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Name of Principal Author and all other author(s): Dr. Gregg M. Burgess and Dr. Jack A. Jackson

Principal Author’s Organization and address: Phone: _____703-588-6906_______
Fax: ______703-588-0232_______
Email: jack.jackson.ctr@pentagon.af.mil

Original title on 712 A/B: Future Combat Model

Revised title:

Presented in (input and Bold one): (WG__5, CG___, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be: UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE
Future Combat Model
## Future Combat Mode

**See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005.**, The original document contains color images.
Outline

- Motivation
- Discriminating Capability
- Unique Approach That Fills a Gap
Motivation

- Changing geopolitical and operational environment
- Increasing importance of C4ISR to military effectiveness
- Capabilities based analysis and use of non-traditional scenarios
- Continued problems modeling C4ISR
Changing Environment

• **Operations:** Getting beyond Force-on-Force Operations to...
  – Asymmetric Warfare by State and Non-State Actors
  – Network-Centric Operations
  – Effects-Based Operations
  – Information Operations

• **Information:** Essential reliance on C4ISR
  – Information Superiority
  – Real-Time Precision Strike
  – Dominant Battlefield Awareness
  – Sensor-to-Target
  – Perception-based decisions and implications of inaccuracies
  – Winning the fight by preventing the fight

• **Resource Planning:** Breaking the Ops-Intel barrier to synchronize resourcing
  – Demand for multi-scenario planning and sequencing
  – Capability-Based Planning
Capabilities Based Planning Paradigm

Irregular
- Non-state and state actors employing “unconventional” methods to counter stronger state opponents—terrorism, insurgency, etc. *(erode our power)*
  - (e.g., terrorism, insurgency, civil war, and emerging concepts like “unrestricted warfare”)
  - **Likelihood**: very high; strategy of the weak
  - **Vulnerability**: moderate, if not effectively checked.

Traditional
- States employing military forces in well-known forms of military competition and conflict. *(challenge our power)*
  - (e.g., conventional air, sea, and land forces, and nuclear forces of established nuclear powers)
  - **Likelihood**: currently decreasing due to historic capability-overmatch and expanding qualitative lead
  - **Vulnerability**: low, but only if transformation is balanced

Catastrophic
- Terrorist or rogue state employment of WMD or methods producing WMD-like effects against American interests. *(paralyze our power)*
  - (e.g., attack on homeland, global markets, or key ally that would generate a state of shock and preclude normal behavior)
  - **Likelihood**: moderate and increasing
  - **Vulnerability**: unacceptable, single event can alter our way of life

Disruptive
- Competitors employing technology or methods that might counter or cancel our current military advantages. *(capsize our power)*
  - (e.g., technological – bio, cyber, or space war, ultra miniaturization, directed-energy, other – diplomatic blackmail, cultural or economic war)
  - **Likelihood**: low, but time works against U.S.
  - **Vulnerability**: strategic surprise puts American security at risk

**Capabilities-based planning should apportion risk across challenges**

Source: OSD/Policy
### The Imperative For Improvement

<table>
<thead>
<tr>
<th>Current</th>
<th>Needed</th>
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<tbody>
<tr>
<td>Force on Force</td>
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<tr>
<td>Attrition Based</td>
<td>Effects Based</td>
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<tr>
<td>Individual Systems</td>
<td>Families of Systems</td>
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<tr>
<td>Shooter to Target</td>
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<td>Target-Weapon centric</td>
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<tr>
<td>Single scenario, focused Ops</td>
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<td>Limited treatment of C4ISR</td>
<td>Driven by information dominance</td>
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<tr>
<td>Model based</td>
<td>Analysis based</td>
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<tr>
<td>Ignore pre crisis phases</td>
<td>Driven by pre-crisis developments</td>
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<tr>
<td>Complex, attrition based</td>
<td>Flexible, effects based</td>
</tr>
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</table>

Analysts & Models are losing touch with the needs of the warfighter
FCM Version 1.0

- Explicitly models the “Road to War”
- Effects Based Planning & Operations using target/effects networks
- Hierarchical & Reactive Command & Control
  - Perception (2-way) based planning
  - Flexible Geographic Representation
  - Innovative aggregation and abstraction supplement high value entity modeling to facilitate fast run-time and improved operational realism
- Fast run-time facilitates:
  - Quick turnaround analyses using parametric sensitivity approach
  - Fast model customization, testing, and VV&A cycles
  - Compressed analyst/decision maker feedback loop
- Stochastic, Deterministic, and Mixed modes
  - Deterministic mode allows for rapid run time & large exploratory experiments
  - Stochastic modes allow for estimation of variation and risks associated with C4ISR/operational decision making and other high leverage processes
  - Focuses use of stochastic modeling on high leverage areas (perception, planning, allocation)
Illustrative Scenario

**Red Objectives:**
- Control Straits of Taiwan
  - Utilize mining of key facilities
  - Position surface ships to protect forces crossing straits
- Protect forces with long range SAMs
- Utilize SOF assets to capture critical nodes and arcs
- Begin invasion with surface-to-surface missile strikes
  - Destroy enemy command and control system;
  - Cripple enemy information systems;
  - Destroy enemy’s most advanced weapons systems;
  - Cripple enemy logistics systems

**Blue Objectives:**
- Defend Taiwan from invasion by mainland Chinese forces
- If deterrence fails, defeat attacking forces and secure long-term security of island

**Limitations**
- Force structure
- Basing

**Response**
- US deploys forces and conducts offensive operations in support of Taiwanese military

**Key to success**
- Adequate indications and warning which allows timely deployment of forces
Red Campaign Plan

• **Phase 1:**
  - Prepare 35 Divisions (5 Heavy, 15 Medium, 15 Light) for movement to SPODS for transhipment by sea-going transports

• **Phase 2:**
  - Move Heavy Divisions by rail to SPODS
  - Prepare and position IADS, and TBM Brigades in operational locations.
  - Prepare and position attack and DCA air forces in operational locations

• **Phase 3:**
  - Load Heavy Divisions onto transports
  - Move Medium and Light Divisions by rail to SPODS

• **Phase 4:**
  - Load Medium and Light Divisions onto transports
  - Sortie transports, surface ships and submarines

• **Phase 5:**
  - Launch TBMs against strategic targets
  - Begin assault with SOF, Marines and Army Divisions
Variable Geographic Representation
C2 & “Stages”

- Each side attempts to meet operational objectives by completing a side specific set of operational “stage orders”
  - Stages are a set of operational orders to create operational effects and achieve desired force distributions

- **Stages are defined for pre-combat and combat phases**
  - Pre-combat stages are designed to achieve desired force positioning objectives
  - Combat stages are designed to achieve campaign objectives
  - Stages can be proactive or reactive

- **Stage progression is based on perceptions of stage progress for self and opponent**
  - Stages can be skipped
  - Stage transitions can be triggered by perception of opponent’s change in stage

- **A stage is completed when:**
  - A pre-defined fraction of asset distribution goals are met
  - Operational effects goals are met

- **Stage transition matrix**
  - Defines next stage to achieve based on own side’s current stage achieved and perceived opponent’s stage
### Stage Definitions

#### Red Stages

<table>
<thead>
<tr>
<th>Day</th>
<th>Red Stages</th>
<th>Tgt Set</th>
<th>Airbase</th>
<th>SPOD</th>
<th>IADS</th>
<th>TBM Bde</th>
<th>Hyw Div</th>
<th>Med Div</th>
<th>Marine Div</th>
<th>Army Lt Div</th>
<th>Marine Lt Div</th>
<th>SubRon</th>
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<td>Load &amp; Go</td>
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#### Blue Stages

<table>
<thead>
<tr>
<th>Stage Name</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Peace</td>
<td></td>
</tr>
<tr>
<td>11 Exercise Reaction</td>
<td>Increase ISR, move &quot;local&quot; CVSG to Taiwan (~3 days), alert &amp; deploy Taiwanese forces</td>
</tr>
<tr>
<td>12 Ambiguous Warning</td>
<td>14+Move 2nd CVSG from Hawaii to Taiwan (~10 days), move 3rd CVSG from IO to Taiwan (~10 days)</td>
</tr>
<tr>
<td>13 Less Ambiguous Warning</td>
<td>15+Fly air defense caps from Japan/Korea to Taiwan, deploy B-1s and B-52s to Guam, alert rapid reaction forces (e.g. MEF &amp; 82nd AB)</td>
</tr>
<tr>
<td>14 Unambiguous Warning</td>
<td>16+Deploy fighters, AWACS, etc to Japan/Korea; deploy Patriots &amp; AA fighters to Taiwan; deploy rapid reaction forces to Taiwan; call up reserves, start mobilization of forces to theater (e.g. Japan/Korea/Taiwan)</td>
</tr>
<tr>
<td>15 Defend</td>
<td>17+Defend Taiwan with available forces (AA fighters, Patriots), attack Chinese ships at sea, attack Chinese IADS, C2, SPODs, APODs</td>
</tr>
</tbody>
</table>
## Red Stage Transition Matrix

**Matrix Analytics**

### Red Stage Transition Matrix

<table>
<thead>
<tr>
<th>Blue Stage</th>
<th>10 Peace</th>
<th>11 Exercise Reaction</th>
<th>12 Ambiguous Warning</th>
<th>13 Less Ambiguous Warning</th>
<th>14 Unambiguous Warning</th>
<th>15 Active Defense</th>
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<tbody>
<tr>
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<tr>
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<td>2</td>
<td>2</td>
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<tr>
<td>2 - Initial MOB</td>
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<tr>
<td>3 - Disperse AC</td>
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<td>4 - Prep Rockets</td>
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<tr>
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Note: Entries in stage transition matrix indicate “Red stage ordered” based on Red’s perception of Red and Blue current stages.
# Blue Reaction Orders

<table>
<thead>
<tr>
<th>Blue Stage</th>
<th>10 Peace</th>
<th>11 Exercise Reaction</th>
<th>12 Ambiguous Warning</th>
<th>13 Less Ambiguous Warning</th>
<th>14 Unambiguous Warning</th>
<th>15 Active Defense</th>
</tr>
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<tbody>
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</tr>
</tbody>
</table>

Note: Entries in stage transition matrix indicate “Blue stage ordered” based on Blue’s perception of Red and Blue current stages.
Red Objective Timeline

Situation Day 50: Red lands X Divisions on Taiwan
Blue remains in a peacetime posture, i.e. carrier strike groups, bombers & fighters are not deployed

Red’s objective is to advance to stage 9 as soon as possible.
**Blue Desired Reaction Timeline**

<table>
<thead>
<tr>
<th>Blue Stage</th>
<th>10 Peace</th>
<th>11 Exercise Reaction</th>
<th>12 Ambiguous Warning</th>
<th>13 Less Ambiguous Warning</th>
<th>14 Unambiguous Warning</th>
<th>15 Active Defense</th>
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</thead>
<tbody>
<tr>
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<td>Day 20</td>
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<td>Day 0</td>
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</table>

**Situation Day 37:** Blue has completed deployment of carriers, bombers, fighters, etc to the theater. Red backs down and cancels planned invasion

Blue’s objective is to achieve unambiguous warning in sufficient time to deter aggression.
Stage Perception

- Perceptions of opponent stage conditions is driven by ISR-based observables and a Bayesian Stage Perception Model
- Observations of opponent force distributions (by cell), opponent force movement activity (within cell), and opponent effects based operations are used to determine likelihood of current stages and subsequent stages.
Illustrative Study Result

Blue’s “Ideal Defense”

Blue’s Response with 21-ball SR

Blue’s Response with No SR

Red’s Campaign Execution

Blue’s Perception of Red’s Stage with 21-ball SR
Summary

- FCM is being developed to analyze C4ISR contributions across a wide range of combat scenarios
- FCM is designed to incorporate:
  - Effects Based Operations, Joint Functional Concepts and Joint Integrating Concepts
- FCM is designed to support analyses that are responsive to decision demands and timelines
- FCM IOC Sept ‘05
Sensor Access Approach

- Access times will vary from hour to hour and from day to day based on pre-computed constellation simulation results (STK)
- Access times may vary from cell to cell depending on size of the region
- Multiple accesses to a cell will increase total access time in a cell; i.e. access time for an hour can exceed 60 minutes
- Simple rules of thumb are used to calculate imaging time from total access
  - For Space RADAR, SAR access will be derived from SMTI access, e.g. SAR access time = 0.7 * SMTI access time
  - For space-based IMINT systems, medium and high quality time will be calculated based on low quality time, e.g. High Quality access time = 0.7 * Low Quality access time

<table>
<thead>
<tr>
<th>Hour</th>
<th>SBR GMTI</th>
<th>SBR SAR High</th>
<th>SBR SAR Med</th>
<th>SBR SAR Low</th>
<th>Nat EO/IR High</th>
<th>Nat EO/IR Med</th>
<th>Nat EO/IR Low</th>
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ISR Resource Availability

- Utilization fraction reduces access time over theater of interest
- Utilization fraction represents
  - Arrival of assets for use in theater
  - Tasking on ISR assets related to out of theater priorities
- In-theater national tasking can be handled with explicit “background” requirements

<table>
<thead>
<tr>
<th>ISR Asset</th>
<th>Peacetime</th>
<th>Exercise</th>
<th>Ambiguous Warning</th>
<th>Less Ambiguous Warning</th>
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<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Advanced Commercial Imagery</td>
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<td>0.6</td>
<td>0.7</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>JSTARS</td>
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<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Global Hawk</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

ISR Availability Table
## Red “Target Sets”

<table>
<thead>
<tr>
<th>Targets</th>
<th>#</th>
<th>5</th>
<th>6</th>
<th>3</th>
<th>3</th>
<th>5</th>
<th>15</th>
<th>15</th>
<th>0</th>
<th>6</th>
<th>6</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

| "C2 node" | 40 | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0| 0| 0 |
| "C2 Mobile" | 0 | 0 | 0 | 4 | 20 | 20 | 20 | 0 | 0 | 0 | 0 | 0 |
| "Hardened Shelter" | 600 | 100 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Attack Helo" | 0 | 0 | 0 | 0 | 12 | 12 | 12 | 20 | 0 | 0 | 0 | 0 |
| "Mobility Helo" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "tactical SAM" | 100 | 100 | 10 | 20 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| "strategic SAM" | 50 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "TBM TEL" | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Tanks" | 0 | 0 | 0 | 0 | 1500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Gnd Combat Elements" | 0 | 0 | 0 | 0 | 200 | 400 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Artillery" | 0 | 0 | 0 | 0 | 550 | 550 | 550 | 0 | 0 | 0 | 0 | 0 |
| "logistics vehicles" | 1000 | 500 | 10 | 100 | 200 | 500 | 1000 | 0 | 0 | 0 | 0 | 0 |
| "Building" | 250 | 1000 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "WMD site" | 20 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Empty Amphib ship" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| "Full Amphib ship" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Surface combatant" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 |
| "Logistics Ship" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Empty Transport Ship" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| "Full Transport Ship" | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 250 |
Effects Based Operations

- Campaign planning will be based on generating “effects” which are based on the interactions among targets.
  - Attrition based planning is driven by a desired number of targets killed
  - Effects based planning is driven by a goal of reducing operational capabilities of operational systems by destroying elements of that system

- “Functional Asset Sets” and capability metrics
  - Airbase Maximum Sortie Rate
  - Carrier Strike Group Maximum Sortie Rate
  - Integrated Air Defense Set Maximum Engagement Rate
  - SSM Brigade Maximum Launch Rate
  - C2 Set C2 latency
  - S&R Set S&R capacity/timeliness
  - Gnd Unit of Action Combat Effectiveness
  - Logistics Set capacity Units supported per day, APOD/SPOD
Effects-Based Operations

KABUL MILITARY AIRFIELD, AFGHANISTAN

Mx Facilities

Aircraft Shelters

C2 Facilities

POL Storage

Ordnance Storage

Sortie Rate Multiplier (% of max)

Sortie Rate Multiplier result with 20 out of 40 C2 nodes remaining
Perception Based Planning

• Truth-Perception Awareness Matrices (TPAM) relate truth and perception for each asset type in each cell for each side.
  – Cell location, kill state, ID-ness, and movement states are assumed to be “mostly independent”.
  – Target states are tracked as distributions for target aggregates within a location cell.

• Perception is used to accomplish all planning functions.

• Truth determines operational outcomes

• The TPAM has four components
  – Cell Location Awareness Matrix (CLAM)
  – Location Awareness Matrix (LAM)
  – Kill Awareness Matrix (KAM)
  – Identification Friend or Foe Awareness Matrix (IDAM)
Truth and Perception are not necessarily consistent at each level of C2

*Truth Perception Matrices exist at 3 levels of C2*
- Theater
- Component
- Local
### TPAM Structure

#### C2 LAM – Red Target 1

**Perception**

<table>
<thead>
<tr>
<th>Truth</th>
<th>C1</th>
<th>C2</th>
<th>Undiscovered</th>
<th>Unaware</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>5/3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>4/2</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>False Tgt</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Σ</td>
<td>6/4</td>
<td>3/2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

#### C2 KAM – Red Target 1

<table>
<thead>
<tr>
<th>Σ</th>
<th>Alive</th>
<th>Indeterminate, Presumed Alive</th>
<th>Indeterminate, Presumed Dead</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dead</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

#### C2 IDAM – Red Target 1

<table>
<thead>
<tr>
<th>Friendly</th>
<th>Neutral</th>
<th>Enemy</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tgt1</td>
<td>Tgt2</td>
<td>…</td>
<td>TgtN</td>
</tr>
<tr>
<td>.05</td>
<td>.01</td>
<td>…</td>
<td>0</td>
</tr>
<tr>
<td>Tgt1</td>
<td>Tgt2</td>
<td>…</td>
<td>TgtN</td>
</tr>
<tr>
<td>.01</td>
<td>.01</td>
<td>…</td>
<td>0</td>
</tr>
<tr>
<td>Tgt1</td>
<td>Tgt2</td>
<td>…</td>
<td>TgtN</td>
</tr>
<tr>
<td>.7</td>
<td>.05</td>
<td>…</td>
<td>.01</td>
</tr>
<tr>
<td>Σ</td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

KAM, LAM and IDAM are only defined “on the diagonal”
ISR Modeling Overview

ISR C2
- NCA
- Theater
- Component
- Local Cdr

Task
- Application (e.g. BDA)
- Priority
- Phenomenology
- Quality
- Point/Area
- Revisit

Assets
- Satellites
- Manned Aircraft
- UAVs

Collect

Intelligence
- Battlespace Awareness
- Stage Awareness

Process, Exploit, Analyse

Theater
- Targets
- AOIs

Decide
ISR Tasks and Characteristics

• **ISR Tasks**
  – Prestrike - collect image of fixed target before striking from air
  – Battle Damage Assessment (BDA) - assess target health after striking from air
  – Mobile Target Reconnaissance – search for lost targets and confirm location/identity of previously located targets
  – Area Reconnaissance – search for undiscovered mobile targets
  – Area Surveillance – monitor known areas of interest with imagery
  – Monitor Mobile Targets- monitor known areas of interest with SMTI
  – Tracking – maintain location of target while it is moving with SMTI

• **Priority**
  – 1, 2, 3

• **Phenomenology/Quality**
  – EO/IR; Low, Med, High
  – SAR; Low, Med, High
  – SMTI (w/ or w/out ID)

• **Image Size**
  – Point
  – Area

• **Revisit Rate**
Current Team

- Buddy Wood, Technical Director
  - MS OR/Stats, NRO, AFSAA
- Gregg Burgess, Managing Director
  - PhD OR, AFSAA, F-16 OT&E
- Jack Jackson, Senior Analyst
  - PhD OR, F-111, AFIT Professor, JAWP, AFSAA
- Duane Apling, Software Engineer
  - BS Math, USAF Meteorologist, NRO
- Kevin Kenkel, Phoenix/LA MA lead
  - F-16 FWS Instructor, CENTCOM J3, Warrior Prep Center Commander, AFSAA
- Jim Sheedy, COS MA lead
  - MS OR, USAF Analyst, EUCOM, AFOTEC
- Kevan Katuin, Senior Analyst
  - MS OR, USMC F/A-18 WSO, NRO

- Glenn Szilagyi, Software Engineer
  - MS Mech Eng, USN Engineer
- Mark Clausen, Software Engineer
  - BS Meteorology, USAF Meteorologist, NRO
- Rich Bordelon, Software Engineer
  - BS Political Science, USN Surface Warfare, NRO
- Jim Grier, COS MUA Analyst
  - MS OR, F-16 FWS, AF/XO
- Dave Yonika, Senior Analyst
  - MS OR, F-4, A-10, AFSAA, NRO