MK 41 Vertical Launching System (VLS)

Mark Zimmerman
Presentation Outline

• Introduction
• System Description
• New Development
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• System Description
• New Development
VLS Genesis – Replace High Maintenance, Single Mission Launchers

• Below Deck Installation
• 360° Hemispherical Coverage
• High Firing Cell Density
• Minimal Mechanical Movement
• Encanistered Missiles
• Multiple Missile/Mission Support

Below Deck. Fewer Moving Parts. Encanistered Missiles
VLS Features

- Ballistic Protection
- BL VII Being Evolved Towards Open Architecture
- Simultaneous Multiple Missile Launch
- Multiple Warfare Area Missile Types
- Any Missile/Any Cell
- Minimal Manning
- High Reliability
- Low Maintenance
- Modular Design and Application
- Combat Proven

A Revolutionary Development in Naval Surface Warfare
VLS Multi-Mission Capability

Land Attack

Ballistic Missile Defense

Defense Against Submarine Attack

Defense Against Air Attack

Launchers

Computers

Multi-Missile Launching System to Support Four Mission Areas
VLS Major Components – USN DDG Example

Encanistered Weapons are Loaded into Launcher Module Cells

USN CG is Similar Except:
- 8 modules forward and aft
- LCUs are in Computer Room

Launch Control Units

Launch Control Units

8-Cell Launcher Module

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Typical Installation. Number of Launchers and Launcher Modules Vary by Ship

Distribution Statement A: Approved for Public Release; Distribution is Unlimited
MK 41 System Diagram

**LCU Segment**
- Maintain Simultaneous Interface with Each WCS – Firewall to the Launchers
- Multi-Warfare Management/Prioritization
- Has Capability for Parallel Operations in Missile Preparation and Launch
- Monitor Launchers
  - Availability
  - Firing Count

**Launcher Segment**
- Provide Pre-Launch and Launch Sequencing
- Provide Gas Management
- Monitor Weapons
  - Weapon Inventory
  - Weapon Availability
  - Hazard Conditions
- Deluge Control, Anti-Icing

**Encanistered Weapons**
- Canister Provides Common Interfaces to the Launcher Regardless of Weapon Type
  - Electrical – 145-pin umbilical connector
  - Mechanical – 24” square
- Any Weapon, Any Cell
- Shipping and Storage

**Anti-Surface Warfare (ASuW) Weapon Control System (WCS) (Tactical Tomahawk)**

**Anti-Submarine Warfare (ASW) WCS (SQQ-89)**

**Integrated Air and Ballistic Missile Defense (IABMD) WCS (Aegis)**

Only Multi-Missile, Multi-WCS Launching System in the World
Integration With Other WCS’s

- SEASPARROW
  - SAABTECH FCS
  - THALES MWCS
  - MELCO FCS

- SM-2 BLOCK II/III/IIIA/IIIB
  - WCS MK 8 AEGIS
  - WDS MK 14 (TRUMP)
  - WDS MK14 (KDX-II)
  - TFC MSS-41 (APAR)

- ESSM/QUAD PACK
  - WCS MK 8 AEGIS
  - SAAB TECH FCS
  - TFC MSS-41 (APAR)
  - FFG MK92

- VLASROC
  - ASWCS MK 116
  - ASWCS (J) OYQ-103

- TOMAHAWK
  - AN/SWG-3
  - ATWCS

- SM-2 BLOCK IV
  - WCS MK 8 AEGIS

VLS Has Been Integrated With Many Different WCS’s Worldwide
MK 41 VLS Fleet

United States
- CG TICONDEROGA: 22 Ships
- DD SPRUANCE: 24 Ships
- DDG ARLEIGH BURKE: 62 Ships

Korea
- DDG KDX II: 6 Ships
- DDG KDX III: 3 Ships

Germany
- FFG BRANDENBURG: 4 Ships
- FFG SACHSEN: 3 Ships

Australia
- FF ANZAC: 8 Ships
- FFG ADELAIDE: 3 Ships

Japan
- DDG KONGO: 6 Ships
- DD MURASAME: 9 Ships
- DD TAKANAMI: 5 Ships
- DDH - 19DD Class: 1 Ship

Netherlands
- DDG DEZVEN PROVINCEN: 3 Ships

Denmark
- FFG / Patrol Ship: 3 Ships
- DDG HOBART: 3 Ships

Canada
- DDG IROQUOIS: 4 Ships

Turkey
- FFG BARBAROS: 4 Ships

Spain
- FFG ALVARO DE BAZAN: 5 Ships

New Zealand
- FF ANZAC: 2 Ships

Norway
- FFG New Escort Vessel: 5 Ships

More Than 12,000 MK 41 VLS Cells in U.S. Navy and Eleven Allied Navies
MK 41 VLS Evolution

Evolution Objectives: New Capabilities, DMS/Tech Refresh, Reduced Cost

Distribution Statement A: Approved for Public Release; Distribution is Unlimited
**MK 41 VLS Evolution – Capabilities**

- **Weapons**
  - Tomahawk, VLA, SM-2 Blk IV, and SM-3
  - BL IV/V introduced ESSM Quadpack in-line at DDG 79
- **Weapon Control Systems**
  - Each VLS baseline is certified/qualified with specific WCS’s

### Table: MK 41 VLS Evolution – Capabilities

<table>
<thead>
<tr>
<th>VLS Baseline</th>
<th>SM-2 Blk II/III/IV</th>
<th>SM-3</th>
<th>Tomahawk Blk III/IV</th>
<th>Tomahawk Blk IV</th>
<th>VLA</th>
<th>ESSM</th>
<th>Aegis</th>
<th>Tomahawk</th>
<th>ASW</th>
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<tbody>
<tr>
<td>BL IIA</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
<td>MK 116 MOD 4/6</td>
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<tr>
<td>BL III</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>BL 2</td>
<td>TWCS, ATWCS</td>
<td>MK 116 MOD 7</td>
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<tr>
<td>BL V</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>BL 3/4/5</td>
<td>TWCS, ATWCS, TTWCS</td>
<td>MK 116 MOD 7</td>
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<tr>
<td>BL VII</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>BL 7</td>
<td>ATWCS, TTWCS</td>
<td>SQQ-89</td>
</tr>
</tbody>
</table>

**New Baselines Have Added New Weapons and New WCS Capabilities**
## VLS Launch Control System Evolution

<table>
<thead>
<tr>
<th>VLS BASELINE</th>
<th>IIA/III</th>
<th>IV/V</th>
<th>VI/VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG 52-73, DDG 51-78, DD 963-992</td>
<td>OL267, USH-26, UYK-20/44, SDEX OS, CMS2</td>
<td>ALP (PowerPC), UYK-44EP, SDEX OS, CMS2, Ada, C</td>
<td>UYQ-70 (PowerPC), VxWorks OS, C++, Ada, C, Object Oriented</td>
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<tr>
<td>LAUNCH CONTROL UNIT HARDWARE AND SOFTWARE</td>
<td>Motorola 6803, 5 MHz, Assembly Language</td>
<td>Intel 386, 16 MHz, Assembly Language</td>
<td>166 MHz Pentium, C++, Object Oriented</td>
</tr>
<tr>
<td>LAUNCH SEQUENCER</td>
<td>100% Military Hardware, Custom Operating System</td>
<td>COTS Single Board Computer, Modern Programming Language</td>
<td>COTS-based design, 100% Modern OS, 100% Modern Programming Languages, Object Oriented Design</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td></td>
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</tbody>
</table>

**Evolution from Militarized Hardware and Software to COTS and Modern Software**
Presentation Outline

• Introduction
• System Description
• New Development
VLS Functional Allocations

Weapon Control System
- Specifies Weapon type
- Specifies Salvo Size
- Generates Missile Flight Orders
- Provide Firing Command

Launch Control Unit Segment
- Interface Management
- Launch Coordination
- Fault Detection/Reconfiguration
- Launcher Equipment Management

Launcher Segment Electronics
- Monitors Missile Status
- Coordinates Module Activities
- Performs Missile Unique Sequencing
  (Translate Generic Request from LCU to Missile Compatible Functions)

Canister
- Provides Environmental Protection
- Provides Missile Electrical Interface
- Initial Missile Launch Guidance
- Monitors Environment
- Provides Missile Round ID
- Reports Missile Away
- Missile
- Performs Prelaunch Preparations
- Reports Status
- Effects Launch
- Intercepts Target

VLS

Distribution Statement A: Approved for Public Release; Distribution is Unlimited
VLS BL VII Launch Control System

Launch Control Unit (LCU) (1 of 2)

- NTDS-E

AAW WCS

- Launch Control Comp. Program
  - Interface to WCS’s and launchers
  - Launch sequences, system monitor and control

ASuW WCS

Advanced LCU Peripheral SW

- HSI and data recording
- Program loading

ASW WCS

Programmable Power Supply (PPS) 1 and 2

Launcher Module (1 of 12 or 16)

- Motor Control Panel (MCP)
  - Fault Isolation Panel (Maintenance Only)

Launch Sequencer (LSEQ)

- 100BaseT
- 100BaseFX

Canister Umbilical (x8)

Launcher Module

100BaseFX

Module Electronics Comp. SW

- Resident in LSEQ, MCP, and PPS
- Launch sequences, module monitor and control
Major Assemblies

Launch Sequencer (LSEQ)
- Missile Interface
- Command the MCP
- Command the PPSs
- Hazard monitors

Motor Control Panel (MCP)
- Controls Hatches
- Controls Plenum Drain Valve
- Controls Deluge
- Ethernet interface to LSEQ

Programmable Power Supply (PPS, qty 2)
- Two identical units
  - Cells 1-4 and cells 5-8
- Provides DC power for weapons and monitors
- Ethernet interface to LSEQ

Launch Control Unit (LCU, qty 2)
- Launch Coordination
- Launch Control
- Data recording
- Operator interface
Eight Cell Module is the Basic Building Block of the VLS Launcher
VLS Module Gas Management System (GMS)

GMS Consists of Canister, Plenum, and Uptake

MK41 FIRING SEQUENCE
- Cell and Uptake Hatches Open
- Drain Closes
- Motor Ignition
- Canister Aft Closure Ruptures
- Missile Flies Through Forward Closure
- Cell Hatch Closes
- Uptake Hatch Closes
- Drain Opens
Canister

- Combination Shipping/Storage and Firing Container:
  - Environmental Protection
  - Shock Isolation
  - Missile Mechanical and Electrical Interfaces
  - Missile Identification
  - Overtemperature Detection
  - Deluge

Canisters Serve as Transportation/Storage Container and Launch Tube
VLS Simulators

IDSIM
• Simulates WCS Interfaces
• Simulates Up to 16 LSEQs
• Provides LCU Simulation for LSEQ Development

Module Support Equipment Rack
• Simulates Cell and Uptake Hatches, Cell Deluge System
• Supports Development Testing
• Provides Missile Simulation via Echo Cards

LCCP Simulation Mode
• Supports WCS Training
• Used On-Board Ship With Ordnance
• Allows Simulated VLS Operation of the LCU/LCCP

MK 683/689
• Simulates All VLS Missile Types
• Supports Development and INCO Testing

Missile Echo Unit
• Portable Missile Simulator that Connects Directly to Missile Umbilical Cable
• Provides Go Path Responses to LSEQ
• Supports Development and INCO Testing
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USN Cruiser and Destroyer Modernization

CGMOD Upgrades One Module per Launcher from BL III to BL VII
New Missile Integration

- Tomahawk Block Upgrades – Enhanced land attack
  - Blk IV
  - SAASM

- SM-6 – Air defense
  - Active seeker
  - Cost-effective capability for the Navy

- SM-3 Blk IA/IB/IIA – Enhanced Ballistic Missile Defense
  - Intercepts BMD threats in upper atmosphere
  - Integral part of the overall self defense system developed to protect against BMD threats

- Vertical Launch Anti-Submarine Rocket (VLA) with Lightweight Hybrid Torpedo (LHT)
  - Next generation hybrid (analog and digital) torpedo
  - Provides enhanced ship defense against submarine threats

Continuing to Add New Capabilities to Meet Mission Needs
Technology Upgrades

- Replace custom military computers with commercial computers and peripherals
  - Better performance
  - Lower cost

- Incorporate programmable devices
  - Makes the system more flexible
  - Reduces the cost to integrate new weapons

- Laptop-based and PDA-based equipment used to:
  - Troubleshoot equipment
  - Configure components and load software
  - Host electronic tech manuals
MK 41 VLS Summary

- Premier Launching System for the USN and 11 International Navies
  - More Than 12,000 Cells In Service Worldwide
  - Qualified and Certified Performance
- Worldwide Logistics Support
  - Performance-Based Supply Support and Depot Level Repair
- Performance, Firepower and Flexibility
  - Any Missile/Any Cell
  - Highest Density Missiles per Footprint Capability
  - AAW Self/Area Defense, BMD, Land Attack or ASW
  - Modularity to Fit Ship Size and Mission
  - Adaptable to New Missiles and Weapon Control Systems
VLS is the Premier Multi-Missile Missile Launching System of Choice for US and Foreign Surface Navies
  - Extensively deployed
  - Universally recognized for capability, reliability, and safety
- The US Navy Continues to Upgrade and Modernize VLS
  - Increase operational capability (new missiles)
  - Increase performance capability (new technology)
  - Reduce life cycle cost

MK 41 VLS – Performance By Design