Common GPS: Development of the Subsystem Specification and ICD for the Common GPS Subsystem for the family of Precision Guided Projectiles

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Outline

• Objectives and Rationale
  – Common GPS goals
  – Unique requirements imposed by indirect fire gun-launched PGMs

• Development Approach and Current Status
  – Participants and stakeholders
  – Relevant milestones and future activity

• Overview of Documents
  – Scope of requirements
  – What is and is not covered

• Conclusion
Objectives

• Define req’ts for common GPS with A/J subsystem across future Joint gun-launched Precision Guided Munitions (PGMs)
  – Develop vendor-neutral Specification and ICD that addresses gun-launched PGM needs (applicable across 81, 105, 120, and 155 mm projectiles) without favoring any one particular solution or technical approach
  – Address A/J req’ts and hardware needs, including projectile spin environments up to 300 Hz
  – Address anti-tamper and modernization imperatives

• Enable GPS hardware commonality benefits
  – Competition in the supply chain: lower unit production cost and hardware availability
  – Simplified integration

*Focused on Common GPS Solution for Major Joint M-Code Market Segment*
Why are Indirect Fire Gun-Launched PGMs Different?

<table>
<thead>
<tr>
<th>Initial Conditions</th>
<th>Indirect Fire Gun-Launched PGMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load GPS Ephemeris data prior to launch and reacquire after muzzle exit at high velocity (up to 800 m/s)</td>
<td></td>
</tr>
<tr>
<td>Shock Environment</td>
<td>Extreme (up to 21,000 Gs)</td>
</tr>
<tr>
<td>Spin Environment</td>
<td>High Spin (up to 300 Hz)</td>
</tr>
<tr>
<td>Size, Weight, Power (SWP)</td>
<td>Desired 40mm Diameter</td>
</tr>
<tr>
<td>Set-Time Requirement</td>
<td>Less than 10 seconds</td>
</tr>
<tr>
<td>POR Quantities</td>
<td>&gt; 100,000</td>
</tr>
<tr>
<td>Durable vs. Consumable</td>
<td>Consumable</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>20 Years</td>
</tr>
</tbody>
</table>

Gun-Launched PGMs Represent Most Demanding Environment
Indirect Fire Gun-Launched PGMs

Mortars
XM395 Accelerated Precision Mortar Initiative (APMI)

- 120mm conventional High Explosive (HE) mortar cartridges equipped with GPS guidance fuse and modified stabilization fins
- Provides Battalion commander with organic precision capability ≤10m CEP
- Urgent Need Fielding: Mar 2011

Provides for complementary employment of precision capacity across the tactical battle space

Artillery
XM982 Excalibur

- Autonomous fire & forget, optimized for urban/complex terrain

<table>
<thead>
<tr>
<th>Increment</th>
<th>Range</th>
<th>Accuracy</th>
<th>Fielding Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a-1</td>
<td>8-24Km</td>
<td>≤ 10m*</td>
<td>Fielded</td>
</tr>
<tr>
<td>1a-2</td>
<td>8-40Km</td>
<td>≤ 10m*</td>
<td>2QFY11</td>
</tr>
<tr>
<td>1b</td>
<td>8-40Km</td>
<td>≤ 10m</td>
<td>3QFY14</td>
</tr>
</tbody>
</table>

*significantly exceeding accuracy requirements >6m

XM1156 Precision Guidance Kit (PGK)

- GPS guidance fuze for 155mm conventional High Explosive (HE) artillery projectiles
- Turns our conventional HE stockpile into near precision rounds ≤ 50m CEP (range independent)
- MS C in FY13
Requirements Development Approach

• Team of stakeholders and experts
  – Government
  – Vendors
  – Integrators
  – Draper Laboratory

• Interface Control Working Group (ICWG) consensus building approach
  – Focus initially on areas of agreement
  – Iteration - Multiple review cycles

• Milestone/Timeline
  – Kickoff: May 2009
  – ICWG Meetings #1 and #2: Nov 2009, March 2010
  – Finalized Initial Spec and ICD: Aug 2010
  – Planned near-term “one pass” revision: April/May 2011
Specification and ICD Scope

- Generic projectile guidance system architecture functional block diagram
  - GPS U/E only
  - GPS + A/J electronics
  - Guidance & Navigation System

- System boundary defines included functionality and interfaces
  - Trade study identified benefits/detrements of each approach

Common GPS Specification and ICD Scope defined by Purple Box

Enables a Common GPS Supplier Paradigm for Gun-Launched PGMs
Mechanical/Form Factor Requirements

• ICWG Team consensus not attainable today
  – Vendors have divergent SAASM roadmaps
    • Circular card perpendicular to axis line-of-fire
    • Gum-Stick form factor along axis line-of-fire
  – Integrators do not want design constraints

• Common GPS Program strongly influenced by Fuze Well Volumetric SWP considerations
  – Constraints imposed by legacy SAASM-based designs
  – User Equipment not based on KDP hardware enable greater design flexibility for miniaturization

Focused on modularity imperative for Joint Service PGM applications
Specification Contents

- External Interfaces (electrical and data exchange requirements)
- States and Modes
- Functional Requirements
  - Self Test
  - Reprogramming
  - Data Storage
  - Operating Conditions [GPS Signal]
  - GPS Reacquisition
  - Security Requirements
- Performance Requirements
  - Time-to-Usable-Navigation
  - Reacquisition
  - Position, Velocity, and Attitude accuracy
  - Timing
  - Performance in a Jamming Environment
- Quality and Reliability
- Environmental Requirements
  - Storage & Transportation
  - Operating
- Verification Methods
Jamming Requirements

• Developed from multiple sources:
  – Excalibur requirements: laydown and jammer types
  – Joint Navigation Warfare Center (JNWC) intelligence briefings focused on current threats
  – Operational considerations for mortars and cannon munitions

• Captured as a classified Appendix to Specification where J/S levels are defined

• Verifiable by reasonable methods as outlined in the Specification
  – Reference antenna characteristics
  – Analysis and test at specified points on a reference trajectory
ICD Boundary

- 2 or 4 (L1-only or L1/L2) antenna input
- Keying through Mission Computer or dedicated interface
- Data messages based on existing AF GPS Directorate ICDs
- Mechanical interfaces not defined
- Electrical connectors not defined
ICD Data Detail

• Trade study investigated using a modern data bus such as FireWire (IEEE 1994b)
  – Unanimous pushback from integrators and vendors
  – Other multi-point and point-to-point protocols considered
• MCSI (Mission Computer Serial Interface) and TEI (Test Equipment Interface) are 3.3V CMOS serial with selectable data rates
  – MCSI messages based on IS-GPS-153D
  – All TEI data messages vendor defined
Conclusion

- Focused on a Common GPS Solution for major Joint Service M-Code Market Segment

- Gun-Launched PGMs Represent Most Demanding Environment

- Definition of MGUE CDD Appendix for PGMs underway

- Enables a Common GPS Supplier Paradigm for Gun-Launched PGMs

*This Common GPS Spec and ICD will continue to be refined and evolve*