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UNCLASSIFIED
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<td>Operations Analysis Division, Combat Development Command, USMC, 3300 RUSSELL RD Rm#128, QUANTICO VA 22134-5134</td>
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Standard Form 298 (Rev. 8-98)  
Prescribed by ANSI Std Z39-18
The following presentation is UNCLASSIFIED
MAGTF Fires Model

focusing on Kinetic Fires

LtCol. John Bruggeman, USMC
Mr. Kevin Hankins
Maj. Chris Michel, USMC
Mr. Mike Bovan

Analysis Branch
Operations Analysis Division, MCCDC

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The Marine Air-Ground Task Force (MAGTF) is the USMC’s principle organization for the conduct of all missions across the range of military operations.

Kinetic fires exercised with this Modeling tool are: mortars, bombs, missiles, rockets, and guns. This tool does not simulate: electronic warfare, energy weapons, or information operations.

This tool is an executable Microsoft Excel VBA file that others can apply to similar questions.
Purpose of this Presentation

The purpose of this Presentation is:

- To share this methodology with you so that you can choose the appropriate tool for your problem set. This could save you months of effort, and influence programmatic decisions that ultimately save lives on the battlefield.

- To obtain your feedback.
MAGTF Fires Model Overview

- This tool models any size scenario. Both set-up time and simulation time are relatively fast.
  - Approximately 24-hour duration frames of a MEF-size MCO scenario may be simulated in 12 minutes (120:1) on a standard Windows PC.
  - The entire simulation may be set up in less than one person-month.
  - Excursions (experimental changes to the baseline) may be set up in minutes.
  - The Model is fully supported by one civilian.
- This has provided insight into USMC Fires Capabilities.

MEF = Marine Expeditionary Force
  (~50,000 Marines and Sailors)
MCO = Major Combat Operations
Example of a recent success

- New questions for a MEF-size MCO scenario:
  - A question was raised concerning # of JSF Sorties per day.
  - A question was raised concerning aerial refueling.

- Mr. Bovan developed excursions, ran the Model many times, and analyzed the results to address both questions, all within one week.
  - # Sorties per day was changed using the Firing Platforms input list Sheet.
  - Aerial refueling was simulated by adding range to the aviation Firing Platforms.

- This illustrates the rapid M&S capability of this Model.
MAGTF Fires Model Agenda

- What type of questions does this Model answer?
- Model Description and Methodology
- How to provide Model Inputs
- Model Outputs
- Issues / Concerns
MAGTF Fires Model Agenda

- What type of questions does this Model answer?

- Model Description and Methodology

- How to provide Model Inputs

- Model Outputs

- Issues / Concerns
“Key Questions”

1. Are USMC fires systems capable of generating all desired effects?

Key concerns are:
- Platform and munition range
- Aircraft movement
- SEAD prerequisite targets
- Precision weapons
- Inclement weather
- Area targets / Volume fires
- Restricted Rules of Engagement
- Moving Targets
- Armored Targets
- Consider the impact of the changes to procurement timelines of “at risk” systems.
“Key Questions”

2. What are the programmatic decisions that can mitigate shortfalls in platforms and munitions?

3. How dependent is the Marine Corps on Naval/Joint fires?
"Is the pile of shooters big enough for the pile of targets?"

**Fire Support Platforms in 2024 MEF**
- 81 mm mortar
- EFSS 120mm mortar
- M777 155mm Lightweight Howitzer
- HIMARS
- DDG 51: (5" Conventional Only)
- DDG 51 Flt IIIA: (ERM capable)
- DDG 1000: (LRLAP capable)
- AH-1Z
- UH-1Y
- JSF

**Ammunition available to the MEF**
- HE: 81mm, 120mm, 155mm, 5"/54
- Excalibur
- DPICM
- M26, CMLRS
- FGM
- LRLAP
- Hellfire
- Rockets
- 25mm
- Maverick
- DMLGB
- SDB
- JDAM (500, 1000, 2000 lbs)
- JSOW
MAGTF Fires Model Agenda

- What type of questions does this Model answer?

- Model Description and Methodology

- How to provide Model Inputs

- Model Outputs

- Issues / Concerns
The MAGTF Fires Model is a deterministic assignment model. It includes stochastic variables for availability of firing platforms, and effect on cluster targets.

It takes the given targets, firing platforms, and munition counts as inputs, then applies them according to all the constraints in a timeless sequence for a limited portion of a fire-fight (analyst-defined, usually ~24 hours).

This is a Microsoft Excel workbook with VBA automation.

This tool usually determines *minimum* capability gaps due to the following assumptions:
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MAGTF Fires Model Assumptions

- **ISR is assumed perfect**
  - Target observation/identification is not explicitly modeled.

- **Perfect Command/Control/Coordination**
  - Firing info is available to firing units, coordination is assumed.

- **No Blue Force attrition inside the model**
  - Begin with T/O and T/E for the chosen scenario.
  - Blue firing platforms availability is user input, stochastic

- **Logistics**
  - Munitions count is limited to the quantity available during the chosen time period (~24 hours) and platform constraints

- **JMEM/JWS data is assumed accurate**
  - No line-of-sight, Ph, or Pk calculations
Overall Modeling Approach

- Determine systems for inclusion and availability during specific years of interest.
- Develop scenarios and tables.
- Perform initial evaluation of each scenario.
  - Phased assessment of fires capacity
  - Assignment Algorithm of Fires resources to targets by Priority**
- Perform analytic excursions.
- Explore results for insights, gaps, and potential fills.

** The Intention is not to predict the outcome of the scenario, but to characterize the fires engagements that are reasonably likely during a particular scenario and assess our ability to accomplish USMC fires goals with the assets available and relative to other, potential, inventories.
MAGTF Fires Model Agenda

- What type of questions does this Model answer?
- Model Description and Methodology
- How to provide Model Inputs
- Model Outputs
- Issues / Concerns
Overall Work Breakdown

**Done by the Analyst:**
* Choose warfare date and scenario.
  * Choose Duration of each Model Run.
  * Obtain data.
  * Enter input tables.
  * Run the Model (Press Reset and Run buttons).

**Done by the Model:**
* For each Target by Priority
  * Determine Munition by Preference and constraints
    * Determine 1 or more Platforms by constraints
      * Make assignments.
        * If Area-Munition and Cluster-Target, apply area effect.
  * If desired effect is not achievable, try lesser effect.
## Example of Included Systems

<table>
<thead>
<tr>
<th>Ground:</th>
<th>EFSS 120mm Mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M777 155mm Howitzer</td>
</tr>
<tr>
<td></td>
<td>HIMARS</td>
</tr>
<tr>
<td>NSFS:</td>
<td>5”/54</td>
</tr>
<tr>
<td></td>
<td>5”/62 (ERM)</td>
</tr>
<tr>
<td></td>
<td>AGS (LRLAP)</td>
</tr>
<tr>
<td>Aviation:</td>
<td>AH-1W</td>
</tr>
<tr>
<td></td>
<td>UH-1N, UH-1Y</td>
</tr>
<tr>
<td></td>
<td>AV-8B</td>
</tr>
<tr>
<td></td>
<td>F/A-18</td>
</tr>
<tr>
<td></td>
<td>JSF</td>
</tr>
</tbody>
</table>
Identify System Availability

**Ground Systems**
- A
- B
- C
- D

**Air Systems**
- E
- F
- G

**NSFS Systems**
- H
- I
- J

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2012</th>
<th>2016</th>
<th>2020</th>
<th>2024</th>
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<tbody>
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<tr>
<td>FOC</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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MAGTF Fires Model Inputs

Regions

- The analyst enters any number of regions.

- A region can be any size. Every target must be included in a region.

- Targets in "Adverse Weather" regions may only be engaged with "All-Weather" munitions.

- Targets in "Restrictive Environment" regions may only be engaged with munitions that are designated as "Precision" and "Limited ECR".

ECR = Effective Casualty Radius

<table>
<thead>
<tr>
<th>Region</th>
<th>Adverse Weather</th>
<th>Restrictive Environment</th>
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<tr>
<td>A</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>B</td>
<td>FALSE</td>
<td>TRUE</td>
</tr>
<tr>
<td>C</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>D</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>E</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>F</td>
<td>TRUE</td>
<td>FALSE</td>
</tr>
<tr>
<td>G</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>H</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
</tbody>
</table>
The analyst enters any number of targets.

- A target may be a single item of equipment or a collection of any number of items or units.
- SEAD prerequisite targets will be assigned first.
- Mobility: S=Static, R=able to Relocate, M=Mobile; (R or M) targets in a cluster are not attacked by subsequent sorties of the same aircraft.
- Effect desired may be: D=Destroy, N=Neutralize, S=Suppress

SEAD = suppression of enemy air defenses

<table>
<thead>
<tr>
<th>Designator</th>
<th>Cluster</th>
<th>SEAD PreReq</th>
<th>Type</th>
<th>Description</th>
<th>Region</th>
<th>X-Location</th>
<th>Y-Location</th>
<th>Mobility</th>
<th>Effect</th>
<th>Pri</th>
</tr>
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<tr>
<td>1010</td>
<td>N/A</td>
<td>N/A</td>
<td>D</td>
<td>building</td>
<td>B</td>
<td>30</td>
<td>150</td>
<td>S</td>
<td>S</td>
<td>1</td>
</tr>
<tr>
<td>1050</td>
<td>N/A</td>
<td>N/A</td>
<td>E</td>
<td>mortar site</td>
<td>F</td>
<td>20</td>
<td>140</td>
<td>R</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>1020</td>
<td>N/A</td>
<td>N/A</td>
<td>D</td>
<td>building</td>
<td>C</td>
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<td>165</td>
<td>S</td>
<td>N</td>
<td>3</td>
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<tr>
<td>1030</td>
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<td>B</td>
<td>armored veh</td>
<td>D</td>
<td>18</td>
<td>175</td>
<td>M</td>
<td>D</td>
<td>4</td>
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<tr>
<td>1031</td>
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<td>D</td>
<td>18</td>
<td>175</td>
<td>M</td>
<td>D</td>
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The analyst enters any number of firing platforms.

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<th>X-Location</th>
<th>Y-Location</th>
<th>Range</th>
<th>Region(s)</th>
<th>All-weather</th>
<th>Availability</th>
<th># of attacks</th>
<th>Aviation</th>
<th>CP-X</th>
<th>CP-Y</th>
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<td>40</td>
<td>50</td>
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<td>0.9</td>
<td>50</td>
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<td>10</td>
<td>500</td>
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<td>0.8</td>
<td>1</td>
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<td>100</td>
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<tr>
<td>20</td>
<td>AV8(2)_A_2</td>
<td>20</td>
<td>10</td>
<td>500</td>
<td>N/A</td>
<td>FALSE</td>
<td>0.6</td>
<td>1</td>
<td>TRUE</td>
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<td>100</td>
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<td>10</td>
<td>400</td>
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<td>100</td>
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<td>10</td>
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<td>100</td>
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<td>147</td>
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<td>50</td>
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<td>41</td>
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<td>147</td>
<td>0</td>
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<td>0.85</td>
<td>50</td>
<td>FALSE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any number of targets may be engaged per row.

- **Aircraft**: Each row is one physical aircraft sortie. “# of attacks” is unused.
- **Non-Aircraft**: Each row is one physical fire system.

Availability = probability of platform being able to respond

Only all-weather platforms can conduct attacks on targets in adverse weather regions.
The analyst enters any number of munitions.

<table>
<thead>
<tr>
<th>Designator</th>
<th>Description</th>
<th>Range</th>
<th>Precision</th>
<th>Limited</th>
<th>ECR</th>
<th>All-Weather</th>
<th>Area Effect</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>120HE</td>
<td>7</td>
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<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>2</td>
<td>5HE</td>
<td>23</td>
<td>FALSE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>3</td>
<td>20mm</td>
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<td>TRUE</td>
<td>TRUE</td>
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<td>TRUE</td>
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<tr>
<td>4</td>
<td>Hellfire</td>
<td>8</td>
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<td>TRUE</td>
<td>FALSE</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>5</td>
<td>TOW</td>
<td>4</td>
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<td>6</td>
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<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>7</td>
<td>JDAM</td>
<td>1</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>8</td>
<td>Maverick</td>
<td>27</td>
<td>TRUE</td>
<td>TRUE</td>
<td>FALSE</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

These tables are relational. Targets in "Restrictive Environment" regions may only be engaged with munitions that are designated as "Precision" and "Limited ECR".

ECR = Effective Casualty Radius
The analyst enters total quantity of munitions available on each platform/sortie during the modeled time period.

<table>
<thead>
<tr>
<th>Platforms</th>
<th>Munitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desig</td>
<td>Descrip</td>
</tr>
<tr>
<td>10</td>
<td>NSFS54</td>
</tr>
<tr>
<td>20</td>
<td>AV8(2)_A_1</td>
</tr>
<tr>
<td>20</td>
<td>AV8(2)_A_2</td>
</tr>
<tr>
<td>30</td>
<td>AH1(2)_A_1</td>
</tr>
<tr>
<td>30</td>
<td>AH1(2)_A_2</td>
</tr>
<tr>
<td>40</td>
<td>EFSS(3)_A</td>
</tr>
<tr>
<td>41</td>
<td>EFSS(3)_B</td>
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</tbody>
</table>
The analyst enters the Attack Guidance Matrix.

<table>
<thead>
<tr>
<th>Target Type</th>
<th>Munition</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>A SAM site</td>
<td>Suppress</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neutralize</td>
<td>3</td>
<td>2</td>
<td>5</td>
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<td>6</td>
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<td>1</td>
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<td>4</td>
<td>3</td>
<td>4</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>B armored veh</td>
<td>Suppress</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td></td>
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If a cell is left empty then that munition will not be employed against that target type.
The analyst enters the Munitions Effectiveness.

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<td>700</td>
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</tbody>
</table>

This is how many are needed for the desired effect. This may be derived from the JMEM / Joint Weaponeering System.

* Numbers here are notional.
MAGTF Fires Model Agenda

- What type of questions does this Model answer?
- Model Description and Methodology
- How to provide Model Inputs
- Model Outputs
- Issues / Concerns
“Turn the crank”: Now that the input Tables are complete, the analyst runs the Model (built-in Excel VBA software). The Model handles error checking along with all the logic.

For each Target by Priority:
- Determine Munition by Preference and constraints
- Determine 1 or more Platforms by constraints
- Make assignments.
- If Area-Munition and Cluster-Target, apply area effect.
- If desired effect is not achievable, try lesser effect.

All results are presented in a series of tables including this main table.

<table>
<thead>
<tr>
<th>Run #</th>
<th>Pri #</th>
<th>Tgt #</th>
<th>Tgt Desc</th>
<th>Desired Eff</th>
<th>Desired Effect Achieved?</th>
<th>Lesser Eff Achieved?</th>
<th>by Platform_1</th>
<th>w/ Munition</th>
<th>WX?</th>
<th>ROE?</th>
<th>Fail Reason</th>
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</tbody>
</table>
MAGTF Fires Model Agenda

- What type of questions does this Model answer?
- Model Description and Methodology
- How to provide Model Inputs
- Model Outputs

- Issues / Concerns
MAGTF Fires Model Possible Improvements

- Munitions/platform cost; Optimization
- Change coordinate system from UTM (0-44km error per longitude zone) to WGS84 (0-1m error).
- Calibrated placement of covariance components in the Model
- Run joint, and unprogrammed, platforms and munitions
- Some blue force land/naval movement (affects availability)
- Greater understanding of JWS munition quantities
- Develop the minimum requirement for reduction in red forces during the ~24 hour duration of the Model.
- Locate/generate relevant scenarios data.
Questions?

Feedback Welcome!
End of ppt
Purpose of the Study

The primary objective is to determine if current and programmed fires capabilities of the USMC are sufficient to meet MAGTF operational requirements.

The secondary objective is to inform senior leadership on recommended courses of action for future capabilities development.
The Fires Triad (Air, Ground, Sea) is essential (if/when systems are removed, gaps are exacerbated)

The use of metrics here are to gain insight not to advocate that some systems could/should replace others. To fully appreciate a systems utility its overall use must be taken into account.

Experimental systems that are useful in OIF now will likely be useful in Irregular Warfare operations in the future … if they are determined to be of value, efforts should be made to make them long term programs.
Results-in-Brief For MEF

Kinetic Fires in MCO

Identified Joint Warfighting Gaps that Effect the Marine Corps

- **Fires Overall.** On average the MEF was only able to address ~58% of the targets in the AO.
- **Inclement weather.** Poor weather reduced MEF fires effectiveness from 60 to 56%.
- **Area targets.** The MEF was less affective against area targets than against point targets. (52% and 83% respectively)
- **Restrictive rules of engagement (ROE).** The MEF was able to affect 54% of ROE targets compared to 66% of non-ROE targets.
- **Mobile targets.** The MEF was able to affect 66% of stationary targets but only 22% of mobile targets.
- **Armored targets.** The MEF was able to affect 72% of non-armored targets but only 28% of armored targets.
“Key Questions”

Are there any system redundancies or inventory quantities that represent a possible excess capacity?

If so, what are the implications on other systems and/or programs?

\[
\text{Fires Capability} \geq \text{Number of targets}
\]
Agenda

- “Key Questions”
- Scope, Assumptions, and Limitations
- Methodology
- Scenario Set
- Analytical Results
- Issues and Timeline
Scope

- Timeframe: 2008 – 2025
  Focus on 2014 and 2024

- Operational and Tactical Kinetic fires, to include:
  - Ground-to-ground
  - Air delivered
  - Naval surface fires

- MAGTFs sized from MEF(+) to MEU(SOC) and SPMAGTF

- Weather: Ideal and Adverse

- ROE/Operational environment:
  - Permissive or Restrictive
  - Scenario dependent
Study Assumptions

- The MAGTF remains the USMC’s principal warfighting organization.

- Expeditionary Maneuver Warfare (EMW) and the family of warfighting concepts are the primary framework for the organization, deployment, employment, and sustainment of the future MAGTF, operating in a joint environment.
  - Will not specifically address DO.

- The Marine Corps maintains the capability to operate across the full spectrum of conflict.
Metrics

- % Targets Serviced
  - analyzed by various target characteristics (range, moving vs stationary, area vs point, etc)

- Ability to service “critical” targets

- Utilization of fires resources
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<tr>
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</table>
Sample Scenario: Baseline Results

Success Rate

MAGTF Fires: Sample Scenario

Success Rate

building 100%

mortal site 90%

building 80%

armored veh 70%

armored veh 60%

armored veh 50%

armored veh 40%

armored veh 30%

armored veh 20%

armored veh 10%

light veh 0%

light veh 10%

light veh 20%

light veh 30%

light veh 40%

light veh 50%

light veh 60%

light veh 70%

light veh 80%

light veh 90%

light veh 100%

inf sqd 101

inf sqd 102

inf sqd 103

inf sqd 104

inf sqd 105

inf sqd 106

inf sqd 107

inf sqd 108

inf sqd 109

inf sqd 110

inf sqd 111

inf sqd 112

inf sqd 113

inf sqd 114
Sample Scenario: PGMM

- Situation: same
- Mission: same
- Execution: changes:
  - Aviation situation same as baseline
  - EFSS has longer range, precision munition (HE)
  - Precision allows EFSS to be employed in urban region
  - Longer range (~3X) makes EFSS available for more targets, allows aviation assets to be used for true long range targets
Sample Scenario: PGMM Results

MAGTF Fires: Sample Scenario

Success Rate

UNCLASSIFIED
Sample Scenario: FARP

- Situation: same
- Mission: same
- Execution: changes:
  - FOB/FARP established ashore (~20 nm inland)
  - RW & FW operate out of FARP -> allows 3 sorties each
  - Closer origin results in less transit time -> increases availability (time on station)
Sample Scenario: FARP Results

MAGTF Fires: Sample Scenario

Success Rate

- Building
- Mortar site
- Armored veh
- Armored light veh
- Armored inf sqd

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%

101 105 102 103 101 103 104 101 104 101 105 104 104 104 104 101
1 2 3 4 5 6 7 8 9 10 11 12 13 14

UNCLASSIFIED
Sample Scenario: Comparison

Overall Success
Baseline 48.93%
PGMM 56.79%
FARP 82.50%
Questions?
Set the Battlespace: Targets

- Not a schedule of fires, instead a list of all targets that might reasonably be engaged by friendly fires assets during this period of the operation.
  - Can be single entities to large units
  - Location specified by x,y coordinates
  - Must fall into a user-defined region
  - Identified as one of any number of user-defined target types (must be compatible with JMEM)
  - Must designate the effect desired (S/N/D)
  - Specified as mobile, able to relocate, or static
  - Priorities are assigned, 1 ... Total # of targets
  - Can be grouped into “clusters”
  - Can have other targets designated as pre-requisites (SEAD)
Set the Battlespace: Fires Assets

- All friendly fires resources that can provide kinetic, tactical or operational level fires during this period.
  - Can be single entities to large units
  - Location given by x,y coordinates
  - Aviation platforms given an origin, CP, and max range
  - All-weather systems are identified
  - Availability = Prob that this asset will be available to respond when called
  - Assets can be designated as DS units
  - Munitions quantities carried by each asset
  - Ground systems may be limited by max # of engagements
  - Avn systems sorties all listed individually, # of attacks per sortie determined by munitions load and range
Set the Battlespace

- **Battlespace**
  - Regions are designated as ideal or adverse weather
    - Adverse WX = Optically guided munitions can not be employed
  - Regions can be designated as “restrictive ROE”
    - Area demanding limited collateral damage
    - Close proximity to friendly forces
    - Other areas/targets requiring precision
    - Only precision-guided munitions will be employed

- **Munitions**
  - Max range must be specified
  - Characteristics include: all-weather, precision-capable, and area effects (as opposed to point effects)
  - Munition preferences set for each target type, for each desired effect
  - JMEM data used to determine quantity of munition (by type) required to achieve desired effect against each target type
Assignment Model

● Loops through targets in order of priority
  - Determine platforms available
    ◆ Availability, # of attacks, DS assignment
    ◆ All platforms available for lowest priority target in a cluster are available for all other targets in the cluster
    ◆ If one sortie of an avn platform is assigned to attack a mobile/able to relocate target, then no other sortie of that platform will be available for that same target or others in that target’s cluster
  - In order of preference, consider the munitions effective against the current target
    ◆ Weather and/or ROE restrictions
    ◆ From available platforms, consider only those employing this munition
    ◆ Determine which of these platforms can range the target
  - Distance from point of origin to CP to launch point(s) back to CP then back to point of origin must not exceed max range
    ◆ If the required quantity of munition is available (single platform or several together), then assign the platform(s)/munition to this target
    ◆ Apply area effects to any other targets in the cluster
Range vs “Reach”
Limitations

• Includes systems that are not yet in production (capabilities are not well defined).
• Some future systems are “other service” and therefore employment and structure is not well defined.
• **Scope is large** – this study is designed to be a “wavetop” view to cover the broad landscape.
  • Won’t necessarily provide “actionable” details for any given scenario/timeframe/system.
  • Will provide recommendations and point out areas of concern requiring a closer look.
Target & Fires Asset Data

- For each scenario
- For given period (operational phases, or shorter)

**Targets**
- Location
- Priority
- Target type/effects desired
- Precision required
  - Restricted terrain / Collateral damage?
  - Moving?

**Fires Resources**
- Location
- Range
- Lethality/effects
- Precision capable
- All-weather capable
- Capacity (availability, tactical employment, etc.)
Basic Modeling Methodology

- Consider a discrete period of time during a given phase of an operation.

- Assignments – match capable fires assets to active targets.
  - Targets are not engaged on a schedule – instead engaged based on target priority guidance.

- Employ JMEM data to determine munition effectiveness vs the particular target type.
  - No line-of-sight or $P_h, P_k$ calculations.

- Fires asset availability is not determined by a strict timeline or “script” but by a set of availability rules.
  - “Timeless” quality to assignments.
### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ECR</td>
<td>Effective Casualty Radius</td>
</tr>
<tr>
<td>ISR</td>
<td>Intelligence, Surveillance, and Reconnaissance</td>
</tr>
<tr>
<td>MAGTF</td>
<td>Marine Air-Ground Task Force (any size)</td>
</tr>
<tr>
<td>MEF</td>
<td>Marine Expeditionary Force (~50,000 troops)</td>
</tr>
<tr>
<td>MCO</td>
<td>Major Combat Operations</td>
</tr>
<tr>
<td>MEU(SOC)</td>
<td>Marine Expeditionary Unit (Special Operations Capable)</td>
</tr>
<tr>
<td>NSFS</td>
<td>Naval Surface Fires Support</td>
</tr>
<tr>
<td>OIF</td>
<td>Operation Iraqi Freedom</td>
</tr>
<tr>
<td>ROE</td>
<td>Rules of Engagement</td>
</tr>
<tr>
<td>SEAD</td>
<td>Suppression of Enemy Air Defenses</td>
</tr>
<tr>
<td>SPMAGTF</td>
<td>Special MAGTF</td>
</tr>
<tr>
<td>VBA</td>
<td>Visual Basic for Applications</td>
</tr>
</tbody>
</table>

### Weapons Systems

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGS</td>
<td>Advanced Gun System</td>
</tr>
<tr>
<td>AH-1</td>
<td>Cobra rotary wing aircraft</td>
</tr>
<tr>
<td>AV-8</td>
<td>Harrier fixed wing aircraft</td>
</tr>
<tr>
<td>DDG-51 Flt I/II</td>
<td>Guided Missile Destroyer w/ TLAM and one 5”/54 gun</td>
</tr>
<tr>
<td>DDG-51 Flt IIA</td>
<td>Guided Missile Destroyer w/ TLAM and one 5”/62 ERM-capable gun</td>
</tr>
<tr>
<td>DDG-1000</td>
<td>Land Attack Destroyer w/ TLAM and two AGS 155mm LRLAP</td>
</tr>
<tr>
<td>F/A-18</td>
<td>Hornet fixed wing aircraft</td>
</tr>
<tr>
<td>EFSS</td>
<td>Expeditionary Fire Support System</td>
</tr>
<tr>
<td>ERM</td>
<td>Extended Range Munition</td>
</tr>
<tr>
<td>HIMARS</td>
<td>High Mobility Artillery Rocket System</td>
</tr>
<tr>
<td>JSF</td>
<td>Joint Strike Fighter fixed wing aircraft</td>
</tr>
<tr>
<td>LRLAP</td>
<td>Long Range Land Attack Projectile</td>
</tr>
<tr>
<td>M777</td>
<td>Lightweight 155mm Howitzer</td>
</tr>
<tr>
<td>UH-1</td>
<td>Huey rotary wing aircraft</td>
</tr>
</tbody>
</table>
Resource-to-Target Assignments

For a Given Phase of a Given Scenario
- Populate Targets
- Populate Friendly Fires Assets
- Set Operational Conditions (WX, ROE)

For a Given Duration, Determine

Availability Module
- Friendly Fire Asset Capacity
- Target Queue

Update and Iterate until Assets or Targets are Exhausted

Assignment Module
Assigns fires assets to targets subject to
- Target / Weapon Characteristics
- Target Priority
- Target / Weapon Preference
- Shooter-to-Target Range
- Asset Availability and Capacity
- Effect Desired

Gaps and Insights
- Targets Successfully Engaged
- Assets Employed

Scenario Input
Fixed Input
Output
MAGTF Fires Availability Module

For a given target:

Loop thru Platforms

Is Target in a cluster?

Are other Tgts lower priority?

Was this platform avail for low pri tgt?

DS OK? # attacks OK? Avail OK?

Tgt mobile/reloc? Earlier tgts attacked by diff instance of same platform?

Platform is available
MAGTF Fires Assignment Module

For a given target

Figure 2
Check: Avail? Tgt Status? Prereq?

FAIL
PASS

Loop thru Munitions

WX check

FAIL
PASS

ROE check

FAIL

Can range target?

Carrying this munition?

All WX?

Loop thru Avail Platforms

NO
YES

NO
YES

Sufficient quantity - single

Sufficient quantity - multiple

NO
YES

NO
YES

Make Assignments

Apply area effects
MACTF Fires Model

1. Enter scenario data, target list, friendly fires assets, and munition characteristics in input tables.
2. Set desired number of iterations below.
3. Randomized seed: Choose.
4. Clear output tables (Output and Summary Sheets in this workbook) with the “Reset/Compact” button.
5. Begin the model iterations with the “Run Simul” button. Watch Status Bar at bottom for status during the run.
6. After viewing/copying/analyzing/saving data, can use the “Reset/Compact” button to reduce file size - all simulation results will be lost, but inputs remain.

** Conceptually, model assumes targets appear sequentially (in order of priority) and engagements occur instantaneously.

- No issues with unit being unavailable because they are engaging another target
  - If tgs are in a cluster, then area wgs get area effects, and ground/naval
  - Assets are guaranteed availability for lower pri tgs in the cluster after initial
  - Attack, even for mobile/relieving tgs

- No delay for avn platforms to reach target
  - Avn assumes avn platforms at CP, otherwise not avail

- Subsequent sorts are available immediately (no deck cycle delay)
  - Essentially, assumes some delay between target appearances

- For large engagements, avail will mitigate (may not be avail for first tgs but may become avail for later tgs)
Output Fail Reason explained

- “N P#1M: JDAM-P no-go, ammo; P#2M: 5HE-P no-go, rng; P#3M: 120HE-P no-go, rng; P#4M: 25mm-P no-go, ammo; P#5M: 20mm-P no-go, ammo; try lesser effect P#1M: JDAM-P no-go, ammo; … P#5M: 20mm-P no-go, ammo; not assigned”

- Reads: For the desired effect (Neutralize): Priority#1 Munition: JDAM – No available platforms have any JDAMs remaining. Priority#2 Munition: 5HE – No available platforms can range the target… For the next lesser effect (Suppress): Priority#1 Munition: JDAM…

- “not assigned” means Blue could not achieve even the lowest level effect (Suppress) on this Target.
### MAGTF Fires Model Outputs

#### other Output Tables

**MAGTF Fires Model, Version 20070522.  5/31/2007 3:44:45 PM**

- **14 Targets, 6 Target Types, 7 Platforms, 8 Munitions, 8 Regions, 1 Iterations**

**Input Tables FilePathName = H:\HSave\MAGTF Fires\MAGTF Fires Model.xls**

**First Reason for each Munition why Desired Effect was not achieved for Targets that were not addressed at all (D,N,S):**

Total of each Column is = 7, the number of non-addressed Targets over all Iterations.

<table>
<thead>
<tr>
<th>Munition</th>
<th>120HE</th>
<th>5HE</th>
<th>20mm</th>
<th>Hellfire</th>
<th>TOW</th>
<th>25mm</th>
<th>JDAM</th>
<th>Maverick</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mun Pref empty</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>21</td>
<td>38%</td>
</tr>
<tr>
<td>Mun Wx</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mun ROE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mun Plt Wx</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mun NoAmmo</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>27</td>
<td>48%</td>
</tr>
<tr>
<td>Mun Range</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Mun Lo#Ammo</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>11%</td>
</tr>
<tr>
<td>Mun Total</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>35/56</td>
<td>100%</td>
</tr>
<tr>
<td>Mun Percent</td>
<td>3%</td>
<td>3%</td>
<td>20%</td>
<td>17%</td>
<td>17%</td>
<td>20%</td>
<td>3%</td>
<td>17%</td>
<td>xxx</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Targets Effected, by Munition.**

- **Desired Effect (D)** | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 4 | 57%
- **Lesser Effect (L)** | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 3 | 43%
- **D or L** | 0 | 1 | 1 | 2 | 0 | 1 | 2 | 0 | 7 | 100%

| of Total D or L Tgts | 0% | 14% | 14% | 29% | 0% | 14% | 29% | 0% | xxx | 100% |

| of Total Tgts*Iters | 0% | 7% | 7% | 14% | 0% | 7% | 14% | 0% | xxx | 50% |

**Quantity, Initial**

| | 100 | 500 | 440 | 4 | 0 | 400 | 8 | 0 | 1,452 | 100% |

**Quantity, Final**

| | 100 | 495 | 280 | 2 | 0 | 200 | 0 | 0 | 1,077 | 74% |