40th Annual Armament Systems: Guns - Ammunition - Rockets – Missiles Conference

MEMS IMU – Common Guidance

Dr. Vicki C. LeFevre

Mrs. Lynne K. Rider

Mr. David W. Panhorst

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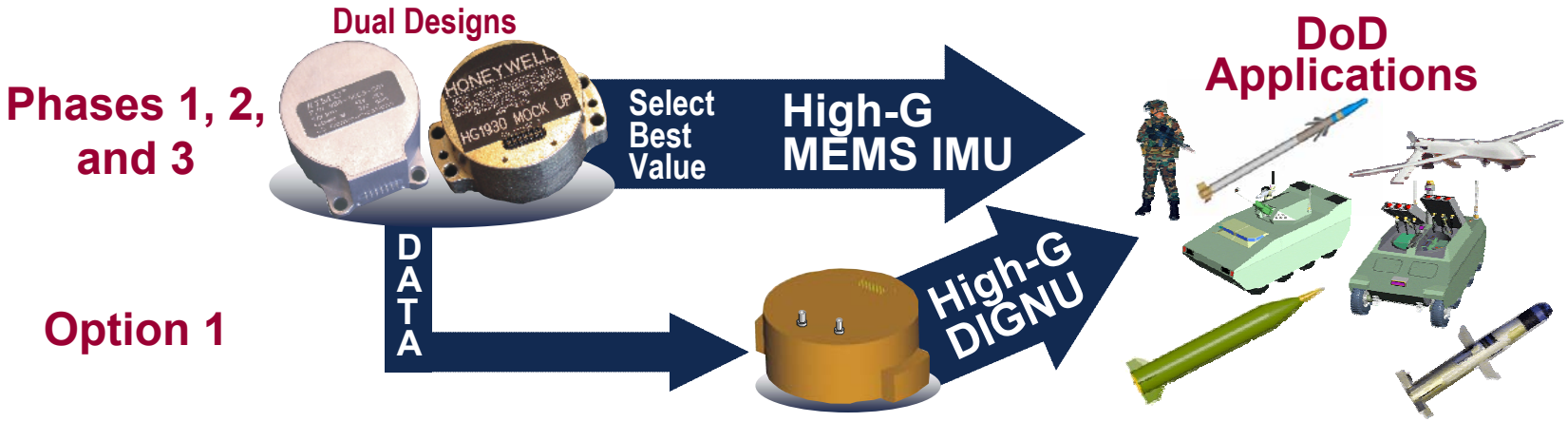
Program/Business Strategy

- **Go To Multiple IMU Design / Manufacturing Teams**
  - L3/IEC
  - Honeywell/Draper/Rockwell Collins
- **Build to Common Requirement**
- **Leverage Process Improvements into Multiple DoD Applications**
- **Teams Incorporate Common IMU into Common, Deeply Integrated (GPS/IMU/AJ) Guidance & Navigation Unit (DI-GNU) Built to Common Specification**



Technology Investment Areas

S & T	***ManTech***
PERFORMANCE DRIVERS •Size •Weight •Performance •Power •Environment •Reliability	**COST DRIVERS** •Touch Time •New Capital Equipment •New Process Development •New Product Development •Low Volume Production
PERFORMANCE IMPROVERS •Technology Development - Design - Test - Evaluate •Improve Design •Improve Technology •Do It Again	**COST REDUCERS** •Automation - Improved Consistency - Reduce Touch Time •Upgrade Equipment -Better Control -Improved Yield •Consolidate •Economy of Scale

Using Manufacturing Technology to achieve Technical Performance Goals

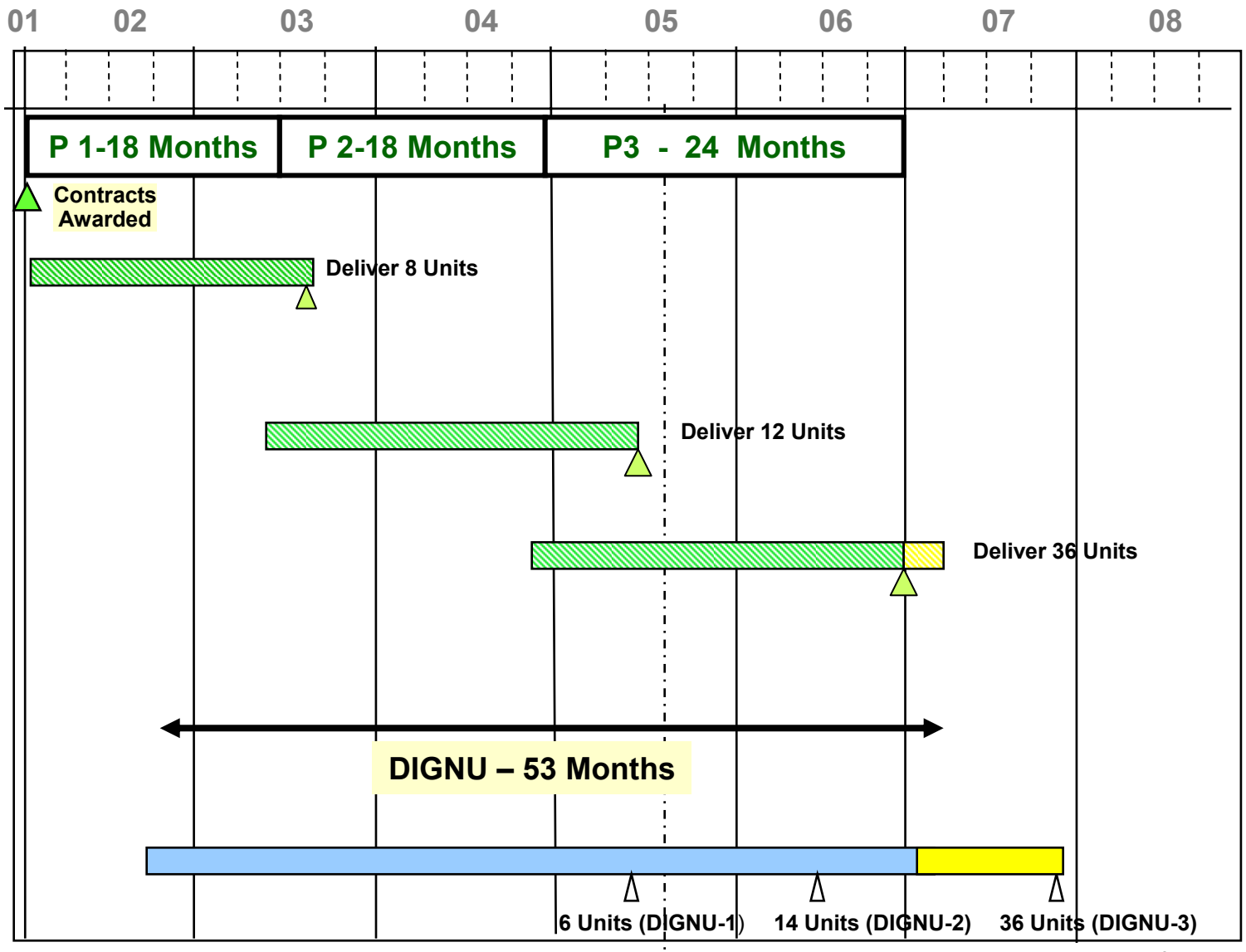
Program Milestones

Phase 1 (3 KTRs)
System Process/ Definition and Sensor and Electronic Design Development; JCG ICD IMU Demo 10K G, < 75 °/hr,< 9 mg, < 8 cu. in.

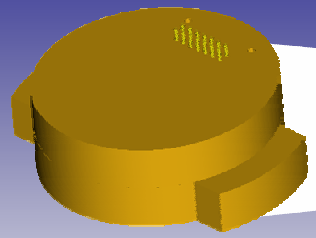
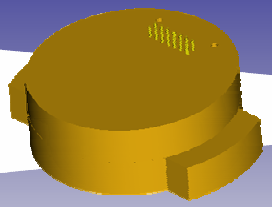
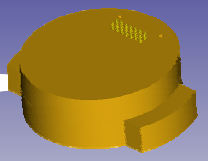
Phase 2 (2 KTRs Min)
IMU Demo > 20,000g, < 20°/hr, < 4mg, < 4 cu in over Environment,

Phase 3 (2 KTRs Min)
IMU Demo > 20K G, 1°/hr, < 1 mg
< 2 cu. in. over Environment,
< $1,200/IMU

Option 1 (2 KTRs Min) DI-GPS/ ISA-IMU / AJ, 4 cu. in., Intg Demo(s), > 20K G, < 1 °/hr over High-G Enviro < $1500



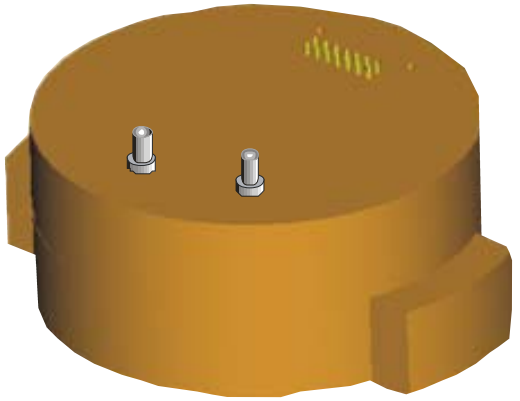
High-G MEMS IMU Evolution

Phase 1	Phase 2	Phase 3
		
<75 Deg/Hr <8 in3 >10 K Gs <9 mg	<20 Deg/Hr <4 in3 >20 K Gs <4 mg	<1 Deg/Hr <2 in3 >20 K Gs <1 mg
18 Months	18 Months	24 Months

Incrementally Shrink Volume and Power While Improving Performance

Deeply Integrated Guidance and Navigation Unit (DIGNU)

- Traditional GPS/INS Integration Enhances A/J Loss of Lock Capability
- Deep Integration Concept Provides 15-20 db A/J Over Conventional Tightly Coupled Solutions (SW Solution Only)



- Improves Weapon Effectiveness by Decreasing CEP
- Common Interface Control Document (ICD)
- Single Processor Architecture
- Higher Reliability

Knowing Where You Are
And Where You Need To Be

Program Output

Provide Common MEMS IMU/DIGNU for 90% of all DoD Applications

- ***Common Interface Control Document for compatibility across multitude of platforms***
- ***Common Performance Specification for consistent output signals***
- ***Two qualified suppliers producing interchangeable devices***

Implementation of System Engineering principles ensure that customer needs are met!

Quality Function Deployment (QFD)

- Two deployments to date
  1. focus on specific technical characteristics
     - provided valuable specification input
     - answered questions on interfaces, environments, and sensor performance
  2. focus on understanding the customer base and their top level requirements
     - resulted in a prioritized list of customers based on:
       - compatibility of production schedules
       - anticipated production volumes
     - allows evaluation of current requirements/cost drivers
     - provides basis for programmatic decisions

- Use of this SE tool resulted in comprehensive understanding of end-user needs

QFD – 1
Example of Results

Requirement	Original Spec	Range of Answers
Per unit cost	<$1200	$1650 to <$1900
Volume	<2 cubic in.	4 cubic in.
Dynamic G-range	30 g	70-100 g
Built in test	Coverage of 80% of testable failures	Max Power up BIT of 95%
Max input power	≤5W	5.25W

Customer QFD Results (by Phase)

Customer	Prod.Yr	IMU vol	Performance
MRM	2009	Phase 2	Phase 2
ERM	2006	Phase 2	Phase 2
PGMM	2008	Phase 2	Phase 2
Excalibur	2005	Phase 2	Phase 2
AGS-LRLAP	2008	Phase 2	Phase 2
SDB	2008	Phase 2	Phase 3
APKWS	2006	Phase 2	Phase 3
JCM	2008	Phase 2	Phase 3
GMLRS	2005	Phase 2	Phase 3
JSOW	2009	Phase 2	Phase 3
JDAM	2008	Phase 2	Phase 3
THAAD	2007	Phase 2	Phase 3
WCMD	2007	Phase 2	Phase 3
Soldier Navigation	2006	Phase 3	Phase 3

Next Steps

- End User feedback on ICD and Performance Specification
  - Contact Information to receive a copy of documents

    Tobey Coombe
    John J. McMullen Associates Inc.
    Engineer
    (202)-741-2041
    TCoombe@JJMA.com
- Requirements data being tracked with SLATE software
- ICD and specs in Configuration Management Control

Summary

- Program structured to meet 90% of end user needs
- Progressing toward meeting both technical and programmatic Phase 3 goals by 1QFY07
- System Engineering has added discipline to the approach