



HART

HETEROGENEOUS AIRBORNE RECONNAISSANCE TEAM

Heterogeneous Airborne Reconnaissance Team (HART)

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Dr. Michael A. Pagels





Problem:

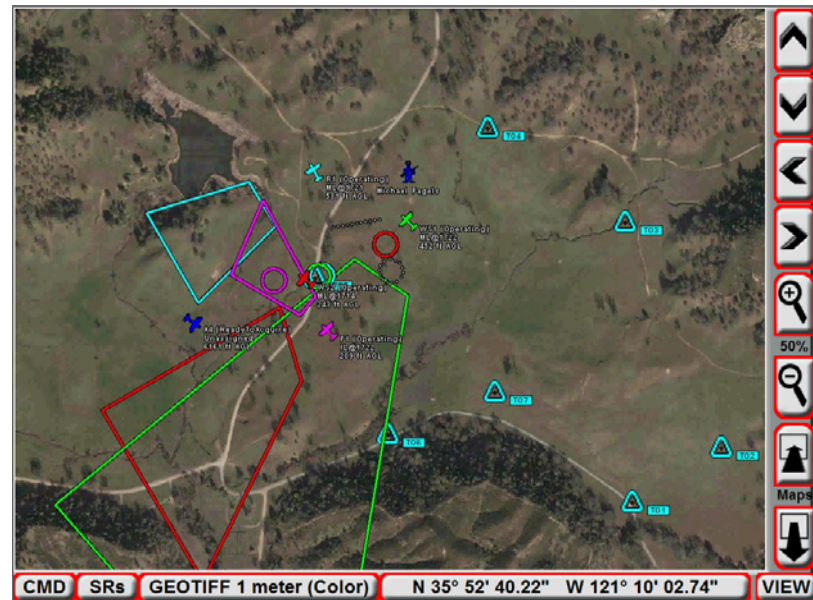
Provide real time RSTA services **directly** to small unit leaders in complex environments
Shorten tasking, **retasking** and sensor-to-shooter timelines

Solution:

Allow direct access to a **system of systems** - multiple tiers, platforms & sensors
Decouple soldiers from flight control, so they can focus on the fight
Disseminate video **to small unit leaders** via handhelds and to TOCs via wide screens

Approach:

Translate multiple RSTA requests into multi-platform taskings
Automate tasking, **airspace deconfliction**, flight path and sensor control
Platform agnostic; add diverse systems quickly with **no changes to UAVs** or their ground stations
Stabilize and **georegister** for targeting, provide multi-platform **mosaics for Situation Awareness**



Rapidly Task and Retask at Any Echelon



HART Architecture – How it's done



What to image...prioritized

User Interface

Commander's

- Mission Priorities, Over-rides

Warfighter's

- Information Requests
- No fly zones

How to collect...optimized

Platform Control

- Launch/Land/Refuel
- Internal airspace management
- External airspace management
- Aircraft flight path planning
- Coordinated tasking & handoff
- Sensor & comms planning

Airspace
Coordination
Areas

*How to coordinate...
distributed*

No Fly Zones

*What and how to display...
customized*

**HART Internal
Wireless Network**

What to capture...full motion EO & IR

How to capture...real-time

How to enhance...georegister & mosaic

*What to show...
by RFI, AOO/AOI, mission,
role/billet
with live annotation*

Imagery Server & Archive














- Long-term all-platform storage
- Map & NTM products
- Single-platform mosaics
- Multi-platform mosaics
- Imagery georegistration
- Time & place queries

External
Imagery

Exploitation Plug-ins & Products

External
Requests

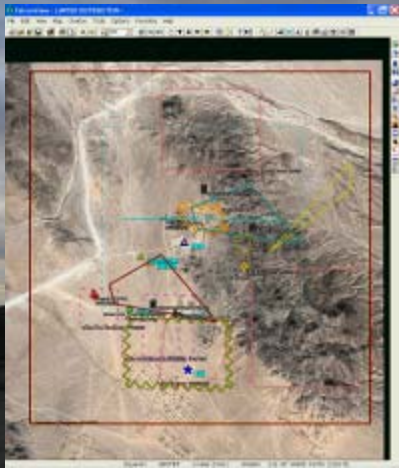
HART is platform agnostic; platform selection is guided by the desire to extend RSTA capabilities

	<i>Platform</i>	<i>Payload</i>	<i>Range</i>	<i>Endurance</i>	<i>Sensors</i>	<i>Control</i>
	Manned A/C	4,215 lbs	3,658 km	5 hrs	EO/IR, SAR	Gimbaled Sensor control
	Hummingbird	1,000 lbs	4,630 km	24 hrs	EO/IR, SAR Modular payload	GPS autopilot
	Warrior Predator B variant	450 lbs	740 km	17 hrs	EO/IR, SAR, MTI	GPS autopilot
	Hunter	275 lbs	125 km-200 km	12 hrs	EO/IR	GPS autopilot
	Fire Scout	200 lbs	204 km	6 hrs	EO/IR sensor ball, SAR, MTI	GPS autopilot
	RMAX	60 lbs	30 km	1.5 hrs	Modular payload, includes stabilized sensor ball	GPS autopilot
	Shadow	50 lbs	125 km	5 hrs	EO/IR	GPS autopilot
	OAV	20 lbs	16 km	2 hrs	EO/IR downward & slant-angle	GPS autopilot
	ScanEagle	5 lbs	150 km	15 hrs	Inertially stabilized EO/IR or low-light/IR	GPS autopilot
	Pointer	2 lbs	10 km	1 hr	EO camera housing; side-look capable	GPS autopilot
	Raven	0.4 lb	10 km	1 hr	One IR; or a combo of down- & side-looking EO cameras	GPS autopilot
	Dragon Eye	1 lb	10 km	1 hr	EO/IR	GPS autopilot
	Wasp	0.3 lb	5 km	45 min	EO camera both forward and side-looking; IR	GPS autopilot

Flown Live

Flown MUSE (SIM)

Potential



Technical Description

Warfighters task platforms with a few simple screen taps

HART translates collection requests into autonomous tasking and control of assets using nonproprietary, net-centric, web-based tools

Automatically package and rout the appropriate video products to the requesting warfighter

Provided stabilized, geo-registered imagery

Provided video mosaicing for maintaining persistent wide-area views and situation awareness

Operational Description

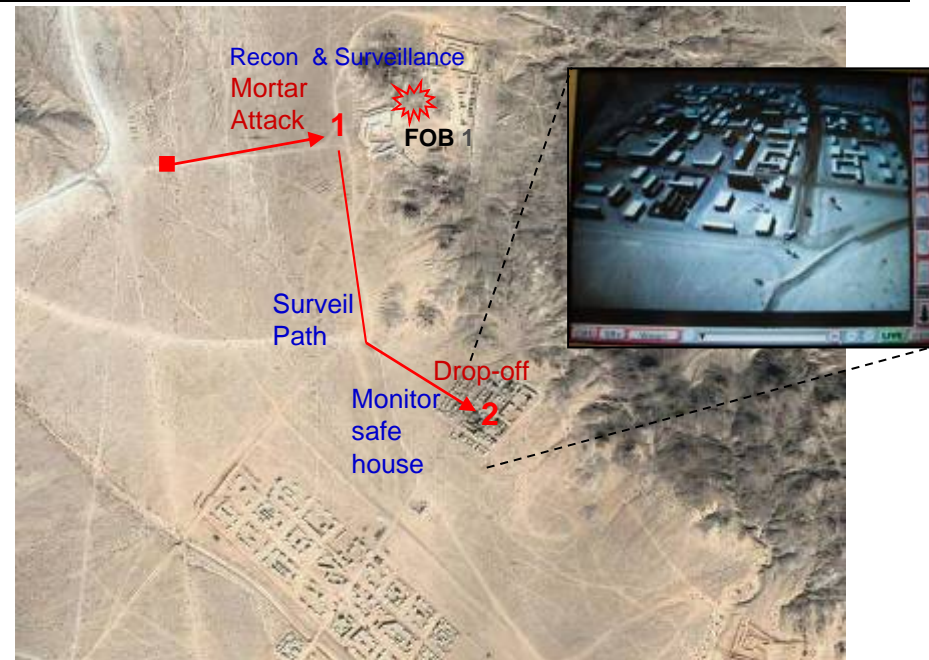
HART provides automatic, real time planning and control of assets for Warfighters at the tip of the spear as well as large exploitation systems

Squad leaders request:

- area surveillance
- route recon / path surveillance
- site monitoring / point monitoring
- vehicle tracking

A handheld touch screen provides fighters with real-time, stabilized, mosaiced video over a backdrop of reference imagery for the region of interest

Commanders prioritize ISR support to the main effort, specify the area of operations, & input No Fly Zones





Coordinating Operations through Integrated Control and Reporting



Transforming ISR platforms into a RSTA Force

How It's Done Today:

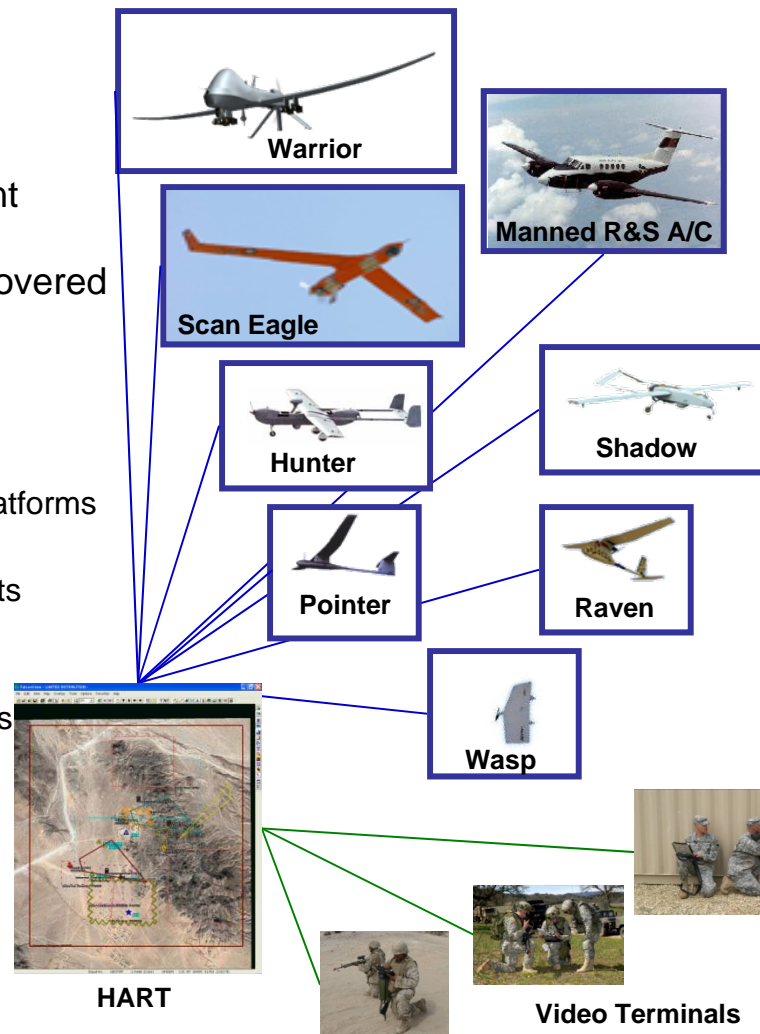
- Peanut butter - platform time allocated across multiple units
- Slow response to complex, cross boundary events (e.g., squinters)
- Bunch ball - multiple platforms converge on a single critical event
- Other events pass unobserved
- To each his own - owners feel assured their priority mission is covered
- Platform utilization suffers

HART Solution:

- Layered platform architecture – integrated collection
- Agile high-altitude sensors fill gaps between proliferated low-altitude platforms
- Prioritized task management
- Senior commanders determine relative priorities among all task requests
- Optimized platform utilization
- Integrated dissemination
- Sensor data accumulated over time, and passed to all interested parties

HART Technical Challenges:

- Airspace management
- Embedded image quality assurance
- Scalability over platform numbers and types
- Communications Architecture (Network)



Real-time imagery from the best available source



Provide video-on-demand from multiple sources to multiple users

Persistence

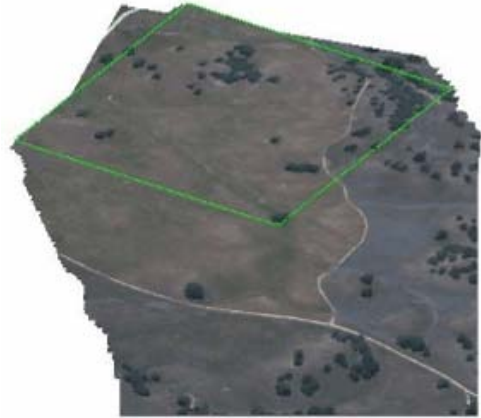
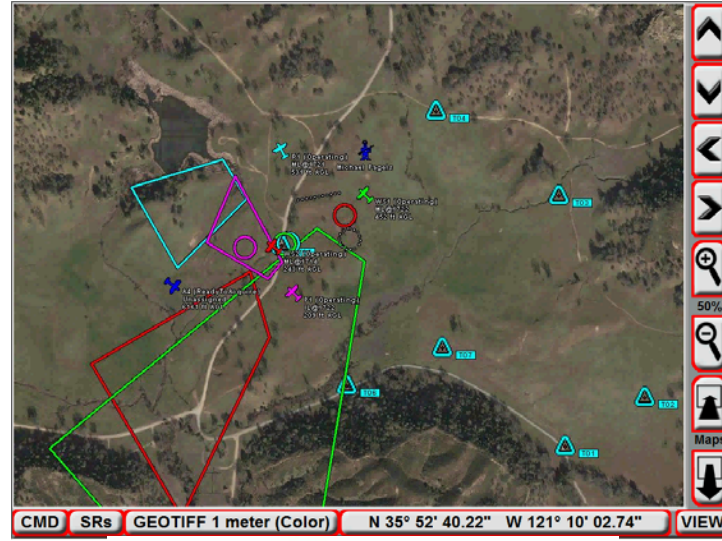
- Support 24/7 operations – day and night
- Multiple aircraft in flight simultaneously
- Multiple aircraft and sensor types
- Multiple users participating simultaneously

Agile Tasking

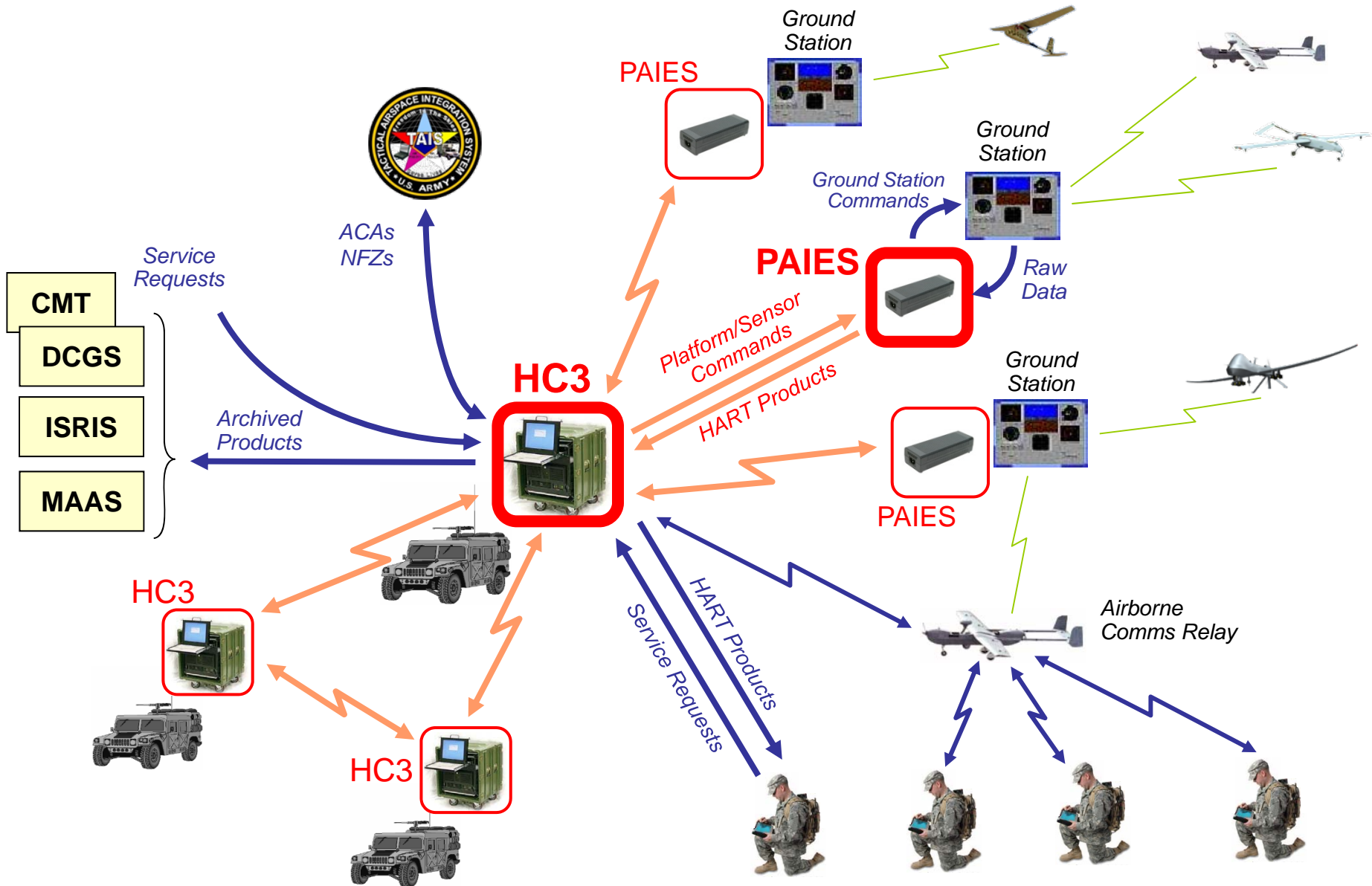
- Support multiple tasks with each platform
 - Deliberate search: Baseline imagery for future ops
 - Derived updates: Revisit tactical hotspots
 - Hasty tasks: Overwatch forces in contact, respond quickly
 - Bound platforms: Platforms limited to tasks from specific users
- No limits on commanders' ability to set priorities
- High platform and sensor utilization rates
- Low latency platform status reporting
- Automatically retask collection of low-quality images
- Adherence to airspace constraints from joint airspace management

Tailored Dissemination

- Georegister all imagery – to targeting accuracy with low latency
- Blend EO and IR imagery at day/night transitions
- Vary compression to fit dissemination bandwidth



Responsive to warfighters at every echelon of command





Operating Modes – Multiple entry points

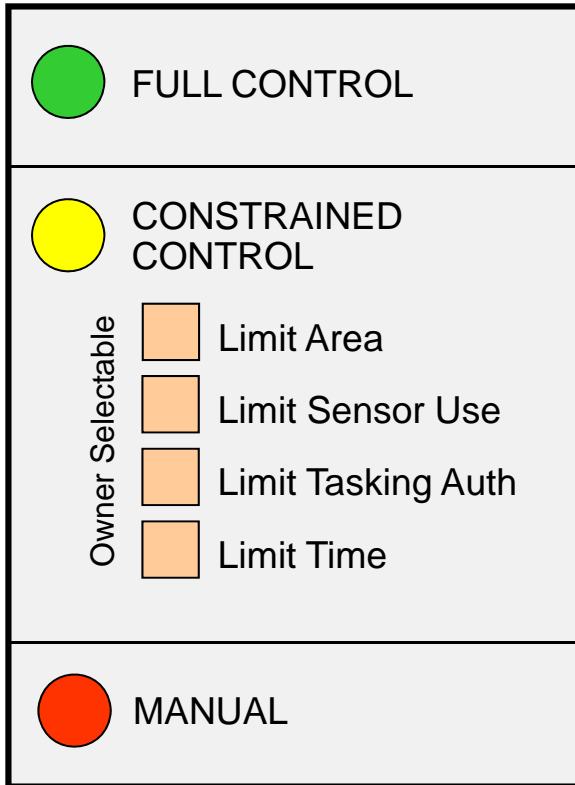


UAV owners will have the capability to place constraints on HURT's use of their assets

UAV Owner

Service Requester

UAV Control Authority Options



- PRO: Complete autonomy
 - CON: UAV Owner gives up all control authority
-
- PRO: Airspace deconfliction
 - PRO: Owner can specify the level of control authority delegated to HART
 - PRO: Control authority can be adjusted to match the operational situation
 - CON: UAV Owner gives up some control authority
-
- PRO: If necessary, the owner can opt out of HART control
 - CON: Teleoperation, the same as 60 years ago!

- PRO: Services requests from the maximum number of requestors
 - PRO: Optimizes UAV/Sensor utilization
-
- PRO: Services requests from a greater number of requestors
 - PRO: Improves UAV/sensor utilization
 - CON: Does not provide optimal resource utilization
-
- CON: UAV is not available to support multiple requestors

Support mission requirements / Support multiple TTPs



Operates within Bandwidth Constraints



Capabilities dynamically tailored to operational bandwidth constraints



Multi-platform, video mosaics for Warfighters, Commanders and Operations Centers at every echelon - processed video products (stabilized, georegistered), system of systems tasking by every echelon, playback from video archives, digital integration with DCGS/CMT, and external Airspace Mgmt – Full up HART

Video mosaics for Warfighters, TOCs, and GCSs – wide area SA with annotated targets, AOIs, NFZs, ACA's, etc.; stabilized and georegistered

Streaming Video – raw, or stabilized, geo-registered)

Video clips - raw or stabilized, geo-registered products

HART uses existing comms infrastructure - mesh networks, and future HART airborne communications relay

Annotated Images to WFs – targets, AOIs, NFZs, ACAs

Image frames for Warfighters – small areas of interest

Image chips for Warfighters – points of interest

Tasking by Warfighters – Responsive, dynamic retasking

SINGARS
10's of bits per second

Airspace Management – Flight path planning, Deconfliction

Platform locations, ACA and NFZ delineation



0 Bandwidth { **HART - Improved video products** at the CGS (stabilization, georegistration, single platform mosaics)
No HART – Raw video products at the GCS (jittery, poorly geo-registered)



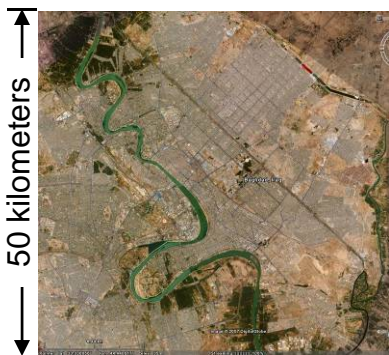
Greater bandwidth, greater capabilities



HART – Live Flight Exercise Objectives and Demonstrated Capabilities



Perform representative tactical missions during a complete 24-hour operations cycle



Deliberate Mission – Days of advanced planning

Wide Area Search & Site Surveillance

- 1 – collect final images for change pairs supporting today's missions
- 2 – collect routine change-detection pairs
- 3 – get baseline images for future pairs

Derived Mission – Hours of advanced planning

Second look nominations for change detection, exploitation, and cross sensor cueing:

- 1 – today's tactical hotspots
- 2 – today's preplanned Phase 1 missions
- 3 – today's follow-on Phase 2 missions



Hasty Mission – No advance planning

FMV and confirmatory re-looks

- 1 – Dynamic support to forces in contact; EOD teams, convoys
- 2 – Conduct rapid re-looks; cross cue



Manned A/C + Large UAVs + Small UAVs

Waypoints & lookpoints

Imagery

Unified Flight Path & Sensor Tasking

Unified Imagery Database

Tasks

Snapshots & streams

Live: Company-level Unit of Action

HART Laptops & OSRVT surrogates for TFO deployed devices

HART Capabilities Demo'ed

- Automated task management
- Automated flight path & sensor planning
- Airspace deconfliction
- Dissemination of live FMV – or stabilized, georegistered, multi-platform mosaics
- TIVO-like playback
- Responsive to commanders, analysts, and frontline troops



HART – Demonstrated Capabilities (Cont.)

Live Flights, April 2007 & Mar 08



Capabilities Implemented to Achieve Mission

Category	Goal	Status
Platforms types and sensors	Live and simulated	Achieved Live: Wasps, Raven, Pointer, ScanEagle, manned A/C Sim: multi-platform, multi-tier control
	Independent gimballed steering	Achieved for both ScanEagle and manned platform
	Required resolution for 5 platform types	Achieved SUAVs live flight goals (Add zoom control for ScanEagle and manned A/C)
Deliberate Missions	Rte Reconnaissance designated roadside target area imaging	Achieved: All designated targets imaged during execution of route reconnaissance
	Target annotations: targets onto live & reference imagery	Real-time annotation, in both live and reference imagery
Derived Missions	Precision georegistration for fixed & gimballed sensors	Native Doesn't achieve targeting accuracy
	Specified viewpoints for 5 platform types	Achieved SUAV live flight goals (Add orientation control for ScanEagle and manned A/C)
Hasty Missions	Multiple SUAVs in flight with refueling	Achieved multiple UAVs in flight with HART cued refueling

Operated through complete collection cycles

Conducted weeks of live flights
Multiple platforms, surrogates and simulations operated day & night
Multiple sorties, many hours of accumulated flight time

Deliberate – Days of advanced planning

Monitored many km of roadway daily
Collected image pairs for detects, performed “Second Looks”, and high-priority re-looks before convoy movements

Derived – Hours of advanced planning

Monitored hotspots, safe houses, weapons caches

Hasty / Immediate – No advance planning

Performed local area surveillance for EOD team security

Supported company-level units of action

EOD team planning from full motion video
Created NFZ to bring in simulated Medevac

The map displays a mission area with several key locations and aircraft types:

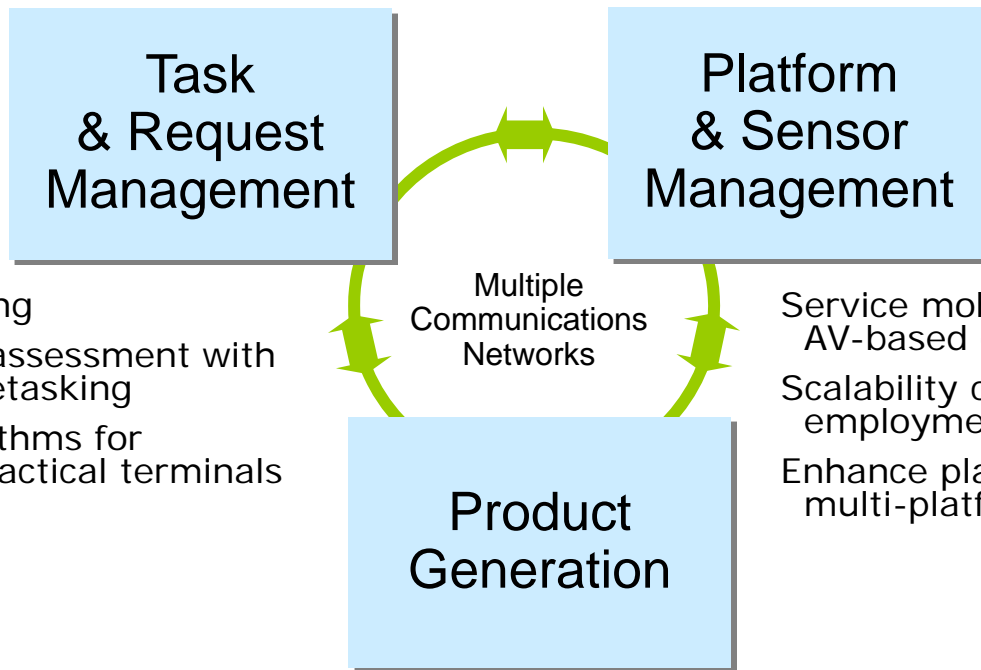
- Scan Eagle:** A large orange aircraft icon in the top left.
- Manned R&S A/C:** A white aircraft icon in the top right.
- Wasp:** A small grey aircraft icon in the bottom left.
- Warrior:** A large grey aircraft icon in the center.
- Weapons Cache:** A green area labeled on the map.
- EOD Team IED:** A green area labeled on the map.
- HC3 Patrol Attacked MOUT Site:** A green area labeled on the map.
- Shadow:** A grey aircraft icon on the right side.
- Pointer:** A blue aircraft icon on the right side.
- Raven:** A yellow aircraft icon on the right side.
- DMax:** A red and white helicopter icon at the bottom right.
- Live Flights:** A white box with the text "Live Flights" in the bottom left.



Overview – Key new functional thrusts



Targeted technical development to maximize tactical impact



Add newest versions of Wasp B3, Raven B, Shadow, Hunter, Warrior- A
XGA EO & IR FMV

Multi-echelon tasking
Embedded quality assessment with fully automated retasking
Compression algorithms for dissemination to tactical terminals

Service mobile warfighters via AV-based comms relay
Scalability commensurate with tactical employment goals
Enhance planning for long duration with multi-platform handoff & calibration

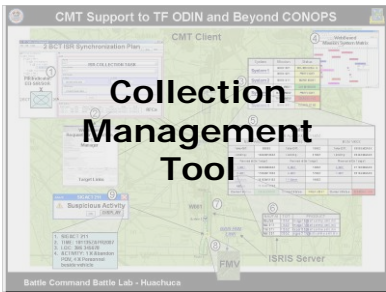
Exploit infrared & higher-resolution EO video
Provide moving target tracking
Geo-register EO/IR imagery products

Ruggedize, miniaturize, and package for deployment
Conduct unit-embedded training

Coordinating goals and objectives with the Army

Coordinate with, support, leverage and transition to ongoing activities

Supporting



Task & Request Management

Platform & Sensor Management

Multiple Communications Networks

Product Generation

Supporting TAIS



Transition Target



HART will provide the planning & control heart of any multi-platform airborne RSTA architecture

Supporting



**MAAS
ISRIS
DCGS
PSDS2
NGA-CALA**

HART provides a uniform set of enhanced image products



HART – Development and Evaluation Plan



Integrate ruggedized technology components and conduct unit-embedded training

Development Spirals (4-months each) - 12 weeks development / 4 weeks HITL testing at factory / 2 weeks exercise & evaluation

	<i>Spiral 1</i> OCT 07 - FEB/MAR 08	<i>Spiral 2</i> MAR 08 - JUN 08	<i>Spiral 3</i> JUL 08 - OCT 08	<i>Spiral 4</i> NOV 08 - FEB 09
Platforms	Wasp B3 Raven B Scan Eagle ARMS Shadow (SIM) Warrior Alpha(SIM)	Wasp B3 Raven B Scan Eagle ARMS Shadow (SIM) Warrior Alpha(SIM)	Wasp B3 Raven B Scan Eagle ARMS Shadow Warrior Alpha(SIM)	Wasp B3 & Raven B Scan Eagle ARMS Shadow Warrior Alpha GlobalHawk
Locations	Fort Hunter Liggett	Fort Hunter Liggett Initial unit-embedded training	Fort Bliss Unit-embedded training with evaluation task force	Fort Hood or Fort Bliss embedded training & evaluation
Objectives	ATEC observation & evaluation; IR and IR+EO capability; Initial integration with CMT	ATEC evaluates Wasp & Raven operations; Initial integration with OS/RVT & Tacticomp	ATEC evaluates Shadow & ScanEagle operations; Initial integration with OS/GCS	ATEC evaluates Warrior operations; Fieldable system & Training package
Vignettes	All independent: Deliberate, Derived, Hasty	Deliberate; Derived + Hasty	All simultaneous: Deliberate + Derived + Hasty	All simultaneous: Deliberate + Derived + Hasty + Live WF developed tasks
Technical Challenges Addressed	Multi-echelon tasking; Scalability commensurate with TF ODIN	Exploit infrared and higher resolution EO video; Georegistration of IR video; Multiplatform handoff	Service forward fighters via filing forward AV handoff; Embedded quality assessment with fully automated retasking	Service mobile warfighter with AV-based Comms relay; Compression algorithms for dissemination to tactical terminals

Go/No-Go Gate

HART Phase 2

Incremental development / Increasing complexity / Increasing expectations



Multi-platform Tasking, Coordination and Control

Demonstrated Technical Capabilities

Automated task management

Automated flight path and sensor planning

Automated airspace deconfliction

Dissemination of raw FMV, or stabilized, georegistered, multi-platform mosaics within seconds

TIVO-like playback

Responsiveness to commanders, analysts, and frontline troops

Goals and Long Range Impact

Enable mixed airspace operations; cross-tier, manned and unmanned

Revolutionize C2 of teams of aerial platforms to create an integrated RSTA force

Allow rapid integration of new platform and sensor technologies into the force structure

Quickly respond to cues and tip-offs by automating planning, coordination & deconfliction tasks

Enhance survivability of friendly forces by providing on-demand RSTA at every echelon

Transforming ISR platforms into a RSTA Force