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Original title on 712 A/B: Lessons Learned from COMOPTEVFOR Use of Distributed Engineering Plant (DEP) in a Recent NGC2P Operational Assessment (OA)

If the title was revised please list the original title above and the revised title here:

PRESENTED IN:

WORKING GROUP: 25

COMPOSITE GROUP: E

SPECIAL SESSION 1:

SPECIAL SESSION 2:

SPECIAL SESSION 3:

DEMONSTRATION:

POSTER:

TUTORIAL:

OTHER:

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 01 JUN 2007		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Lessons Learned from COMOPTEVFOR Use of Distributed Engineering Plant (DEP) in a Recent NGC2P Operational Assessment (OA)				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Commander Operational Test and Evaluation Force (COMOPTEVFOR) 7970 Diven Street Norfolk, VA 23505				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM202526. Military Operations Research Society Symposium (75th) Held in Annapolis, Maryland on June 12-14, 2007, The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 27	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Lessons Learned from COMOPTEVFOR Use of Distributed Engineering Plant (DEP) in a Recent NGC2P Operational Assessment (OA)

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Operational Test and Evaluation Force / Center for
Naval Analyses

MORS Symposium

14 June 2007

Take Aways



- COMOPTEVFOR leveraged a DEP test event to provide data supporting joint interoperability assessment in an OA
- Interoperability metrics cued root-cause discovery of a serious interoperability issue
- NGC2P program pursuing TTP and materiel risk mitigation efforts prior to OPEVAL
- *DEP is a useful tool supporting interoperability testing of major combat systems and their ancillary equipment in a joint environment*
- *An OT resource, especially in early phases of testing*

Overview



- ➔ Leveraging of DEP event
 - VV&A lessons
 - DEP-based assessment lessons

What's a DEP?



- Distributed Engineering Plant (DEP)
- Hardware in the loop (HWIL)
- Hardware = entire major combat systems and ancillary equipment
- Multiple system labs linked by ATM-VLAN
- Sensors stimulated with common scenario
- TDL connectivity via GTE over ATM-VLAN

OA System Under Test: NGC2P



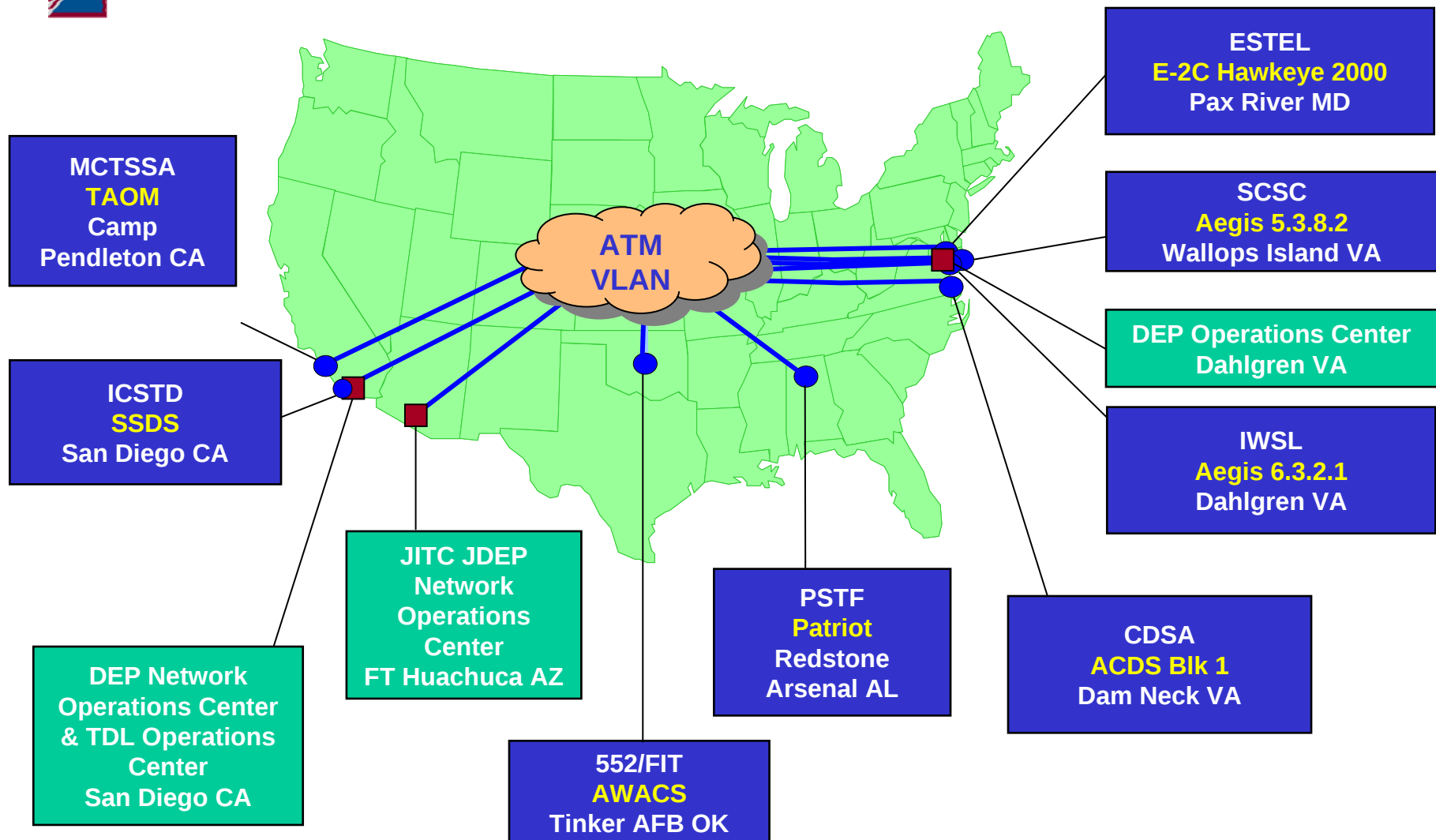
- Next Generation Command and Control Processor (NGC2P)
 - Surface Navy tactical data link (TDL) interface
 - New increment adds JRE and other capabilities
- NGC2P OA in Match 06
 - Hawaii and SOCAL
 - Two Aegis ships and land-based test site
 - Brief participation in strike group TDL
 - ***Non-Navy participants not available for test to support assessment of joint interoperability***

C/DIT 06 Joint DEP Event

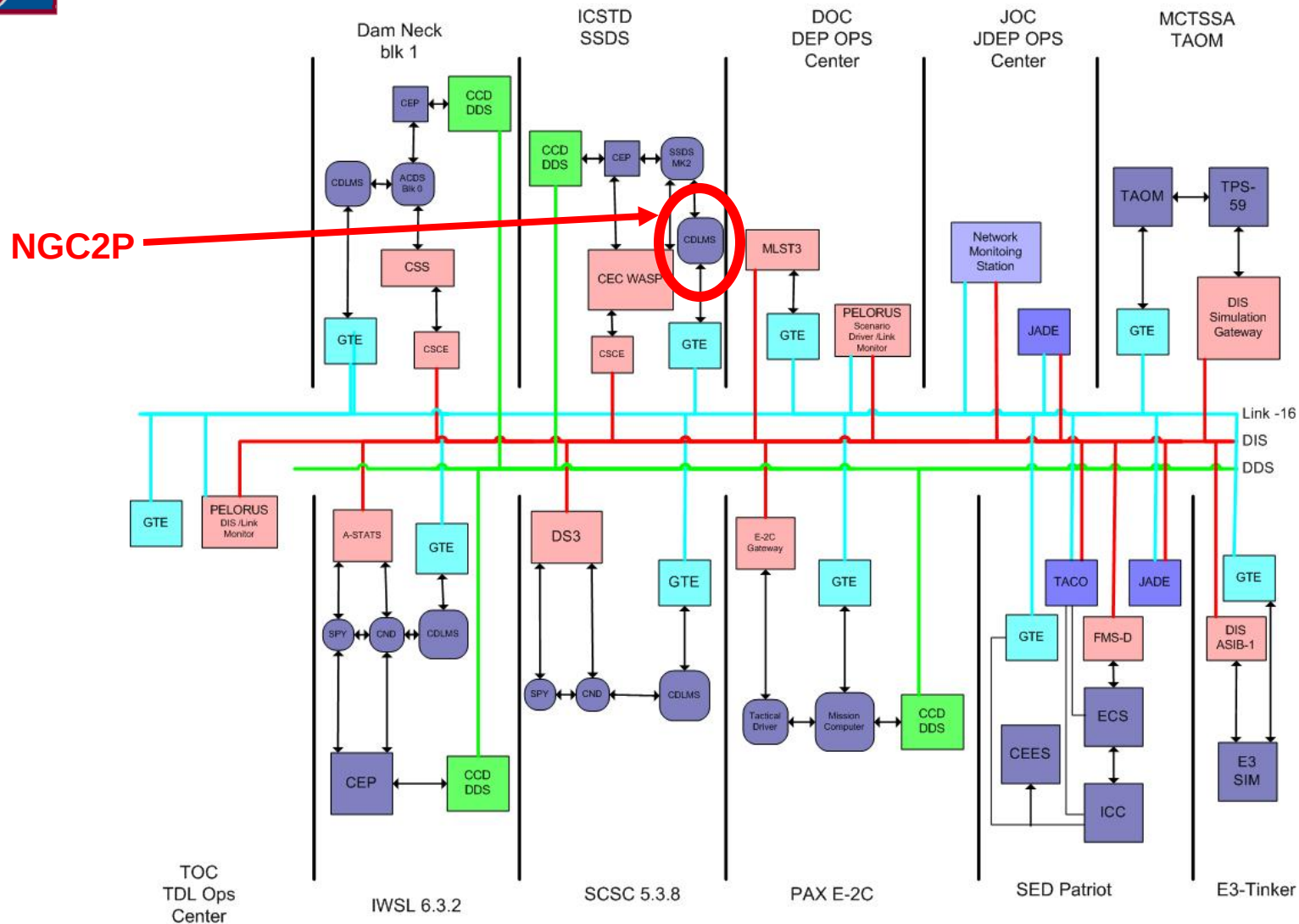


- Correlation/Decorrelation Interoperability Test (C/DIT) runs for record (first week) in DEP 27 Feb – 2 Mar 06
- Ship Self Defense System (SSDS) participant uses NGC2P as TDL interface
- Many other Navy and joint participants
 - Navy: Aegis (x2), ACDS Block 1, E-2C HE2K
 - Joint: Army Patriot and Air Force E-3 (AWACS)
- Opportunity to expand the scope of the OA to better address joint interoperability
- COMOPTEVFOR obtained permission of NGC2P program, NAVSEA, and C/DIT director to observe and analyze data in addition to live NGC2P OA events

C/DIT 06 Participants



C/DIT 06 DEP Event Architecture *



C/DIT 06 Adjunct to the NGC2P OA



- C/DIT Primary objective to test MILSTD 6016C track correlation protocol (Corr/Decorr ICP)
- But baseline cases were run “without” Corr/Decorr ICP (tactical loads)
- Robust/challenging 71-object scenario largely derived from live Red Flag and JCIET events
- Scenario and diversity of participants ideal for OA assessment of joint interoperability

Efficiencies



- C/DIT analysis team performed air picture reconstruction supporting primary C/DIT test objectives
- C/DIT data reduction and reconstruction a fully-leveraged input to NGC2P joint interoperability assessment analysis
- OT&E cost limited to observer TAD and analyst time (~3 months) for V&V and data analysis

Overview



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Verification, Validation & Accreditation (VV&A)



- COMOPTEVFOR Policy requires M&S VV&A for HWIL
- Inadequate time to perform V&V prior to event
- Opted for concurrent V&V and analysis
- Accreditation and V&V plans developed per policy
 - M&S requirements, assessment methods, acceptance criteria:
 - Stimulation to NGC2P host combat system and other C/DIT participant's sensors
 - Emulation of TDL

VV&A Approach



- Review relevant prior DEP V&V efforts
- Review results of C/DIT integration, risk-reduction, and dry-runs
- COMOPTEVFOR observations at ICSTD during the test
- C/DIT team observations at other sites
- Post-test analysis of combat-system track-file and data link extracts

V&V Findings



- Six of eleven requirements completely satisfied
 - NGC2P host interface
 - Support of multiple combat systems
 - DIS interfaces
 - Scenario
 - IFF data errors
 - Airborne participants in DIS; consistent with TDL data

V&V Findings (cntd.)



- Four requirements partially satisfied
 - Scenario objects within coverage tracked locally
 - Lack AWACS track file data to confirm true for AWACS
 - Aegis 5.3.8 participant lacked local tracks of E-2 and AWACS
 - Scenario consistency across units
 - some DIS data distortion at AWACS causing some “track jumps”
 - IFF data anomaly; later determined to be SGS/AC issue (not DEP)
 - Terminal emulator performance (latencies at Patriot site during most runs)
 - Scenario aircraft non-C2 PPLIs (update rate too slow)
- CEC/DDS requirement not satisfied (no data from runs where DDS was used)
- Note: most of the plant-related issues from C/DIT 06 week 1 have since been resolved

Accreditation



- Plant and system problems precluded meeting many C/DIT 06 objectives
- But C/DIT 06 was adequate to support assessment of NGC2P joint interoperability for the OA with following restrictions:
 - Portions of test runs with terminal emulator latencies were not to be used
 - Runs where DDS operations were attempted were not to be used
 - Runs including non-C2 PPLIs were not to be used
 - Effects of noted anomalies on the air picture to be carefully accounted for and distinguished from NGC2P performance

Parallel V&V and Assessment



- V&V and assessment based on identical data
- Overlap of V&V and assessment activities; efficiencies
- Analyst experience/familiarity with strengths and weaknesses of the data used for the assessment
 - Valuable in defending results and obtaining community acceptance of their credibility
 - DEP data withstood considerable post-report scrutiny due to unanticipated high-level interest in the findings
 - Validity of findings was ultimately acknowledged by all stakeholders

Overview



- Leveraging of DEP event
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- ➔ • DEP-based assessment lessons

Interoperability Assessment Methodology



- Operational effects of interoperability performance manifest in the completeness, clarity, correctness, and commonality of information shared among FoS operators
- Information/picture quality quantified using reconstructed operational picture attribute metrics
 - Each system's tracks matched to "truth" tracks (targets instrumented)
 - Attributes scored from matched tracks
- Picture attributes correspond to requirements/KPPs in overarching MA ICDs
- Measures end-to-end operational effectiveness of information exchanges IAW OTA Commanders' stated NR-KPP assessment role (forest)
- Attribute results also cue root-cause analysis supporting fault isolation (trees)

Air Picture (SIAP) Attributes



- Completeness: % of objects depicted
- Clarity: % of depicted objects dualized
- Continuity*: Track number changes/hour, gaps
- Commonality** : % tracks held in common
(same position+/-, same ID, same time)
- ID Completeness: % objects identified
- ID Accuracy: % IDs correct
- ID Clarity: % IDs unambiguous

*"Rolled up" across time by definition; non-instantaneous

**Rolled up across units by definition

Operational Picture Attributes



- Broad acceptance of SIAP attributes
 - Vetted by all services
 - Widely used in TAMD communities
- KPPs in TAMD/CID MA ICDs; required and objective performance thresholds
- Reflected in recent CDDs/TEMPs
- Adaptations to maritime and ground operational pictures

Root-Cause Analysis



- Analysis of attributes cues root-cause analysis
 - Reveals generally degraded performance
 - Reveals performance differences between units, among reconstructed objects, vs. time
- Frequently spotlights problems not observed in real-time or during initial playback
- Cues to specific tracks/times
- Focuses analysis to relevant system data to better characterize or isolate the underling problem or problems

OA Assessment



- Observed degraded commonality attribute
- Drilled down to specific tracks/times
- Several long-duration uncommon tracks
- Some of these isolated to SSDS host (pair-wise commonality)
- Examined relevant link message exchanges in NGC2P data
 - For affected tracks NGC2P sent different track number to host than received over TDL
 - Associated with earlier receipt of AWACS J7.4 messages

OA Interoperability Assessment Outcome



- Operational Picture attributes cued root cause discovery of interoperability problem
 - NGC2P interpretation of AWACS J7.4 message
 - Software error in addition to the TDL standards interpretation issue
 - Track number substitution (passed different track number to SSDS host than received over TDL)
 - SSDS saw different track number than other participants on same track
 - Occasionally caused track numbers to be applied to more than one track at a time
- COMOPTEVFOR reported a joint interoperability risk
- NGC2P program risk mitigation efforts:
 - TTP/work-arounds, coordinating with NCTSI, NNWC, and USAF (Global Cyberspace Integration Center A6I)
 - Software correction
- *DEP use in OA will probably result in better outcome at OPEVAL later this year than would have occurred otherwise*

Other OA Lessons/Considerations



- Learned more about DEP capabilities and limitations in OT context
- DEP revealed interoperability issues with high operational impact across the family-of-systems
 - NGC2P/AWACS issue
 - Also, SGS/AC software problem; fix has been developed
- *Not all bad news*; many aspects of *correct* NGC2P processing in the joint environment were demonstrated
- Serendipity was valuable, but cannot be counted upon; in general need to plan to utilize this resource whether on a dedicated or NIB basis
- Prudent to include potential use of DEP in TEMP negotiations
- Need also to ensure adequate data reduction and analysis resources/expertise on tap

DEP is a Valuable T&E Asset



- Testing in a joint environment; it's here!
- Operational mission capability impacts of major combat system interoperability
- Expanding scope: joint and coalition (UK participation in C/DIT 07 this summer)
- Full-up combat systems include all operator interfaces; potential to explore HMI, etc.