OneSAF as an In-Stride Mission Command Asset

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ABSTRACT: To provide greater interoperability and integration within Mission Command (MC) Systems the One Semi-Automated Forces (OneSAF) entity level simulation is evolving from a tightly coupled client server architecture dependent on customized thick client technologies to a more flexible web-enabled infrastructure accessible via commonly available browser-based user tools. This fundamental redesign of the simulation service interface not only opens the door for easier integration with C4I and Mission Command (MC) devices but also allows greater opportunities to support coalition-focused interoperability. This paper describes the technologies, evolving experimentation results and lessons learned in leveraging the new web-enabled architecture in the context of employing OneSAF as an in-stride Mission Command asset.

1. Introduction

Modeling and simulation (M&S) systems such as OneSAF have long been utilized to stimulate operational Mission Command (MC) systems for training, testing, research/analysis, and experimentation activities while ether deployed or at fixed simulation centers in support of Command and Staff related events. In general simulations support connectivity to MC systems leveraging gateways to translate between simulation data and protocols and MC-defined message and data sets. While this loosely coupled approach has some advantages allowing complex simulations and simulation federations and mission command systems to work independently and join at a well-defined boundary. It does little to tame the complexity associated with leveraging the power of simulations for more closely coupled applications within the Mission Command environment such as mission planning, mission rehearsal, and course of action analysis activities. In fact a loose coupling approach encourages separate and distinct MC and simulation development to occur resulting in a massively complex environment when simulation federations and MC federations are used together.

This paper provides a review of the evolving OneSAF web-enabled architecture and describes the significant design points that will transform OneSAF's ability to support a right-sized integration with MC systems in support of training, experimentation, mission planning, and mission rehearsal capabilities as specifically called out within the Network enabled Mission Command Initial Capabilities Document (NeMC ICD). The OneSAF design has been significantly influenced by commercial web-based development trends, as well as past efforts including the the Defense Advanced Research Projects Agency's (DARPA) Deep Green project mentioned in [1], SIMCI sponsored efforts the use and maturation of SISO standards (specifically the Military Scenario Definition Language (MSDL) and the Coalition-Battle Management Language); and the PEO STRI and Army Modeling & Simulation Office OneSAF sponsored NATO efforts as part of the Modeling and Simulation Group C4I to simulation interoperability investigation efforts including MSG-048 and it's follow on activity MSG-085. The NATO

Utilizing M&S tools/products beyond the traditional pre-deployment applications and embedding them into a Command Post environment has the potential to offer significant, in-stride automated support for military operational capabilities including:

- Mission Planning/Rehearsal;
- Automated Course of Action Analysis/Wargaming;
- Deployed Command Staff Training and After Action Review; and
- Commanders Critical Information Requirements (CCIR) Identification and Tracking.

This vision is only achievable if the simulation tools undergo a significant transformation allowing integrated operational access to the simulation services.

This paper defines the key transformations as discovered through recent experiences extending OneSAF capabilities in support of the DARPA Deep Green, the AMSO-SIMCI, and NATO MSG-085 activities. A short description of each of these activities and the key insights they provided are discussed in the following subsections.

2.1 DARPA Deep Green

Between 2008 and 2011 the Defense Advanced Research Projects Agency (DARPA) sponsored the Deep Green Program. This futuristic project's objective was to develop a Mission Command system with an integrated simulation-based decision support system. The simulation engine at the heart of Deep Green was to take real-world mission data as input. Run many iterations with user or computationally selected branch points based on Command level objectives and provide best-selection mission planning outputs to the Commander and Staff. The Deep Green program leveraged OneSAF as a test harness to provide the operation context and stimulation. Although never fielded the intent was to quickly move the Deep Green system from the laboratory to the field. During this project OneSAF simulated the battlefield and produced real-world messages that drove the Deep Green system.

Key insights as provided by OneSAF's participation within Deep Green for required simulation services in support of an embedded mission planning/mission rehearsal system include:

- The simulation must have fully automated behaviors that are initiated based on command level orders;
- Simulations must support faster than real-time execution to support the timelines associated with mission planning cycles;
- Simulation setup, execution, and control must be transparent to the operational user;
- The simulation must leverage Mission Command data for the simulation start point;
- The simulation must allow for user selectable branch points;
- The simulation must allow for selectable optimization criteria;
- The simulation must provide for command selectable reporting and running estimates;
- The simulation must allow for comparison of plans with actual execution;
- The simulation must allow for easy separation and identification of simulation and real-world data;
- The simulation must allow for OPFOR initialization and behavior representations; and
- The simulation must allow for a broad range of warfighting functional area representations.

2.2 AMSO-SIMCI MC Simulation Service Development

The U.S. Army Simulation-to-Mission Command-Interoperability (AMSO-SIMCI) project is a PEO Simulation Training and Instrumentation (STRI) and PEO Command, Control, Communications-Tactical (C3T) co-chaired program that has the chartered mission for "improving interoperability between M&S and C4I domains [8]" through alignment of M&S standards, architectures, and common components. Greater AMSO-SIMCI project participation is satisfied through an Overarching – Integrated Product Team (OIPT) whose membership includes a broad spectrum of Army organizations spanning each M&S domain, material/acquisition developers, combat developers, Army staff, and cross domain members.

To accomplish its mission, AMSO-SIMCI conducts activities in three main functional areas to include outreach to share solutions (workshops, O-IPT meetings, papers), lead strategic efforts (recommend and influence programs, policies, etc.), and sponsor/resource focused projects supporting Army priorities. On the latter functional area, AMSO-SIMCI released a FY12 annual project call focusing specifically on providing simulation services for mission rehearsal. This included topics addressing time services of MC, simulation control by MC, and distribution of simulation services for MC.

In response to the topic call, a number of independent prototype efforts were awarded. After the award it was recognized by one of the awarded Government team leads, Mr. Amit Kapadia, that a greater, more significant capability could be prototyped and demonstrated by forming an integrated multi-project team. This was coordinated with the AMSO-SIMCI principals and the Combined Team was formed across the projects listed below:

- PM OneSAF & CERDEC Command Power & Integration Team – Develop simulation services to conduct basic technical control of OneSAF from MC (start, stop, pause, etc.) and initialize simulation scenarios via MSDL from available MC repositories (i.e., DDS);

- PM Training Devices (TRADE) – Enhance MC simulation control service (i.e., checkpoint, restore, fast forward, scenario selection) and support time management services;
- CERDEC Night Vision and Electronic Sensors Division (NVESD) – Adapt the Night Vision Image Generator (NVIG) toolset within a virtualized computational environment and provide streaming video services to MC.

Each organization within the Combined Team executed their projects without initial linkage to the others, as prescribed in their respective management plans. Through AMSO-SIMCI oversight and combined collaboration (discussed later united through evolution of the Common Operating Environment (COE) and the Command Post Computing Environment (CP CE)), an integrated, prototype CP CE services and combined testbed environment was progressively developed. This included each team member providing resources and collaborating to achieve the larger overall mission objectives to deliver embedded simulation services to the Command Post.

Key insights, as provided by OneSAF's participation within the Combined Team, for simulation services in support of an embedded mission planning/mission rehearsal system include:

- Leveraging simulation and MC standards eases integration and reduces development time;
- Reusing and extending existing simulation and MC infrastructure and tools reduces development costs and testing time;
- Existing MC data from PASS/DDS, C2R and other infrastructure assets provides viable and feasible BLUFOR and OPFOR data for simulation initialization;
- Existing MC GUI and widget infrastructure can be leveraged and extended to house simulation execution and control tools;
- Providing tools to easily identify and control simulation data vice real-world data is a current gap that must be addressed. It should be noted that data fields do exist to identify simulation vice real-world data but the data fields are not handled consistently across MC systems; and
- Support of web-enabled technologies are critical to allow simulation control within existing MC applications.

2.3 NATO MSG-085 Development

The NATO technical activity MSG-085 focused on demonstrating the operational utility of using two SISO standards to enhance simulation to C4I interoperability. The Military Scenario Definition Language (MSDL) standard provides a XML-based transmittal format for simulation start data that can be populated and shared by C4I devices. Additionally, the Coalition-Battle Management Language (C-BML) is an XML-based format for transmitting orders, taskings, reports, and operational requests between MC assets and simulations. These standards are intended to enhance the automated initialization and runtime transmission of information between simulations and C4I systems.

Currently, MSG-085 is in its final report production stage. The group has provided a number of successful demonstrations showing the benefits of using the MSDL and C-BML standards.

Key insights, based on OneSAF's participation within the NATO activities, for simulation services in support of a coalition-focused embedded mission planning/mission rehearsal system include:

- Leveraging Simulation Interoperability Standards Organization (SISO) standards for simulation initialization (MSDL) and for order, report, and request transmission (C-BML) reduce development and integration costs when operating in a single Nation exercise or within a broader coalition mission planning/rehearsal exercise;
- Common supporting web-enabled infrastructure for publish and subscribe, persistence, bridging, and merging of initialization and order and report service eases cross coalition-based integrations;
- Defining specific coalition initialization and order, report, and request agreements reduce development, integration, and rework costs when developing and executing mission planning activities within a federation environment;
- Loose coupling of coalition resources is necessary to allow multi-Nation simulation and MC and C4I applications; and
- Web-enabled access to simulation and MC and C4I systems is necessary to allow

distributed access to mission planning/mission rehearsal assets.

It should be noted that the key insights listed above were generated independently of the other projects.

3. OneSAF Evolution

The initial architectural vision for OneSAF was to support entity-level simulation user requirements across the three Army Modeling and Simulation domains; the Advanced Concepts and Requirements (ACR) domain, the Research Development and Acquisition (RDA) domain, and the Training, Exercise, and Military Operations (TEMO) domain. To support the wide-range of requirements the OneSAF Version 1.0 implementation provided a DoD open-source, distributed simulation architecture. Although not within the scope of the paper the open-source characteristic allowed specific user customizations that could be implemented by OneSAF users and reintegrated for future release and maintenance by the OneSAF Program Office.

The original architecture employed a synchronized, distributed runtime database called the Simulation Object Runtime Database (SORD). The distributed runtime database provided a consistent data foundation in support of an underlying distributable discrete-event based simulation engine. With the original design all simulation clients were required to access SORD data locally through a “friendly” accessible local API. The complex data synchronization protocols were hidden from general client use and were used exclusively for SORD to SORD distributed communications and synchronization.

This underlying design naturally led to thick client implementations which proliferated across the OneSAF architecture. It meant that every native OneSAF client (those not connectivity via DIS or HLA) connecting to the OneSAF simulation engine needed to bring along its own copy of the SORD database. Within this architecture all clients from the C2 Adapter to the OneSAF Management and Control Tool (MCT) required a SORD instance that could potentially impact the reliability of the entire distributed simulation. The distributed design was further confounded by tightly coupled SORD to SORD synchronizations that precluded the simulation from advancing if any of the distributed database instances could not be synchronized with the master. This constraint was intended to keep distributed simulation instances consistent but was also carried across to simple display-only clients. While these display-only clients do not impact simulation consistency they could and did have huge impacts on system reliability, scalability as a single display-only client could falter and the entire simulation would fail.

OneSAF’s underlying architecture remained largely the same until the release of Version 6.0 in January 2013. Two fundamental architectural changes occurred in Version 6.0. The first was the introduction of a new lightweight JavaScript Object Notation (JSON) based data communication protocol. The second was removing SORD-related simulation engine advance restrictions on non-simulating client instances.

With these recent fundamental web-focused enhancements OneSAF is now better poised to support the key requirements identified across the three projects outlined above. The following three subsections discuss how OneSAF capabilities address the key requirements within each project.

3.1 Deep Green

Requirement DG-1: The simulation must have fully automated behaviors that are initiated based on command level orders.

OneSAF Support: OneSAF provides a wide range of semi-automated behaviors. These behaviors can be fully automated through additional software development or by chaining existing behaviors. This remains a gap area as there has been relatively little effort to create fully automated behaviors (either through additional coding or order-based chaining) that require little user configuration and no additional user input after simulation execution is started to direct unit and/or entity activities.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement DG-2: Simulations must support faster than real-time execution to support the timelines associated with mission planning cycles.

OneSAF Support: OneSAF supports faster than real-time execution as well as the ability to provide statistical replication-based results. The limiting factor is the computational platform on which the simulation is executing. Recent web-enabled distribution allows the simulation to be hosted in a remote location with potentially more computational power and the results distributed to the operational user.

Assessed Maturity Level: Full Capability

Recommended Next Steps: Ready for operational tuning and access.

Requirement DG-3: Simulation setup, execution, and control must be transparent to the operational user.

OneSAF AMSO-SIMCI Extension Support: By leveraging DIS simulation control PDUs OneSAF was extended with limited development to allow start, stop, pause, resume, and faster/slower that real-time control for a web-enabled MC system.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for additional prototype to support monitoring and control functions to provide insight and control over the status of simulation assets.

Requirement DG-4: The simulation must leverage Mission Command data for the simulation start point.

OneSAF AMSO-SIMCI Extension Support: By leveraging MC data mediation services along with the SISO MSDL standard real-world MC data from a number of sources was accessed and transformed into standard simulation importable (MSDL) format. The data included a subset of task organization, electronic order of battle, tactical graphics, and an intelligence picture of the OPFOR.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for additional data capture and an extended prototype in an operational setting that automates the transformation of real-world data into simulation digestible format.

Requirement DG-5: The simulation must allow for user selectable branch points.

OneSAF Core Support: OneSAF allows for automated and/or user selectable checkpoints to be created that can be selected for restart.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

OneSAF Prototype Extension Support: OneSAF allows for export of standards-based (MSDL) scenario files that include OneSAF order sets that can be used as a starting point for a new run.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement DG-6: The simulation must allow for selectable optimization criteria.

OneSAF Support: This remains as a gap within the OneSAF capability set.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement DG-7: The simulation must provide for command selectable reporting and running estimates

OneSAF Core Support: OneSAF provides a limited capability for selectable running estimate reporting. Currently OneSAF provides for combat power reporting across BLUFOR and OPFOR.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement DG-8: The simulation must allow for comparison of plans with actual execution.

OneSAF Support: This remains as a gap within the OneSAF capability set.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement DG-9: The simulation must allow for easy separation and identification of simulation and real-world data

OneSAF Support: This remains as a gap within the OneSAF capability set.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

3.2 AMSO-SIMCI MC

Requirement AS-1: Leveraging simulation and MC standards eases integration and reduces development time.

OneSAF Core Support: OneSAF support for DIS allow easy development and integration of simulation controls within the MC Command Web widget set and MC mediation services.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

OneSAF AMSO-SIMCI Extension Support: OneSAF's extended support for MSDL and C-BML allow for lower-cost development and integration of user simulation management and control tools within the MC Command Web widget set and MC mediation services.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement AS-2: Reusing and extending existing simulation and MC existing infrastructure and tools reduces development costs and testing time.

OneSAF AMSO-SIMCI Extension Support: By leveraging defined standards the development was able to jump-start to data translation implementation services vice started with data model analysis and development. Furthermore as MC infrastructure services were used very little code was developed although several standards-based (XSLT) translation scripts needed to be developed.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement AS-3: Existing MC data from PASS/DDS, C2R and other infrastructure assets provides viable and feasible BLUFOR and OPFOR data for simulation initialization.

OneSAF AMSO-SIMCI Extension Support: The AMSO-SIMCI project was able to successfully initialize OneSAF for the first time by populating an MSDL transmittal file using data accessed dynamically from DDS topics and the C2 Registry task order information via access from the C2 mediation services infrastructure.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement AS-4: Existing MC GUI and widget infrastructure can be leveraged and extended to house simulation execution and control tools.

OneSAF AMSO-SIMCI Extension Support: The SIMCI project was able to successfully initialize and control the OneSAF simulation for the first time extending the Command Web widget set with simulation control tools.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement AS-5: Providing tools to easily identify and control simulation data vice real-world data.

OneSAF Support: This remains as a gap within the OneSAF capability set.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement AS-6: Support of web-enabled technologies are critical to allow simulation control within existing MC applications:

OneSAF Core Support: Web-enabled capabilities were introduced as part of OneSAF Version 6.0 and were also leveraged as part of the AMSO-SIMCI project.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

3.3 NATO MSG-085

Requirement N-1: Leveraging Simulation Interoperability Standards Organization (SISO) standards for simulation initialization (MSDL) and for order, report, and request transmission (C-BML) reduce development and integration costs when operating in a single Nation or coalition mission planning/rehearsal execution.

OneSAF AMSO-SIMCI Extension Support: OneSAF's extended support for MSDL and C-BML allow for lower-cost development and integration of user simulation management and control tools within the MC Command Web widget set and MC mediation services.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement N-2: Common supporting web-enabled infrastructure for publish and subscribe, persistence, bridging, and merging of initialization and order and report service eases cross coalition-based integration.

OneSAF AMSO-SIMCI Extension Support: OneSAF's extended support for connectivity to the George Mason University Scripted Battle Management Language and enhanced GMU/SAAB server were successfully prototyped and demonstrated during the MSG-085 activity. A connection was also provided to a Virginia Modeling and Simulation Center (VMASC) implementation although, this implementation was leveraged as part of a demonstrated prototype capability.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

Requirement N-3: Defining specific coalition initialization and order, report, and request agreements reduce development, integration, and rework costs when developing and executing mission planning activities within a federation environment.

OneSAF AMSO-SIMCI Extension Support: As part of the AMSO-SIMCI projects coalition-based federation agreements based on MSDL and C-BML templates were prototyped. The initial findings were that the standards-based templates provided a substantive starting point for entering into coalition and federation based agreements to guide development and shorten both development and integration timelines.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement N-4: Loose coupling of coalition resources is necessary to allow multi-Nation simulation and MC and C4I applications.

OneSAF AMSO-SIMCI Extension Support: As part of the AMSO-SIMCI projects loose coupling between all independent Nation-based federated assets was critical to allow each Nation to manage, develop, and integrate their prioritized MC and simulations with minimal impact to other Nations. This is largely dependent on defining the cross Nation interactions as specific federation agreements.

Assessed Maturity Level: Minimal Capability

Recommended Next Steps: Prototyping necessary to determine appropriate design and implementation for in-stride MC use.

Requirement N-5: Web-enabled access to simulation and MC and C4I systems is necessary to allow distributed access to mission planning/mission rehearsal assets.

OneSAF AMSO-SIMCI Extension Support: As part of the AMSO-SIMCI projects distributed access between and among all independent Nation-based federated assets was critical to allow comprehensive Nation participation in development, testing, and demonstration events at lower and non-prohibitive cost than collocated interactions.

Assessed Maturity Level: Partial Prototype Capability

Recommended Next Steps: Ready for an extended prototype in an operational setting for in-stride MC use.

4. Analysis for OneSAF-based In-Stride Mission Command Asset Development

The vision for OneSAF to support an in-stride Mission Command asset providing an integrated mission planning and mission rehearsal capability is consistent with the overall objectives of the DARPA Deep Green project. The main difference lies in the implementation approach. While DARPA began with a funded project to complete the capability as a "big bang" approach the approach here is based on reuse and an evolutionary development process. The benefits of the reuse and evolutionary process is that it allows leveraging existing investments in both the Military and commercial sectors for simulation, Mission Command, as well as web and cloud-enabling technologies. Additionally, it allows incremental extensions to be added as they emerge and allow for cost effective implementation.

The paper identifies a number of key requirements and prototype capabilities at various levels of implementation for an integrated simulation-based mission planning system. Several of these capabilities are ready for an extended prototyping effort in an operational setting; while others require initial or additional development to flesh out the final design and implementation patterns. The following sections summaries the finding provided above listing those OneSAF capabilities that are fall into the different categories.

OneSAF capabilities falling under the "Minimal Capability" assessed maturity level within Section 3 include:

1. **Fully-automated behaviors (DG-1)**: OneSAF provides a wide range of semi-automated behaviors. These behaviors can be fully automated through additional software development or by chaining existing behaviors. This remains a gap area as there has been relatively little effort to create fully automated behaviors (either through additional coding or order-based chaining) that require little user configuration and no additional user input after simulation

execution is started to direct unit and/or entity activities.

2. **Allows for selectable optimization criteria (DG-6):** OneSAF has no capability to allow the user to tune a run based on an optimization criteria selection.
3. **Allows for selectable reporting and running estimates (DG-7):** OneSAF provides a limited capability for running estimate reporting. Currently OneSAF provides for combat power reporting across BLUFOR and OPFOR.
4. **Allows for comparison of plan with actual execution (DG-8):** OneSAF does not provide output tuned for such comparisons.
5. **Allows for easy separation and identification of simulation and real-world data (DG-9, AS-5):** OneSAF does not provide an automated mechanism to tag or otherwise identify simulation data from real-world data.
6. **Automated mechanisms to support initialization and order, report, and request coalition agreements (N-3)**: OneSAF does not provide automated mechanisms supporting this capability.
7. **Automated mechanisms to define data exchanges in support of loose coupling (N-4):** OneSAF provides a limited set of tools supporting this capability.

OneSAF capabilities falling under the "Partial Prototype Capability" assessed maturity level within Section 3 include:

1. **Transparent simulation setup, execution, and control (DG-3)**: By leveraging DIS simulation control PDUs OneSAF was extended with limited development to allow start, stop, pause, resume, and faster/slower that real-time control for a web-enabled MC system.
2. **Leverage start data from MC (DG-4)**: By leveraging MC data mediation services along with the SISO MSDL standard real-world MC data from a number of sources was accessed and transformed into standard simulation importable (MSDL) format. The data included a subset of task organization, electronic order of battle, tactical graphics, and an intelligence picture of the OPFOR.
3. **User selectable branch points (DG-5)**: OneSAF allows for automated and/or user selectable checkpoints to be created that can be selected for restart.
4. **Leverage simulation and MC standards to ease integration and reduce development time (AS-1, N-1)**: OneSAF supports a number of simulation and MC standards.
5. **Reuse and extension of existing simulation and MC infrastructure to reduce development costs and testing time (AS-2, N-2)**: OneSAF reuses a number of commercial and MC software assets.
6. **Leverage MC data to provide simulation start data (AS-3):** OneSAF leverages a subset of PASS/DDS, C2R, and other infrastructure assets to populate standards-based simulation start data information.
7. **Leverage MC GUI and widget infrastructure (AS-4):** OneSAF is beginning to leverage MC assets to support GUI development.
8. **Support web-enabled capabilities (AS-6, N-5):** Starting with version .6.0 OneSAF offered a limited web-enabled capability.

OneSAF capabilities falling under the "Full Capability" assessed maturity level within Section 3 include:

9. **Faster than real-time execution (DG-2)**: OneSAF supports faster than real-time execution as well as the ability to provide statistical replication-based results. The limiting factor is the computational platform on which the simulation is executing. Recent web-enabled distribution allows the simulation to be hosted in a remote location with potentially more computational power and the results distributed to the operational user.

5.0 Conclusions and Recommendations

This paper investigates and describes emerging OneSAF support for an in-stride mission planning and mission rehearsal activities accessible via Mission Command devices. It does this by first reviewing the OneSAF architecture and its promising evolution toward web-enabling technologies.

The paper then looks across 3 OneSAF related projects and derives fundamental requirements necessary to support mission planning and mission rehearsal capabilities. These projects include the DARPA Deep Green Effort, the AMSO-SIMCI efforts, and

NATO MSG-085 C2 and simulation interoperability efforts.

Next a short analysis of the OneSAF capabilities showed varying levels of support from minimal to fully implemented across the spectrum of requirements. The section also provided a listing of recommended next steps to continue to strengthen OneSAF's support as an easily accessible in-stride mission planning and mission rehearsal tool within an operational Mission Command system.

The results of the analysis highlight the need for additional prototyping and to begin introducing the capabilities within an operational environment. This would provide a host of benefits from introducing the technologies to the end user community to providing critical feedback on how the final products should look, feel, and execute in an operational environment.

As a final point and in line with the prototyping recommendations provided in Section 3, it is emphasized that the prototyping activities should be collaborative efforts across the development lifecycle between PEO STRI and PEO C3T. In this way both organizations can provide best-of-breed capabilities and take co-ownership of the resulting product set.

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