# HART

## HETEROGENEOUS AIRBORNE RECONAISSANCE TEAM

Heterogeneous Airborne
Reconnaissance Team (HART)

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DARPA
BRIDGING THE GAP
POWERED BY IDEAS

# Collaborative Tasking of ISR Assets

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1958 · 50 YEARS · 2008
POWERED BY IDEAS

HART
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**Problem**:

Provide real time RSTA services *directly* to small unit leaders in complex environments

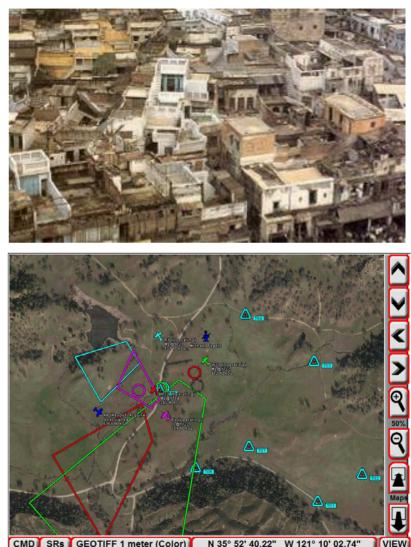Shorten tasking, *retasking* and sensor-to-shooter timelines

**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*
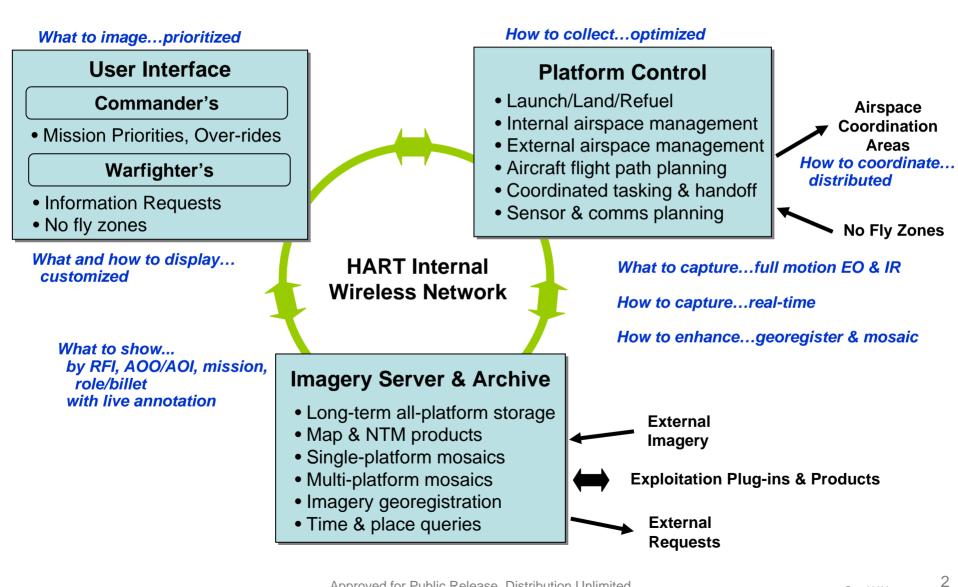




CMD | SRs | GEOTIFF 1 meter (Color) | N 35° 52' 40.22"   W 121° 10' 02.74" | VIEW

**Rapidly Task and Retask at Any Echelon**

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**What to image…prioritized**

## User Interface

### Commander's

• Mission Priorities, Over-rides

### Warfighter's

• Information Requests
• No fly zones

**What and how to display…
  customized**

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

## Platform Control

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

**How to collect…optimized**

**Airspace Coordination Areas**

**How to coordinate…
distributed**

**No Fly Zones**

## HART Internal Wireless Network

**What to capture…full motion EO & IR**

**How to capture…real-time**

**How to enhance…georegister & mosaic**

## 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**

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# Platforms & Payloads

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

| Platform | Payload | Range | Endurance | Sensors | Control |
|---|---|---|---|---|---|
| **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 |

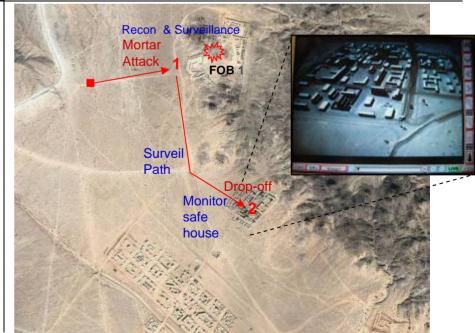Flown Live    Flown MUSE (SIM)    Potential

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## 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

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., squirters)
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)

**Warrior**

**Manned R&S A/C**

**Scan Eagle**

**Shadow**

**Hunter**

**Pointer**

**Raven**

**Wasp**

**HART**

**Video Terminals**

Real-time imagery from the best available source

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**Provide video-on-demand from multiple sources to multiple users**
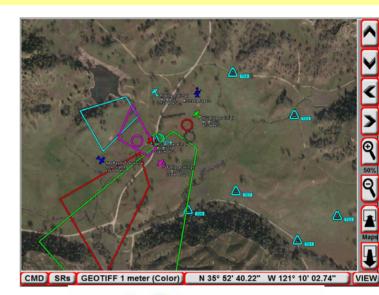
## Persistence
Support 24/7 operations – day and night
Multiple aircraft in flight simultaneously
Multiple aircraft and sensor types
Multiple users participating simultaneously

## 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
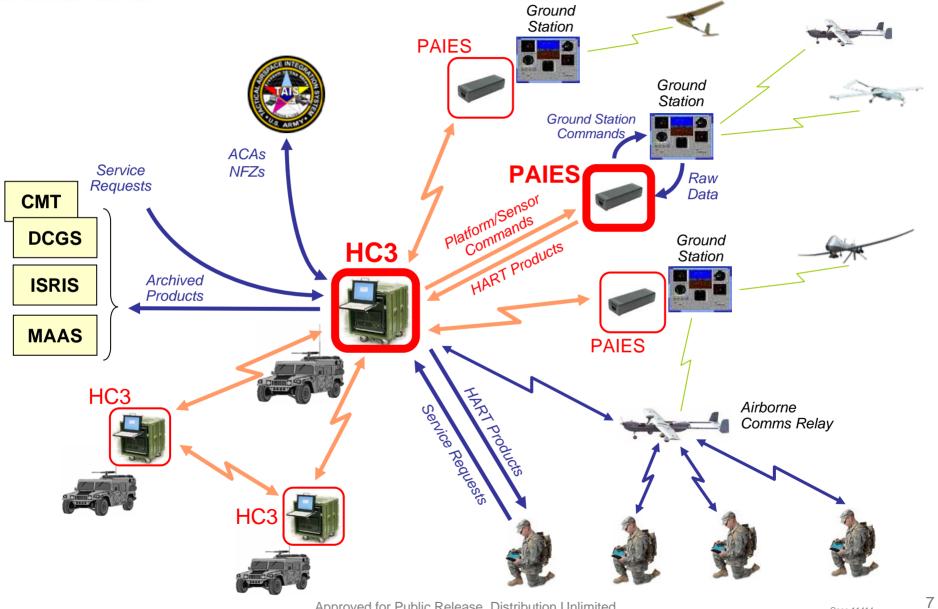Vary compression to fit dissemination bandwidth



CMD  SRs  GEOTIFF 1 meter (Color)  N 35° 52' 40.22"  W 121° 10' 02.74"  VIEW



**Responsive to warfighters at every echelon of command**

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

## UAV Control Authority Options



- 🟢 FULL CONTROL
- 🟡 CONSTRAINED CONTROL
  - **Owner Selectable**
    - 🟧 Limit Area
    - 🟧 Limit Sensor Use
    - 🟧 Limit Tasking Auth
    - 🟧 Limit Time
- 🔴 MANUAL

### UAV Owner

- ➢ PRO: Complete autonomy
- ➢ CON: UAV Owner gives up all control authority

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- ➢ 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

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- ➢ PRO: If necessary, the owner can opt out of HART control
- ➢ CON: Teleoperation, the same as 60 years ago!

### Service Requester

- ➢ PRO: Services requests from the maximum number of requestors
- ➢ PRO: Optimizes UAV/Sensor utilization

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- ➢ PRO: Services requests from a greater number of requestors
- ➢ PRO: Improves UAV/sensor utilization
- ➢ CON: Does not provide optimal resource utilization

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- ➢ CON: UAV is not available to support multiple requestors

**Support mission requirements / Support multiple TTPs**

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**Capabilities dynamically tailored to operational bandwidth constraints**

**2 Mb/s**

**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

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

**Image frames** for Warfighters – small areas of interest

**Image chips** for Warfighters – points of interest

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

**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

**HART - Improved video products** at the CGS (stabilization, georegistration, single platform mosaics)

**0 Bandwidth**

**No HART** – Raw video products at the GCS (jittery, poorly geo-registered)

**Greater bandwidth, greater 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

50 kilometers

**Derived Mission** – Hours of advanced planning

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

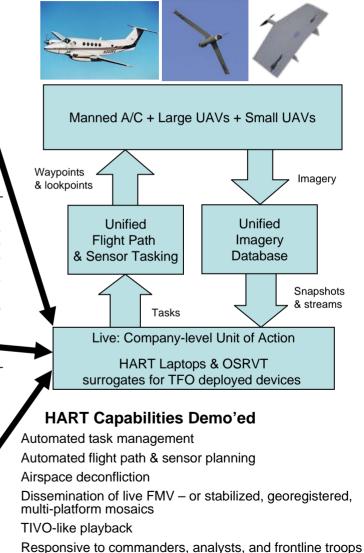1 – today's tactical hotspots
2 – today's preplanned Phase 1 missions
3 – today's follow-on Phase 2 missions

10 kilometers

**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

1 kilometer

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

| 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 gimbal 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 & gimbaled sensors** | **Native Doesn't achieve targeting accuracy** | **HART, Real-time Well within req'd targeting accuracy requirements** |
| | **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
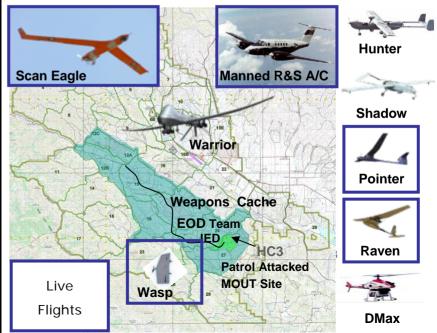Monitored many km of roadway daily
Collected image pairs for detects, performed "Second Looks", and high-priority re-looks before convoy movements

### 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
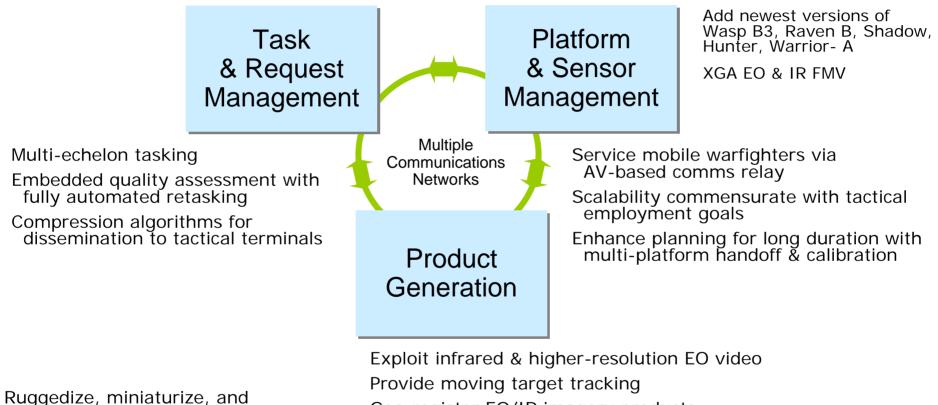Created NFZ to bring in simulated Medevac



Scan Eagle

Manned R&S A/C

Hunter

Shadow

Warrior

Pointer

Weapons Cache

EOD Team

IED

HC3

Raven

Patrol Attacked
MOUT Site

Live Flights

Wasp

DMax

Targeted technical development to maximize tactical impact

**Task & Request Management**

**Platform & Sensor Management**

Multiple Communications Networks

**Product Generation**

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
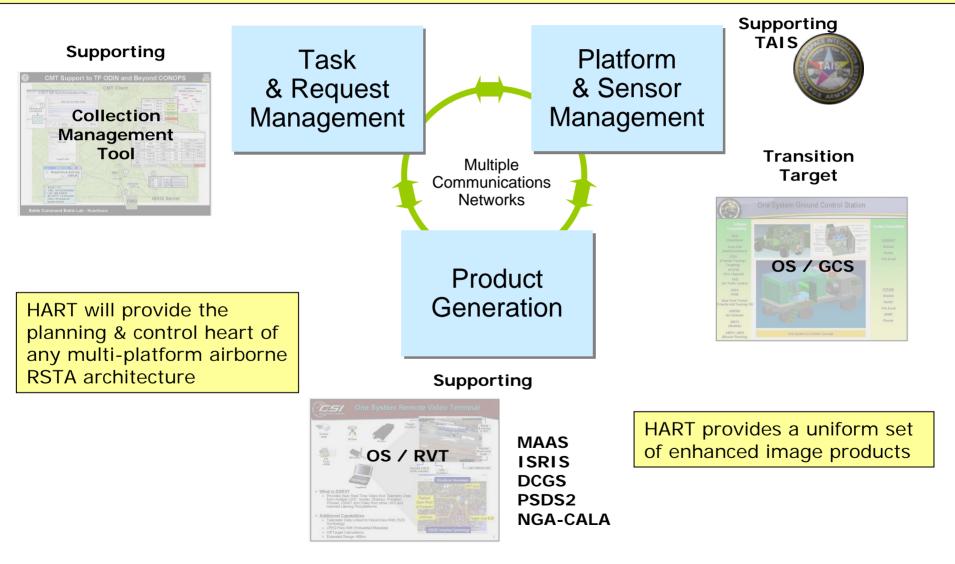
Coordinating goals and objectives with the Army

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Coordinate with, support, leverage and transition to ongoing activities

**Supporting**



**Task & Request Management**

**Platform & Sensor Management**

**Supporting TAIS**



Multiple Communications Networks

**Transition Target**



OS / GCS

**Product Generation**

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

**Supporting**



OS / RVT

MAAS
ISRIS
DCGS
PSDS2
NGA-CALA

HART provides a uniform set of enhanced image products

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**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

| | Spiral 1 | Spiral 2 | Spiral 3 | Spiral 4 | | |
|---|---|---|---|---|---|---|
| | OCT 07 - FEB/MAR 08 | MAR 08 - JUN 08 | JUL 08 - OCT 08 | NOV 08 - FEB 09 | | |
| **Platforms** | Wasp B3<br>Raven B<br>Scan Eagle<br>ARMS<br>*Shadow (SIM)*<br>*Warrior (SIM)* | Wasp B3<br>Raven B<br>Scan Eagle<br>ARMS<br>Shadow<br>*Warrior (SIM)* | Wasp B3<br>Raven B<br>Scan Eagle<br>ARMS<br>Shadow<br>Warrior | Wasp B3<br>Raven B<br>Scan Eagle<br>ARMS<br>Shadow<br>Warrior | DARPA Director's Go/No-Go Gate | HART Phase 2 |
| **Locations** | Fort Hunter Liggett | Fort Hood<br>Initial unit-embedded training | Fort Hood<br>Unit-embedded training &<br>evaluation with TF ODIN CAB | Fort Hood<br>Unit-embedded training &<br>evaluation with TF ODIN CAB | | |
| **Objectives** | ATEC observation & evaluation;<br>IR and IR+EO capability | ATEC evaluates<br>Wasp & Raven operations;<br>Initial integration with TAIS | ATEC evaluates Shadow &<br>ARMS/MARS C-12 operations;<br>Initial integration with CMT,<br>OS/RVT, OS/GCS | ATEC evaluates<br>Warrior operations;<br>Fieldable system &<br>Training package | | |
| **Vignettes** | All independent:<br>Deliberate, Derived, Hasty | Deliberate;<br>Derived + Hasty | All simultaneous:<br>Deliberate + Derived + Hasty | All simultaneous:<br>Deliberate + Derived + Hasty<br>+ Live WF developed tasks | | |
| **Technical Challenges Addressed** | Multi-echelon tasking;<br>Scalability commensurate with<br>TF ODIN | Exploit infrared &<br>higher resolution EO video;<br>Georegistration of IR video;<br>Multiplatform handoff | Service mobile warfighter<br>via AV-based comms relay;<br>Embedded quality assessment<br>with fully automated retasking | Moving target tracking;<br>Compression algorithms for<br>dissemination to tactical<br>terminals | | |

**Incremental development / Increasing complexity / Increasing expectations**

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## 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**