

GENERAL DYNAMICS

Ordnance and Tactical Systems

Low Cost Course Correction (LCCC) Technology Applications

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Basic Description

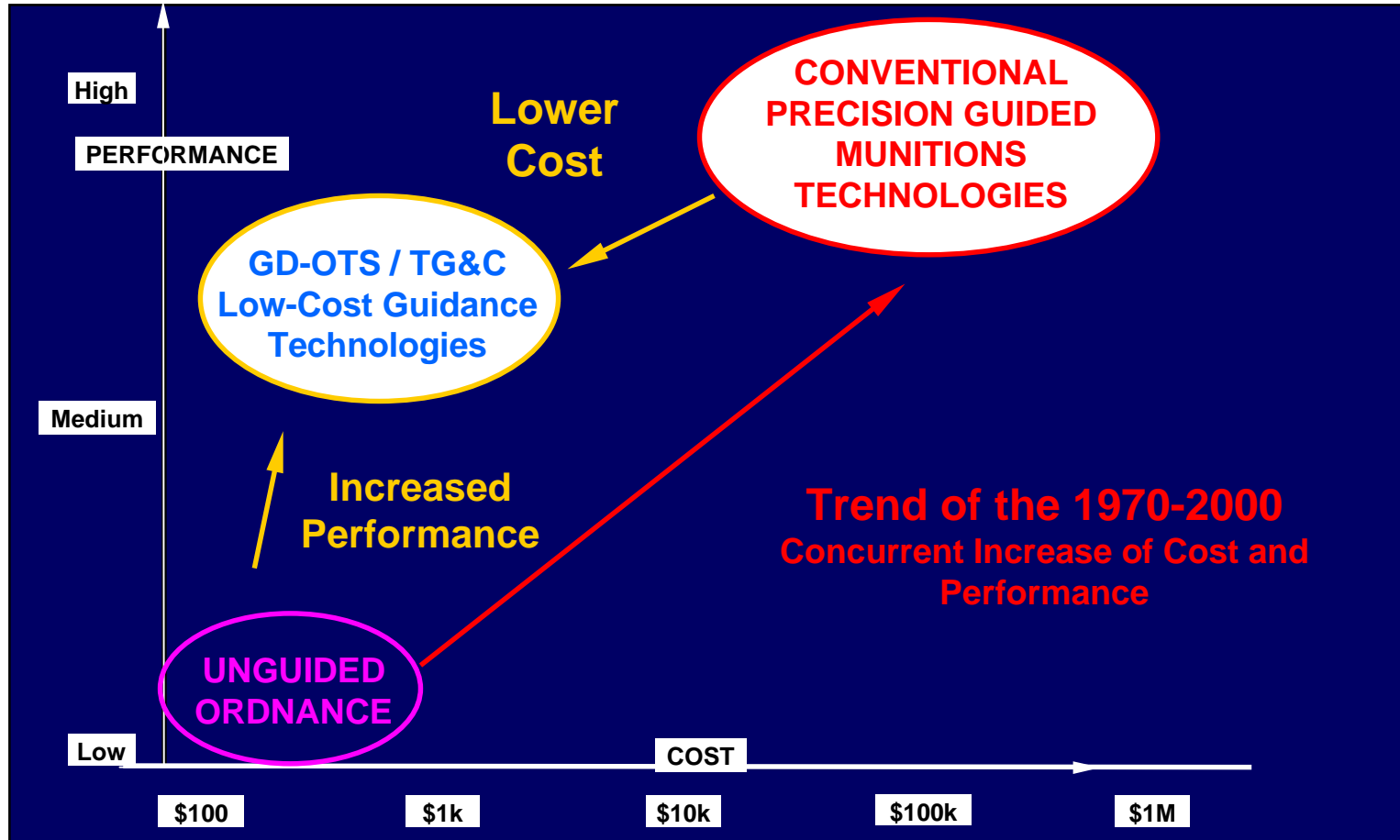
Low Cost Course Correction (LCCC)

- A Non-Gimbaled, Wide FOV, Semi-Active Laser (SAL) Based Projectile Guidance System
- Uses “Off the Shelf” Parts from High Volume Component Suppliers
- Uses Low Cost Pyrotechnic Diverters for Trajectory Adjustments (Stowed Impulse - Chemical Energy)
- Suited to High-G Gun Launch Applications (no moving parts)
- Has its Limitations from a Pursuit Guidance and “One Shot One Kill” Perspective but Ideal for “Close is Good Enough” or Multiple Shot Scenarios



The New Defense Paradigm

High Performance at Low to Moderate Costs



What Is Low Cost?

Everyone Seems to Be Claiming the “Low Cost” Attribute Because it Does Sound Good

- If Compared to the Cost of an Unguided Round Most Guided Munitions Labeled as Low Cost Are Still too Expensive for Widespread Fielding (10X to 20X the cost)
- Most Low Cost Claims Stem from Estimates Based on Production Volumes Which May Never Materialize 5 to 10 Years Down the Road When Actual Procurement Begins
- A \$60K Missile May Be Low Cost Compared to its First Generation Predecessor and May Perform Exceptionally Well, **BUT** that Level of Per Unit Cost Prevents Widespread Application to Bullets Given the DoD’s Projected Procurement Budgets



What Is Low Cost to a Munitions Manufacturer?

GD-OTS Wants to Bridge the Gap Between Traditional Unguided Munitions and Today's Low Cost Precision Guided Munitions

- Typical Larger Caliber Munitions Cost Roughly Between \$1,000 to \$3,000 Per Round Depending on Sophistication, Materials and Fuze Type
- LCCC is Estimated to Add Approximately \$2,000 to the Cost of Unguided Large Caliber Rounds
- LCCC Leverages Off Existing Munition Thereby Eliminating the Need for Costly Munitions Development and Qualification
- This Estimate is Based More on Actual Parts Costs and Less On Discounts Due to Future Procurement Volume



How is it Possible?

Give Up Some Precision to Achieve Low Cost

- Apply the LCCC Technology Where it Makes Sense
 - Improve the CEP of Area Weapons (especially VLR-RAP) and Use the Precision Guided Stuff for High Value Targets Only **OR** Use Multiple LCCC Rounds to Defeat the Target
 - Improve the TID for Multi-Purpose Direct Fire Projectiles at Extended Ranges (2KM to 4KM) and Use the More Sophisticated Stuff When Necessary (BLOS scenarios)
 - Provide the Level of Precision Necessary for Certain Short Range Applications (Shoulder Fired Rockets)
- Don't Design the System to Meet Today's Precision Standards – Open Up the Guidance Requirements to Reduce Unit Cost During Manufacturing



How is it Possible?

Give Up Some Precision to Achieve Low Cost

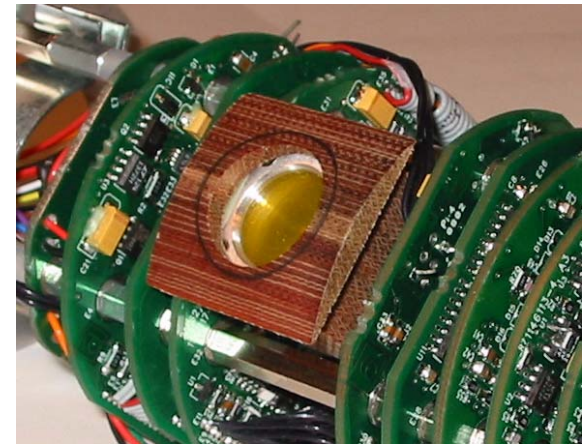
- Eliminate the Need for Inertial Sensors Altogether for Shorter Range Applications
- Incorporate Low Cost – High Drift Rate MEMS Based Inertial Sensors for Longer Range Applications
 - Use an Inexpensive MEMS IMU to Correct Initial Errors and Finish Up with Laser Guidance
- Leave Costly Target Recognition and Classification to the Satellites, UAV's and Forward Observers
 - Remote Robotic and/or UAV Based Laser Designators Will Reduce Risk to Laser Designator Operators While Maintaining the Man-In-the Loop Decision Process



Vertical Sensor

Vertical Orientation and Spin Rate Sensor

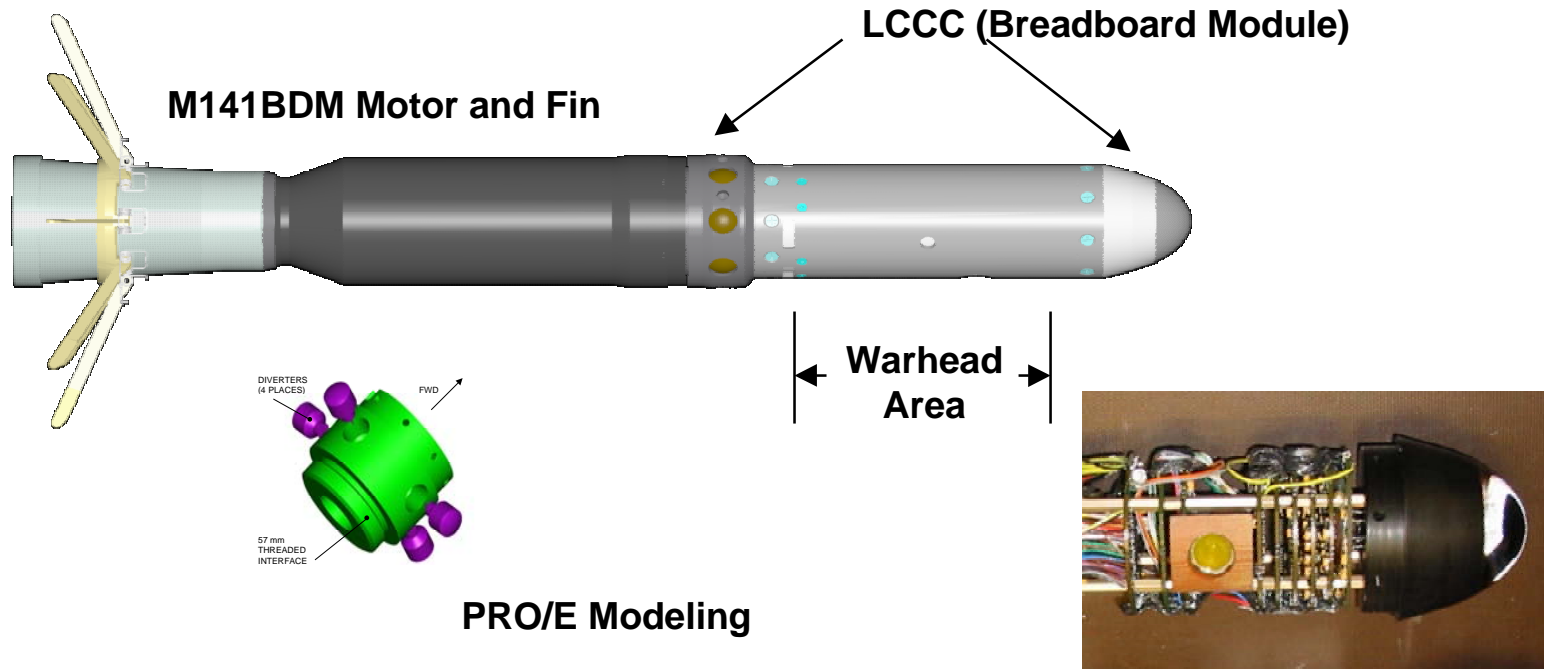
- Low Cost Sensor Eliminates Need for IMU for Short Range Tests
- Proven Functionality During Multiple 2.75" LCCC Relevant Environment Rocket Tests (6.5km Range)
- Air Gun Tested to 16,000 G's



Shoulder Fired Mmunition Demonstrator

ARDEC Sponsored LCCC Demonstration

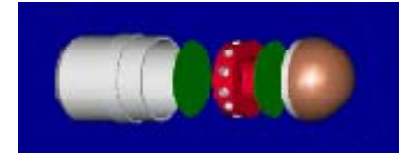
- LCCC Integrated with M141 BDM Shoulder Fired Munition
- First Flight Tests in August 04



Medium Caliber Applications

40mm Applications

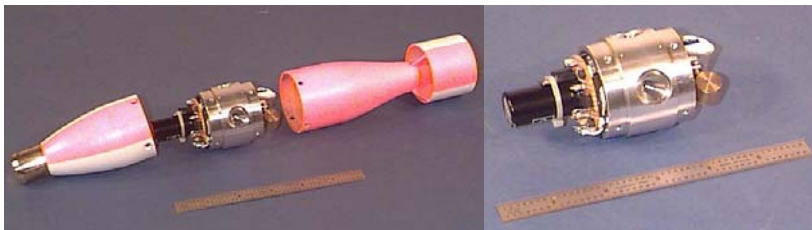
- Inexpensive Optics
 - 25-mm Aperture Plastic Lens (injection molded)
 - Low-Pass Pigment Filter Integral to Lens or Clear Lens with Separate Narrow-Band Interference Filter
 - 13-degree Field of View
- Silicon Quadrant Photo Detector Array
 - Uncooled
 - Sensitized for 1064-nm Optical Wavelength
- Simple Electronics
 - Commercially Available Parts



40mm Grenade Concept



4 Element Diverter
Module Test



50mm
Experimental
Guided
Projectile



40mm
Experimental
Seeker



Concluding Remarks

- **Requirements That Can Be Addressed by LCCC Type Systems Must Be Created by the User in Order to Drive the Commercial Interests of Ammo Systems Suppliers**
 - **Effective Analysis Indicates Large Operational Benefits with Course Corrected Munitions**
- **LCCC Like Guidance Systems Can Be in Production Within 2 to 3 Years at One Third the Development Cost of Precision Guided Munitions**
- **An LCCC System May Be the Near Term Solution for Providing Accuracy Improvements Now (20M CEP or less) at an Affordable Cost**
- **2nd and 3rd Generation LCCC Type Systems Could Very Well Be the Path Towards Precision Systems at the \$2K-\$4K Unit Cost Level**

