Heavy Machinegun Fire Control as a Distributed Operations Enabler

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Harnessing the Power of Technology for the Warfighter

Distribution Statement A: Approved For Public Release; Distribution Unlimited
Background

• Request from ONR Code 30 Fires to address 40mm Indirect Fire feasibility as part of Improved Fire Control Systems FNC

• Proof of Concept demonstrator built and tested in late FY03
  – COTS components
  – In-house software
  – MCWL weapon/ammo/test support
Technical Approach

- Ballistic kernel calculates targeting solution using
  - Target & weapon geo-location
  - Inertial sensor for weapon attitude
  - MET data
- Provides aiming parameters to gunner when firing from defilade
- Lobbing trajectory allows substantial mask clearance at longer ranges
  - Hills
  - Trees
  - Buildings
40mm Range/Trajectory

Low Angle Solution Only

Low and High Angle Solutions Possible

(not to scale)
Proof of Concept Test

• Demonstrated 40mm Indirect Fire Proof of Concept
  – Used GD 40mm ALGL as test platform
  – Accurate to full range of weapon
  – Promising results exceeded user expectations

• Improvements needed
  – High-angle ballistic profile
  – Hardware integration
  – Software usability
  – Gunner interface

Hawthorne, NV, 2003
Emerging Guidance

• Marine Corps Improved Heavy Machinegun (IHMG) UNS
  – Signed Nov 2003 by BGen Neller
  – Validated by DOTMLPF working group Feb 2004
  – Improved .50 cal and 40mm weapons
  – Common compatible mount w/ quick slewing capability
  – Direct and Indirect Fire Control with integral LRF
  – Common optics bench for current/emerging inventory sights

• Addresses Expeditionary Maneuver Warfare Capability Gaps
  – Enhance capabilities of infantry heavy weapons by incorporation of advanced fire control technologies.
  – Provide all-weather, fully integrated, and continuous lethal and non-lethal fires with extended range, volume, and accuracy.
  – Develop means to reduce time delay from target detection to identification and from target identification to engagement.
  – Provide extended, coordinated, and sequenced joint fires in support of maneuver elements.
HMG Indirect Fire History

- Used effectively in WWI & WWII - “rain of slugs”
- Occasional use in Korea
- Foliage of Vietnam reduced opportunities
- New mounts did not facilitate high angles
- Instruction/Training lacking
  - Time and Ammunition intensive
  - .50 cal Indirect Fire is a lost art - no longer taught
  - 40mm Indirect Fire only taught at MC Advanced Machinegun leaders course
    - 45 minutes to set up a mission
    - Lucky to hit within a football field on first shot
- Lack of doctrine for accurate, coordinated, and timely employment
- Loss of expertise due to lack of use
Technology Opportunity

- Major transformation for Heavy Machineguns
  - Extends practical useable range of weapons
  - Enables timely execution of accurate indirect fire
  - Increase in first round accuracy for direct fire

- Radical enhancement of CONOPS
  - Ideal for current conflicts & MOUT engagements
  - Situational awareness for heavy machinegun teams
  - Networked Fire Control allows
    - Direct sensor-to-shooter link
    - Call for fire support on targets of opportunity
    - Collaborative attack capability
Project Sponsors

- Office of Naval Research (ONR)
  - Expeditionary Maneuver Warfare Department
    - Fires Thrust Area

- Marine Corps Warfighting Lab (MCWL)
  - Technology Division
    - Ground Combat Element Branch
Team Responsibilities

• Technology Transition Agreement between ONR, MCWL, & MCSC signed June 2004
  – NSWC Crane (ONR Design Agent)
    • Fire control development
    • Communications / networked fires interoperability
    • Overall system integrator
    • Coordinate technology demonstration
  – MCWL
    • Advanced Common Mount (ACM) development
    • Evaluation of MK19 replacement candidates
    • Weapon, ammo, and range support for tests and demos
    • Operational demonstrations
    • Funded fire control completion and system verification test in FY06
Indirect Fire Employment

Forward Observer (FO)

FO Determines Target’s Location and Adjust Fires

HMG with DF/IF capability

FO relays Targeting information

Fire orders sent via JVMF

FSCC

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Direct Fire / Sensor Employment

HMG with DF/IF capability

HMG determines target’s location using LRF, IMU, and GPS

FSCC

Radio

IMU + GPS

Mission computer

LRF

HMG sends digital target information via JVMF

FSCC

Fire orders sent via JVMF

Fire support asset delivers ordnance

Enemy target

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Distributed Operations Enabler

• Provide the ability to distribute or re-aggregate depending on the threat.
• Provide the ability to quickly and accurately engage targets using a distributed processing architecture.
• Provide collaborative and coordinated engagement of targets.
• Provide teams that are multifunctional (sensor, shooter, and/or comms relay).

• Provide multiple teams a coordinated, interdependent approach to intelligence gathering, situational awareness, and target identification/location.
Distributed Ops Application
HMG Fire Control on CCM

- Weapon Attitude Sensor
- PLGR or integrated SAASM
- Computing Platform
- Optical Quadrant Deck
- Gunner’s Display

Common-Compatible Mount w/ std T&E
HMG Fire Control on ACM

Vehicle Mount

Dual Range Pedestal High

Dual Range Pedestal Low

Gunners Display

Optical Quadrant Deck

Team Leaders Display

Computing Platform

Advanced Common Mount with Integrated T&E and Trigger Mechanism
Optical Quadrant Deck

Motorized Direct Fire platform keeps eyes on while engaging targets

- MIL-STD-1913 rail mounted optic
- Pressure/Temperature Sensor
- SLAM-R Software Controlled LRF Module
- Motor pans optics array to calculated QE
Computing Platform

Hot Swappable BA-5590 Form Factor Battery Power

L1/L2 GPS Antenna

Shock Mounted PC-104 Stack
- Single Board Computer
- Solid State Hard Drive
- SAASM Compliant GPS
- Tactical Radio Interface
- 8-port Serial Card

Vehicle Power Interface/Conditioning

OQD Motor Controller

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Squad Leaders Display - CJMTK

Harnessing the Power of Technology for the Warfighter

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Squad Leaders Display - Fixed

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Gunners Display

Weapon Aiming Cues

System Data Interface
Test conducted by MCPD Fallbrook at Hawthorne, NV in Sept 2006

- Test system performance against TTA exit criteria.
  - 40mm HK GMG and M2HB .50cal
  - Direct Fire and Indirect Fire engagements
  - Low and High QE 40mm
  - Average Radial Error for accuracy
  - CEP for burst fire precision
.50 cal Direct Fire @ 1400m

1400m, Direct Fire, Burst Mode

- Burst 1
- Burst 2
- Burst 3
- Initial Target
- Adjust Fire
- Gun-Target Line

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.50 cal Direct Fire @ 4000m
.50 cal Indirect Fire @ 4800m
40mm Direct Fire @ 1600m

1600m, Direct Fire, Low Angle, Single Shot Mode

- Initial Target
- Adjust Fire
- Gun-Target Line
40mm Direct Fire @ 1600m
40mm Indirect Fire @ 1600m
## HMG TTA Exit Criteria

<table>
<thead>
<tr>
<th>Attribute/Parameter</th>
<th>Current</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Weight</td>
<td>150 lbs – foot mobile with 3 Marines</td>
<td>Shall not increase number of personnel needed to transport weapon</td>
<td>Shall not add more than 10 pounds total to weapon system</td>
</tr>
<tr>
<td>Indirect Fire Engagement Time - ground</td>
<td>Greater than 15 minutes</td>
<td>Less than 7 minutes</td>
<td>Less than 2 minutes</td>
</tr>
<tr>
<td>Indirect Fire Engagement Time - vehicle</td>
<td>No Capability</td>
<td>Less than 7 minutes</td>
<td>Less than 2 minutes</td>
</tr>
<tr>
<td>40mm Indirect Fire Accuracy - first shot</td>
<td>Radial error greater than 200m</td>
<td>Average radial error &lt; 50m</td>
<td>Average radial error &lt; 15m</td>
</tr>
<tr>
<td>40mm Indirect Fire Accuracy - first adjust</td>
<td>Unknown</td>
<td>Average radial error &lt; 15m</td>
<td>Average radial error &lt; 5m</td>
</tr>
<tr>
<td>40mm Fire Precision - automatic fire</td>
<td>Unknown</td>
<td>Achieve CEP &lt; 50 m</td>
<td>Achieve CEP &lt; 15 m</td>
</tr>
<tr>
<td>.50 cal Indirect Fire Accuracy - first burst</td>
<td>No Capability</td>
<td>Achieve beaten zone impact within 100m of target</td>
<td>Achieve beaten zone impact within 50m of target</td>
</tr>
<tr>
<td>.50 cal Indirect Fire Accuracy - first adjust</td>
<td>No Capability</td>
<td>Achieve beaten zone impact within 50m of target</td>
<td>Achieve beaten zone impact on target</td>
</tr>
<tr>
<td>.50 cal Direct Fire accuracy on first burst</td>
<td>Unknown</td>
<td>Achieve beaten zone impact on target at 75% of weapon’s maximum effective range (1400m)</td>
<td>Achieve beaten zone impact on target at 110% of weapon’s maximum effective range (2000m)</td>
</tr>
<tr>
<td>Integrated Fire Control</td>
<td>No automated fire control for indirect fire</td>
<td>Provide onboard fire control using HMG-unique BK</td>
<td>Provide onboard fire control using integrated NABK</td>
</tr>
<tr>
<td>Networked Fires Connectivity</td>
<td>Voice only.</td>
<td>External connectivity to higher echelons via JVMF encoded messages</td>
<td>Same as threshold.</td>
</tr>
</tbody>
</table>
Results Summary

• Achievable effects on target on initial engagement
• Consistent effects on target after first adjustment
• Low angle accuracy is better than High angle, but allows for less mask clearance
Potential Enhancements

- Improved inertial sensor
  - Smaller/lighter
  - Improved accuracy
  - Greater shock tolerance

- Ammunition improvements
  - More consistent muzzle velocity
  - Less variance from propellant temp

- Wind compensation
  - Improved collection of wind data
  - Better incorporation of wind data into BK
Questions?

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