S2975: Improved Cable Installation and Testing

NSRP All Panel Meeting 2025

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Agenda

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10. Next Steps
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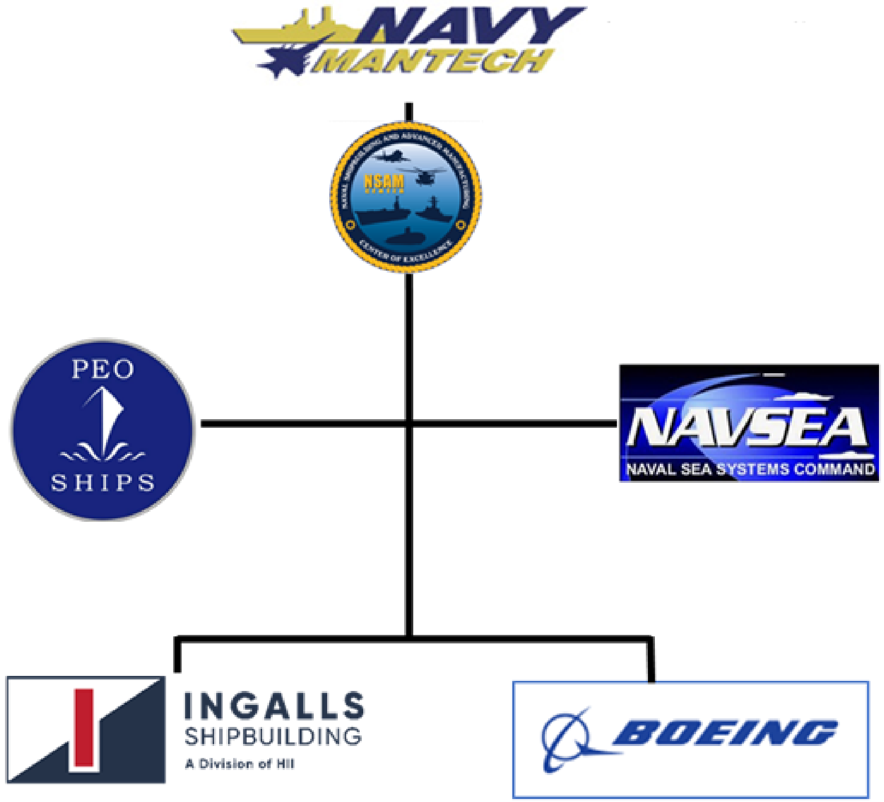
Project Organizational Structure



Project Overview/Objectives

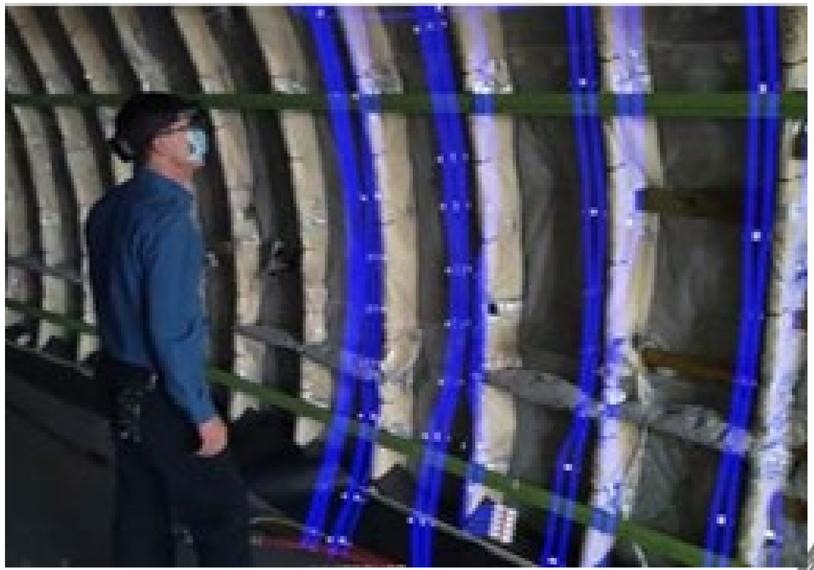
- Issue Description:
  - The process of installing and testing cable on naval platforms is a very time consuming and labor-intensive process.
  - Sensitive cable media, including fiber optic and semi-rigid coax (i.e. Heliax) cables are often replaced due to testing performance (i.e. non-conformance to test requirements). These cable types are easily damaged in the ship construction environment.
  - Due to the delicate nature of Heliax cables, they require substantial manpower to install. Performance can be impacted by manufacturing defects, geometrical changes after installation, connector installation, or cable damage.

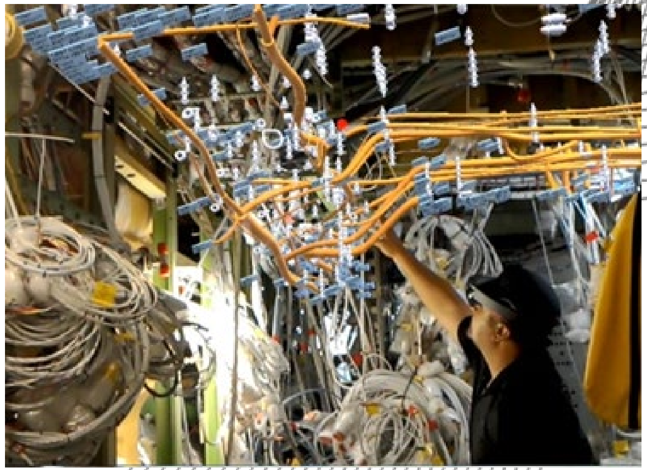
Heliax Cable

Project Overview/Objectives

The overall objective of this project is to improve performance of shipboard cable plant manufacturing and installation.

- Improve first time yield (FTY) of cable plant fabrication and focus on improvements to sensitive cable media, including coaxial and optical cable types.
- Make updates to specific cable installation and testing requirements as needed.
- Evaluate and test an Augmented Reality Cable Installation system in a shipboard environment.





Boeing AR System

ManTech Metrics

Goal 1: Improve First Time Yield (FTY) of Cable Installation and Testing

Parameter	Baseline Value	Requirement Threshold Value	Requirement Objective Value	How to Measure	Timeframe to Verify	Achievement Value	Achievement Date	Demonstration Method
Number of Circuits	Engineering Design Data	5%	10%	Production data will be used to determine the number of circuits reworked by hull for baseline rework. Phase II pilot will for impact to baseline balues.	Subtask 5.2 and 7.2	TBD	TBD	IE Study

Goal 2: Reduction of Man Hours Required for Cable Installation and Testing

Parameter	Baseline Value	Requirement Threshold Value	Requirement Objective Value	How to Measure	Timeframe (i.e. Subtask X.X) to Verify	Achievement Value	Achievement Date	Demonstration Method
Installation Data	Historical Cost Data	5%	10%	Pilot project will evaluate installation and rework time against baseline values	Subtask 5.2 and 7.2	TBD	TBD	IE Study

Goal 3: Reduction of Material Costs for Cable Installation and Testing

Parameter	Baseline Value	Requirement Threshold Value	Requirement Objective Value	How to Measure	Timeframe (i.e. Subtask X.X) to Verify	Achievement Value	Achievement Date	Demonstration Method
Material Cost	Historical Material Cost Data	5%	10%	Pilot project will evaluate installation and rework time against baseline values	Subtask 5.2 and 7.2	TBD	TBD	IE Study

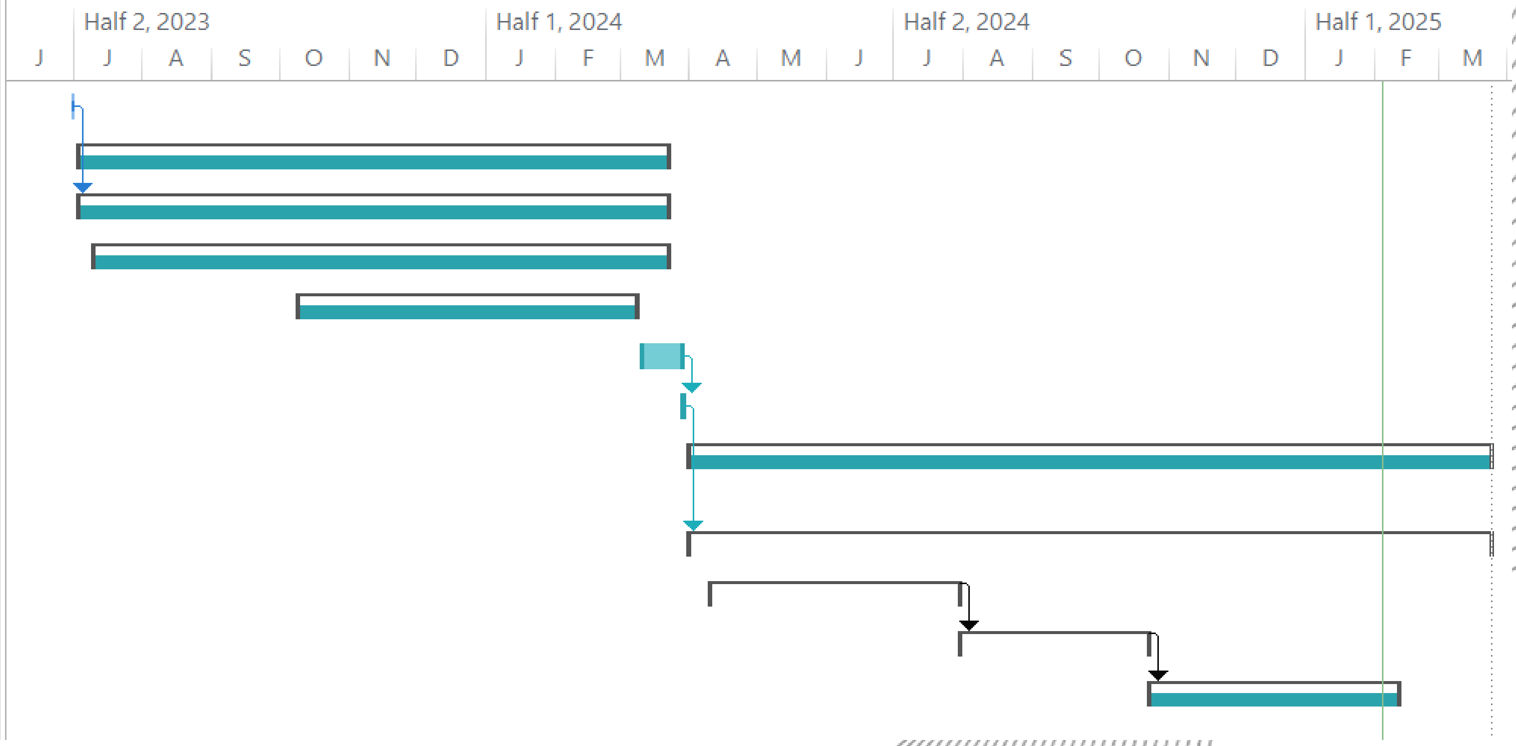
Goal 1: First Time Yield ⬆	**Goal 2:** Man Hours Required ⬇	**Goal 3:** Material Costs ⬇

Benefits / Payoff / Business Case Update

- Major Benefit: Reduction in cost associated with an increase in first time yield of cable installations. The objective of this project is to reduce both the labor costs and material associated with cable system rework by 10%. This will be achieved by eliminating the need to rip out and reinstall cables that have failed operational tests or have been installed incorrectly.
    - Projected 5-year All Platforms ROI: 5.3
    - Projected 5-year ROI: 1.5

Project Schedule

Task Name
Contract Award - Phase 1
Phase I (Base Period) – Requirements Definition and Feasibility
Task 1: Phase I Project Management
Task 2: Evaluate Cable Installation Materials and Processes
Task 3: Evaluate Augmented Reality (AR) Technology
Contracting Process - (Option Period 1)
Contract Award - Phase II (Option Period 1)
Phase II (Option Period 1) – Pilot Cable Materials, Processes, Technology and Develop New Requirements
Task 4: Phase II Project Management
Task 5: Pilot Cable Installation Materials and Processes
Task 6: Develop New Technical Requirements
Task 7: Pilot Boeing AR Technology



Technical Approach

- The first phase of this project is concentrated on evaluating the current processes and materials to define areas of opportunity in which a possible solution could be implemented. The team will also perform an initial survey and assessment of AR technology. The second phase of the project will pilot new cable installation materials, processes and technologies. Newly proposed technical requirements will be developed, and new processes, materials, technologies, etc. will be piloted in a shipyard environment.
- Phase I
  - Task 1 – Project Management
  - Task 2 - Evaluate Cable Installation Materials and Processes
  - Task 3 – Evaluate Augmented Reality (AR) Technology
  - Gate Review (Q1 2024)
- Phase II
  - Task 4 – Project Management
  - Task 5 – Pilot Cable Installation Materials and Processes
  - Task 6 – Develop New Technical Requirements
  - Task 7 – Pilot Boeing AR Technology

Current and Available Cable Products

Blown Optic Fiber (BOF) Systems and Heliax Cable

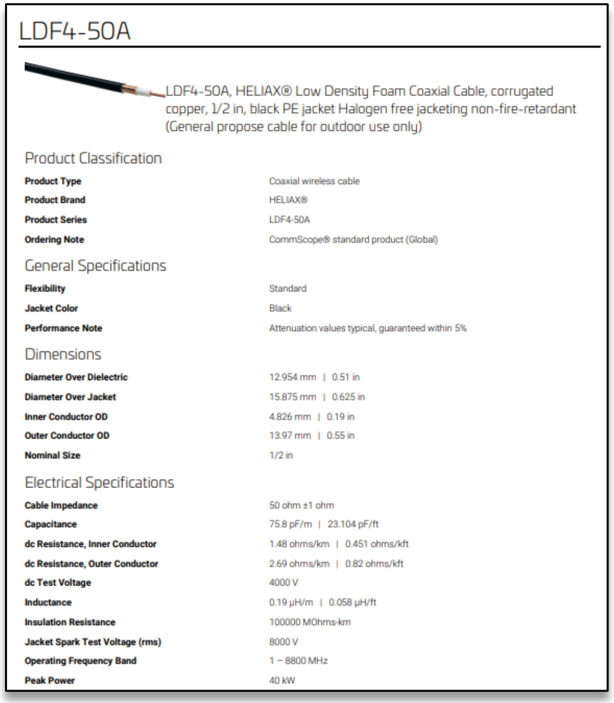
- BOF is designed to MIL-PRF-84045
  - Utilizes conduit for the fiber installed in the ships cableway
  - System is connected through tube routing boxes to make a compete path for the optical fiber to be installed later in ships construction cycle
  - BOP system also provides an efficient method of removing and reinstalling optical fiver as needed for damaged fiber or system upgrades.

DESCRIPTION	DAO
BOF CONDUIT, 7 TUBE	6015-DA0-746232
BOF CONDUIT, 1 TUBE	6015-DA0-746233

Blown Optical Fiber Cable

Current and Available Cable Products

- Heliax Cable
  - ➢Semi rigid; covered by MIL-DTL-28830; 3 sizes currently
  - ➢During installation, the cable can be subject to stress which can causes kink/ permanent deformation of the outer shell.



LDF4-50A

LDF4-50A, HELIAX® Low Density Foam Coaxial Cable, corrugated copper, 1/2 in, black PE jacket Halogen free jacketing non-fire-retardant (General propose cable for outdoor use only)

Product Classification

Product Type	Coaxial wireless cable
Product Brand	HELIAX®
Product Series	LDF4-50A
Ordering Note	CommScope® standard product (Global)

General Specifications

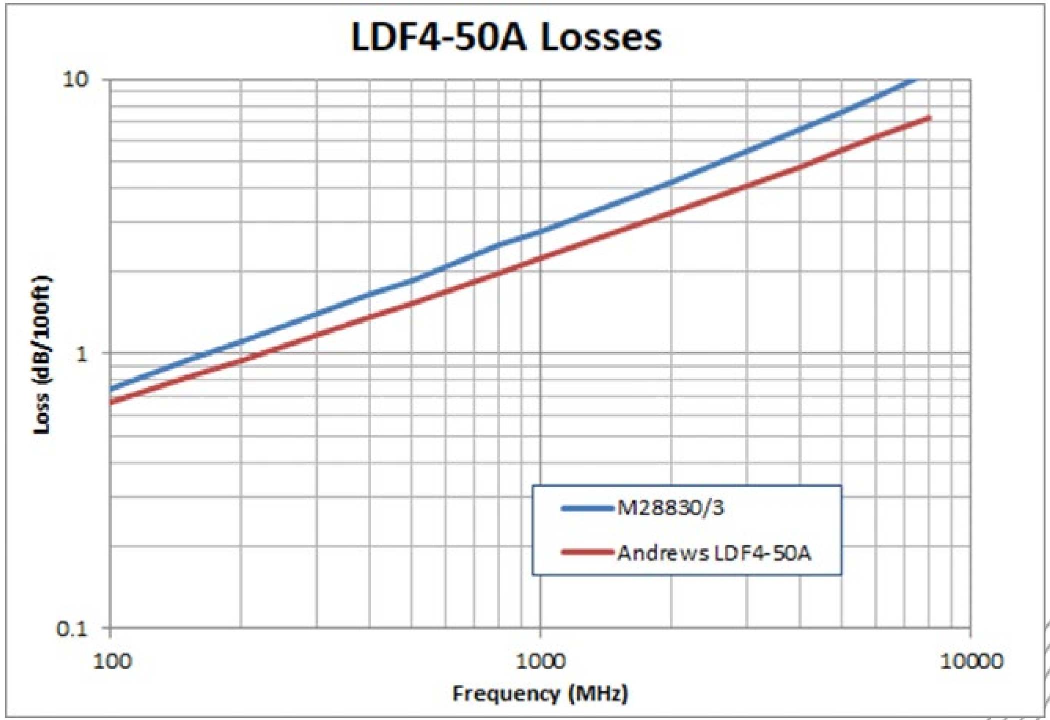
Flexibility	Standard
Jacket Color	Black
Performance Note	Attenuation values typical, guaranteed within 5%

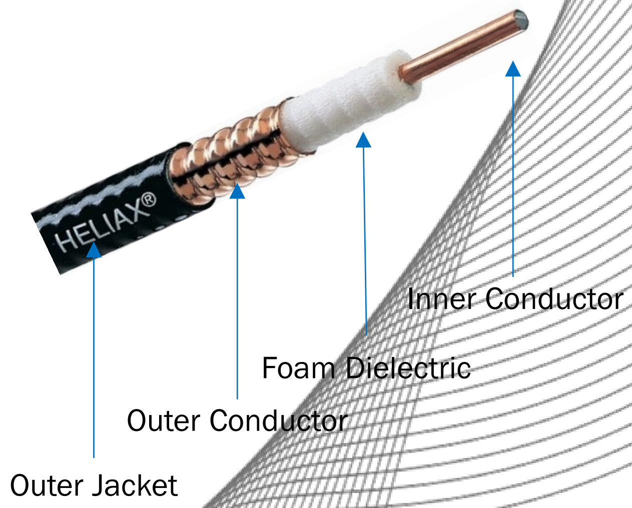
Dimensions

Diameter Over Dielectric	12.954 mm | 0.51 in
Diameter Over Jacket	15.875 mm | 0.625 in
Inner Conductor OD	4.826 mm | 0.19 in
Outer Conductor OD	13.97 mm | 0.55 in
Nominal Size	1/2 in

Electrical Specifications

Cable Impedance	50 ohm ±1 ohm
Capacitance	75.8 pF/m | 23.104 pF/ft
dc Resistance, Inner Conductor	1.48 ohms/km | 0.451 ohms/kft
dc Resistance, Outer Conductor	2.69 ohms/km | 0.82 ohms/kft
dc Test Voltage	4000 V
Inductance	0.19 µH/m | 0.058 µH/ft
Insulation Resistance	100000 MOhms-km
Jacket Spark Test Voltage (rms)	8000 V
Operating Frequency Band	1 – 8800 MHz
Peak Power	40 kW





Heliax Cable

Cableway Design & Installation

- Cableway design includes development of
  - Circuit information
  - Wireway model
  - Cable Run Sheets
- Optimal cable route determined
- Barcode installed on cable hanger and cable
- Cable routing sheets used for identification of proper route
- Scanning tool used during installation activities to verify route and progress

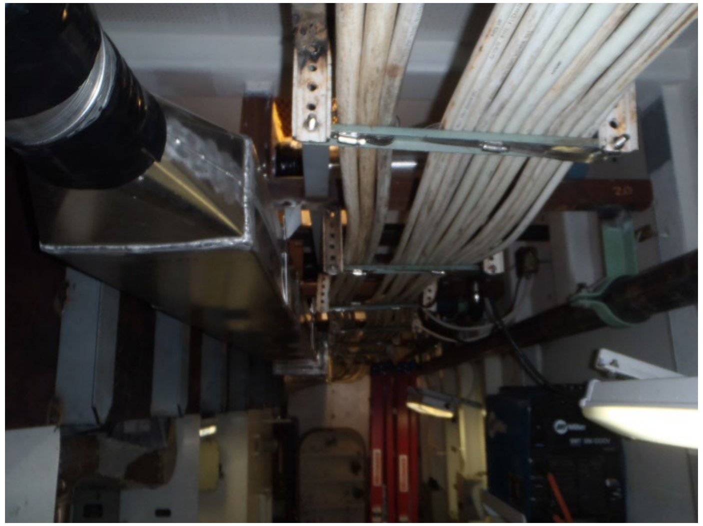
Example scanning tool

Cableway Improvement Opportunities Identified

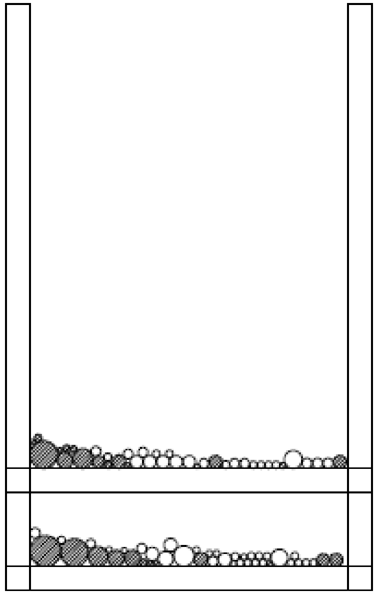
- The concept of bundling cables and use of color-coded cable jacket materials was identified. Potential benefits include:
  - Improve care and protection efforts of cable types
  - Enable technicians to readily identify sensitive cables types
  - Decrease damage to cables during and after installation
  - Decrease cableway congestion
  - Improved planning and improved QA processes
- A pilot installation was conducted to evaluate the cable bundling concept

Cableway Pilot

- Location: MTA Mock-Up
- Circuits from ship cableway selected and installed
    - 83 circuits
    - 40 cable types
- Circuits installed using standard/baseline method
- Cableway modified to demonstrate benefits of new method



Cableway Mock-up



Tier Cableway Example

Cable Type	Cable Jacket Color	
Fiber optic	Blue	
BOF	Blue	
CAT	Black	
Heliax	Black	
Coax	Black	
Control	Black	
Power	Red	
Power	White	

Cable Colors and Grouping

DISTRIBUTION STATEMENT A: Approved for public release: distribution is unlimited.

Heliax Cable Testing

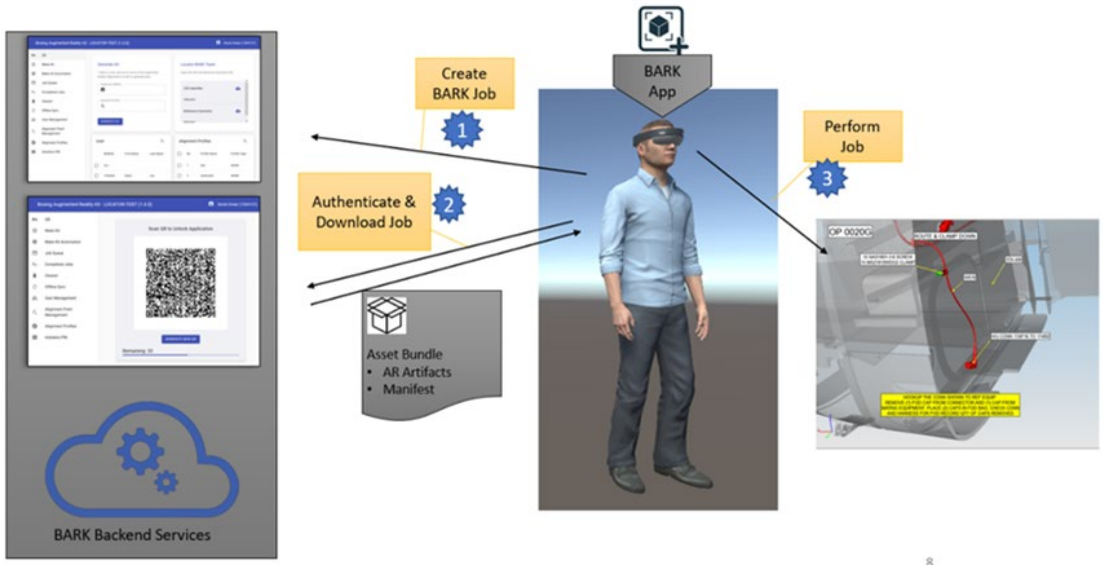
- Initial laboratory testing conducted to characterize pre-installed cable segments and performance to requirements
- Overview:
  - CUT: 162.4' segment on reel
  - Both 2-Port and Remote power head options included for evaluation
- Cable installed in cableway mock-up for additional testing to evaluate installation impacts
- Testing evaluated:
  - ✓ Initial cable performance
  - ✓ insertion loss (IL)
  - ✓ voltage standing wave ratio (VSWR)

	Powerhead with MML Allowance		2-Port with MFG Tol, Real Conn HF and MML Allowance		2-Port without MML and Cable Allowance	
DESCRIPTION	**Item**	**dB loss**	**Item**	**dB loss**	**Item**	**dB loss**
Cable Loss @ 8.8 GHz (7.69 dB/100ft)	162.4 ft cable	12.49	162.4 ft cable	12.49	162.4 ft cable	12.49
Manufacturing tolerance	zero buffer		1.05 buffer	0.62	zero buffer	
Connectors	2 connectors	0.20	2 real conns [2]	0.30	2 connectors	0.20
Mismatch	MML	0.18	MML	0.18	MML	0.00
Calibration Hardware	Cal bullet [1]	0.10				
Total - Max Allowable Loss	**Total**	**12.77**	**Total**	**13.59**	**Total**	**12.69**
Lab Test Result	***Measured Value***	***12.92***	***Measured Value***	***12.72***	***Measured Value***	***12.72***
	FAIL		**PASS**		**FAIL**	

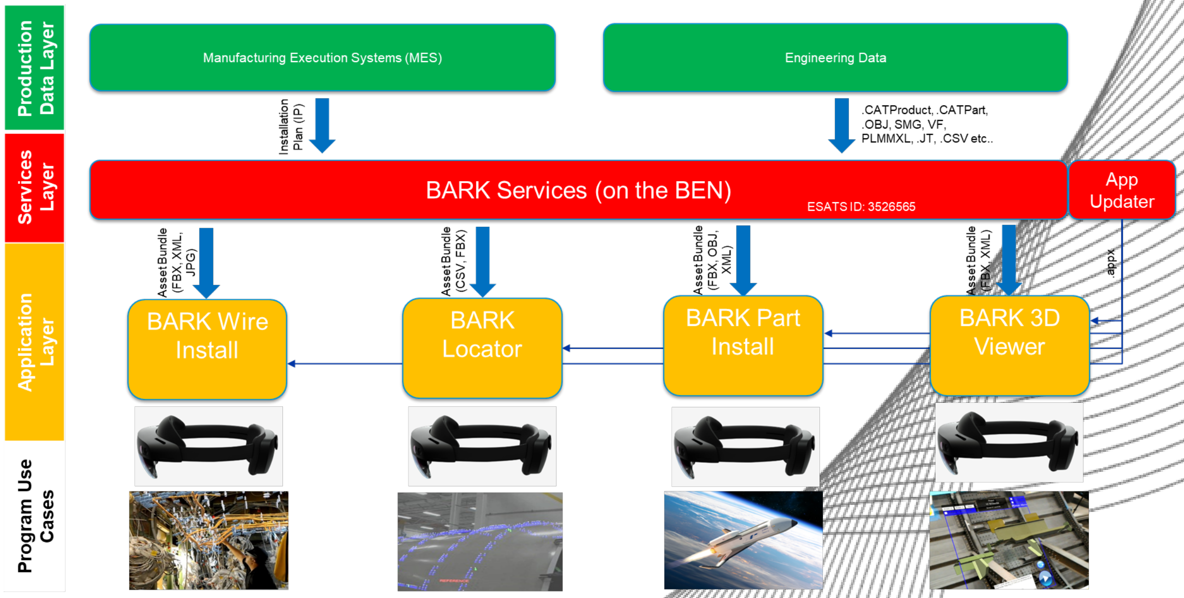
Notes:
1) *bullet used in Cal and not used in Test*
2) *calculated value at 8.8 GHz*

Augmented Reality System

- The Boeing Augmented Reality Kit (BARK) system provides AR capability to the technician to aid in cable installation, fastener installation, and QA processes in airframe construction
- Developed four use cases for Phase II



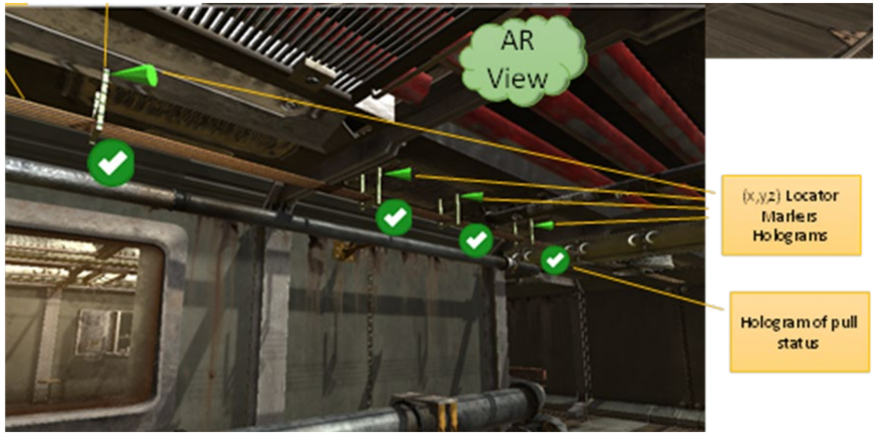
Bark Overview



IT Interfaces

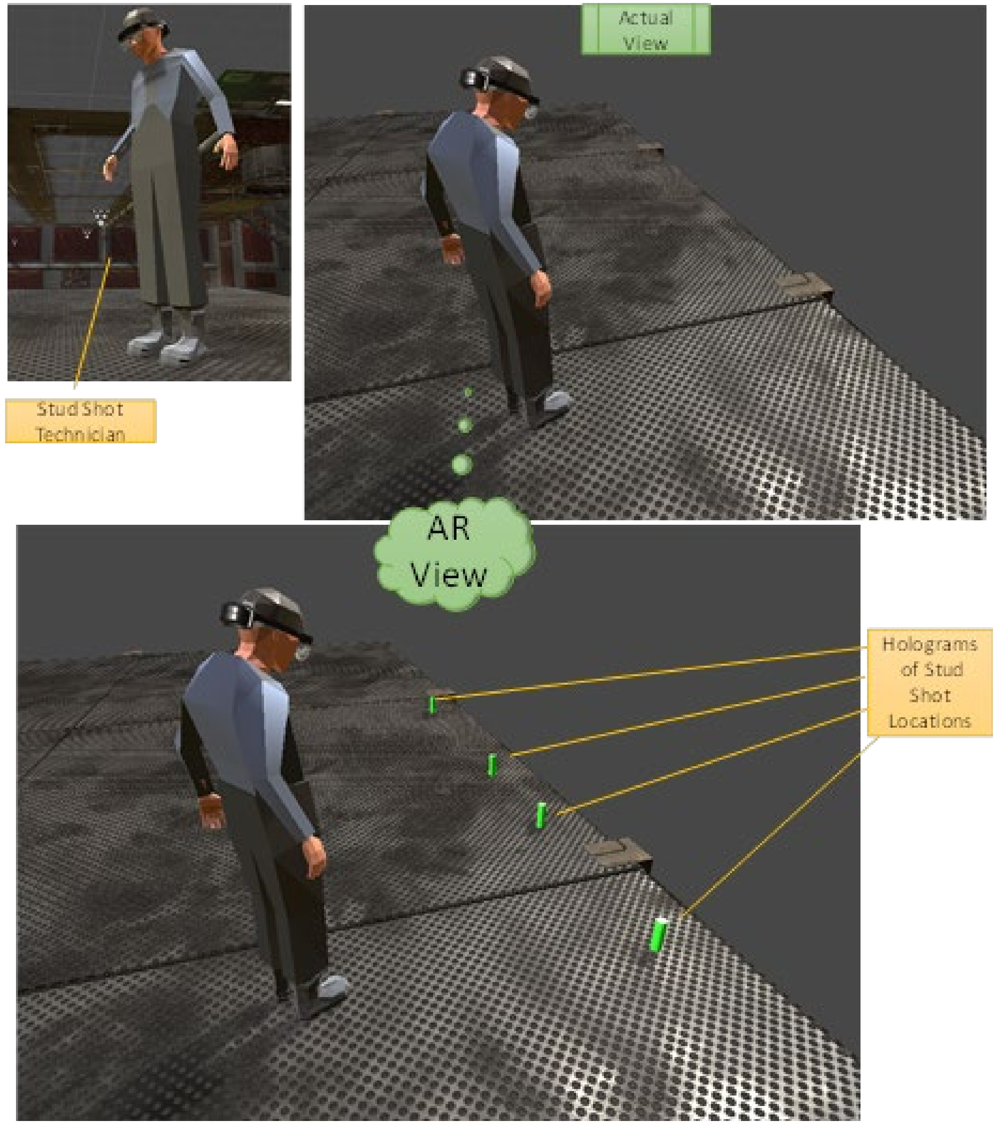
Pilot Boeing AR Technology—Use Cases

- Use Case 1: Project simple graphic onto the BARK display to indicate key hanger locations and cable route of interest.
- Use Case 2: Project graphics onto the BARK display to indicate key hanger locations and cable route of interest.
- Use Case 3: Project enhanced graphics onto the BARK display to illustrate key-station hanger location and circuit paths.
- Use Case 4: Project simple graphic onto BARK display to indicate cableway stud attachment locations to aid in cableway installation processes.

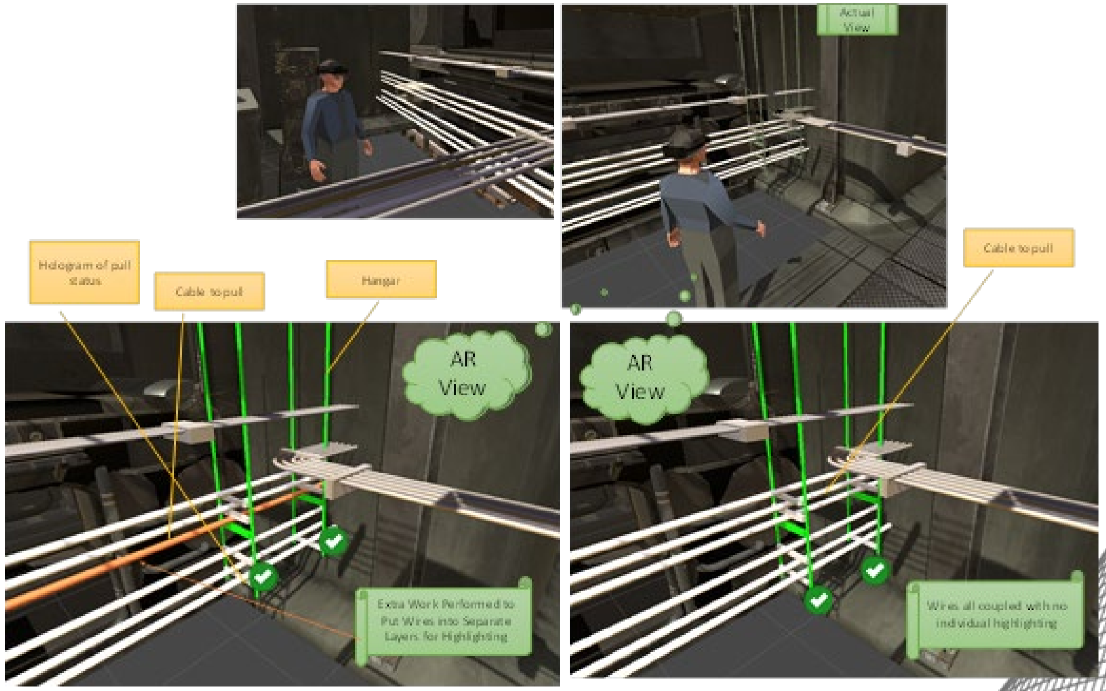


Cable Route Identification Example
(Use Case 1)

Use Case 3 & 4



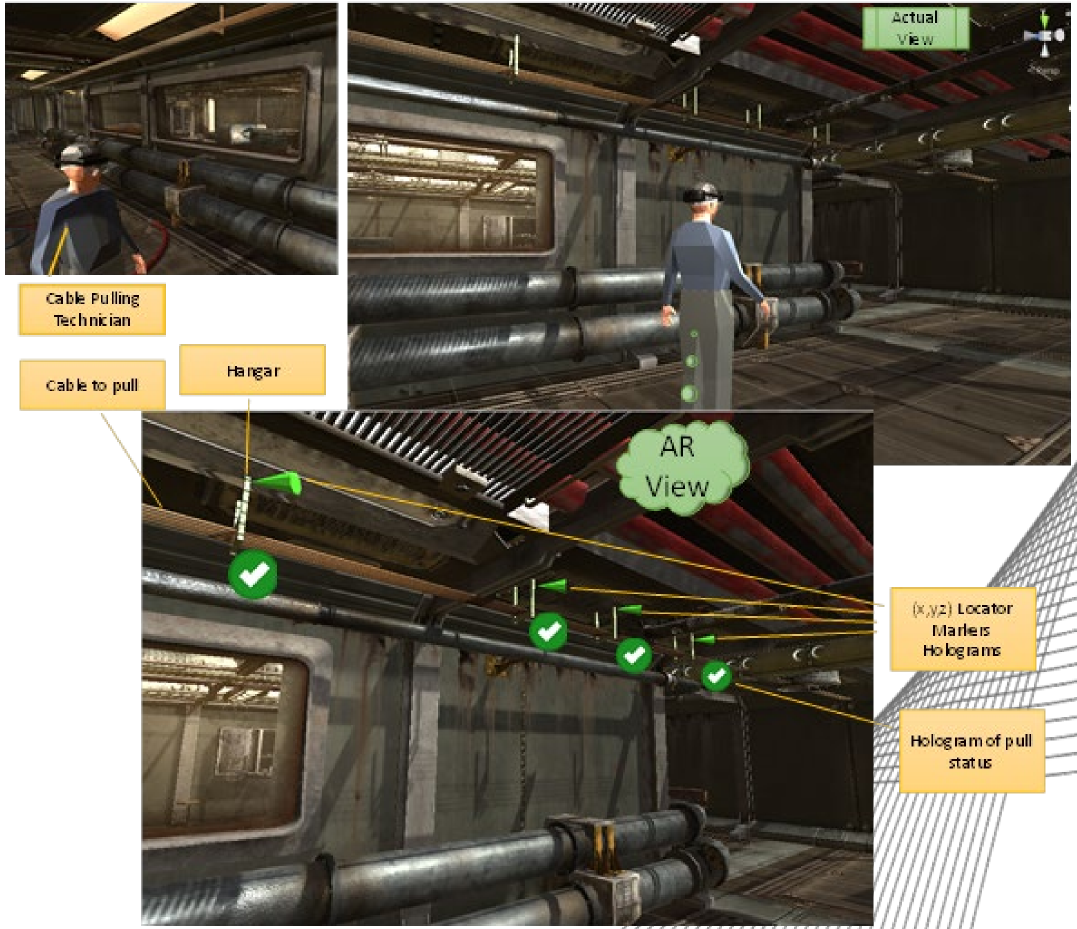
Cableway Stud Installation Example
(Use case 4)



Cableway Hanger and Cable Position Identification Example
(Use Case 3)

Pilot Boeing AR Technology

- Boeing completed two preliminary site visits at Ingalls:
  - Reviewed use case locations, determined potential marker location(s) and evaluated system alignment in the shipboard environment.
  - Alignment points were updated and verified in the field.
  - Team successfully tested the BARK tool shipboard.
- Data packages for all use cases are now complete
- Final AR trials conducted January 30th



Cable Route Identification Example (Use case 2)

Transition/Implementation

- Transition Event:
  - The technologies and processes successfully developed through this ManTech effort will be pursued for implemented across all ship classes built by Ingalls Shipbuilding at their Pascagoula, MS facility. The IPT will develop a comprehensive list of recommendations at the end of the Phase II effort. New technologies, cable materials, and/or process change recommendations will be reviewed with Ingalls Engineering, Operations, and applicable Program Office Management Teams for approval.
- Required Non-ManTech Transition Investments: N/A
- Implementation:
  - Target: Ingalls Shipbuilding

Next Steps

- Submit findings from the Cableway Pilot and the Boeing AR Technology Pilot
- Conduct Final Review

Questions?

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