Design and Development
of the
OICW Miniature Fire Control System

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Objective Individual Combat Weapon Target Acquisition / Fire Control System

Content

• Describe challenges and accomplishments associated with developing a miniature, lightweight, full function fire control system for OICW

• Discuss system trade-offs required to obtain optimum performance in the face of severe limitations on size, weight and power.

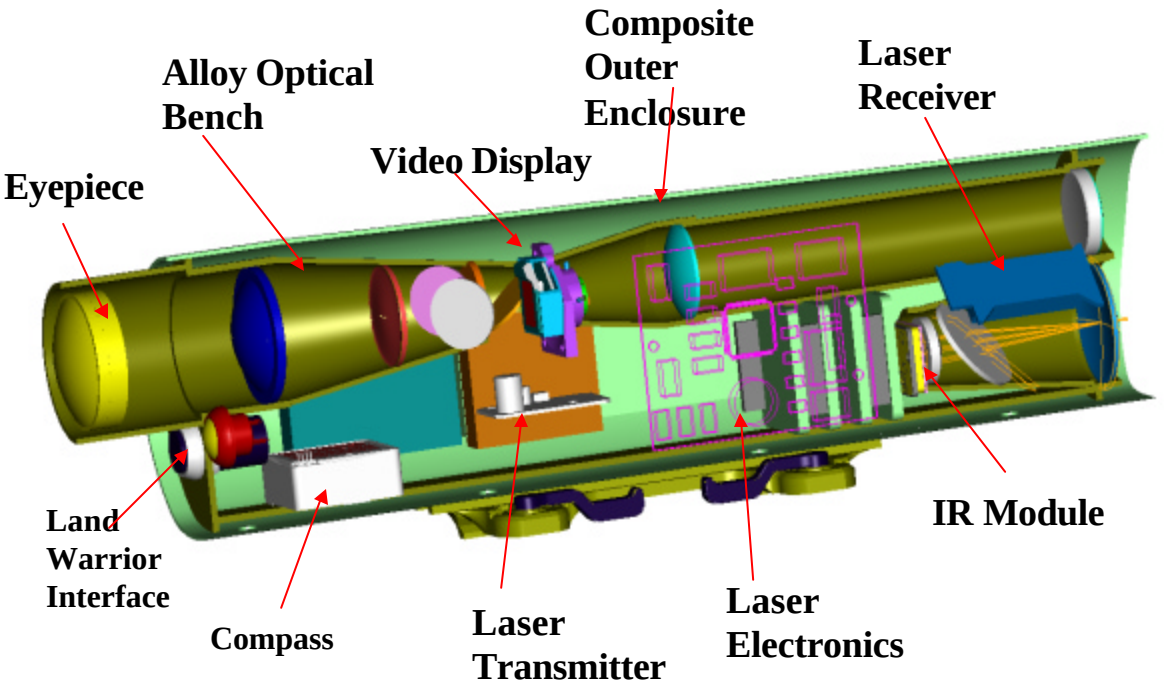
• Describe rangefinder, thermal imager, mechanical structure, display and overall electrical architecture.

• Present test results and examples of sub-system performance

Overview - OICW TA/FCS

- A full solution, day/night, multifunctional system providing:
  - A ballistically adjusted weapon aimpoint
  - Range/ballistics based High Explosive Air-Burst fuze setting
  - Target imagery, range and location data to Land Warrior

Integrates laser rangefinder, direct view optics, thermal imager, day video imager, multifunctional display, compass/inclination/cant sensor, ballistic processor, fuze setting electronics and environmental sensors within a single housing



TA/FCS Maturation

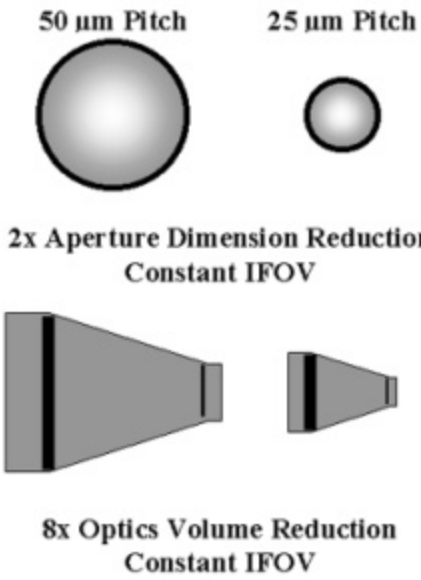
Primary system challenge is to achieve a significant weight reduction

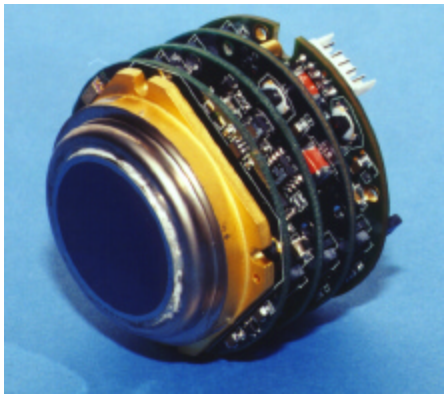
Past: (FY00)	Current: (FY02)	Future: (FY08)
> 7 lbs. 3X magnification 10^{o} Horiz. FOV .7 $P_{R/D}$ @700 m Thermal not integrated 12W Avg Power 40W Peak power Not Ruggedized Limited environments	= 2.72 lbs. 2X magnification 13^{o} Horiz. FOV .9 $P_{R/D}$ @500 m Fully integrated ~3W Avg Power ~9W Peak power Ruggedized Full Mil Environments Land Warrior Compatible	< 2.72 lbs. Enhanced features: Target tracking Multi-function laser Sensor fusion OFW compatible

TA/FCS contributed >60% weight reduction with increased operational capabilities

Thermal Imager

- Evaluated various Uncooled IR technologies - microbolometer(Vox) & Amorphous Silicon , Ferro-electric (BST) Thin & Thick Film, U-cantilever technology(capacitive)
- Selected thermal module candidates for further investigation:
  - 320x240~50µm
  - 640x480~25 µm
  - 320x240~25 µm
- Emerging Uncooled Thermal Technology - Mini-Thermal Module 320 x 240 ~25 µm pixels pitch - Size ~ 26 mm diameter by 26 mm length - <50mk NEDT

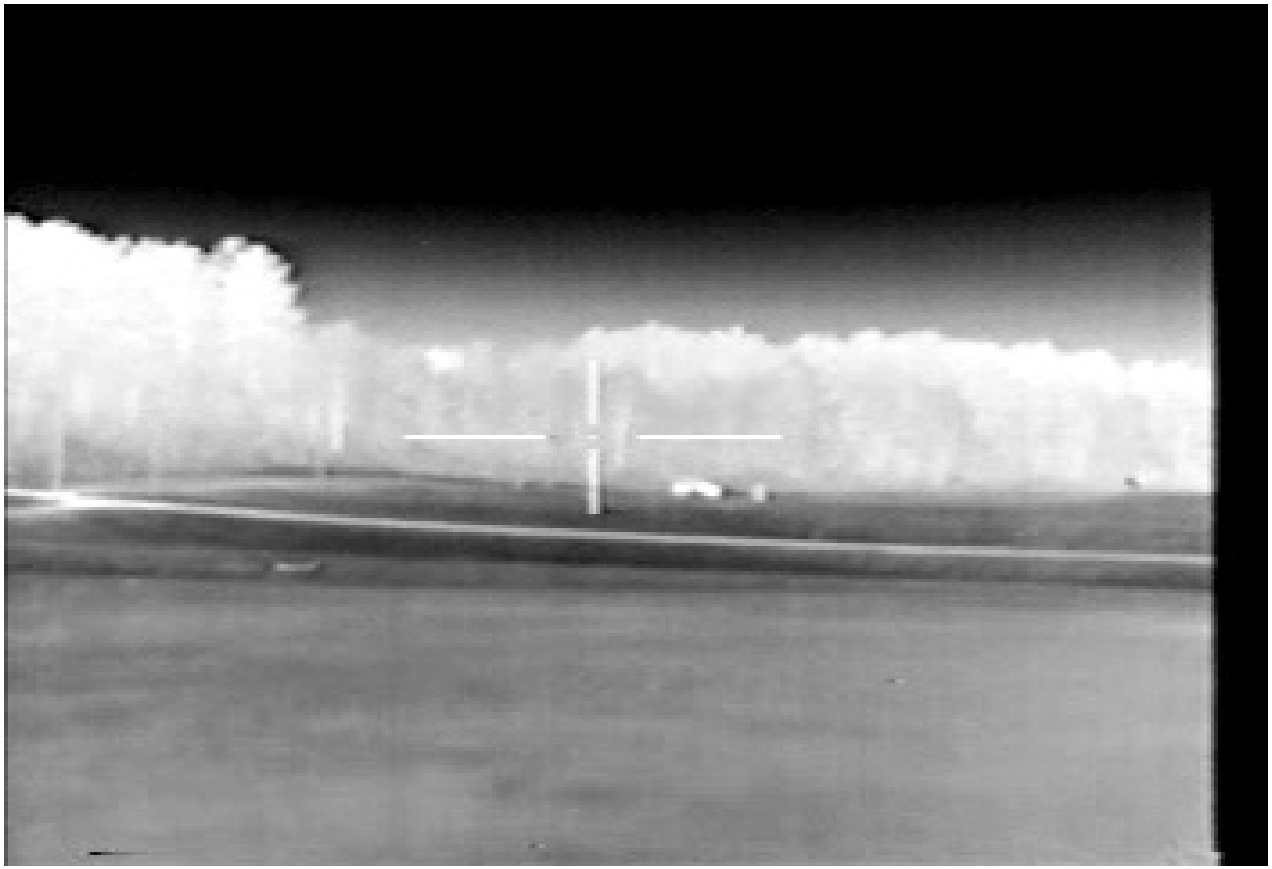




25 µm pixel provide significant savings in weight/size, power, and cost -

Thermal Imager Range Performance

Benign Conditions



Walking personnel & vehicle target at 500 meters
microbolometer sensor 320 x 240 - HFOV=15^0

Selected largest FOV possible to meet recognition range requirements, provide situational awareness, and reduce system size and weight

Laser Rangefinder Selection Process

•Challenge is to obtain <1 meter accuracy on moving personnel target from a shoulder supported fire control system

•Approach

Laser technologies studied to identify test bed candidates

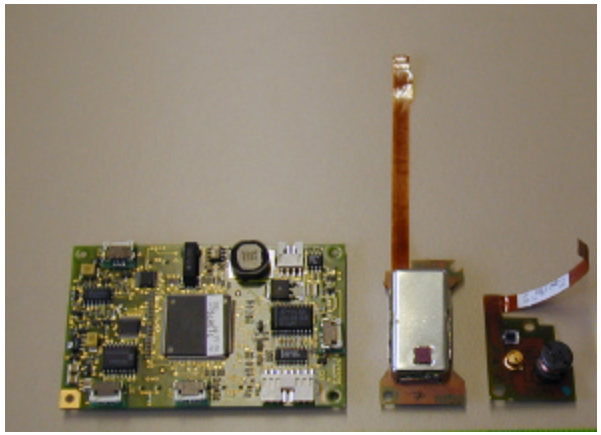
Designed/built/tested two laser rangefinder test beds

Developed & utilized Probability of Correct Lase model to optimize LRF parameters for OICW application

Both of our rangefinder test beds demonstrated the performance needed to achieve the required weapon system lethality

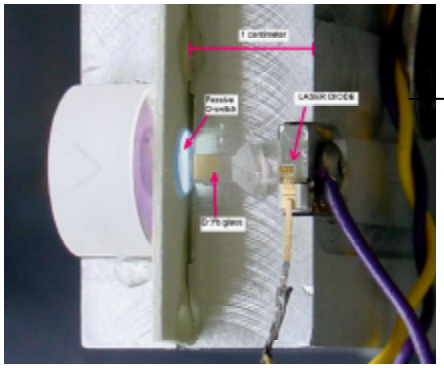
Laser Rangefinder Technology

Semiconductor LRF

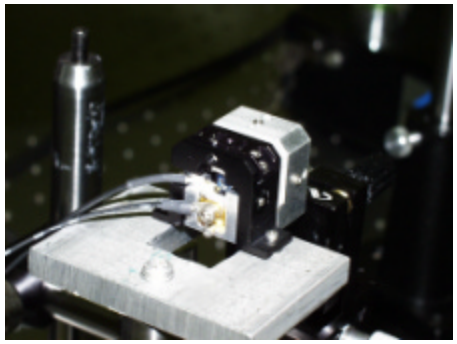


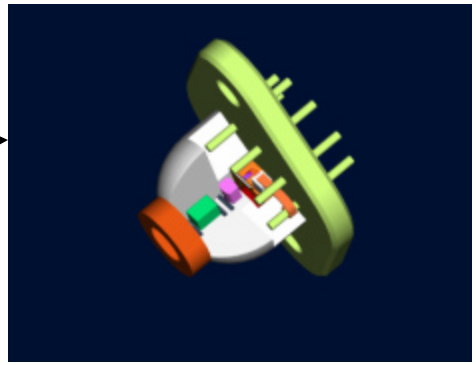
Investigated over 20 different laser rangefinder systems and downselected to these two technologies

Erbium microchip laser transmitter



Roadmap

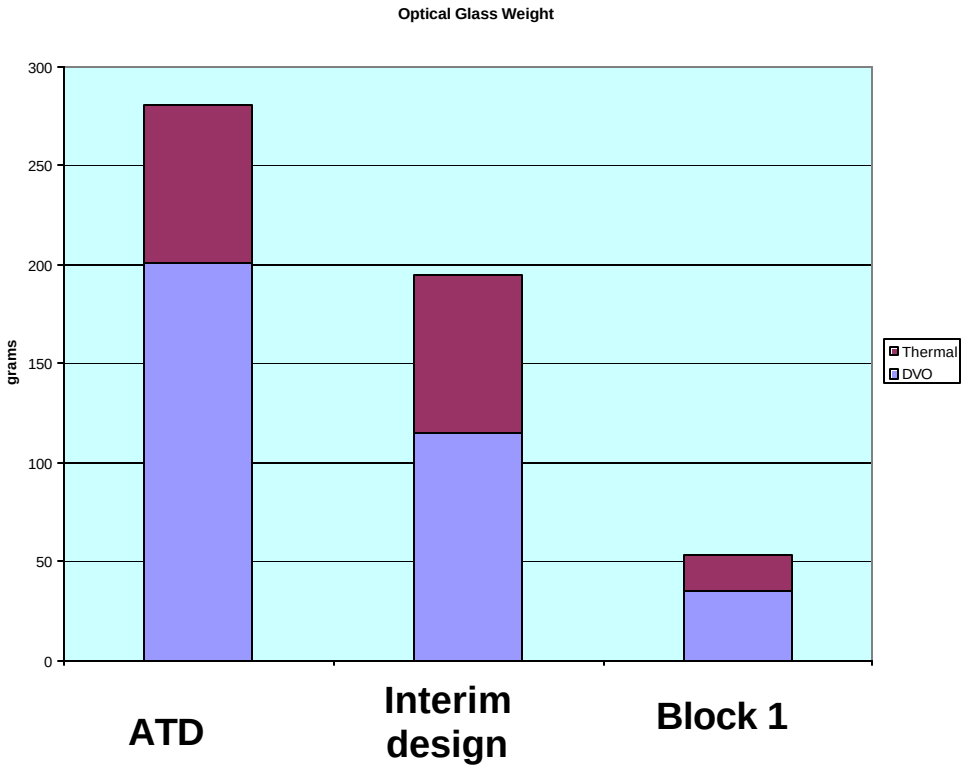




Tested Erbium Laser Tx

Both LRF technologies have been field tested with excellent probability of correct lase & range measurement accuracy results

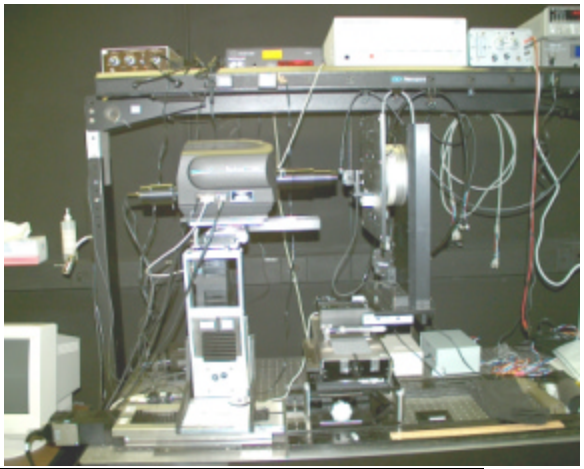
Optical Highlights



Trade studies of optical performance versus weight resulted in a hybrid optical design with both reduced weight and improved performance over ATD

Display Study

Lab Testing

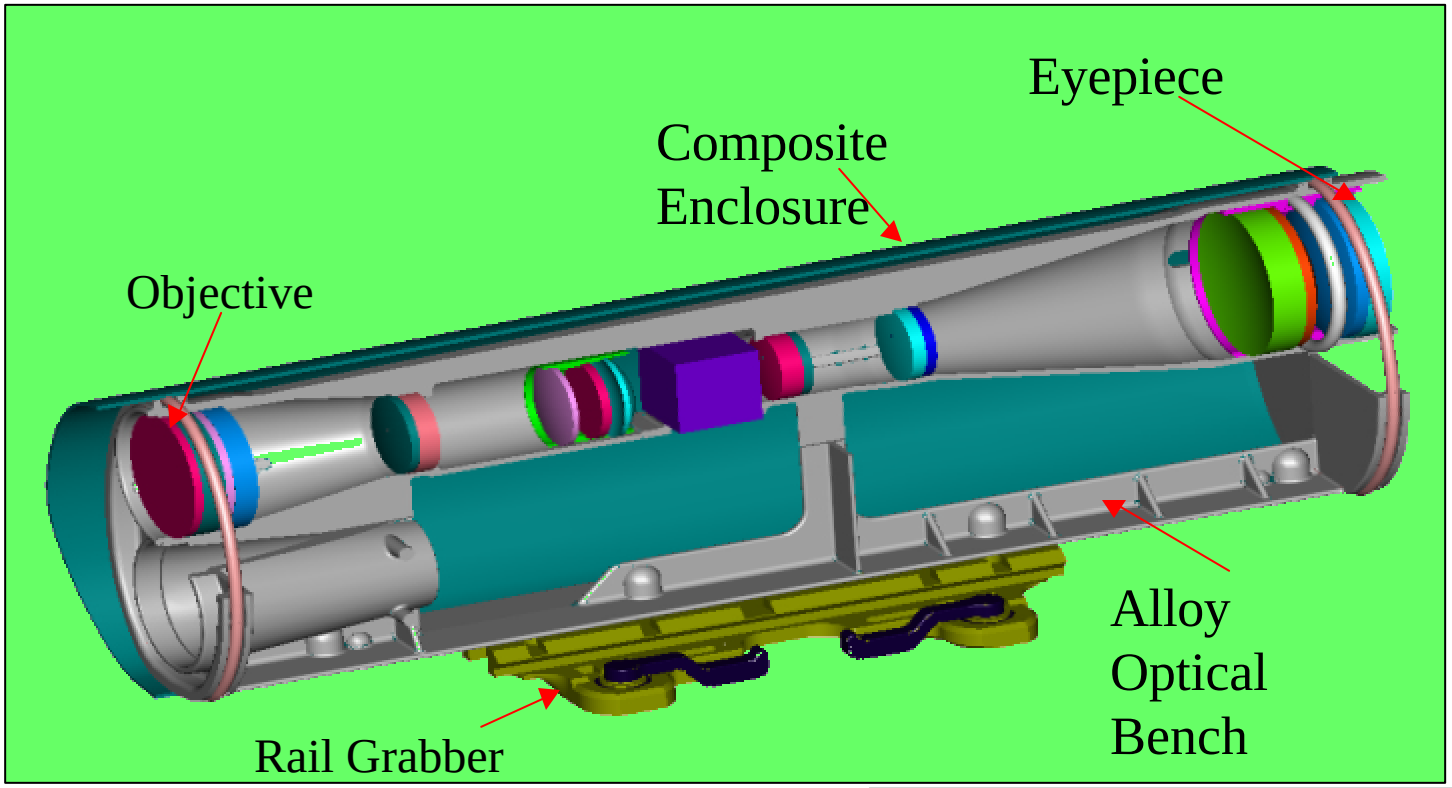


Display symbology overlay on DVO

- Extensive investigation of numerous color video display technologies
- Down selected prime candidates
  - OLED -Organic Light Emiting Diode
  - LCOS -Liquid Crystal On Silicon
  - AMLCD -Active Matrix LCD
- OLED & LCOS display characterization completed at NVESD on 1/4/02
  - OLED brightness of 29.6 ft-L
  - LCOS brightness of 71.9 ft-L
  - Limited environmental test performed

Multifunction display provides thermal/day video & symbology overlay for the direct view optics

Housing & Optical Bench



Extensive materials & process trade study

- Materials (Plastic, Epoxies,Metals)
- Coatings
- Manufacturing Process for production

Environmental Testing
- Weapon Shock
- Drop & impact
- Solar Loading/ Thermal Cycling
- Salt Fog Corrosion
- Adhesive Testing

Highly integrated architecture and two-piece housing provide rugged light-weight structure

Electrical Architecture and Power Supply Challenges

Challenges/Goals

•Define primary battery providing background system draw for ~ 10 hours, weighing only 0.3 lb (tactical) and (0.4 lb training)

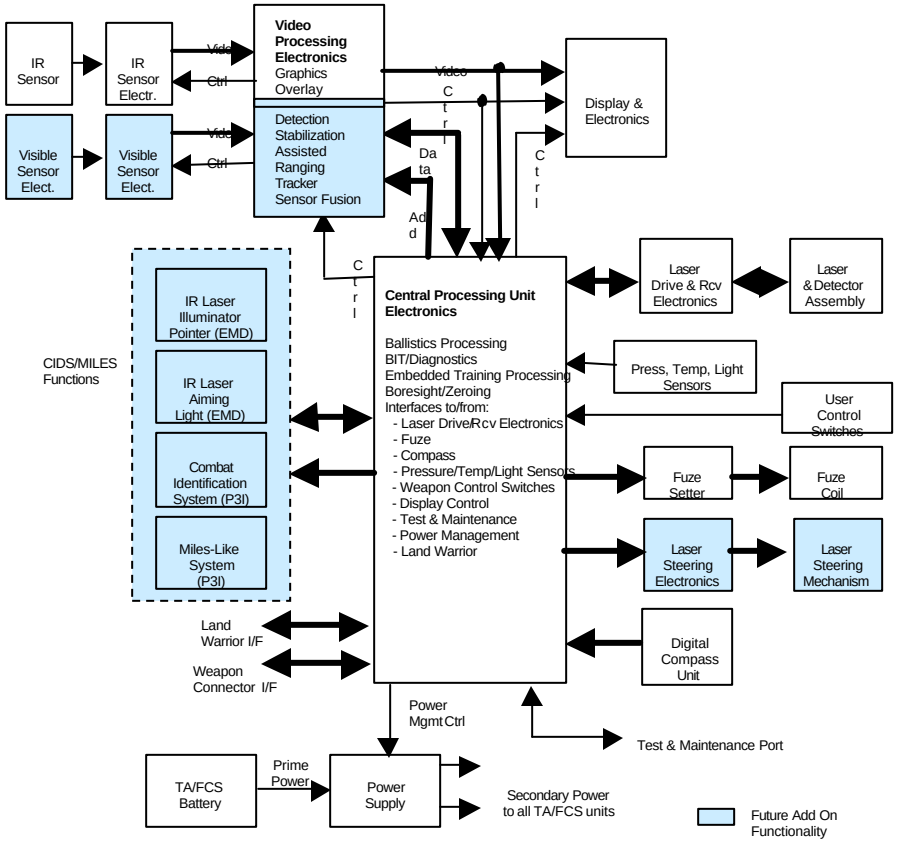
•Provide high current/low energy pulses for fuze setting

•Reduce system power significantly and apply power management techniques to allow small battery with reasonable run time

•Provide battery which will operate at low temperature

•Determining best system level solution for battery location and meet Army battery safety requirements

•Define rechargeable supply for training affordability



Electrical System Achievements

- Reduced FCS electronics power requirement by factor of > 4
- Reduced battery pulse peak current draw from > 12 A to < 5A
- Designed low risk primary battery utilizing LiMnO2 D-cells

  Tested from –50°F to +125°F

  Verified ability of cells to output sufficient current at low temperature

  Established system run time requirement can be met at room temperature and run time degrades gracefully at extreme cold
- Identified approach for rechargeable training battery using Li-ion
- Able to operate from Land Warrior and vehicular power
- Able to shut down redundant functions when used with Land Warrior
- Involving CECOM early to ensure we meet Safety requirements

System battery incorporates Army-approved components for low risk

Summary

•Conducted over 30 trade studies to establish best combination of OICW cost, performance and weight

•Regular involvement of User in establishing trade space and sharing of results as part of Integrated Product Team

•Continual involvement of key government labs (particularly NVESD) and offices in technical activities and decision process

•Major Critical Technology testbed activity - Design/Built/Tested

LRF	(3)	Optical (Hybrid & IR)	(3)
Thermal	(2)	Housing/cover/optical bench	(4)
Displays	(3)	Video Trackers	(2)

•Obtained substantial data base to allow OICW User an informed choice of capability versus weight

Testbed data shows we can meet system requirements within the very challenging FCS weight goal