DDG 1000 Class Destroyer

U.S. Navy Port Engineers

31 August 2011

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DDG 1000
Maintenance Lead
PMS 500

Distribution Statement A: Approved for Public Release; distribution is unlimited.
1994 – SC 21:
• JROC approved Mission Needs Statement
• 32 ships planned

1994 – DD 21:
• DD-21 Operational Requirements Document (ORD) approved

2001 – DD(X):
• 32 ships planned

2004 – DD(X):
• DD(X) ORD approved

2005 – DD(X):
• Milestone B
• 10 ships programmed

2006 – DD(X):
• Milestone B
• 10 ships programmed

2008 – DDG 1000:
• Awarded construction contracts
• 3 ships programmed

2006 – DDG 1000:
• 7 ships programmed

2010
Nunn-McCurdy Certification
Background

• Nunn-McCurdy critical cost growth breach required program certification and Milestone B review

• AT&L certified a restructured DDG 1000 Program – 01 Jun 2010

• The certification for the restructured DDG 1000 Program is for a total quantity of three ships, and includes
  – Remove Volume Search Radar (VSR) - Cost Risk mitigation
    • Key Performance Parameters (KPPs) can still be met
  – Revise Test and Evaluation (T&E) requirements - Cost risk mitigation
  – Shift Initial Operational Capability (IOC) date from FY15 to FY16 to provide schedule margin

• AT&L certification letter to Congress requested support of funding actions
  – Program will be funded to the Cost Assessment and Program Evaluation (CAPE) estimate FY11-15, Navy estimate FY16 and beyond
  – Fully fund to amount requested in the President's FY 11 budget and support the Department intentions to address the FY 11 shortfall through reprogramming actions
DDG 1000 Requirements

- Carry the fight to the enemy through offensive operations and destroy enemy targets ashore with precision strike and volume fires
- Contribute to littoral dominance: surface, air, sub-surface
- Employ an open architecture total ship computing approach
- Be highly survivable
- Reduce crew size

<table>
<thead>
<tr>
<th>Key Performance Parameters</th>
<th>Top Level IERs</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of Guns</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Gun Magazine Capacity</td>
<td>80</td>
<td>128</td>
</tr>
<tr>
<td>Vertical Launch Cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radar Cross Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manning</td>
<td>175</td>
<td>125</td>
</tr>
<tr>
<td>Survivability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force Protection</td>
<td></td>
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</tbody>
</table>

Threshhold Objective

Designed to meet all requirements
DDG 1000 Physical Design

Hull
- Wave-Piercing Tumblehome

Sensors
- SPY-3 X-Band
- Multi-Function Radar (MFR)
- Volume Search Radar (VSR) (Space & Weight Reservation)
- HF & MF Bow Sonar Arrays
- Multi-Function Towed Array
- EO/IR System
- ES System

Weapons
- (80) Advanced Vertical Launch (AVLS) cells for Tomahawk, ESSM, Standard Missile
- (2) Advanced Gun System (AGS) 155 mm guns
- (600) 155 mm rounds
- (2) 57 mm Close In Guns (CIGS)
- Torpedo Defense (Space Reservation)
- Anti-Terrorism

Characteristics
- Overall Length: 610 ft
- Maximum Beam: 80.7 ft
- Navigational Draft: 27.6 ft
- Speed: 30 kt
- Displacement Full Load: 15,494 LT
- Installed Power: 78 MW
- Crew Size (incl. Aviation detachment): 148

Integrated Power System (IPS)
- (2) Main Turbine Generators (MTG)
- (2) Auxiliary Turbine Generators (ATG)
- (2) 34.6 MW Advanced Induction Motors

Superstructure
- Composite Structure

Aviation
- MH60R and (3) VTUAVs (Capacity for 2 MH 60Rs)

Boats
- (2) 7m RHIBs (sized for (2) 11m RHIBs)
DDG 1000 Critical Technologies

Dual Band Radar (DBR)
- MFR (X Band) at sea-based testing complete
- DBR Land Based Testing complete
- Leap ahead clutter rejection capability in the littorals

Composite Deckhouse & Apertures Test Article
- Composite production ability proven
- Tested for RCS and EMI
- Validated RCS KPP can be achieved

Advanced Gun System (AGS)/Long Range Land Attack Projectile (LRLAP)
- Full scale Gun and Magazine produced
- Automated Magazine and Gun rate of fire validated
- 9 Guided Flights successfully conducted – to threshold range of 63NM
- 1st Ship gun tested at Dugway Proving Grounds, UT

Peripheral Vertical Launch System (PVLS) / Advanced VLS
- Detonation tests and missile restrained firing testing complete
- Enhanced survivability design proven and ability to carry all current missiles (SM 2/3/6, ESSM, VLA)

Integrated Power System (IPS)
- Full scale testing of components
- Full rated power and torque validated
- IPS components either have completed or are progressing through First Article and Factory Acceptance Testing

Autonomic Fire Suppression System (AFSS)
- At-sea weapons effect autonomic fire suppression testing demonstrated
- Critical technology enables reduced manning

Total Ship Computing Environment (TSCE)
- 5 of 6 Software Releases complete and authorized by the Navy (~4M ESLOC)
- Open Architecture principles applied
- Release 6 Coding in progress

Hull Form Scale Models
- Sea keeping, stability and RCS performance validated by model testing
- Underwater explosion testing complete – hull whipping requirement validated

Integrated Undersea Warfare (IUSW)
- At-sea mine avoidance capability proven
- Reduced ASW Manning validated

Engineering Development Models (EDMs) Successfully Mitigated Risk
### DDG 1000 Zumwalt Class Program Schedule

As of 12 Jul 2011

<table>
<thead>
<tr>
<th>FY 10</th>
<th>FY 11</th>
<th>FY 12</th>
<th>FY 13</th>
<th>FY 14</th>
<th>FY 15</th>
<th>FY 16</th>
<th>FY 17</th>
<th>FY 18</th>
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**Program Milestones**

- Nunn-McCurdy Milestone B
- Annual Review
- Annual Review
- Annual Review
- Annual Review
- Milestone C

**DDG 1000 (BIW)**

- Lay Keel
- Christening / Launch
- Ship Custody Transfer
- Combat Systems Acceptance Trial
- IOC
- Commissioning
- OPEVAL

**DDG 1001 (BIW) (Planning Dates)**

- PRR
- Start Fabrication
- Continue Manufacturing & Award Remaining Construction
- Lay Keel
- Christening / Launch
- Ship Custody Transfer
- Combat Systems Acceptance Trial
- Sail Away
- Commissioning

**DDG 1002 (BIW) (Planning Dates)**

- Award Construction Contract
- Start Fabrication
- Lay Keel
- Christening / Launch
- Combat Systems Acceptance Trial
- Sail Away
- Ship Custody Transfer
- Commissioning

*DDG 1001/1002 schedule will be confirmed though negotiation of FPI contract with BIW.*
DDG 1000 Program Highlights

- Started DDG 1000 fabrication February 2009
  - 100% of DDG 1000 is in fabrication at Bath Iron Works (BIW) and Huntington Ingalls Industries (HII)
- Started DDG 1001 fabrication March 2010
  - 86% of DDG 1001 is in fabrication at BIW and HII
- All 26 major Mission Systems Equipment (MSE) hardware in production and on pace for on time or early delivery to shipyard
- Software development progressing to support ship activation and delivery
  - Software Releases (SR) 1-5 complete
    - SR 5 Integration and Testing completed 30 Sep 2010
  - SR 6 Critical Design Review (CDR) completed 28 Sep 2010
    - SR 6 timed to support Ship Delivery in Q3FY14
- Advanced Gun System (AGS) manufacturing underway at 3 facilities (Cordova, AL; Fridley, MN; and Louisville, KY)
  - 1st and 2nd AGS magazines delivered early to BIW
  - Testing of 1st AGS gun at Dugway Proving Grounds, UT completed – Shipped to Fridley for refurbishment
- Long Range Land Attack Projectile (LRLAP) development and testing ongoing
  - Guided flight tests (GFT) completed 08 July 2009 and 15 January 2010
- Integrated Power System (IPS) testing at Philadelphia Land Based Test Site (LBTS)
  - Full Power completed 11 May 2011
- Dual Band Radar (SPY-3 / VSR) tested at Wallops Island
  - Developmental testing complete
DDG 1000 & 1001
Construction Status

As of 01 Jul 11
100% of DDG 1000 is in Fabrication
DDG 1000 manufacturing progress is 51.9% complete

86% of DDG 1001 is in Fabrication
Overall DDG 1001 manufacturing progress is 19.7% complete

BIW Status

HII Status

Notes:
* Pre-Outfit 1 occurs prior to blast and paint in the Assembly building.
** Pre-Outfit 2 occurs after blast and paint in the Ultra Hall.
Bath Iron Works Fabrication

Grand Block Erection & Outfitting

MT 62 Magazine Loadout in Ultra Hall

Zone 3140 / 3150 Joins with 3130 / 3120 in Ultra Hall

Forward PVLS Erection

Port Advanced Induction Motor Load-Out
Huntington Ingalls Industries

Aft PVLS, Composite Deckhouse & Hangar Fabrication

PVLS Unit 3170

Bridge Window Cut-Outs

IFF and SPY-3 Z-Frame Installation on Port Oblique Side Shell
BAE Systems
AGS Production Assembly and Testing
Raytheon
Mission Systems Equipment

X/Ka
EME Fully Populated
EME#1
Common Array Cooling System

MK 41 Hatch Assembly
Electro-Optical / Infra-red Sensor
Multi-Function Radar
AN/SQQ-90 Acoustic Sensor Suite
### Zumwalt
- **Displacement**: 15,494 LT
- **Length / Beam**: 610 ft / 80.7 ft
- **Draft**: 27.6 ft
- **Crew Size**: 148
- **Flight Deck**: 150 ft x 51 ft
- **Freeboard**: 22 ft
- **Electric Power Available**: 78 MW
- **Connectivity**: Net-Ready / Unmanned Radio Room

### DDG 79
- **Displacement**: 9,217 LT
- **Length / Beam**: 509 ft / 67 ft
- **Draft**: 31 ft
- **Crew Size**: 314
- **Flight Deck**: 71 ft x 57 ft (fwd) / 44 ft (aft)
- **Freeboard at hangar at transom**: 13 ft / 16 ft
- **Ship's Service Power**: 7.5 MW
- **Connectivity**: 14 Radio Personnel
DDG 51 vs DDG 1000 Crew

<table>
<thead>
<tr>
<th></th>
<th>DDG51 FLT IIA</th>
<th></th>
<th>DDG1000</th>
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<tbody>
<tr>
<td>CO</td>
<td>1</td>
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<td>Aviation Det</td>
<td>22</td>
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<tr>
<td>Total</td>
<td>317</td>
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<td>148</td>
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Reduction in Crew by 169 enabled by Automated Sensor Processing, Virtual Presence and Other Technologies
## DDG 1000 / DDG 51 Comparison

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radar Cross Section</td>
<td>Significantly smaller</td>
</tr>
<tr>
<td>Ship detectability by threat aircraft</td>
<td>Threat must fly lower and closer to detect/target ship</td>
</tr>
<tr>
<td>Firm Track Range vs enemy ASCM</td>
<td>Significant improvement in FTR especially in land clutter environments</td>
</tr>
</tbody>
</table>
| Performance vs Small Boat Swarm Raid | Engage @ 3X range  
Engage 10X more threats                                                |
| Safe Operating Area vs Bottom mines | Significantly larger safe operating areas in littoral waters               |
| Land Attack                    | 3X lethality and 5X range of current munitions with unmatched precision     |
| Manning                        | 50% less crew                                                               |
| Electrical Power               | Capacity for new systems: high-power microwave, rail gun, lasers, and radar |
The DDG 1000 has an all-electric drive with an Integrated Power System (IPS) based on the use of Advanced Induction Motors (AIM).

The IPS configuration consists of two Main Gas Turbine – Generator sets (MTGs), two Auxiliary Gas Turbine – Generator sets (ATGs), two propulsion motor systems, high voltage and ship service power distribution and conversion equipment, and controls and power management.

The hardware consists of two 36 MW MTG and two 3.9 MW ATGs generating 13.8 kilovolts, two 36 MW Advanced Induction Motors (AIMs), high voltage and ship service power distribution, control, management and conversion equipment.

Flexibility of power generation and distribution over mechanical propulsion system.
IPS – System Benefits

- **Warfighting improvements**
  - Rapid reconfiguration of power
  - Capacity for advanced pulse-power weapons
- **Reduced cost**
  - Improved fuel economy from more efficient loading
  - Reduced manning from automation and reduced prime movers
- **Reduced noise**
  - Eliminates propulsion gear
- **Power capable of being fully distributed**

*Quiet and Survivable in the Littorals with Future Growth*
DDG1000 Integrated Power System Benefit

- Only four prime movers—two large and two small
  - All power is available to all users

- Plant can operate with only 2 small gas turbines most of the time.
- Ship can still achieve in excess of 27 knots with loss of a large gas turbine
- Plant is lighter, smaller, less expensive to buy and operate
High Voltage Power System (HVPS)

- High Voltage Power Generation
  MTG’s / ATG’s (4160 Vac)

- High Voltage Power Distribution
  HV Switchboards

Low Voltage Power System (LVPS)

- Integrated Fight Through Power (IFTP)
  Power Conversion Modules
  AC & DC Load Centers

- Ship Service Distribution System (SSDS)
  Automatic Bypass Transfer Switches (ABT’s)
  Uninterruptible Power Supplies (UPS’s)
  Distribution Panels

- Emergency Diesel Generators (EDG’s)

Ship Loads

- Ship Service Loads & Load Controllers
  HM&E
  Mission Critical Equipment

* Loads & Load Controllers are not part of LVPS
DDG 1000 IFTP System Characteristics

System Characteristics

• Converts and conditions the DDG 1000 HV power (4160 Vac) to suitable levels for the Low Voltage Power System (LVPS)
• Consists of modules (PCM4, PCM1, PCM2, PCM2A and both DC and AC Load Centers) that perform specific power conversion, power distribution and survivability functions
• Sub-divided into four electrical zones forward to aft and two segregated Longitudinal Buses port and starboard. One PCM4 and one SSDS is in each of the four electrical zones
• Allows the IFTP system to be re-configured such that faults are isolated and power can continue to be supplied to critical loads in the LVPS
Maintenance Strategy - Key Tenants

- Two levels of maintenance – “on ship” and “off ship”
- Maintenance contractors accomplish most “off-ship” maintenance requirements through RMC
- Sufficient Maintenance Funding is essential
- Operational manning mandates innovative shore workload migration
  - Shore Workload Migration
  - Preventive Maintenance (PM) tasks of quarterly periodicity or greater to a shore activity
  - Defer non-mission-critical Corrective Maintenance (CM) for accomplishment ashore
- One Port Engineer assigned per hull and 1 Combat Systems Engineer per 3 hulls
- Employ repair-by-replacement of Lowest Replaceable Units (LRUs) where possible
- Reliance on Distance Support (DS) capability
- Use existing and planned Navy Maintenance Programs of Record (POR) and Shore Support Infrastructure wherever possible
- Use Performance Based Logistics (PBL) for maintenance accomplishment of new and unique systems/equipment where validated by Business Case Analysis (BCA)
Budget - DDG 1000 Maintenance Requirements

Updated submission based on SEA 21 SSLCMA Technical Foundation Paper (TFP) ESL efforts and DDG 51 lessons learned – tailored for DDG 1000 results in 15% delta from PR11

Approved POM 13 requirement based on parametric estimate by SURFMEPP. Major changes to DSRA durations and frequency. Growth based on actual DDG 51 and LHD return costs vs. notionals.

DDG 1000 Technical Foundation Paper (TFP) equivalent completed for POM 13
## 4700 Requirements

### Availability Breakdown

<table>
<thead>
<tr>
<th>Availability</th>
<th>Man Days (Kmds)</th>
<th>Duration (weeks)</th>
<th>Periodicity (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSRA</td>
<td>40.3</td>
<td>12</td>
<td>108</td>
</tr>
<tr>
<td>SRA</td>
<td>8.7</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>CM - Total</td>
<td>10.7</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### CM Breakdown

<table>
<thead>
<tr>
<th>CM Breakdown</th>
<th>Man Days(K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM - DM</td>
<td>1.3</td>
</tr>
<tr>
<td>CM - PM</td>
<td>6.8</td>
</tr>
<tr>
<td>CM - FM</td>
<td>2.6</td>
</tr>
<tr>
<td>CM - Total</td>
<td>10.7</td>
</tr>
</tbody>
</table>
Summary

• DDG 1000 will be a multi-mission surface combatant tailored for the littorals
  – Signature reduction, active and passive self-defense systems, and enhanced survivability features
  – Designed to fulfill volume firepower and precision strike requirements
  – Provides credible forward naval presence while operating independently or as an integral part of Naval, Joint, or Combined Expeditionary Strike Forces
  – Reduced Life Cycle Cost

• Production is progressing well at all four prime contractors

• DDG 1000 Initial Operational Capability (IOC) in FY16
Back-Up
Multi-Mission Combatant Tailored for the Littorals
Zumwalt Advantage
Land Attack

AGS / LRLAP

<table>
<thead>
<tr>
<th></th>
<th>DDG 1000*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munition Weight (AUR)</td>
<td>290 lbs</td>
</tr>
<tr>
<td>Magazine Capacity</td>
<td>600 LRLAP</td>
</tr>
<tr>
<td>Ordnance Stored</td>
<td>174,000 lbs</td>
</tr>
<tr>
<td>Manning (excl Fire Control)</td>
<td>Unmanned</td>
</tr>
<tr>
<td>Warhead Weight</td>
<td>60 lbs</td>
</tr>
<tr>
<td>Sustained ROF</td>
<td>20 rpm</td>
</tr>
<tr>
<td>Volume of Fire (W/H(^{*})ROF)</td>
<td>1200 lbs/minute</td>
</tr>
<tr>
<td>Range (spec)</td>
<td>63 nmiles</td>
</tr>
<tr>
<td>Ashore Coverage @ 25 nmile standoff</td>
<td>5,000 nmiles(^{*})2</td>
</tr>
</tbody>
</table>

5 X Fire Support Coverage Ashore; 2 Unmanned Magazines
Zumwalt Advantage
Anti Air Warfare -- Aircraft and ASCMs in Littoral

Radar Cross Section of a Fishing Boat

Ship Weapons Release Envelope

Other Combatants
Threat Aircraft Detection Volume

DDG 1000 Range Advantage

Harder to Detect, Localize, Classify, and Target; Improved Detection and Engagement Ranges of Threats
Zumwalt Advantage
Anti-Air Warfare in Littoral

• Advanced threat ASCMs tracked in littorals at longer ranges
• ASCMs Acquisition range of DDG 1000 reduced
• Large battlespace timeline provides multiple opportunities to destroy ASCMs
• Expends 50% fewer missiles per engagement
Zumwalt Advantage
Anti-Surface Warfare

DDG 1000 Engages 10X more Swarming Boat Threats at 3X range of CIWS
Zumwalt Advantage
Integrated Undersea Warfare

- Quieter Acoustic and reduced Magnetic Signature

- Enables significant increase in safe operating Area against mine threats

- With 50% decrease in manning for In Stride Mine Avoidance plus ASW

DDG 51 = 10 watchstanders
DDG 1000 = 5 watchstanders
Zumwalt Advantage
In-Stride Mine Avoidance

Steps:
1. Automated Detection
2. Automated Classification
3. IUSW Operator confirms
4. Authority issues turn command
5. Helmsman commands turn
6. Ship turns
7. MLO Avoided
8. Authority commands return to course
9. Helmsman commands turn
10. Ship Returns on course
Zumwalt Advantage
Submarine Warfare

Steps:
1. Automated Detection
2. Automated Classification
3. IUSW Operator confirms
4. Authority issues response commands
5. Helicopter readied and Launched
6. And/or VLA readied and Launched
7. Helo finds threat and engages
8. And/or VLA splashes
9. Helo returns to DD(X)
10. Ship continues mission

Timeline:
1. $\Delta T_{Detect}$
2. $\Delta T_{Decide}$
3. $\Delta T_{Command}$
4. $\Delta T_{Prepare VLA}$
5. $\Delta T_{VLA Flyout}$
6. Helo Fly-out
7. Helo locate and engage
8. Helo returns to ship
9. $\Delta T_{Helo Locate}$
10. $\Delta T_{Launch Torpedo}$
11. $\Delta T_{Launch}$

DDG 1000

Command
VLA Launch
Prepare VLA
Launch
Missile
Fly-out

Steps:
1. Automated Detection
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