).
- **Deploys in a few minutes.** The drone ascends/descends in less than 30 seconds
- **Needs minimal user training.** The tethered drone flies itself, requiring no user inputs. It auto-launches and auto-lands.
- **Operates anywhere power is available.** Consuming < 400W, power sources can be shore power, a vehicle's 12 or 24 Vdc, any generator, or a box of batteries.
- **Flies "forever."** HARC-TD has no operational limit on flight endurance. The longest powered operation to date is a 400-hr (16+ day) test at LMPT, which was only interrupted by a thunder storm that cut the power.
- **Is safe.** A small backup battery safely auto-lands the drone if tether power is lost.
- **IS RF Quiet.** As a tactical communication specialist, Syntonics knows that any tethered system must be RF quiet to achieve the radio's full sensitivity. Careful RF filtering and shielding has been part of the HARC-TD design since Day One.
- **Cannot be jammed and does not emit.** Designed from Day One for tactical operations, the tether uses an optical fiber to transport all command/control and payload signals. The optical fiber in the tether cannot be jammed by EW and does not emit RF signals. All drone and payload signals are transported in complete security.



- **Several interchangeable communications and ISR payloads are already available.**
Additional payloads for additional radio types or waveforms can be readily developed.

With a HARC payload, HARC-TD provides persistent BLOS communications between distant points that are otherwise “over the horizon” to each other, either because of terrain or distance. Flying by itself at 75-mAGL, the system achieves up to ~30-km (18 mile) range over flat ground. Ranges up to 60-km (36 mile) can be achieved when two systems are used, one at each end.

2.0 Indago sUAS

Developed and supplied by Lockheed Martin Procerus Technologies (LMPT), which is teamed with Syntonics for HARC-TD, the Indago sUAS was initially developed for special operations forces and is widely used today (Figure 2). It features:

- Whisper quiet, rugged, all-weather capability in winds up to 30 mph, free-flight or tethered
- Operating altitude up to 18,000 ft. MSL
- Industry-leading image stabilization with its camera payloads
- Proven Kestrel 3 autopilot
- A ready-to-fly weight of 5 lbs. with payload included.

HARC-TD with UHF payload, viewed from below	Indago UAV folded for transportation	Indago hand controller with screen for imaging payloads
		

Figure 2. The highly expeditionary Indago UAS has been fielded for several years with SOF users.

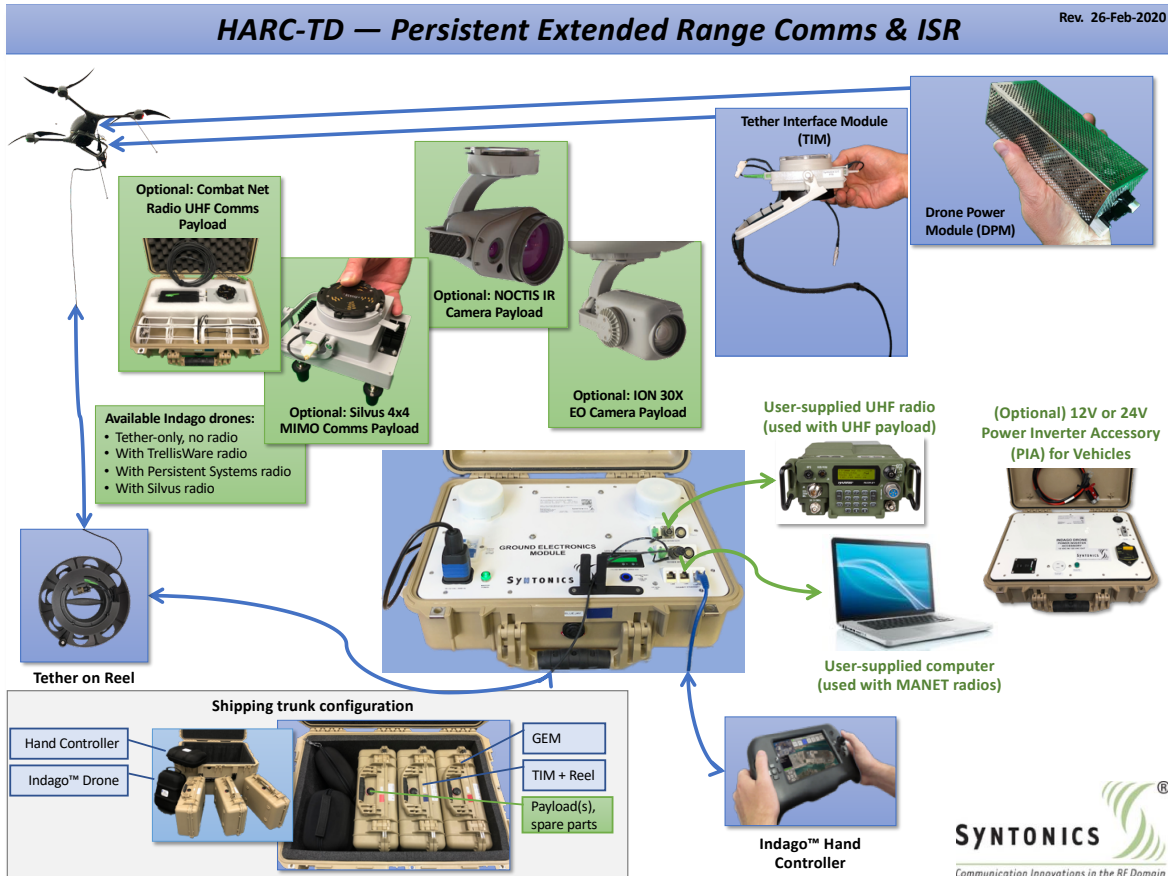
Looking forward, the LMPT / Syntonics product roadmap includes:

- A dual-compatible Indago that can be either a free-flyer or tethered. Dual-compatibility empowers users to use their inventory of Indago drones, tethers, and payloads as an interoperable ecosystem of interchangeable capabilities.
- A tether auto-spooler that automates tether management, enabling operations from moving vehicles and small boats.
- A high-lift kit that enables flying in winds >> 30 mph and/or with heavier payloads.
- A “fast follow-me” mode for operating from moving vehicles and small boats. (Indago already has a slow “follow me” mode for following a walking operator.)

3.0 Powered Tether Subsystem

HARD-TD's powered tether subsystem (PTS) is optimized for the Indago sUAS. Figure 3 is a schematic view of the PTS components, accessories, and user-supplied equipment.

Figure 3. The Powered Tether Subsystem has four principal components: DPM, TIM, Tether, GEM



The four PTS components are:

Drone Power Module (DPM)

- Installs in the Indago battery bay
- Converts high to low voltage DC for the drone
- Contains a Hold-Up Battery so that the Indago can auto-land if tether power is lost

Tether Interface Module (TIM)

- Installs on the Indago payload interface
- Hangs the tether via a double-hinged support yoke
- Provides Indago to-payload connections
- Converts optical signals in the tether to electrical signals for the drone and the payload

Tether and Reel

- Transports high voltage DC electrical power and optical signals between the drone and GEM
- Manual reel minimizes size-weight-power, maximizes reliability

Ground Electronics Module (GEM)

- Converts ground electrical power to tether power
- Converts electrical to optical signals
- Provides RF-over-Fiber and Gigabit Ethernet connections for external devices



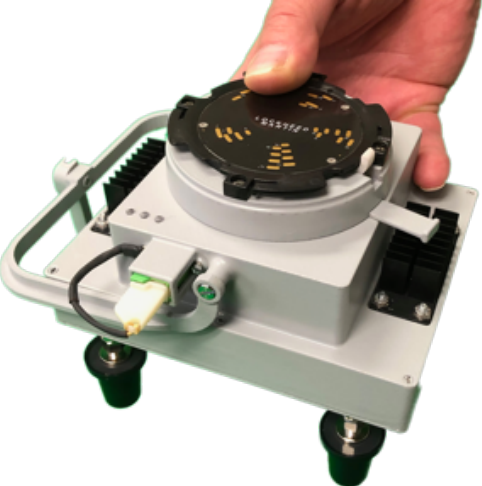
4.0 Current Payloads

HARC-TD currently has two communications payloads available. One is an RF-over-Fiber payload for Combat Net Radios operating with UHF waveforms such as TSM-X or Warrior Robust Enhanced Network-Narrowband (WREN-B). Using Syntonics' RF-over-Fiber technology means that radios with Type 1 encryption can stay on the ground, securely and conveniently under the User's control. Only the antenna is flown high aloft on the drone.

The second is a Silvus payload developed for the Army's CyberQuest 2019. Packaging the S-band SC4400 4x4 MIMO radio with Indago's circular quick-disconnect payload interface (1/8 turn to install or remove), this payload flies the radio and its four antennas because Type 1 encryption is not involved. The optical fiber in the tether provides a 1 GB Ethernet connection from the ground to the radio. *OEM radio modules by TrellisWare Technologies or Persistent System can also be easily packaged and flown as HARC-TD payloads.*



Both communications payloads are shown in Figure 4.

Figure 4. Proven HARC payloads for UHF Combat Net Radios and Silvus radios already exist.

Existing Combat Net Radio Payload	Existing Silvus SC4400 Radio Payload
<p>HARC-TD's UHF payload for Combat Net Radios transmits/receives all military UHF waveforms (225-450 MHz) using radios by Harris and others, such as the PRC-117G, PRC-163, etc.</p>	<p>Using two HARC-TD systems, the Silvus SC4400 payload demonstrated 10+ Mbps throughput at ~4 miles range at Ft. Gordon during CyberQuest 2019.</p>
<p>UHF payload is shown flying (at left) and in its rugged transport case (below).</p>  	<p>Silvus SC4400 payload showing quick-disconnect interface to UAS.</p> 

Two ISR payloads are also currently available. Figure 5 shows them both.

Figure 5. These two camera payloads cover both daytime and nighttime ISR requirements.

ION 30X		NOCTIS	
Video	720P global shutter	Imaging	<ul style="list-style-type: none"> • 640x512 FLIR Boson IR • NIIRS 8 at 400m
Optical Zoom	30x (2° fully zoomed FOV)	Optical Zoom	<ul style="list-style-type: none"> • 32° Wide HFOV Lens • 8° Narrow HFOV Lens • Digital zoom to 2°
Stabilization	3-axis mechanical + electronic	Optional Laser	<ul style="list-style-type: none"> • Class 4 Laser Pointer
			

5.0 Syntonics LLC

Syntonics develops innovative RF communications equipment that meets unique requirements.

Syntonics (www.SyntonicsCorp.com) is an engineering-driven technology company that designs, develops, and manufactures specialty RF communications equipment. 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:

- Quality Management System registered to ISO 9001-2008.
- Cyber security conforming to NIST 800-171.
- Cost accounting system approved by the Defense Contracts Audit Agency (DCAA).
- Security clearances by the Defense Counterintelligence and Security Agency (DCSA).

- Traditional COMSEC account by the National Security Agency (NSA).

Since developing the first FORAX systems for a U.S. military sponsor, Syntonics has continued to develop the technology and expand the FORAX, FORAX-HARC, and FORAX-HARC-TD product lines. 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 Sales at Sales@SyntonicsCorp.com or call 1-US-SYNTONICS (1.877.968.6642).