Sensor Fusion Technology Assessment

Presented
by

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Sensor Fusion Technology Assessment

- Program Sponsor:

  MAJ Tom Young, Office of Naval Research, Expeditionary Warfare Operations Technology Division, Firepower Science & Technology Programs

- Key Principal Scientist:

  Mr. George Ax, Northrop Grumman Mission Systems

- Project Participants:

  Mr. Jack Lillie, US Army Night Vision Electronic Sensors Directorate

  Mr. Joe Costantino, US Army Armament Research, Development and Engineering Center

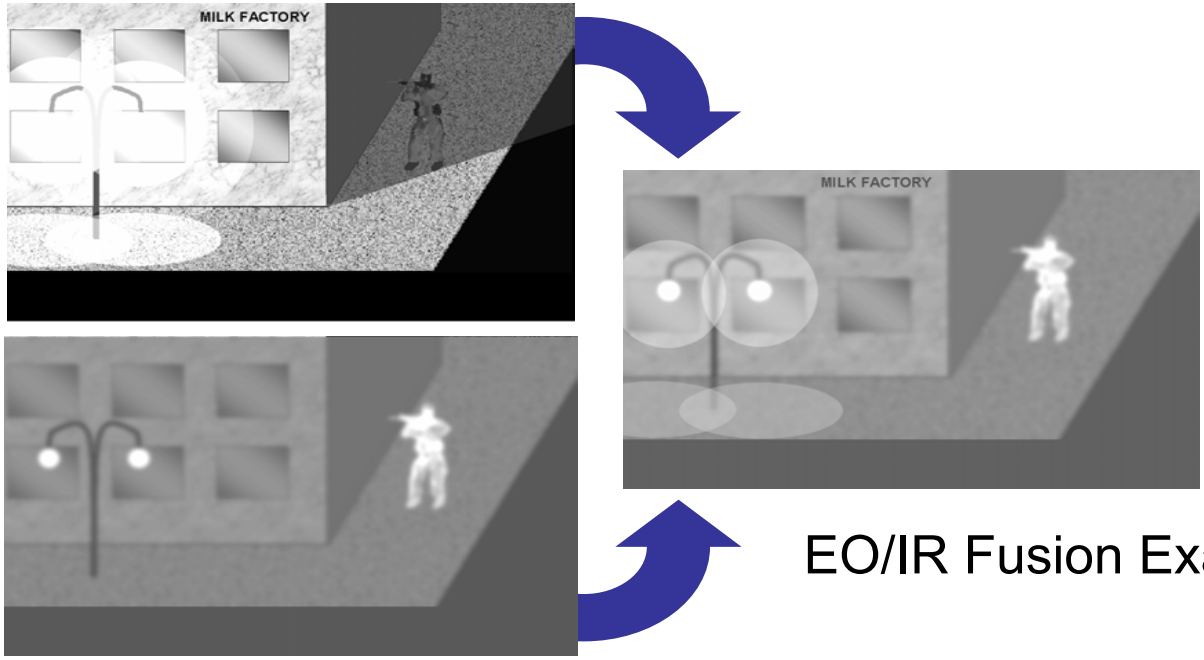
Sensor Fusion Technology Assessment

Objective:

- Assess the state-of-the-art in small arms fire control systems with,
- Maturation projection
- Outline a future road map.

Image Intensification

Thermal Imaging



EO/IR Fusion Example

Project Approach to Sensor Fusion Assessment

The three parts consist of

•Part One – Survey Assessment of Current Systems and Activities,

Completed; Over 125 reports identified. Addition areas of Display and Power Supplies supplement survey.

•Part Two - Technology and Performance Assessment

(includes discussion on Measures of Performance and Environment and Physical limits of Performance and Opportunities)

Complete

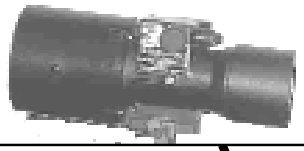
•Part Three – Projection on Full Integration for a full complement of Sensor Fusion Target Acquisition/ Fire Control Systems. (Near, Mid & Far Term)

Wrapping up Final Report

Optical Systems Technology Incorporated

Shared Aperature Fusion Weapon Sight

UNIVERSAL NIGHT SIGHT ™ (UNS)
I^2 CLIP-ON 1X NIGHT SIGHT

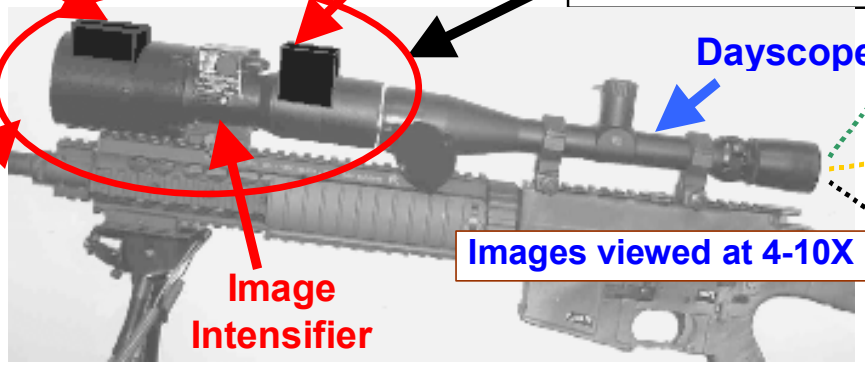


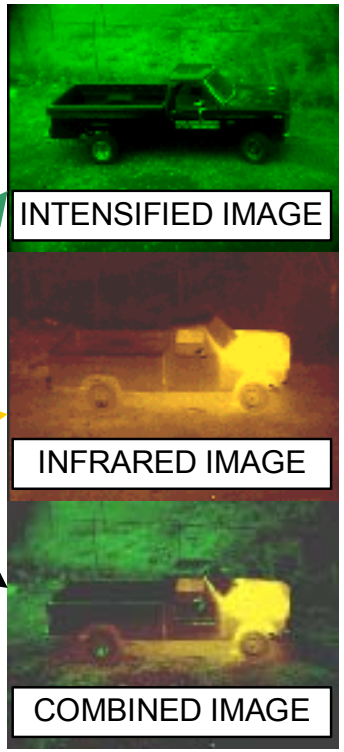
2.0 lbs

(IN PRODUCTION)

DUALBAND IR / I^2 6X TELESCOPE

(IN PROTOTYPE)





CLIP-ON DUALBAND UNIVERSAL NIGHT SIGHT (DUNS)
(UNCOOLED IR + IMAGE INTENSIFIER)

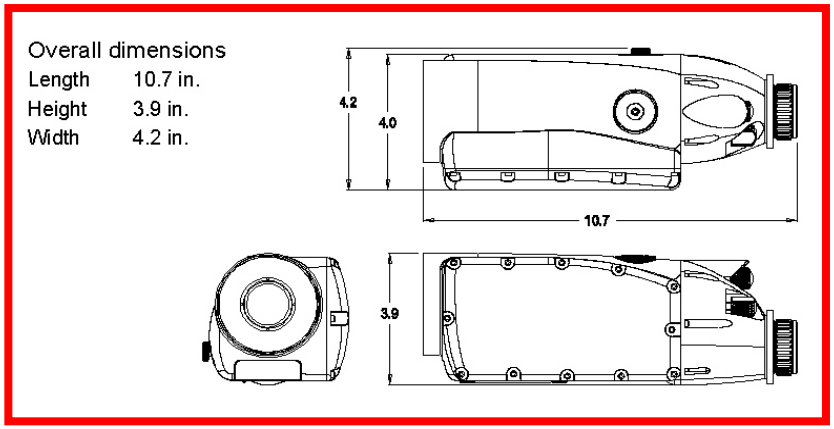
Sample Mature Available Technological Capability – Near Term

Northrop Grumman EOS and NVESD

Fused Multi-Spectral Weapon Sight (FMWS)

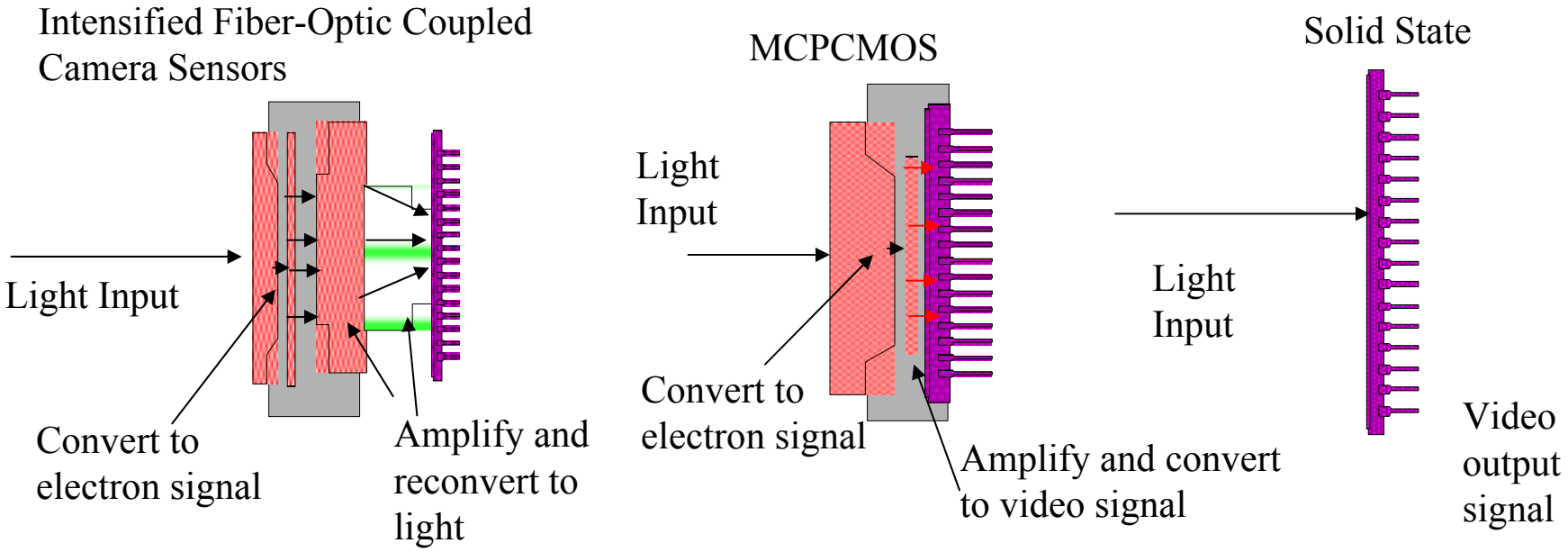
Program Goals

- Dual Band Digital Image Fusion (I^2/IR)
  - HD I2CMOS and U7000 LWIR
  - 2X Digital Zoom
  - Fire Wire Digital Output
- Weight required: < 4 Lbs
- Dimensions: 10.7”x 3.9”x 4.2”
- 12 prototypes fabricated
- Nested optical objectives
- Digital display



Sample Maturing Technological Capability – Mid Term

Candidate Technologies for LLL Imaging (ITT)



- Sensor function is to create an video image based on signal inputs down to overcast starlight environment
  (4e-7 fL sensor illumination)
- Head mounted applications need light weight, compact, high MTF performance, low power, and low cost sensors
- Digital output desired for input into fusion systems

Sample Maturing Technological Capability – Med Far Term

Focal Plane Growth

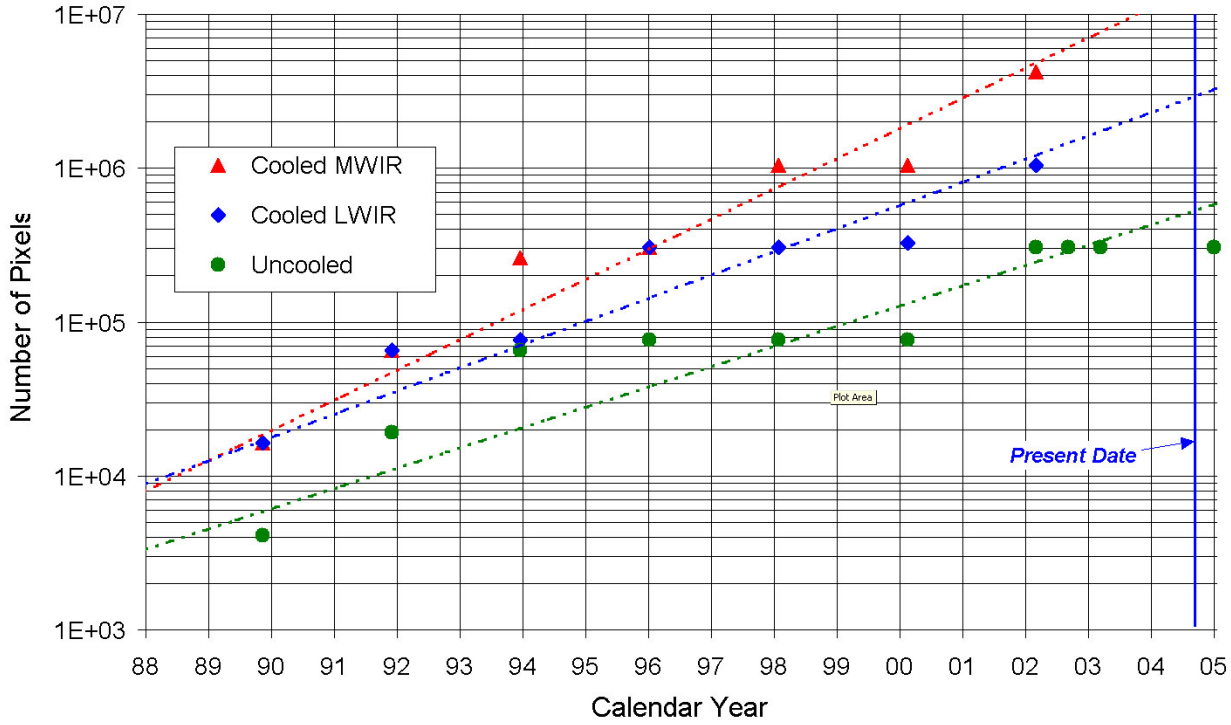


Figure 2-2. Growth in number of pixels (uncooled IR FPAs) over time.

Note: Increase in pixels have a associated cost and power increase

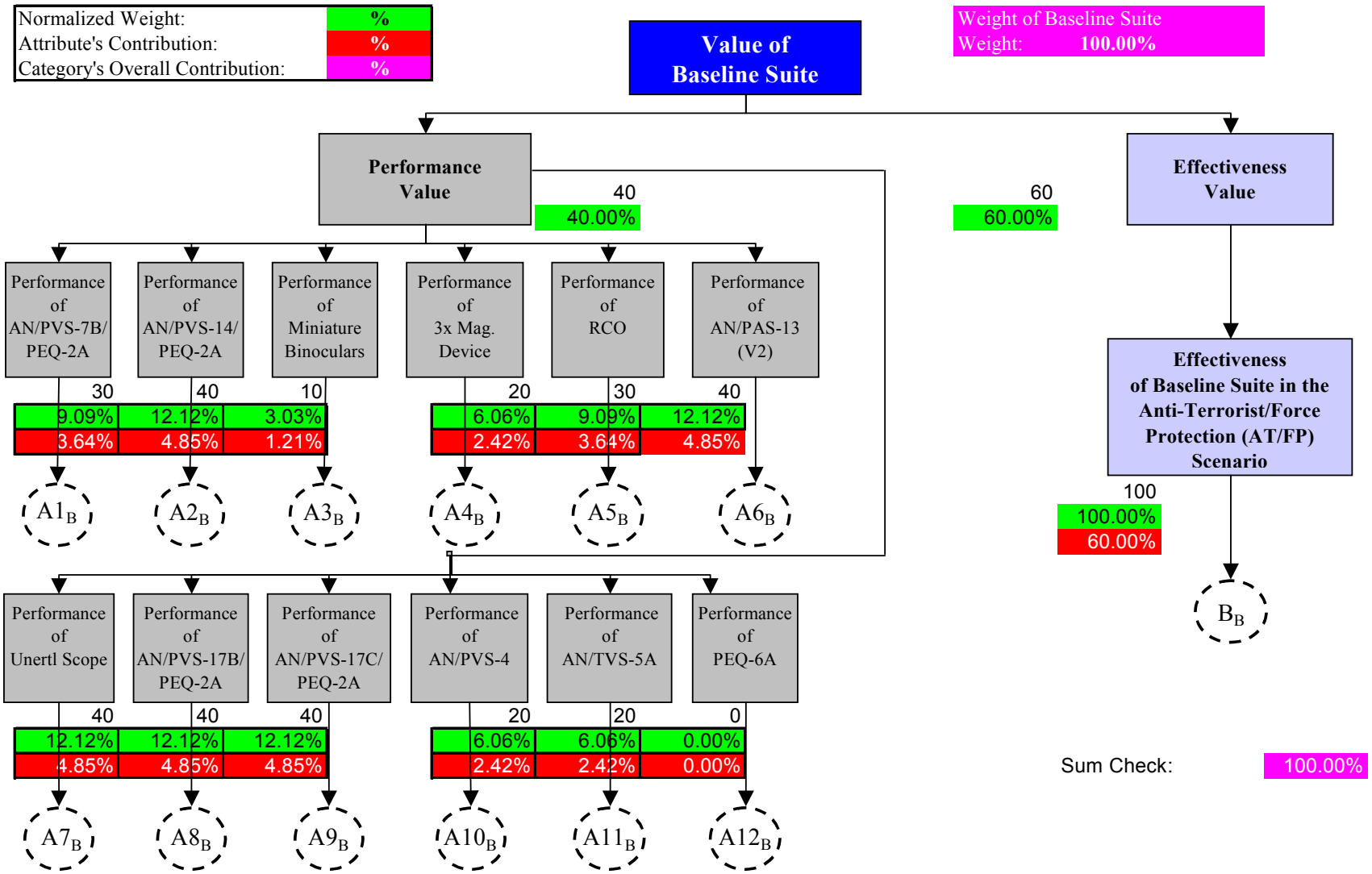
Value Model (selected Figure of Merit)

Task II

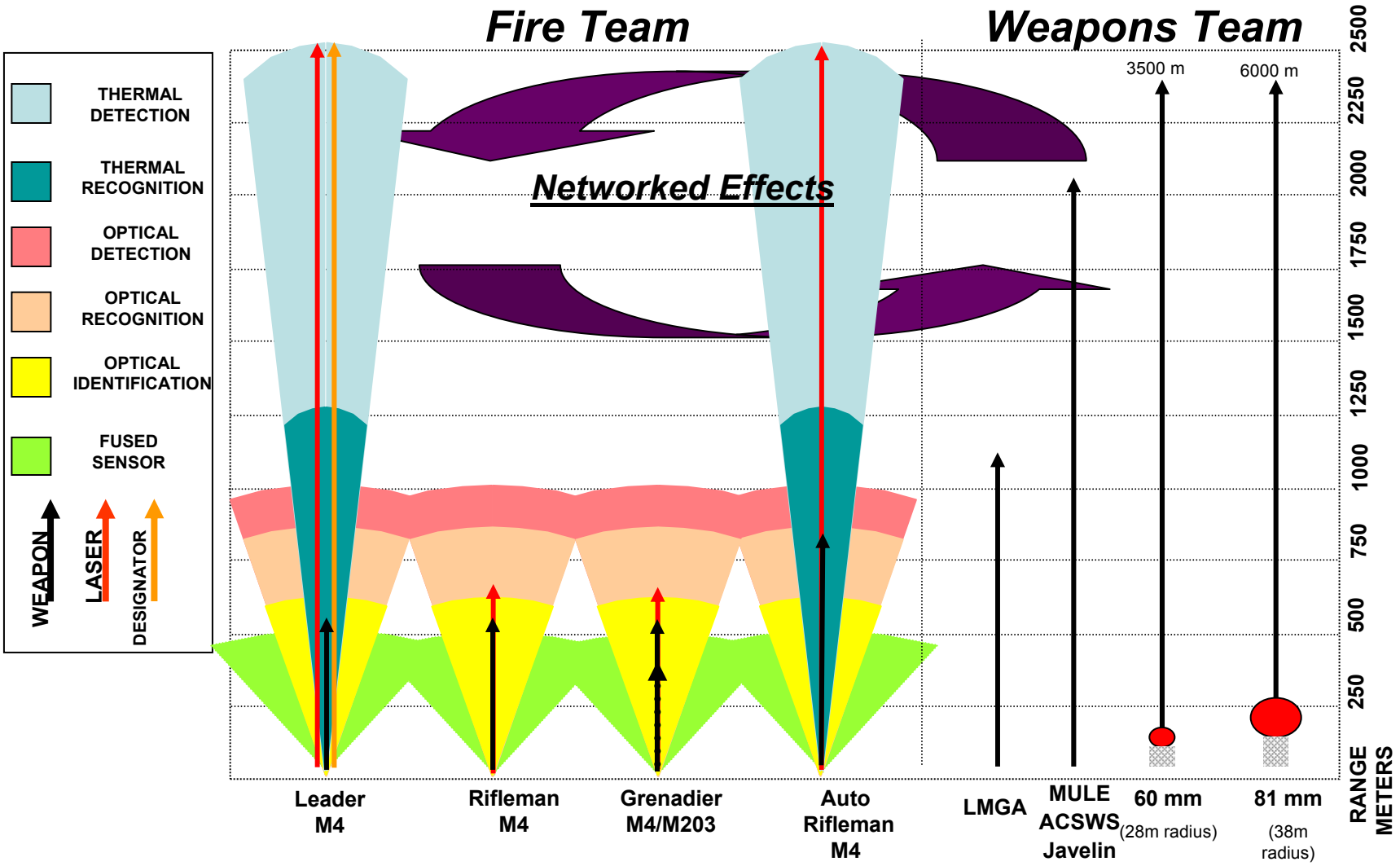
What is a Value Model?

- Based on Multi-Objective Decision Analysis
- A Means To Choose/Decide Among Competing Alternatives by
  - Defining Objectives and Measures Relevant to a Decision
    - Quantitative
    - Qualitative/Subjective
  - Organizing Those Objectives and Measures
    - Hierarchical Value Tree
  - Rating Their Importance
    - Weights Assigned by Operational Subject Matter Experts (SME)
  - Scoring Performance of Competing Alternatives on Each of the Chosen Measures
  - Comparing Overall Desirability on a Consistent, Numerical Scale

Example Value Model
Baseline Suite

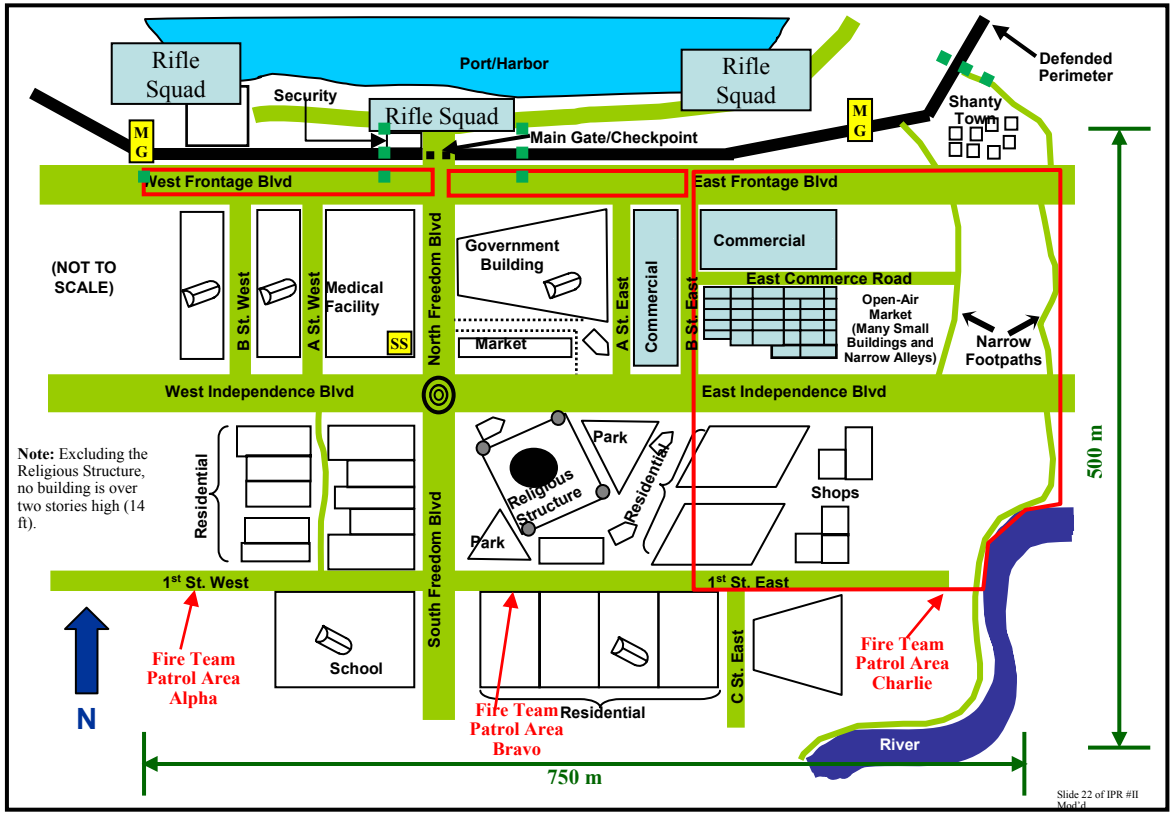


Small Combat Unit Lethality



Use of Pythagoras in an AT/FP Scenario

- USMC Mission: Provide Humanitarian Aid to Local Populace
  - Distribution Point at Pier
  - Persons Processed at Main Gate
- Marine Corps Forces
  - Reinforced Rifle Platoon
    - 2 HMMWVs with M2 HMGs
    - Scout/Sniper Team
    - Roving Rifle Squad
- Indigenous Persons
  - Innocent Civilians (72)
    - Non-Hostile (Seeking Food)
    - Proceeding Toward Port Area
    - If Challenged, Will Stop, Show ID Papers And Proceed Toward Main Gate
  - Terrorists (24)
    - Seek To Cross Defended Perimeter And Disrupt Aid Effort
    - Avoid Main Gate
    - If Challenged, Fled But Not Fight (with Marines in Pursuit)
  - Movement Began at Random Times from Random Locations



- *Model fusion as sequential process (detect > pursue > acquire)*
  - *Use $P_{detection}$ for IR devices*
  - *Use $P_{recognition}$ for LLL devices*

Projection on Full Integration of Target Acquisition Fire Control Small Arms

Task III

- **Utilize the Value Method to define sensitivity of effectiveness that includes multi aspects of consideration (maturity, technology, use, size, weight, power, weapon – sensor linkages, etc.)**
- *Task III technology forecast characterization*

  Not relevant eliminate from consideration

  Monitor: relevant, yet not mature and not ready for investment

  Define Further; opportunities for investment

Conclusions

- **Conclusions**
  - **Assessment nearing completion**
  - **Physical Models are the first step to characterize performance**
  - **Figure of Merit through Value Model aligns with JCIDs**
  - **Couples well with JCIDs for individual weapon**
  - **Logical next step to USMC Optical System Capability Assessment**