Advanced Mooring System (AMS)

Industry Day
Washington DC – 27 April 2010

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## Industry Day

**Tuesday, April 27**

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Introductions / Comments
Purpose / Procedures

- **Why are we here?**
  - Promote industry awareness of AMS program
  - Present draft performance specifications and design requirements
  - Capture industry feedback – goal is a reasonable solicitation with clearly stated specifications and requirements

- **Note taking is permitted**

- **Please write questions/comments on provided note cards – answers during Q&A Session**

- **All presentations/information cleared for public release to be posted after Industry Day**

- **Sign-up for FBO posting notification**
Seabasing FNC Overview
Sea Power 21

- Forward Presence & Pre-positioned Platforms
- Force Closure
- Defensive/Offensive
- Power Projection
- Focused Joint Logistics
- Coherent Joint C4ISR

Seabasing Concept: Deployment of warfighting capabilities sustained from the sea without reliance on shore facilities
Seabasing

Seabasing Tasks

Close... a Marine Expeditionary Brigade-sized force within 10-14 days

Assemble... a Marine Expeditionary Brigade-sized force within 24-72 hours

Employ... one battalion vertically and one battalion via surface within 8-10 hours

Sustain... selected joint forces and up to two brigades operating up to 150 nm inland with minimal logistics footprint ashore

Reconstitute... forces for future operations within 30 days
Seabasing FNC Goal

- Develop and integrate technologies into products which can be demonstrated at TRL 6
- Transition to acquisition community to provide warfighter with required seabasing capabilities as envisioned under Sea Power 21
EC Investment Strategy Process

1. OPNAV Identifies Requirements/Gaps
2. Roundtables for stakeholder input
3. ONR Develops Proposed ECs
4. IPT Reviews/Prioritize ECs
5. TOG Working Group Reviews/Recommends ECs to TOG
6. ONR Conducts Technical Review of ECs
7. ONR Endorsed ECs Delivered to TOG WG
8. Prioritized List of ECs Approved by TOG
9. Investment Strategy
Future Naval Capabilities

FUTURE NAVAL CAPABILITIES ARE FOCUSED ON FILLING WARFIGHTER GAPS
Advanced Mooring System Program Overview
Interest in fendering & mooring after recent events

- Interface Ramp Technology program refocused from Large, Medium-Speed, Roll-on/roll-off to Joint High Speed Vessel after CNO and Commandant of the Marine Corps expressed serious concerns about JHSV sea state 1 capability
- Joint West African Training Cruise 2008 - mooring lines snapping
- Flickertail State / container ship skin-to-skin test – cargo damaged
Shortfalls in Current Capability

- Sea-based loading and unloading of ships and connectors is slow, labor-intensive, and limited to lower sea states (1 or 2)

- Mooring and Fendering issues with Connectors
  - Conventional mooring systems not designed for use with lightweight hull structures in the seaway
  - Conventional fenders exceed load limits of lightweight hull structures

- Complicated by diversity of ships (large number of mooring permutations required)
  - 10-12 mooring lines to a wide range of bitt and chock locations, numbers, and load ratings
  - Range of relative longitudinal locations to reach all container stacks with MLP crane
  - Fendering with large separations at waterline due to significant flare and waterline angles at ends of ships
  - Need to avoid fouling transfer systems to permit at-sea transfer
Project Schedule

11/2010 - 7/2011
Phase I: Concept Development

Phase II: S&T/Modeling

12/2012 - 12/2013
Phase III: Sea Demonstration/Wrap-Up

7/2013 - 9/2013
At-Sea Testing
Phase I Objectives: Concept Development

- Concept of Operations for specific technology(ies)
- Concept design of full-scale technology demonstrator
- Estimated production acquisition cost
- Feasibility demonstration of concept through analysis, modeling and simulation
- Identification of ship impacts, risks and a risk mitigation plan
- Identification of applicable design standards, criteria, and procedures to provide equivalent margins of safety compared to traditional mooring equipment
- Proposed follow-on statement of work, test plan, demonstration plan, schedule and cost estimate.
Phase II Objectives: S&T/Modeling

- Fabrication, testing, and evaluation of a sub-scale, proof-of-concept technology demonstrator
- Demonstration of sub-scale, proof-of-concept AMS technology demonstrator with moderate sea conditions acting on system
- Detailed design of a full-scale, proof-of-concept technology demonstrator
- Updated estimated production acquisition cost for a production AMS, with appropriately increased fidelity
Phase III Objectives: Sea Demo

- Fabrication, testing, and evaluation of a full-scale, proof-of-concept AMS technology demonstrator
  - Individual sub-systems
  - Full-system

- Demonstration of full-scale, proof-of-concept AMS technology demonstrator in a relevant, dynamic motion environment (TRL 6)
Introductory Video
Flickertail State / Containership
Skin-to-Skin Test
Background
Background

- Overview of types of skin-to-skin mooring anticipated to be required to support a sea base
- AMS would increase operating envelope to allow operations through Sea State 3 (threshold) to through Sea State 4 (objective)
Skin-to-Skin Mooring Cases

- Large vessel to connector operations
- Navy Lighterage to connector operations
- Large vessel to large vessel operations
Primary Connectors/Lighterage

- **Connectors**
  - JHSV
  - Landing Craft Utility (LCU) 1600
  - LCU 2000

- **Lighterage**
  - Improved Navy Lighterage System (INLS)
  - Roll-on/Roll-off Discharge Facility (RRDF)
Primary Large Vessels

- Large, Medium-Speed, Roll-on/Roll-off Ships (LMSR)
- Maritime Prepositioning Force (MPF) ships
- MLP variants
- Commercial container ships
- Secondary “large vessels” might include
  - Ready Reserve Force (RRF) crane ships
  - RRF Roll-on/Roll-off (RORO) ships
Large Vessel to Connector Operations

TEN 3M DIA FENDER (FLOATING AT WATERLINE)
TWO 2.5M DIA FENDERS (SUSPENDED NEAR DECK EDGE)
TWO HEAD LINES (PROVIDED BY MLP)
THREE AMIDSHIPS SPRING LINES (PROVIDED BY MLP)
ONE STERN LINE (PROVIDED BY JHSV)

(NOT TO SCALE)
Lighterage to Connector Operations
Large Vessel to Large Vessel Operations

**Diagram**

- **Nominal Panamax Ship**
  - **Nominal MLP**
  - **Four 4.5m DIA Fender (Floating at Waterline)**
  - **Two 2.5m DIA Fenders (Suspended Near Deck Edge)**
  - **Six Head Lines (Four Provided by MLP)**
  - **Four Amidships Spring Lines (Four Provided by MLP)**
  - **Four Stern Lines (Two Provided by MLP)**

*(Not to Scale)*
AMS Applicability

- Technology is needed for all ship classes which support sea-based logistics operations
  - The large vessel to connector scenario will be what is demonstrated at TRL 6
- A key challenge: potential for damage to the connector vessel during skin-to-skin mooring with the larger sea base vessel
- While the focus of the demonstration will be a large vessel to connector scenario, proposed technology solutions capable of facilitating all three scenarios will be viewed favorably
Break
Current Scenario
Current Scenario

- Skin-to-skin mooring for naval sea basing operations is not a current capability
- Closest commercial analogue is oil tanker lightering operations (non-rigid, moored connection between very large crude carrier and smaller oil tanker)
Commercial Tanker Lightering Operations

- Detailed industry standard procedures and operational checklists for tanker lightering ops
  - See *Ship to Ship Transfer Guide: Petroleum* by Oil Companies International Marine Forum
- Mooring plan prepared by Mooring Master and approved by both vessels’ Masters prior to arrival
- Mooring Master present during evolution, likely onboard approaching vessel
Typically smaller lighter vessels are equipped with specialized fender systems specifically designed for skin-to-skin operations.
Commercial Tanker Lightering Operations (cont.)

- Fenders are moved into position as vessels approach.
- Figure shows typical approach maneuver to bring vessels parallel at which point the vessels will continue to close separation distance preparing for skin-to-skin mooring.
Approaching vessel, with fenders already lowered, closes distance at approx 6 knots with larger tanker dead in water

In heavier seas, larger tanker would steer a favorable course
Smaller lighter will typically approach larger tanker directly from starboard side at 3.5 knots, and within approx ½ mile of tanker begin turning to starboard to begin approach on a parallel course.

Final approach occurs at approx 2 to 4 knots, closing at an angle of approx 5 degrees.
Commercial Tanker Lightering Operations (cont.)

- First mooring line may be passed when vessels are approx 20 feet apart
- In calm seas, lines might not be passed until contact has been made
- Approaching vessel is using 50% left thruster and 10 degrees right rudder
- Forward lines are passed first, followed by stern lines
Once mooring lines are across and tensioned, cargo hoses are taken across

In calm weather, both vessels will drift

In heavier seas, lighter would typically shut down engines, with larger tanker steering a favorable course to reduce ship motions maintaining a slow forward speed
Relative drafts of vessels shift and mooring system must be able to accommodate changes and vessel motions.
Commercial Tanker Lightering Operations (cont.)

- Mooring lines are removed at conclusion of skin-to-skin ops
- With lines cleared, larger vessel thruster is right 100% with rudder left 10 degrees to keep stern of smaller vessel clear
- Once sufficiently apart, rudder is eased and bow is allowed to swing out
- Once clear, fenders are recovered
Performance Specifications and Design Requirements
Specifications and Requirements

- Technical proposal shall address how proposed concept will satisfy performance specifications and design requirements established for final AMS
General Specifications

- System shall provide for open architecture, where appropriate (e.g. control systems) – threshold
- Operation and routine at-sea maintenance can be accomplished by ship’s force personnel with minimal additional training – threshold
- Mitigate risks inherent in traditional mooring systems – threshold
  - Personnel safety (line handling)
  - Risk to vessels (approach, relative motions due to sea state and emergency break away)
General Specifications

- **Scalable – threshold**
  - Accommodate range of ship motions
  - Scalable to alternative ship sizes and configurations

- **Modular and Deployable – objective**
  - Transferrable from one vessel to another
  - Technology is vessel independent
  - Minimal ship interface/impact
Environmental Specifications

- Loads due to ship motion
  - Operational through sea state 3 – threshold
  - Operational through sea state 4 – objective
  - Survivable through sea state 8 in stowed configuration – threshold

- Equipment exposed to weather shall be capable of operating in air temperatures from -29°C (-20°F) and 49°C (120°F) with seawater temperatures from -2°C (28.4°F) to 35°C (95°F) – threshold

- Relative humidity 0 to 95% – threshold

- System must be designed to facilitate safe day and night operations – threshold
Vessel Data

AMS will be required for a variety of vessels, with the following ranges of motions operating independently:

- **Roll**: 1 to 12 degrees
- **Pitch**: 1 to 3 degrees
- **Heave**: 1 meter to 1.83 meters
- **Surge**: none to 1.2 meters
- **Sway**: none to 1 meter
- **Yaw**: none to 1 degree
• **Accelerations** the system may be subject to include up to 0.15 g to 1.20 g vertical, 0.11 to 0.20 g transverse, and 0.10 to 0.20 g longitudinal

• **Mooring** may occur between vessels of lengths ranging from 100 meters to 276 meters

• **Vessel drafts** may range from 3.9 meters to 12 meters

• **Operating freeboards** may range from 3.5 meters to 6 meters with higher raised decks locally such as at bow and stern

• **Hullforms.** System should be designed to accommodate a variety of hullforms

• **Full load displacements** of 2,400 MT up to 105,000 MT should be considered
Operational Specifications

- Employ skin-to-skin mooring; solutions relying on dynamic positioning will not be considered – threshold
- Operation at zero knots or minimum maneuverable forward speed up to 8 knots to maintain favorable heading – threshold
  - Not at anchor
- Support vehicle, personnel, and container transfer during skin-to-skin mooring – threshold
- Maintain safe separation distance – threshold
  - 3 meter separation assumed for JHSV due to JHSV ramp
  - For large to large vessels such as MLP to containership, 4.5 meter fenders would be utilized absent AMS
  - Proposers may recommend alternative separation distances
Operational Specifications

- **Time required shall be**
  - Less than 1 hour to moor – threshold
  - Less than 15 minutes to unmoor (planned) – threshold

- **Accommodates**
  - Freeboard differences between platforms – threshold
  - Draft changes during the evolution – threshold

- **Proposed technology accommodates longitudinal changes in vessel alignment during the evolution – objective**

- **Facilitates emergency breakaways – threshold**
  - Rapid, safe breakaway
  - Minimal time to recover AMS to an operational state

- **Accommodates various hull forms and vessel characteristics – threshold**
Operational Specifications

- Reliability, Maintainability and Availability – threshold
  - Operational availability of 98% ($A_0 = .98$) or better
  - Actuators and other machinery components shall not require replacement of component parts during 5000 hours of operation *
  - Any control components shall not require replacement of component parts during a Mean Time Between Failure of 3750 hours *
  - Maximum Mean Time to Repair shall be eight hours for all sub-systems
  - System shall be designed to minimize scheduled preventive maintenance man-hours and not require use of proprietary tools or tools not normally carried aboard ship

* Exceptions to part replacement requirements are planned replacement type components
Operational Specifications

- Reliability, Maintainability and Availability (cont.)
  - System may be subjected to continuous periods of non-use up to three years. Following this period of non-use, system shall operate without degraded performance
  - System shall operate without degraded performance following lay-up and start-up maintenance after stowage
  - System may be subjected to idle periods of non-use up to 6 months in duration. Following this, system shall not require start-up maintenance prior to operation

- Amount of scheduled preventative maintenance shall be minimized – threshold

- Amount of special test equipment and tools required for maintenance shall be minimized – threshold
Design Requirements

- **Area, Volume and Weight**
  - Ships are area, volume and weight critical – system area, volume, and weight shall be kept to a minimum

- **Workload**
  - Manning is a major lifecycle cost factor - workload requirements for system operation and maintenance shall be kept to a minimum

- **Safety**
  - Equipment design shall incorporate system safety practices to identify, classify, and manage mishap risk in accordance with MIL-STD-882
Design Requirements

- **Safety**
  - **Failsafe Design**
    - Equipment shall be designed and constructed for failsafe operation
    - Failure of a drive mechanism power source shall not result in damage to vessels or jeopardize safety of personnel;
    - or result in uncontrolled movement of vessels or equipment
  - **Control System**
    - Failure or fault of a single control system component shall not result in uncontrolled movement of equipment;
    - or result in equipment operations that jeopardize the safety of vessels, equipment or personnel
System Controls

• If technology contains a control system:
  – Control system shall perform self diagnostics upon start-up to ensure operational status
  – Control system shall continually monitor itself, halt operations if off-normal condition is detected, and notify operator

System shall have safe range indications (procedural, mechanical, or electrical) for:

• Operating limits, including range of motions
• Wear
• Failure of components
Design Requirements

- **Ship impact (i.e. power, services, weight, and arrangements) shall be kept to a minimum**
  - Ship’s service 125 PSIG LP Air is available
  - Wheels or rollers - contact pressure with ship's deck shall not exceed 250 lbs/sq.in.
  - Ship’s service 440VAC, 60 Hz, 3-Phase, high resistance ground, Type I power system having steady state and transient characteristics in accordance with MIL-STD-1399-300

- **Any proposed ship modification must be made in accordance with classification society rules**
Break
Focus Area Priorities
Focus Area Priorities

a. **Technical Merit.** This focus area is divided into the following sub-areas which are listed in priority order

i. **Performance.** This sub-area focuses on the extent to which the concept is expected to meet or exceed the performance specifications and design requirements in the areas of:

1. **Operating Envelope:** Concept improves the operating envelope for vehicle, personnel and container transfer during skin-to-skin operations
2. **Modular and Deployable:** Concept is scalable, modular and deployable
3. **Breadth of Applicability:** Concept facilitates all three scenarios
4. **Changes in Position:** Concept accommodates changes in draft and vessel alignment
Focus Area Priorities (cont.)

a. **Technical Merit (cont.)**

ii. **Ship Impact.** Concept minimizes system area, volume, weight, and power

iii. **Affordability.** Degree to which acquisition and total ownership costs are minimized

iv. **Risk Mitigation.** Degree to which the concept reduces risks associated with skin-to-skin mooring

v. **Technical Plan.** Degree to which proposal describes a complete system concept and provide a detailed scope of work for development of core technology(ies)
b. **Scientific Merit.** This focus area assesses the degree of innovation involved and whether the proposed concept/technology presses the state of the art while still having credibility with regard to technical approach.

c. **Technology Transition.** This focus area assesses a technology’s potential Naval relevance and likelihood of implementation on Navy platforms.

d. **Offeror’s Capabilities.** This focus area assesses other related project experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

e. **Team Strength.** Qualifications, capabilities, and experience of the proposed management team and technical personnel.

f. **Cost Realism.** Realism of the proposed costs and availability of funds.
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