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?

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

Gun-Launched PGMs Represent Most Demanding Environment

Indirect Fire Gun-Launched PGMs

Mortars

XM395 Accelerated Precision Mortar Initiative (APMI)
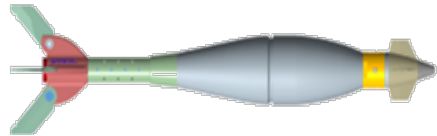
- 120mm conventional High Explosive (HE) mortar cartridges equipped with GPS guidance fuse and modified stabilization fins
- Provides Battalion commander with organic precision capability ≤10m CEP
- Urgent Need Fielding: Mar 2011

Provides for complementary employment of precision capacity across the tactical battle space
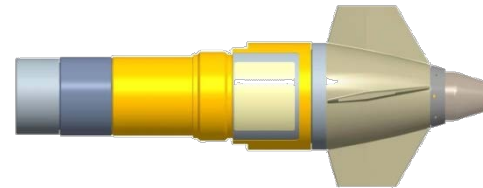
Artillery
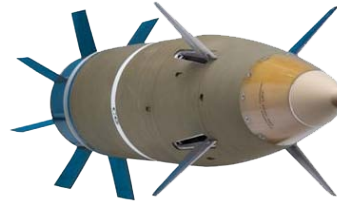
XM982 Excalibur

Autonomous fire & forget, optimized for urban/complex terrain

Increment	Range	Accuracy	Fielding Status
1a-1	8-24Km	≤ 10m*	Fielded
1a-2	8-40Km	≤ 10m*	2QFY11
1b	8-40Km	≤ 10m	3QFY14

*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**

Definition of MGUE CDD Appendix for PGMs underway

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/detriments of each approach**
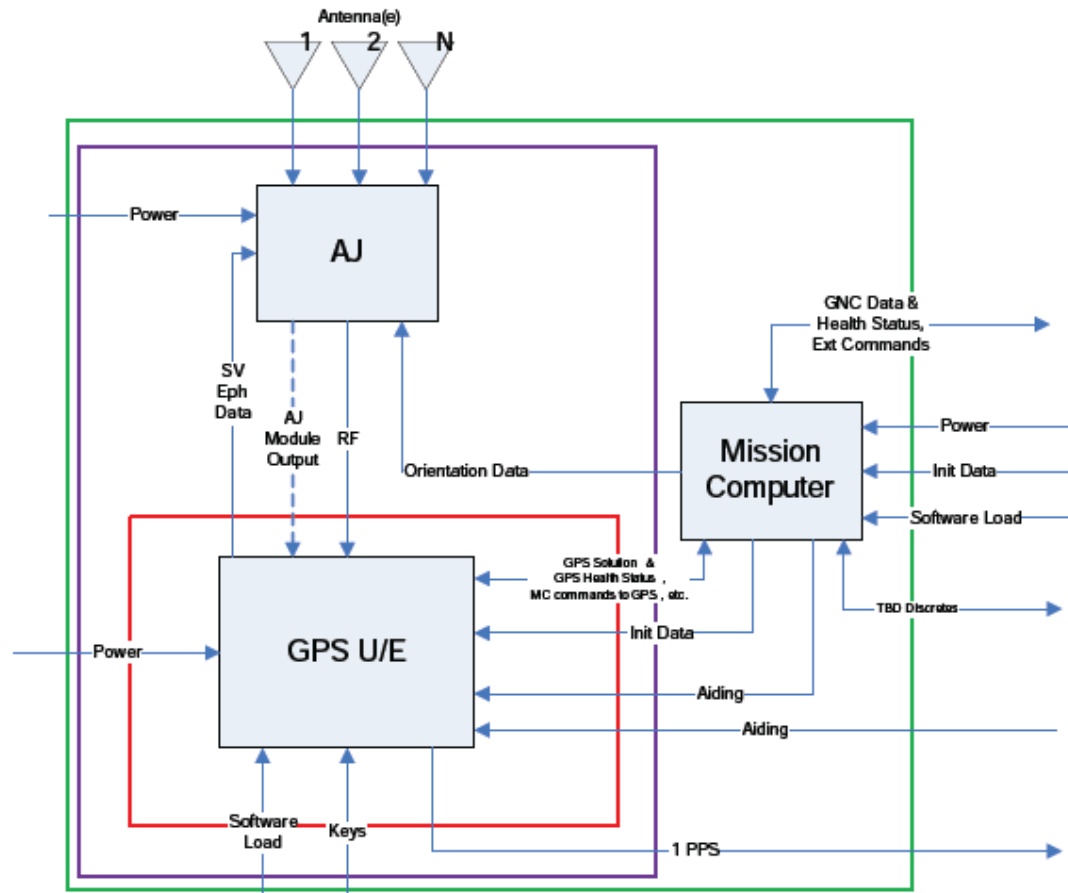
Common GPS Specification and ICD Scope defined by Purple Box

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**
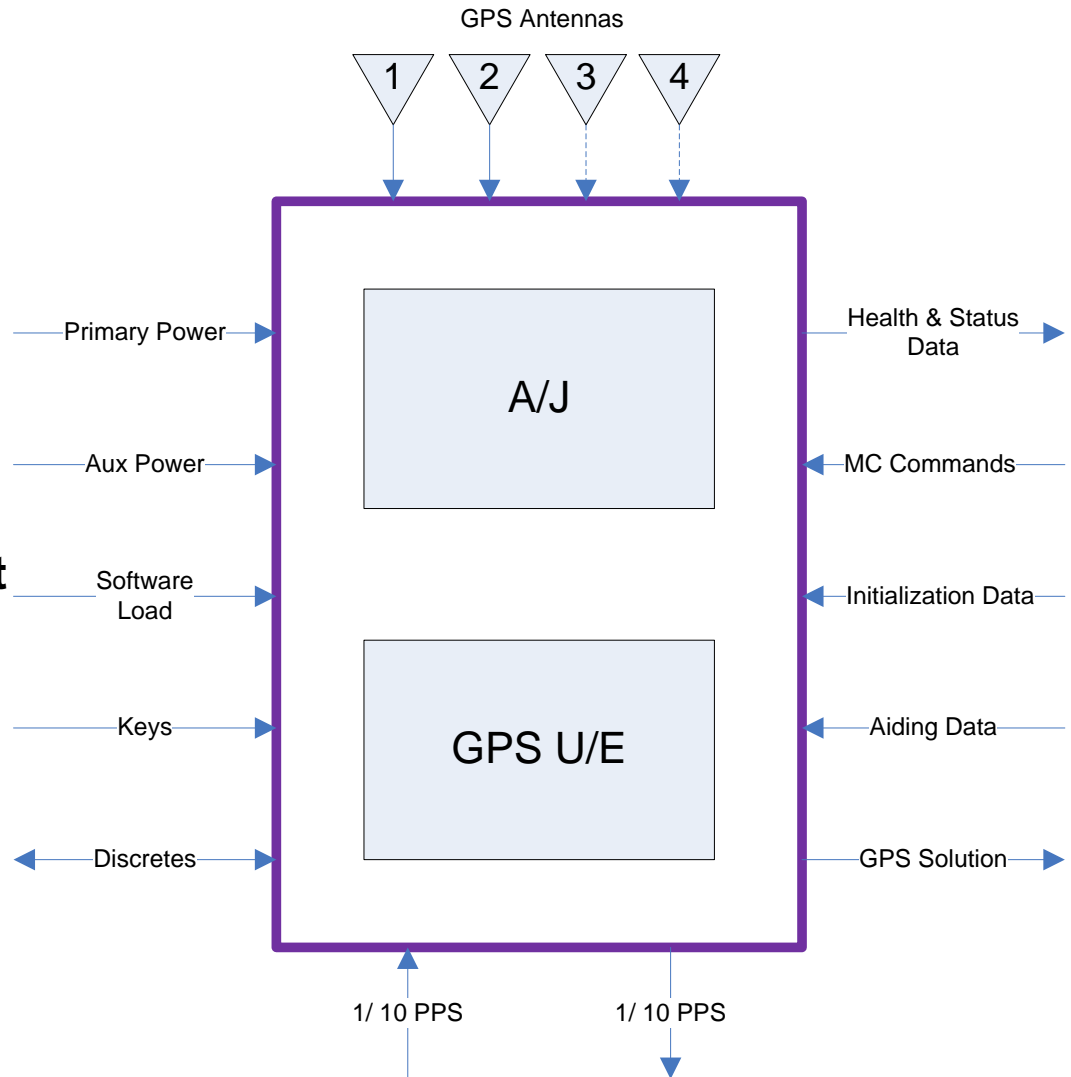 - **Operating**
- **Verification Methods**

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**
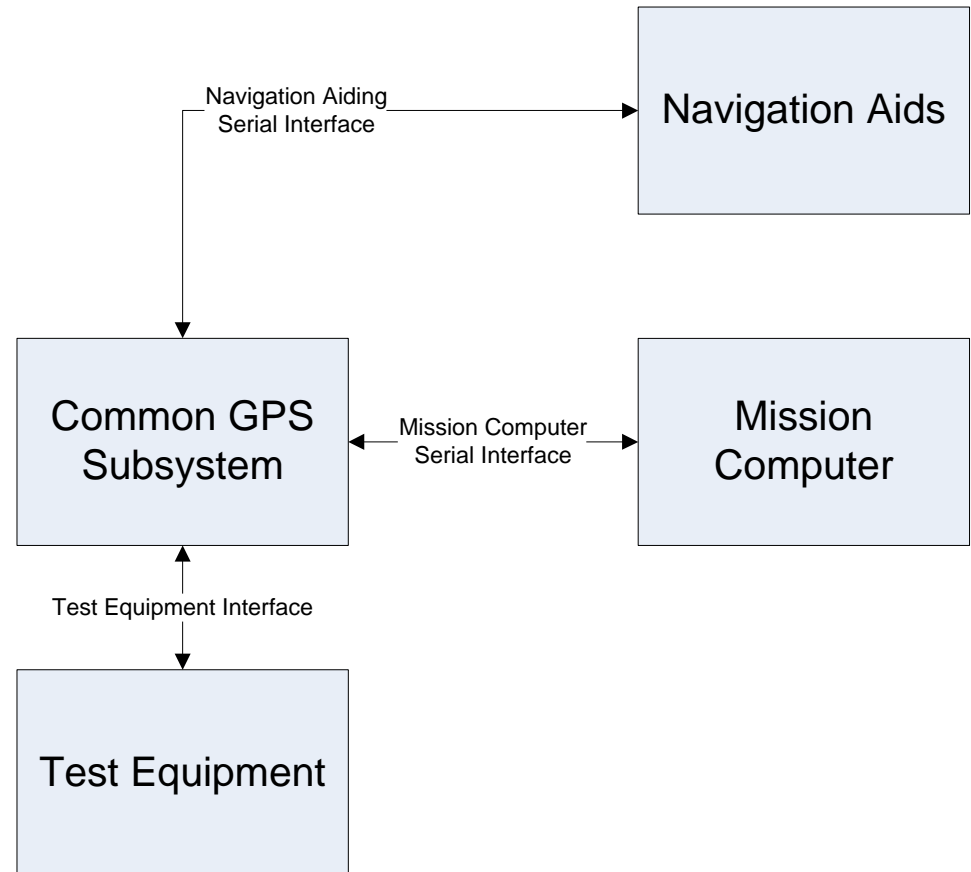 - **Analysis and test at specified points on a reference trajectory**

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**

GPS Antennas

1 2 3 4

Primary Power

Aux Power

Software Load

Keys

Discretes

A/J

GPS U/E

Health & Status Data

MC Commands

Initialization Data

Aiding Data

GPS Solution

1/ 10 PPS   1/ 10 PPS

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**

Navigation Aiding Serial Interface → Navigation Aids

Common GPS Subsystem ←Mission Computer Serial Interface→ Mission Computer

Test Equipment Interface

Test Equipment

Conclusion

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- **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

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