DDG 1000 Case Study - Overview

Risk Based Source Selection Concept

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07 November 2006

Surface Warfare N86

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DDG 1000 ZUMWALT Class Destroyer

Characteristics

Length	600 ft	Displacement	14,564 LT
Beam	80.7 ft	Installed Power	78 MW
Draft	27.6 ft	Crew Size (incl. Aviation detachment)	142
Speed	30 kt		

Sensors

Dual Band Radar
- S-Band VSR
- X-Band MFR

HF & MF Bow Sonar Arrays

Multi-Function Towed Array

EO/IR System

ES System

Weapons

(80) Advanced vertical launch cells for Tomahawk, ESSM, Standard Missile

(2) AGS 155 mm guns

(600) 155 mm rounds

(2) 57 mm Close In Guns

Torpedo Defense (Space Reservation)

Anti-Terrorism (Space Reservation)

Superstructure

Composite structure

Aviation

MH60R and (3) VTUAVs

(Capacity for 2 MH 60Rs)

Integrated Power System

(2) Main Turbine Generators (MTG)

(1) Auxiliary Turbine Generator (ATG)

(2) 34.6 MW Advanced Induction Motors

Integrated Fight Through Power

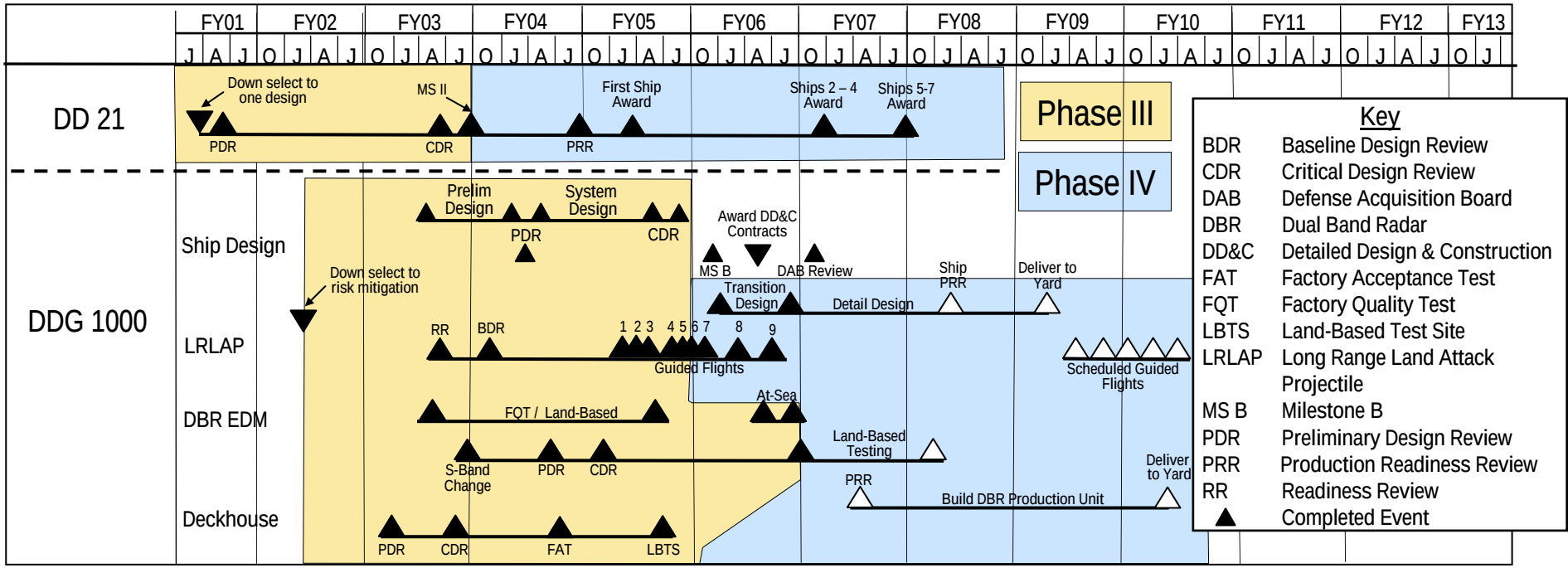
Boats

(2) 7m RHIBs
(sized for (2) 11m RHIBs)

Hull

Wave-piercing tumblehome

DDG 1000 Acquisition Strategy



Technology Development Focused on DD 21 With Limited Prototyping	**Technology Development**	Technology Development Focused on Family of Ships With Extensive Engineering Development Model Prototyping
Down select to Full Service Contractor – Single Step to Full capability	**Acquisition Approach**	Down select to Design Agent – Incremental steps to Full Capability
FY05 Lead and 3 Follow Ships (FY07) Included as Options in Proposals	**Procurement Profile**	FY05 Lead Ships to be Procured Under Separate Contract

DDG 1000 Critical Technologies

Infrared Mockups (IR)

- Land-based suppressor testing complete
- At-sea panel testing complete

Integrated Composite Deckhouse & Apertures (IDHA)

- RCS testing complete
- Co-site testing complete

Advanced Gun System (AGS)

- Initial guided flight testing complete
- Land-based testing complete

Dual Band Radar (DBR)

- MFR sea-based testing complete
- VSR final land based assembly complete

Peripheral Vertical Launch System (PVLS) / Advanced VLS

- Two detonation tests conducted
- Missile restrained firing testing complete

Integrated Power System (IPS)

- Component factory testing complete
- Critical Test Parameters (CTPs) complete

Total Ship Computing Environment (TSCE)

- Software Releases 1, 2, and 3 successfully coded, tested, and authorized by the Government
- Release 4 coding in progress

Hull Form Scale Model

- Performance validated by model testing
- UNDEX testing

Integrated Undersea Warfare (IUSW)

- At-sea mine avoidance testing complete
- Automation testing complete

Autonomic Fire Suppression System (AFSS)

- At-sea weapons effect and autonomic fire suppression testing demonstrated

SPY-3 Multi-Function Radar (MFR)

SPY-3 Engineering Development Model (EDM)
at Wallops Island and onboard the Self Defense Test Ship

*Note: DBR refers to an integrated radar suite made up of MFR (X-band) and Volume Search Radar (VSR) (S-band)

- X-band active phased-array radar detects the most advanced low-observable anti-ship cruise missile (ASCM) threats
- Successfully completed land-based developmental testing at Wallops Island and Electro-Magnetic Interference (EMI) Testing at China Lake
- Successfully completed at sea testing aboard the Self Defense Test Ship
- Demonstrated firm track range and clutter rejection

Results are Characteristic of all EDM Efforts

Integrated Deckhouse and Apertures (IDHA)

Deckhouse EDM at China Lake

IDHA constructed at China Lake

RCS testing event

- Large scale, composite Integrated Deckhouse Assembly (IDHA) with low-observable, high data-rate, multi-beam antennas provide dramatic signature reduction that buys critical battle space
- Radar Cross Section (RCS) Key Performance Parameter (KPP) and Co-Site Performance verified
- Fully qualified a new composite material system of fiber and resin, reducing a major program risk

Results are Characteristic of all EDM Efforts

Phase III EDM Risk Reduction

KEY TECHNOLOGIES	TRL Phase III Start	2002		2003				2004				2005			TRL MS B
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
Integrated Power System (IPS)	3	H	H	H	H	H	H	H	M	H	M	M	L	L	6
Total Ship Computing Environment (TSCE)	3	H	H	H	H	H	M	M	L	L	L	L	L	L	5
Peripheral Vertical Launch System (PVLS) / Advanced VLS	3 / 3	H	H	M	M	M	M	M	M	M	M	M	M	M	5 / 5
Infrared (IR) Mockups	3	M	M	M	M	M	M	M	L	L	L	L	L	L	6
Dual Band Radar Suite – Multi-Function Radar (MFR) / Volume Search Radar (VSR)	5 / 3	M	M	M	M	M	L	L	L	L	L	L	M	L	6 / 5
Integrated Undersea Warfare (IUSW)	4	M	M	M	M	M	M	M	M	M	L	L	L	L	7
Advanced Gun System (AGS) and Long Range Land Attack Projectile (LRLAP)	3	H	H	H	H	H	H	H	M	M	M	M	M	M	6
Hull Form Scale Model	3	H	H	H	H	H	H	H	H	H	M	M	M	M	6
Integrated Deckhouse & Apertures (IDHA)	3	H	H	H	H	H	H	H	H	M	M	L	L	L	5
Autonomic Fire Suppression System	4	M	M	M	M	M	M	M	M	M	L	L	L	L	6

Risk was Reduced while Technology Readiness Levels were Improved!

DDG 1000 Case Study - Requirements

Risk Based Source Selection Concept

Brian Wells
Total Ship System Engineer

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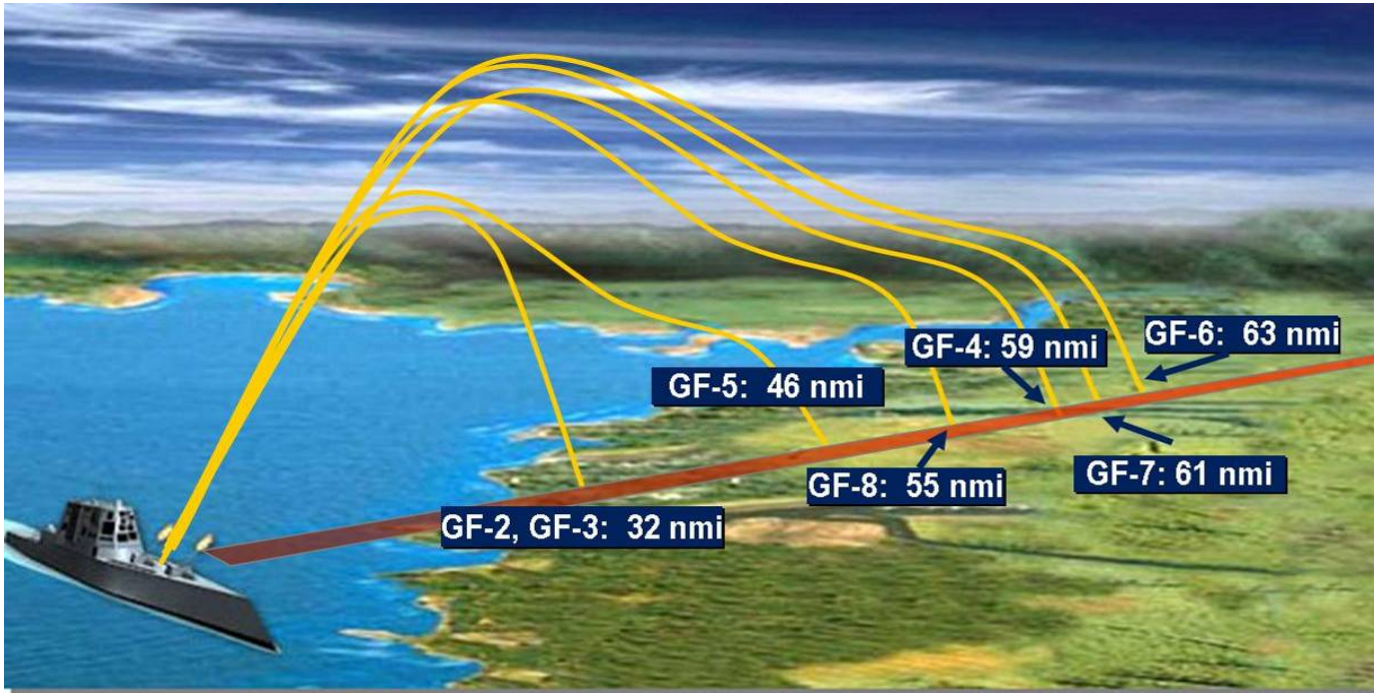
Long Range Land Attack Projectile (LRLAP)



- ORD Threshold/Objective requirement of 63/100 nm, System Requirement of 83nm
- Flight test data allowed for greater accuracy in predicting maximum range
  - System Requirement of 83nm achievable, but at additional cost and increased risk
  - Current design of 76nm well within Test Program demonstrated range, accuracy, and maneuverability and supported program risk reduction
- Traded range to reduce risk and program cost

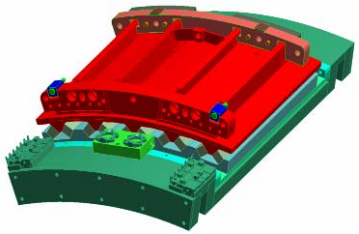
EDM Results Enabled Smart Requirements Trade Offs

Integrated Power System (IPS)

Proof of Concept
Permanent Magnet Motor (PMM)

Transitioned from PMM to AIM before MS B based on EDM Test Program

Advanced Induction Motor (AIM)



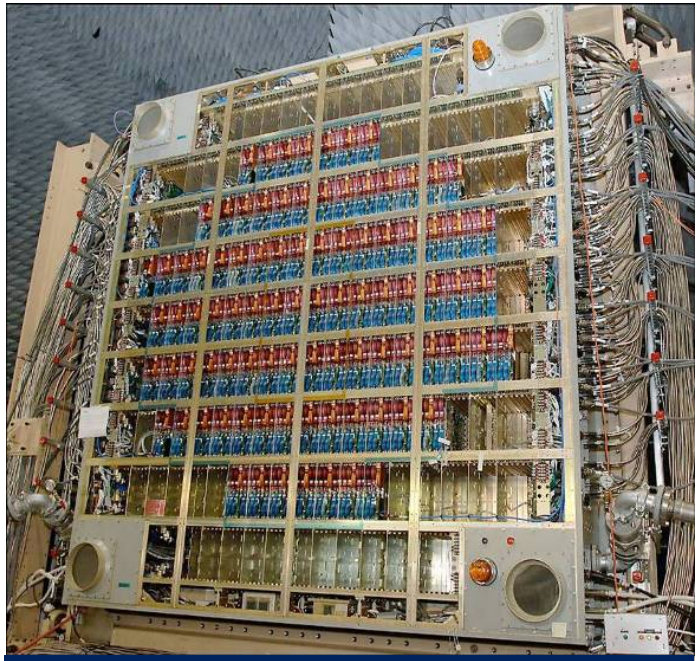
Permanent Magnet Motor Stator

- Testing of IPS Motor was a Milestone B Exit Criteria
- Temperature problems in Stator found during PMM EDM testing
- Transitioned to lower risk alternative technology
- Modified ship machinery requirements and allocations
  - Fuel efficiency, space, weight, etc.
- No change to System Level Requirements

EDM Testing Avoided Costly Program (MS B) Delay

Volume Search Radar (VSR)

- Early VSR Transmit / Receive Integrated Microwave Module testing indicated reliability problems at full power
- System performance analysis showed that mission requirements could be met at lower power levels
- VSR power requirement was reduced to improve reliability
  - Avoided costly redesign
  - Reduced lifecycle costs (higher reliability)
  - Met System level requirements



Volume Search Radar (VSR) Array

EDM Results Avoided Costly Redesign and Reduced Lifecycle Cost

Requirements Summary

- DDG 1000 Linked the Risk Management and the Requirements Processes and Databases
- Engineering Development Models provided invaluable technical information to achieve a balanced design
  - Resulted in modifications to some requirements at the System and Subsystem Levels
  - ORD Requirements and Key Performance Parameters were not affected
  - Reduced technology risk in Subsystems and the Total Ship System
- Allowed the Program to remain on schedule and within cost

Risk Reduction Results Allowed the Program to Make Sound Design and Requirements Trade Off Decisions!

DDG 1000 Case Study – Cost Estimates

Risk Based Source Selection Concept

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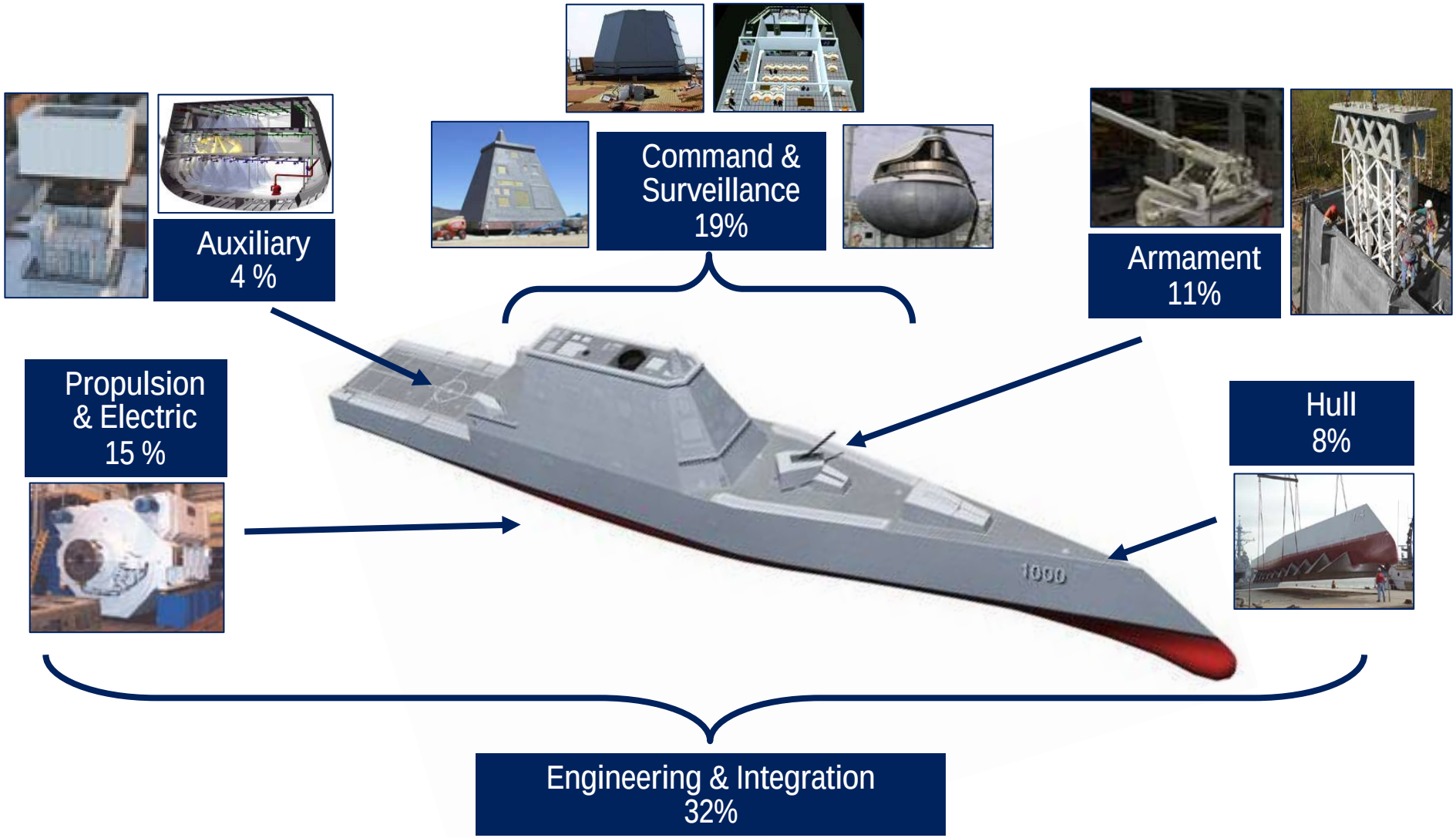
Benefits of EDMs to Cost Estimating Process

- When focused on high-risk technology areas, help to identify cost drivers
- Enable early management of design factors that may trigger unnecessary costs
- Identify manufacturing difficulties that can result in improved production and assembly processes
- Identify cost drivers that, once found, can offer opportunities to instate cost-reduction efforts
- EDMs bring together multiple sub-components, bringing to light problems and costs associated with integration at System Level at early stage
- Actual cost returns provide strong basis for production cost projections
  - Data are being used with step-down factors & learning to cost Flight 1 Equipment
  - EDM drawings improve quality of prime contractors' material quotes from vendors
  - EDMs produce a preliminary Bill of Material, contractor quotes, and sometimes LRIP costs of some key components

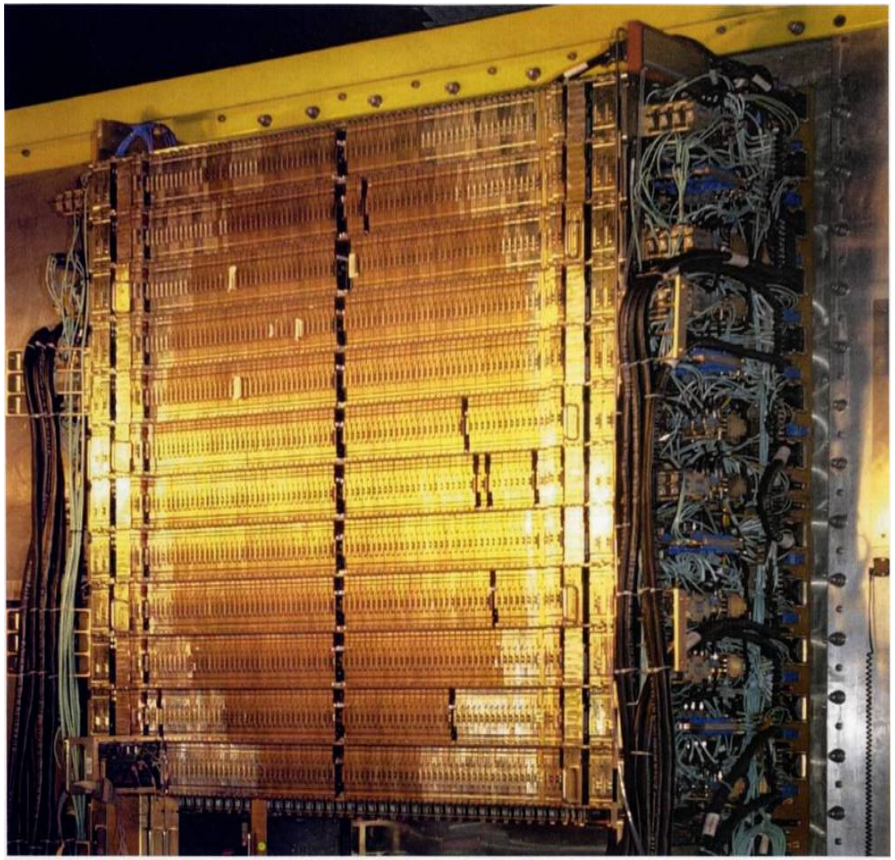
DDG 1000 Ship Cost Drivers



EDMs Improved the Accuracy of Navy Cost Estimates

SPY-3 EDMs Representative of Flight 1 Design

- EDM actual cost returns provide strong basis for production cost projections
  - EDM 1: 2 X-Band Arrays
  - EDM 2: 1 X-Band Array
  - REX and SDP Equipment
- EDMs resulted in a preliminary Bill of Material and firm contractor quotes
- EDMs helped pinpoint manufacturing difficulties that can result in improved production and assembly processes
- Return cost data helped identify cost drivers that enabled Navy to initiate Module Cost Reduction Program
  - Factored into Navy estimates



SPY-3 ARRAY

EDMs Enhanced Quality of Production Cost Estimates

AGS EDM Representative of Flight 1 Design

- Differences between EDM and Flight 1
  - Mount does not contain train drive or weather shield
  - Magazine has 7 storage locations on one level (40 locations and two levels in Flight 1)
- EDM built using Flight 1 Production processes and planned configuration for actual cost returns
- EDM return cost data enabled better quality estimates than parametric comparisons to legacy gun systems

~60% of Contractor's Proposal is Based on EDM Data

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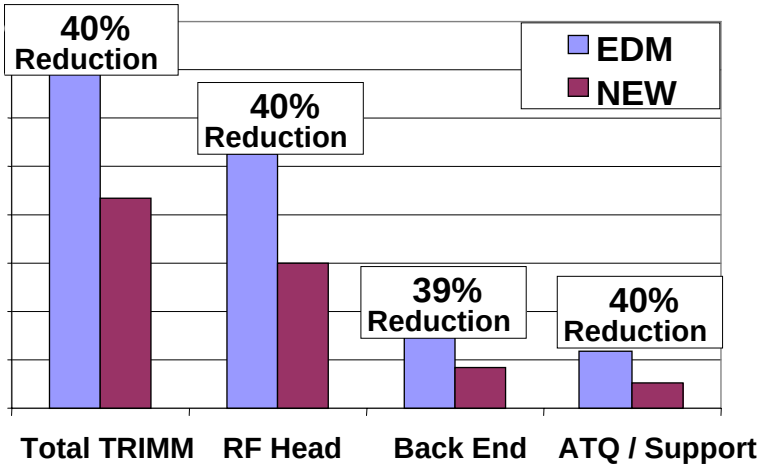
"Smart Buyer"

- Actual cost data for the design, development, manufacturing, integration, and testing of the 10 EDMs enabled the Navy to effectively negotiate follow-on contracts

- Integrated Deckhouse Assembly (IDHA)
  - Return cost data from IDHA EDM provided baseline comparison to contractor cost proposal
  - Reduced Detailed Design labor cost by 54% and material cost by 58%
  - Deleted unnecessary scope
  - Added additional scope in areas under bid by contractor

- AN/SPY-3 X-Band Radar
  - Transmit / Receive Integrated Multi-channel Module (T/RIMM) made up about 50% of EDM antenna cost
  - Repairability, maintainability and cost reduction drove the need for a form, fit, and function replacement for EDM T/RIMMs
  - T/RIMM Cost reduced by 40% per Production System



Summary

- DDG 1000 is the centerpiece for the development of critical transformational technologies
- Program risk was successfully mitigated during Technology Development Phase through robust land-based and / or at-sea testing of 10 Engineering Development Models
- The success of DDG 1000 Technology Development Phase
  - Increased technical maturity
  - Increased level of confidence in cost estimates
  - Increased ability to successfully negotiate follow-on contracts
  - Increased confidence in program success prior to Milestone B authorization to proceed to System Development and Demonstration

DDG 1000 Phase III efforts validates the OSD Risk Based Source Selection Concept!