

Unified Data Alliance Advances Enterprise Solutions and Standards

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ABSTRACT

Warfighters and mission partners need the right information at the right time to enable informed decision-making and mission execution across all levels of operation in a complex operational environment (OE). Modeling and simulation (M&S) support to planning and execution is a Joint Command and Control (JC2) operational priority. Mining and extracting mission relevant OE data from the vast distributed collection of global data is a huge technical challenge. Machine processing is needed to aid decision making; however, integrating disparate OE source data into purposeful data sets is labor intensive, time consuming, and cannot be consistently accomplished within mission critical timelines.

The Operational Environment (OE) Unified Data (UD) alliance is collaborating to leverage, reuse, and horizontally integrate data service capabilities as enterprise solutions in the Joint Information Environment (JIE) and Mission Partner Environment (MPE). The military services and communities (Experimentation, Acquisition, Test and Evaluation, Training, Planning, Intelligence, and Analysis) recognize the value of a holistic approach for improving our warfighter's information superiority. Information superiority is the operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same.

This paper will describe the OE UD concept and collaborative approach to promote unity of effort for providing integrated OE data to enable planners to wargame courses of action (COAs) that will support their analysis of apply Diplomatic, Information, Military, and Economic (DIME) elements of national power to shape favorable mission outcomes. It will address challenges associated with manual data assimilation processes including: 1) Defining and understanding a complex OE; 2) Providers of PMESII-PT information are often diverse and disparate in their missions, geographic locations, and data transmission means; and, 3) Source data for PMESII-PT information is developed and stored in myriad formats and structures.

ABOUT THE AUTHORS

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THE DATA CHALLENGE

Warfighters and mission partners must have the right information at the right time to enable informed decision-making and mission execution across all levels of operation in a complex operational environment (OE). Mining, extracting, and integrating mission relevant OE data into purposeful data sets is labor intensive and time consuming; consequently, modeling and simulation support to planning and execution cannot be accomplished within mission critical timelines. Decision makers need information superiority to achieve the operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same.

Resources to develop data services typically address specific Service, Agency, or community capability gaps without regard to broader application and enterprise reuse. Resource sponsors must support 'non-core' reuse of their data service capabilities. Program managers are reluctant to rely on the delivery of external capabilities that may interfere with their critical path milestones.

Compounding the data challenge is that enterprise governance responsibilities do not directly align with United States (U.S.) Code Title 10/50 data service tasking authorities. The difficulty in enforcing policy and guidance mandates has resulted in the Department of Defense (DoD) not realizing the goals of the Net Centric Data Strategy (NCDS) (US Department of Defense, 2003) to make data visible, accessible, understandable, trusted, and interoperable (VAUTI). With the DoD facing resource shortfalls across the board and the mantra of 'No New (Program) Starts', it is essential for information service stakeholders to partner efforts together to develop enterprise approaches for discovering, delivering, sharing, and processing data to meet the exponential growth in requirements.

ENTERPRISE COLLABORATION

The Army has initiated a Unified Data (UD) approach to provide integrated data for mission execution and advance information superiority. Following Nobel Prize winning nuclear physicist Ernest Rutherford's (n.d.) declaration that 'We've got no money, so we've got to think', the Joint Staff (JS) is extending the Army's UD alliance to Combatant Command, Service, Agency (CC/S/A), and Mission Partner OE data stakeholders. With the goal of closing data integration gaps in the Joint Information Environment (JIE) and Mission Partner Environment (MPE), the OE UD alliance champions enterprise solutions to provide application-ready data from authoritative sources to the point of need. Evolving a holistic ability for Joint Task Forces (JTFs) to collect, discover, share, access, and store joint operational data for analysis in and out of theater requires a community-driven, government-wide, standards-based approach to exchanging information. The OE UD alliance promotes unity of effort and synergy by utilizing existing forums to focus collaboration on leveraging, reusing, and horizontally integrating cross-community data service capabilities as enterprise solutions to common OE data needs. Enterprise collaboration provides the opportunity to address interoperability issues early during requirements, architecture, and material development.

In June 2016, the Defense Modeling and Simulation Coordination Office (DMSCO) hosted the JS J6 chaired M&S Community of Interest (COI) Data Management Working Group (DMWG) to initiate the OE UD alliance. The DMWG highlighted the Army's efforts to address integrated OE data needs by converging on common standards and collaborating to reuse data service solutions. The OE UD alliance continues to grow as data stakeholders recognize the value of closing data integration gaps at the enterprise level to improve our warfighter's information superiority. Participants were cautiously optimistic yet lauded the effort.

The need for OE data is not unique to planning or training missions. While each community does have unique OE data requirements, there are common needs. In fact, communities enabled by M&S can benefit from sharing data and reusing data services. Figure 1 illustrates that the Intelligence, Planning, Training, Analysis, Experimentation, Acquisition, and Test and Evaluation communities all need OE data to support current and future Warfighting missions. Training the way you fight drives common data needs between the Warfighting, Planning, and Training communities. All need access to some intelligence information.



Figure 1. Common OE Data Needs

UNIFIED DATA SUPPORTS SHAPING THE OPERATIONAL ENVIRONMENT (OE)

Joint commanders strive to achieve a comprehensive approach with mission partners through continuous dialogue with higher authorities, translation of this dialogue, subsequent development of desired conditions and favorable outcomes, and issuance of guidance and intent to subordinates to achieve unity of effort with mission partners. (US Department of Defense, 2013) In order to shape favorable mission outcomes, warfighters must understand their complex OE. To achieve the desired effect while minimizing risk, loss, and casualties, planning considerations must include the available spectrum of Diplomatic, Information, Military, and Economic (DIME) elements of national power, Figure 2.

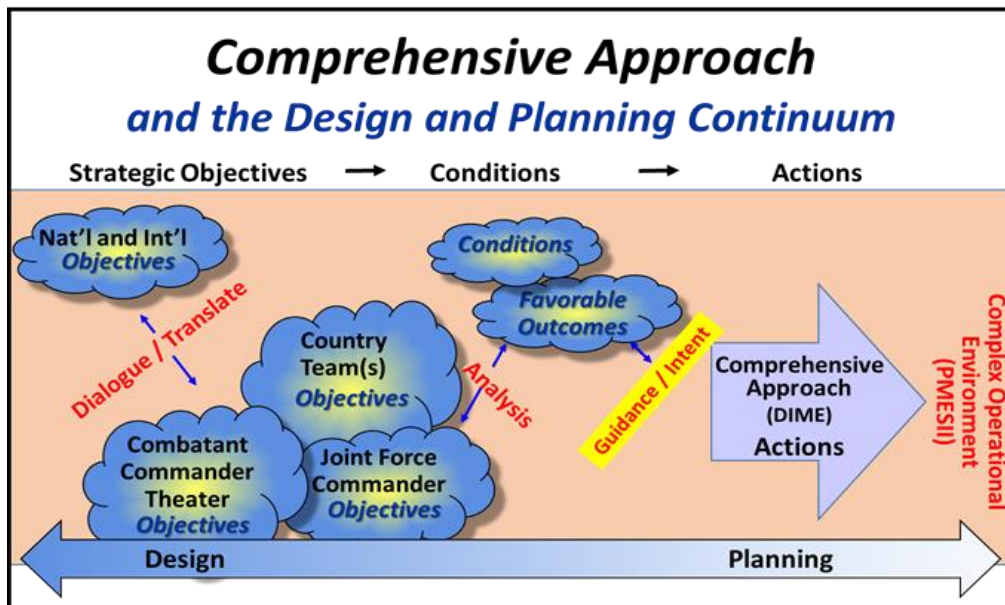


Figure 2. Shaping the OE (US Department of Defense, 2013)

Wargaming courses of action (COAs) improves a planner's ability to identify and mitigate weaknesses in the plan's concept of operation and support. Access to unified data will enhance the relevance and rigor of wargaming different COAs. Up-to-date and integrated Political, Military, Economic, Social, Information, Infrastructure, Physical Environment, and Time (PMESII-PT) information is needed to fully understand the conditions of the OE. Machine processing provides computational analysis on the relationships between PMESII-PT data to support improved decision-making. Current simulation, data processing, and visualization technologies are available to provide planners with a wargaming capability; however, there are significant technical data challenges impeding the realization of this capability need. Figure 3 illustrates the complex relationships of PMESII-PT information. Instituting a unified approach to data provides a means to tackling the technical data challenges to address this capability need.

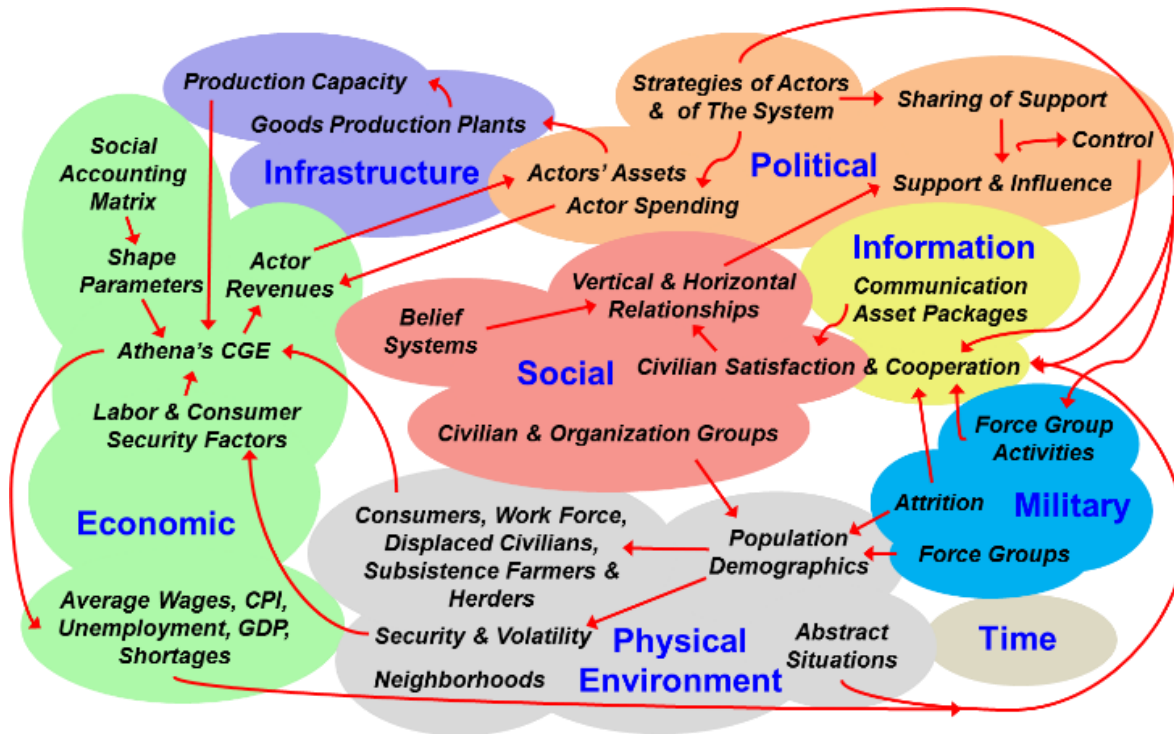


Figure 3. Complex Relationships of an OE

BUILD A MULTI-PARTNER ENVIRONMENT FOR DATA

Information superiority requires access to and understanding of all relevant OE information, especially data from our coalition partners that pertains to their organic OE. The U.S. involvement with multinational partners and nongovernmental organizations (NGOs) for mission planning, training, and execution, creates the need for a Mission Partner Environment (MPE). The ultimate objective of the MPE (US Department of Defense, 2015) is to integrate U.S. and mission partner Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) data to improve mission execution and achieve national and military objectives. Figure 4 shows the operational view that the Joint Staff J6 is advancing by horizontally integrating CC/S/A, and Mission Partner data service capabilities as enterprise solutions for the JIE and MPE. The U.S. has enduring and episodic mission partner relationships where releasable information must seamlessly flow.

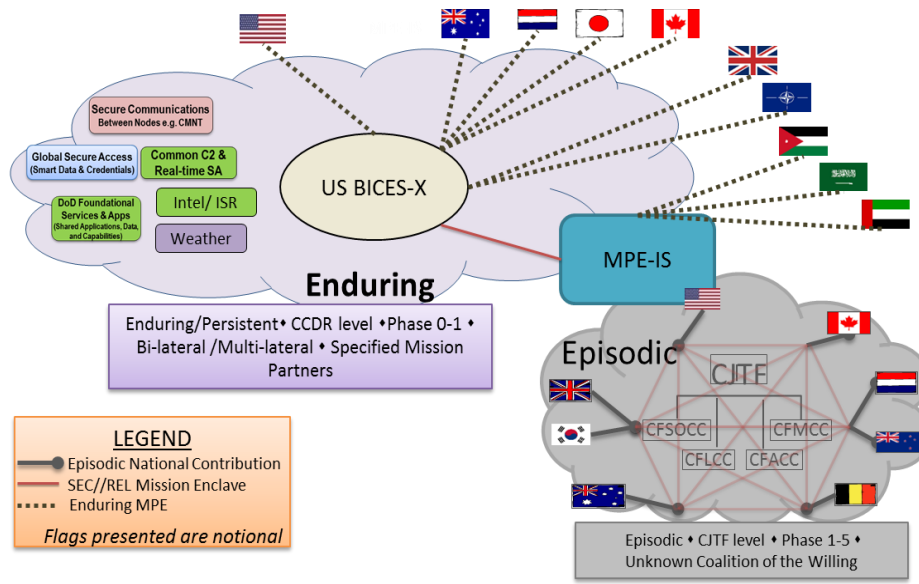


Figure 4. Mission Partner Environment

DEMONSTRATED VALUE OF INTEGRATED DATA

The value of providing application-ready data from authoritative sources at the point of need cannot be overstated. Building a simulation databases for large training exercises can exceed 8 months. The author’s experience for building the 101st Airborne (Air Assault) Division Mission Rehearsal Exercise (MRX) database to support a command post exercise with six federated constructive simulations took approximately 600 labor hours in 2008. This effort averaged 100 labors hours per federate (about 2.5 weeks) which at the time was a rather quick turn-around time for an integrated database build. A year later, the 82nd Airborne Division MRX database build took 6 hours of military labor to create by leveraging the Joint Staff Joint Training Data Services (JTDS) integrated data repository. JTDS generates an extensible markup language (XML) data file that each federate was able to parse and initialize their simulation system that resulted in gained efficiencies of increased training throughput, reinvestment of labor elsewhere in the event, and increased simulation utilization.

DATA SERVICE CAPABILITY NEEDS AND REQUIREMENTS

The need for integrated data to support improved decision-making and mission execution is clearly stated in many Joint Capabilities Integration and Development System (JCIDS) requirements and DoD policy documents. In many cases, the timing is right to collaborate across capability development activities to advance common standards and enterprise solutions. Below is a partial list of requirements and policy, in no particular order, that identify and drive the need for integrated OE data:

- The Joint Information Environment (JIE) (US Department of Defense, 2014) must provide the warfighter access to information and data resources to enable informed decision-making and mission execution across all levels of operation.
- The ultimate objective of Episodic Mission Partner Environment (MPE) is to integrate U.S. and mission partner C4ISR data for improved mission execution and achievement of military objectives.
- Joint C2 Operational Priority: rapidly war-game COAs to identify and mitigate weaknesses in the plan's concept of operation and support.
- Army Common Operating Environment (COE) Information Systems Capability Development Document (IS CDD): Unified Data (UD) Cross Cutting Capability (CCC) (US Department of Defense, 2016) shall converge disparate data structures along COE established standards to allow Commanders, Leaders and Soldiers to

more expeditiously apply disparate data to support the execution of Mission Command in operations and training. Data complies with COE standards without manual intervention.

- The Army Network-enabled Mission Command Display (US Department of Defense, 2011) /Share Relevant Tactical Information on the COP from dismounted Soldier to all higher echelon CPs. This includes PLI, symbols, graphic control measures, intelligence and operational information, civil considerations, and information on the operational environment - PMESII-PT; Area, Structure, Construction, Organization, People, Events (ASCOPE); and Sewage, Water, Electricity, Academics, Trash, Medical, Security (SWEAT-MS) variables from disparate information and intelligence systems.
- The Army M&S Capability Portfolio Review Gap addresses the need for accurate and consistent representation of the complex OE, which is also the Army Training and Doctrine (TRADOC) Capability Needs Assessment (CNA) gap #15.
- The Enterprise Services and Data Panel Operational Data Tiger Team Quick Turn Capabilities-Based Assessment (US Department of Defense, 2016) documented that Joint Task Forces require a capability to collect, discover, share, access, and store joint operational data for analysis in and out of theater.
- DoD Instruction (DoDI 8320.07) (US Department of Defense, 2015) CIO instructional guidance to share data, information, and information technology (IT) services to enable a secure sharing environment within Defense that supports the warfighting, business, DoD intelligence, and enterprise information environment mission areas.
- DoD CIO Memorandum (US Department of Defense, 2013) guidance that adoption of the National Information Exchange Model (NIEM) within the DoD offers potential efficiencies, long-term development cost savings, streamlined governance, and most importantly, improved information sharing across the DoD and with our mission partners.
- DoD CIO Memorandum guidance Cloud Computing Strategy (US Department of Defense, 2012) - Warfighters and decision makers need “Informational data services that enable the mash-up of multiple data sources located in data centers across the globe into a correlated purposeful data set supporting a user’s mission needs.”

THE TECHNICAL CHALLENGE

In addition to the organizational needs and challenges for unified data, the OE UD alliance is addressing the technical challenge of rapidly delivering integrated PMESII-PT source information as purposeful mission data sets. Modeling a complex OE is a big data challenge. Decomposing the technical challenge into data mining, data integration, data service development, and data governance components promotes incremental progress. Source data for PMESII-PT information transcends multinational, government, agency, and public domain boundaries, and is developed and stored in myriad formats and structures. Humans are incapable of mining and extracting relevant PMESII-PT information from zettabytes (10^{22} bytes) of distributed global data; however, big data analytic technology is rapidly advancing to support commercial, military, economic, and policy decision making. The United Nations Economic Commission for Europe (UNECE) (2013) projects global data will increase to 40 zettabytes in the year 2020, Figure 5.

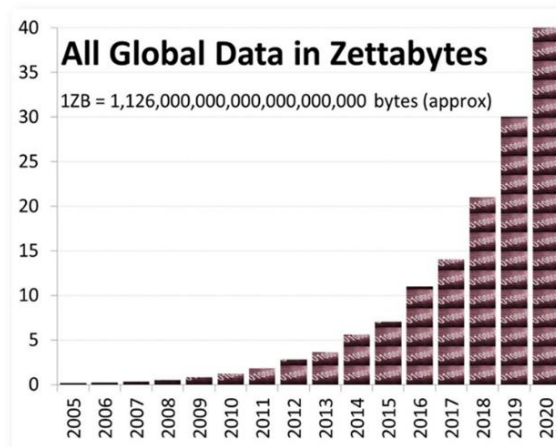


Figure 5. Global Data Growth Projections (UNECE, 2013)

Machine processing is necessary to separate mission relevant data from the global data chaff. Integrating PMESII-PT data to initialize decision support systems is currently stove-piped, time consuming, labor intensive, unsustainable, and does not support mission critical timelines. Technical issues contributing to this problem include: 1) Providers of PMESII-PT information are often diverse and disparate in their missions, priorities, geographic locations, and data transmission means. 2) Source data for PMESII-PT information is developed and stored in a myriad of formats and structures, at different classification levels, and 3) Cybersecurity practices are typically risk averse, locally interpreted and administered, and are reluctant or prohibit machine-to-machine information exchanges.

The collaborative nature of the OE UD alliance promotes optimal solutions to technical issues, and how they can best meet enterprise needs.

SOLVE THE DATA CHALLENGE

The collective goal of the OE UD alliance is to advance informed decision-making and mission execution across all levels of operation by leveraging, reusing, and horizontally integrating CC/S/A, Joint, and mission partner capabilities as enterprise solutions in the JIE and MPE. The objective is to provide integrated OE data in near real time to jump start mission workflow activities and accelerate decision support system initialization. The initial community of interest meeting identified data activities that could be leveraged as collaborative efforts. Unified Data (UD) repositories provide commonly needed OE data to improve situational awareness, mission planning and execution, training, concept and capability development, acquisition, test and evaluation, intelligence processing, and analysis decision making. The OE UD concept provides an organizing construct to align cross-community activities that are addressing solutions to common OE data needs, Figure 6.

The yellow Unified Data Repository (UDR) is the cornerstone of the OE UD concept that is a physical data store of integrated OE data. Since it is infeasible to integrate all OE source data for all mission decision support systems in a single repository, specific types and fidelity of PMESII-PT data will be provided by many UDRs at distributed consolidated data centers (CDCs).

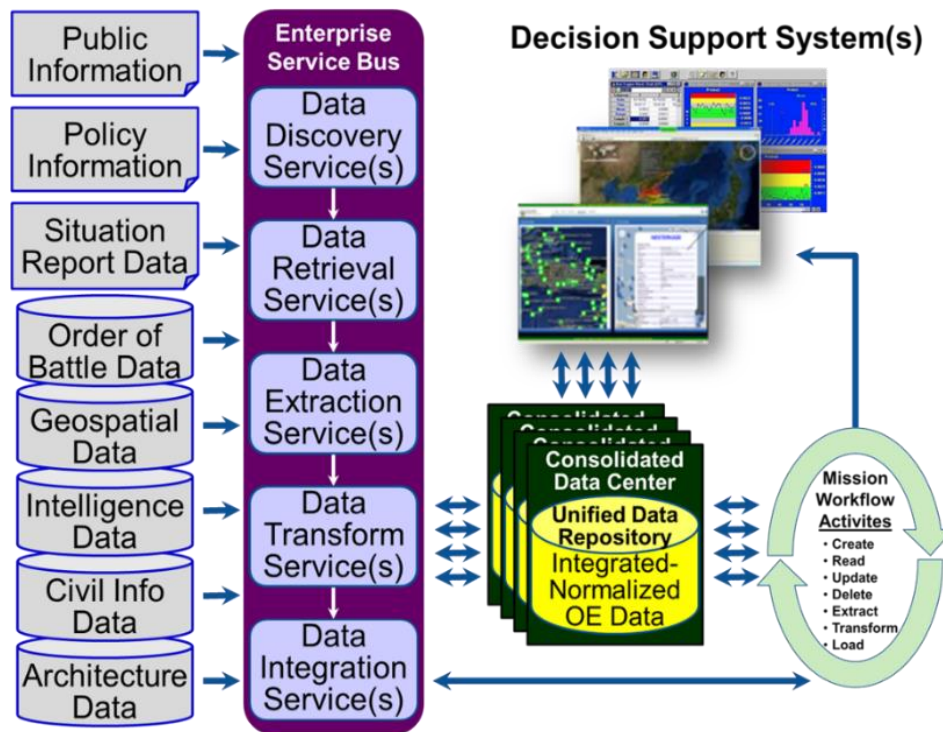


Figure 6. OE UD Concept

The DoD has already starting fielding UDRs for specific data types. For example, The Joint Staff J8 leads the Global Force Management Data Initiative (GFM DI) with the US Military Services, Joint and Intelligence communities to provide standardized and integrated authorized force structure data through Organization Servers. The Joint Staff J7 has implement an integrated order of battle (OOB) service to improve Joint training simulation federate initialization. The Defense Intelligence Information Environment (DI2E) is working to fuse intelligence data. While these efforts are necessary for describing parts of the OE, integrating PMESII-PT data and information is required to fully understand and model a complex OE.

Authorized users will extract mission relevant OE data from the UDR to transform and load the needed information into their mission unique workflow. Typically, each community mission workflow must repetitiously access, extract, transform, and integrate OE source data for their decision support system. Moreover, swivel-chair processes describe many of these manual activities. Resource sponsors believe this business model is unsustainable and will not support agile mission requirements. Enabling enterprise access to value added decision support system result data will promote information superiority. Recording dynamic OE information will improve operations analysis.

The gray cylinder and document icons represent types of OE source data to help focus deliberate collaboration between providers of similar information to advance common methods for making holdings web-accessible using standardized syntax and semantics. The notional set of data types include publically available information (PAI), policy information, situation report, order of battle, geospatial, intelligence, civil information, and architecture.

The purple enterprise service bus identifies the collection of data services needed to auto-generate integrated and normalized OE data and support mission workflows. The approach is to reuse existing and collaboratively develop new data service capabilities as enterprise solutions to common needs. Identifying and growing the alliance with other contributing data stakeholders will promote an efficient and effective use of resources in meeting requirements.

OE UD WAY AHEAD

Advancing warfighter information superiority is both a top-down and bottom-up approach. The top-down approach begins by defining the OE in terms of PMESII-PT information domains and uses ontologies to model the real world and promote understanding of cause and effect relationships. The bottom-up approach starts by identifying the physical data needs of cross community decision support systems to evolve common integrated data structure solutions. The OE UD alliance collaborates to establish a Unified Data Structure (UDS) for commonly needed integrated OE data. The UDS schema defines how integrated PMESII-PT data is stored in UDR(s). The M&S COI DMWG will document the Defense M&S Reference Architecture data pattern that describes the process of decomposing OE entity relationships into logical and physical data models for a UDS. Figure 7 illustrates the process of transforming real world observations into integrated OE data for computational analysis to support improved decision-making.

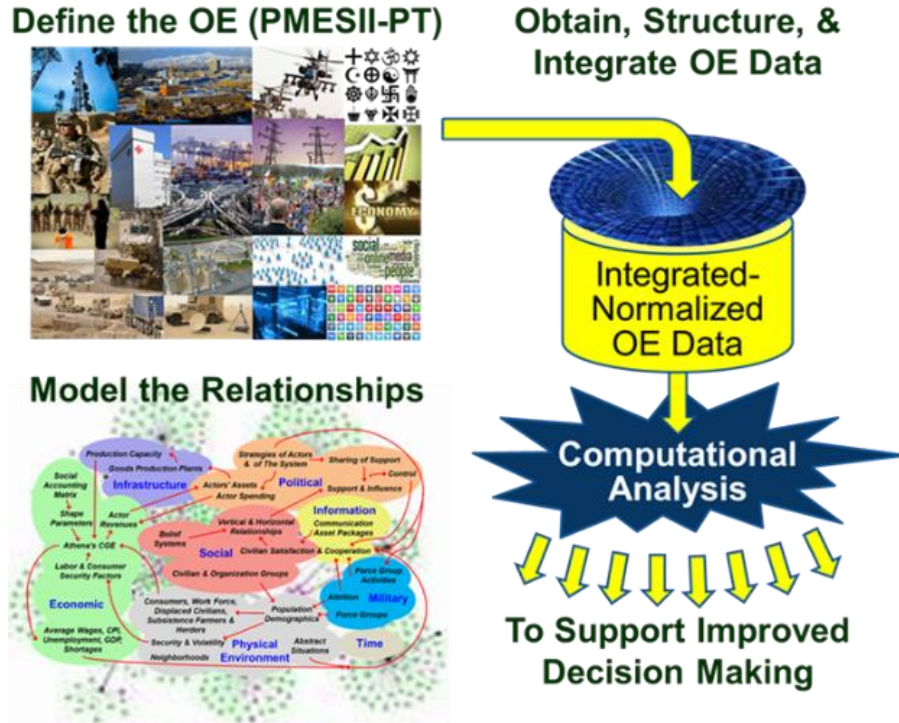


Figure 7. OE UD Data Pattern

The OE UD alliance engages DoD and multinational collaboration forums to identify and leverage CC/S/A, mission partner, and industry data service capabilities and development priorities as enterprise solutions for the MPE. Current and planned enterprise forums include, but not limited to, Command and Control Data Working Group (C2DWG), M&S COI DMWG, North Atlantic Treaty Organization (NATO) Command and Control (C2) Centre of Excellence (COE) Seminar, Army Data Board (ADB), Intelligence Support to Command and Control (ISC2) Working Group (WG), Enterprise Services and Data Panel (ESDP), Enterprise Architecture and Services Board (EASB), and Interservice/Industry Training Simulation Education Conference (IITSEC).

In October 2016, the ISC2 WG will host the OE UD alliance collaboration event to advance enterprise modeling of the real world by formulating an optimal approach for integrating disparate OE ontologies. Ontology stakeholders include the Office of the Director of National Intelligence (ODNI), Under Secretary of Defense for Intelligence (USDI), United States Special Operations Command (USSOCOM), Central Intelligence Agency (CIA), U.S. Army Research, Development and Engineering Command (RDECOM), Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)), Defense Information Systems Agency (DISA), National Geospatial-Intelligence Agency (NGA), Office of Naval Research (ONR), US Army TRADOC, and the Joint Staff.

The Army TRADOC G2, Army M&S Office, and Program Executive Office (PEO) for Simulation, Training, and Instrumentation (STRI), the Naval Air Warfare Center Training Systems Division (NAWCTSD), Joint Staff, and the National Training and Simulation Association (NTSA) are collaborating to plan and incorporate a data focus at IITSEC's Operation Blended Warrior (OBW) in 2017. As OE UD capabilities evolve and mature, the Network Integration Evaluation (NIE), Bold Quest (BQ) operational assessment, and Enterprise Challenge (EC) Intelligence, Surveillance, and Reconnaissance (ISR) interoperability demonstration venues will provide more realistic warfighting venues to obtain and address warfighter recommendations.

CONCLUSION

Access to timely and accurate integrated OE data is critical to initialize decision support tools within mission timelines. Establishing Unified Data Structures (UDS) for common OE data will provide a clear target for source data providers to deliver their holdings in a manner that supports users across the enterprise, and will enable web service automation to extract, transform, and load source data into an UDR. Incorporating metadata-tagging requirements into the UDS will enable data service algorithms to auto-generate metadata during source data production. Enterprise standards for metadata-tagging will enable user access adjudication at the data level, and promote consistent pedigree and provenance-tracking information to assess whether data is fit for a specific mission.

Enterprise standards strengthen the industry market and accelerate data technology infusion to improve information superiority. Semantic search technology will improve data mining for relevant information to help identify relationships between disparate sources. Enterprise reuse frees resources for community specific priorities. OE UD alliance participants have discussed how reusing integrated training data could result in increased time for analysis and the ability to conduct more complex testing or increased number of scenarios tested.

The DoD has invested billions of dollars in simulation, visualization, and decision support system development with very little applied to addressing the fundamental data problem. In some cases, warfighters do not use the tools because preparing data takes longer than the real world requires for the action. We must change our culture of staying the course because we know how to do it; even though, it might not be fast, effective, or affordable. If we continue to do the same thing by traveling the same road, we will get the same disappointing results in not delivering information superiority capabilities to our Soldiers, Sailors, Marines, and Airmen.

A successful enterprise requires many more organizations participate with the OE UD alliance; however, the authors have established an initial foundation of core members with leadership support. It is time to equip our decision makers with the power that comes from understanding OE data, causes, and effects. It is time to eliminate the long pole of preparing data to provide M&S support to planning and execution and advance information superiority in the OE.

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