

# GENERAL DYNAMICS

Ordnance and Tactical Systems

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## Low Cost Course Correction (LCCC) Technology Applications

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## Basic Description

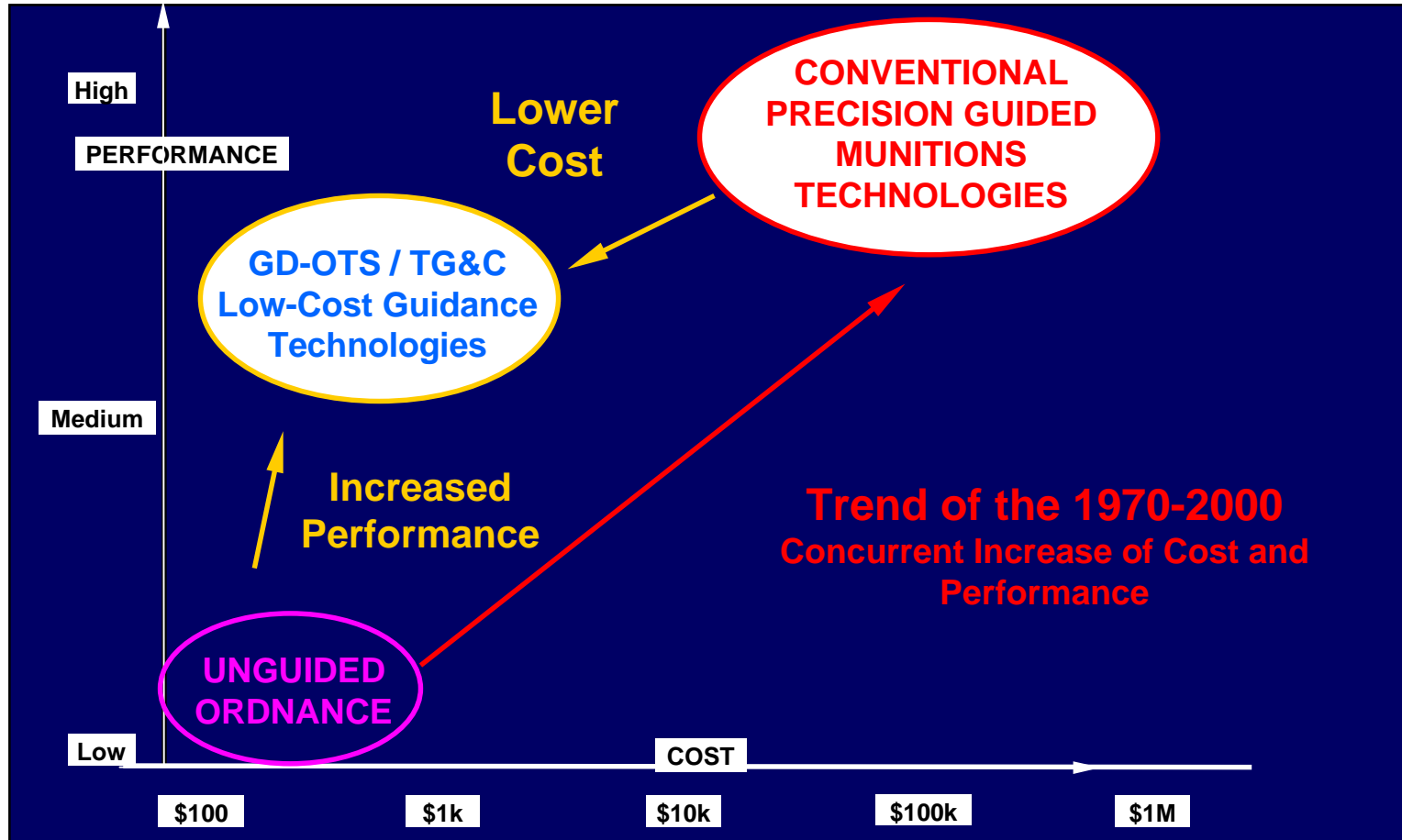
### Low Cost Course Correction (LCCC)

- 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

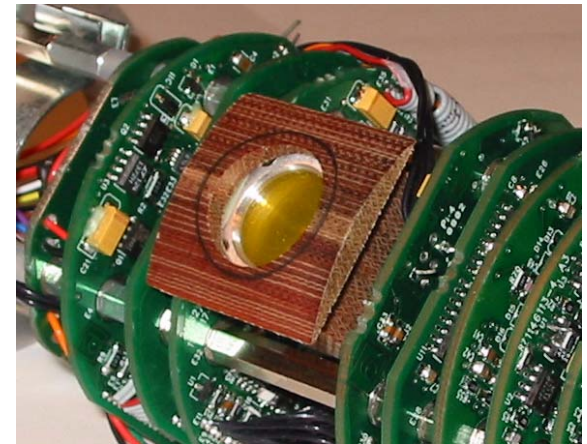
- Eliminate the Need for Inertial Sensors Altogether for Shorter Range Applications
- Incorporate Low Cost – High Drift Rate MEMS Based Inertial Sensors for Longer Range Applications
  - Use an Inexpensive MEMS IMU to Correct Initial Errors and Finish Up with Laser Guidance
- Leave Costly Target Recognition 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

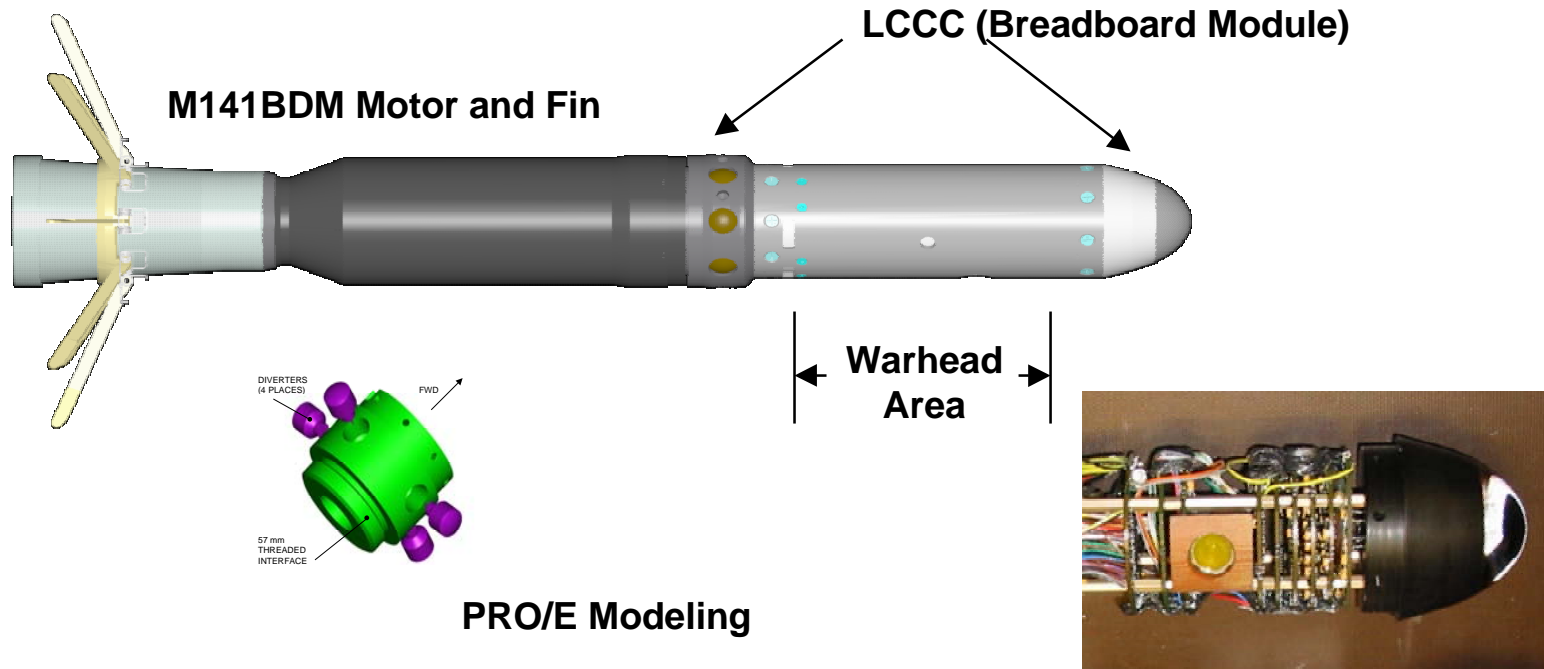




# Shoulder Fired Mmunition Demonstrator

## ARDEC Sponsored LCCC Demonstration

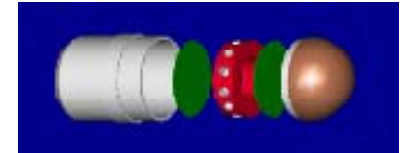
- LCCC Integrated with M141 BDM Shoulder Fired Munition
- First Flight Tests in August 04



# Medium Caliber Applications

## 40mm Applications

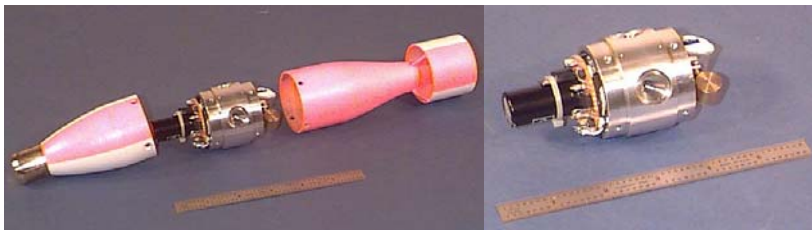
- Inexpensive Optics
  - 25-mm Aperture Plastic Lens (injection molded)  
Low-Pass Pigment Filter Integral to Lens or Clear Lens with Separate Narrow-Band Interference Filter
  - 13-degree Field of View
- Silicon Quadrant Photo Detector Array
  - Uncooled
  - Sensitized for 1064-nm Optical Wavelength
- 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**
- **2<sup>nd</sup> and 3<sup>rd</sup> Generation LCCC Type Systems Could Very Well Be the Path Towards Precision Systems at the \$2K-\$4K Unit Cost Level**

