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

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

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

Paul Symborski
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 DEP Event Architecture

NGC2P
• 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

• Leveraging of DEP event

→ VV&A lessons

• DEP-based assessment lessons
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
- VV&A lessons
  - 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 dualed
- **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 underlying 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.