Department of Defense

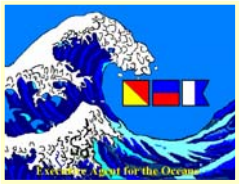
Pre-runtime

Integrated Natural Environment Authoritative Representation Process

(INEARP)

Concept of Operations

30 June 2000



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Scope

Environmental data can be delivered to a simulation while the simulation is running (Runtime delivery) or the environment can be delivered to the simulation before the simulation starts (Pre-runtime delivery). This Concept of Operations (CONOPS) addresses only the Pre-runtime delivery situation. Work is currently underway to address Runtime data delivery.

Introduction

The Department of Defense (DoD) Air & Space, Ocean, and Terrain Natural Environment Modeling & Simulation Executive Agents (MSEAs) developed this Integrated Natural Environment Authoritative Representation Process Concept of Operations (INEARP CONOPS) to describe how users of Modeling and Simulation (M&S) applications, hereafter referred to as 'customers', will acquire authoritative representations of the natural environment using an effective, readily accessible infrastructure. In this context, the "I" in INE means cross-domain, physical consistency. In August 1999 the DMSO leadership adopted the Pre-runtime INEARP CONOPS as a natural complement to, and extension of, the DMSO-funded environmental representation program, that is developing the enabling technologies that are critical components of the INEARP.

IDEF0 was chosen to model the CONOPS. The model (Annex A) with its accompanying description (Annex B) and glossary of terms (Annex C) provides the blueprint for this process. This is the blueprint to achieve the Tri-MSEA INE vision defined in the INE Strategy document and is derived directly from the M&S vision in the DoD Modeling and Simulation Master Plan. While this blueprint does not specify technical solutions, it does highlight critical INEARP capabilities and issues that address the customer's need for Pre-runtime environments. These capabilities are natural extensions to ongoing DMSO, MSEA, and Service/Agency programs and/or capabilities.

Many issues center around organizations referred to in this document as Environmental Data Providers. These providers could be DoD production centers within the Military Departments or other DoD or non-DoD Government centers, or commercial providers who would support this process fee-for-service. As DMSO and MSEA programs mature, production centers need to provide or acquire the capacity to field these INEARP capabilities. Providers also need to develop internal CONOPS that support the INEARP infrastructure.

Implementation of this CONOPS is a significant milestone for development of cost-effective, reusable capabilities to incorporate the natural environment into DoD M&S. The INEARP presented in this document will lead to major advances in the realism of simulated environments for M&S applications including training, acquisition, analysis, mission planning and mission rehearsal. When the capabilities and capacities to support this CONOPS are implemented, the DoD community will have taken a major step towards achieving the fully integrated authoritative representations needed to effectively and efficiently simulate the effects of the environment on planned operations.

High Level Description - Pre-runtime INEARP Concept of Operations (CONOPS)

At the highest level, the challenge addressed in this CONOPS is to:

Create a Natural Environment Representation that is Physically Consistent, both within and among the Atmosphere, Ocean, Space, and Terrain Domains, for Delivery to a Customer Application / System that meets the needs of its Components (A0).

The IDEF0 model describes the activities that must be completed to build authoritative natural environmental data sets tailored to specific customer needs to incorporate environmental effects for realistic training, analysis, acquisition, and mission rehearsal. These activities must be completed to provide the required integrated data in a timely manner, ensure that each domain is physically consistent within and among the other applicable domains, and delivered in a standard form. Natural environment data are available in many forms, some of which are readily accessible and usable in native formats; however, most data require additional manipulation to make them useful for simulations. This process model describes the key components of the INE strategy to locate data sources, retrieve data and/or produce them to order, and deliver them in the form needed. DMSO and the DoD MSEAs for the Natural Environment must determine if the technology and infrastructure are available to meet requirements, and develop and manage projects to solve shortfalls to meet the needs of developing simulation programs.

For this CONOPS to succeed, the environmental data provider community must be prepared to respond to requests for environmental information needed by the simulation customers. In coordination with other providers, they must produce the integrated scenario(s) that meets the customer's simulation objectives.

Annex A contains the IDEF0 model that documents the CONOPS. It defines what processes must be performed for a simulation system to request and obtain integrated natural environmental information, as well as the technologies needed to execute the process. The information in Annex B further describes the processes in the IDEF0 Model.

The DMSO-funded environmental representation program is developing those key infrastructure technologies required to implement this CONOPS. Master Environmental Library (MEL) is developing the Library Services capability. Environmental Scenario Generator (ESG) is developing the Scenario Composition, customer interface, Process Controller, and prototype scenario generation technologies. Synthetic Environment Data Representation and Interchange Specification (SEDRIS) is developing a standard M&S Transmittal Mechanism for natural environment data.

In support of Scenario Generation, environmental data production centers will need to acquire both the technology and the capacity to support these emerging capabilities. The MSEAs are responsible for identifying Environmental Data Providers for their respective environmental domains. Environmental Data Providers also will need to develop their own CONOPS that support the INEARP infrastructure. These data providers could be existing DoD operational

centers like the Naval Oceanographic Office, the Air Force Combat Climatology Center, the National Imagery and Mapping Agency, the Army Corps of Engineers Research and Development Center (ERDC) (Topographic Engineering Center, and the Waterways Experiment Station). Environmental Data Providers could also be Government (non-DoD) centers or commercial providers who would support this process fee-for-service. The DoD providers that provide day-to-day support to the operational community have significant skills that can be readily employed to support the warfighters in M&S missions.

High-level descriptions of INEARP technologies follow:

a. Library Services through the Master Environmental Library (MEL): The MEL facilitates discovery, access, subscription, and delivery of environmental information, products, and data wherever they are stored. Customer environmental requirements can be passed directly to the MEL through its web interface or through the MEL Application Programmer's Interface (API) via programs like the Environmental Scenario Generator (ESG), or can be transferred through other methods determined by the provider. The data discovered via the MEL are ordered and delivered by the environmental providers who build, archive, and maintain the databases. These data can be delivered using data provider product specific formats like GRIB, BUFR, and VPF, or using the more general STF (SEDRIS Transmittal Format) supporting cross-domain integrated representations.

b. Scenario Composition and Scenario Generation through the Environmental Scenario Generator (ESG): The ESG provides the Customer Interface for Scenario Composition and Scenario Generation. The Interface will translate the customers' environmental requirements (e.g., rocky, rainy, high waves, solar disturbances) into environmental parameters (e.g., temperature, wind, sea state, etc., to include determination of the appropriate scale of the needed parameters to determine the Authoritative Representation). Through use of data mining or other appropriate techniques, locate instances when the desired conditions can be found in reference data sets made available by MEL Resource Sites. In some cases, when the data available through MEL meet some but not all requirements, the ESG can efficiently perform value-added functions like regridding, interpolations, and derivation of additional needed parameters through use of authoritative transforms. In some cases, actual model runs in one or more domains are required. The Process Controller applies automated production process business rules to achieve inter-domain integration. The Process Controller also orchestrates post-processing of the data (e.g., spatial reference frame conversions or re-gridding) and coordinates the delivery of the environmental information to the customer by producing an appropriate Coordination AR that describes each of the data transmittals from each of the data provider centers involved.

c. Standard Transmittal Mechanism through the Synthetic Environment Data Representation and Interchange Specification (SEDRIS) or other standard methods: SEDRIS promotes interoperability and reuse of data by providing a complete data interchange mechanism for use with environmentally aware M&S applications. SEDRIS technologies support the integrated representation and interchange of data to a simulation and subsequent "sharing" between and among heterogeneous, distributed simulations for all environmental domains at any level of fidelity or resolution. This is accomplished through a common data representation model, data coding specification, spatial reference model, transmittal data access APIs, interchange format,

and data conversion and validation tools. With SEDRIS conversion capabilities from native formats, the customer requests data as a SEDRIS Transmittal. Customers will be furnished with SEDRIS transmittal access capabilities in the form of data access APIs and environmental data extraction applications to facilitate the examination and use of the environmental data transmitted in response to their INEARP request.

d. Scenario Generation Production Capability Projects: A customer could require environmental data that do not exist. In these cases, a Just-in-Time (JiT) production requirement may occur at one or more of the designated data provider sites. The MSEAs are identifying, and in some cases developing, the needed capabilities for this JiT production. These "produce-to-order" capabilities must be in place at the designated providers who offer the needed production capacity. Various MSEA and DMSO projects are developing or have fielded JiT production capabilities. These Providers are integral parts of the INEARP. Instituting the necessary agreements with and among these providers is requisite to implementing this CONOPS.

When a customer needs integrated environmental data for more than one domain (air, space, terrain, and/or oceans), the ESG Process Controller will orchestrate the timely production of a physically consistent authoritative representation. The designated providers, however, will be responsible for the actual production using the proper models, algorithms, and procedures to ensure intra- and inter-domain consistency. The data needed by the customer will be produced at the proper authoritative resolution. After authoritative data are produced, they may be further transformed (interpolated/extrapolated) to meet specific needs.

ANNEX A - The IDEF0 Model

USED AT:	AUTHOR: INE Process Action Team	DATE: 06/30/00		WORKING	READER DATE	CONTEXT:
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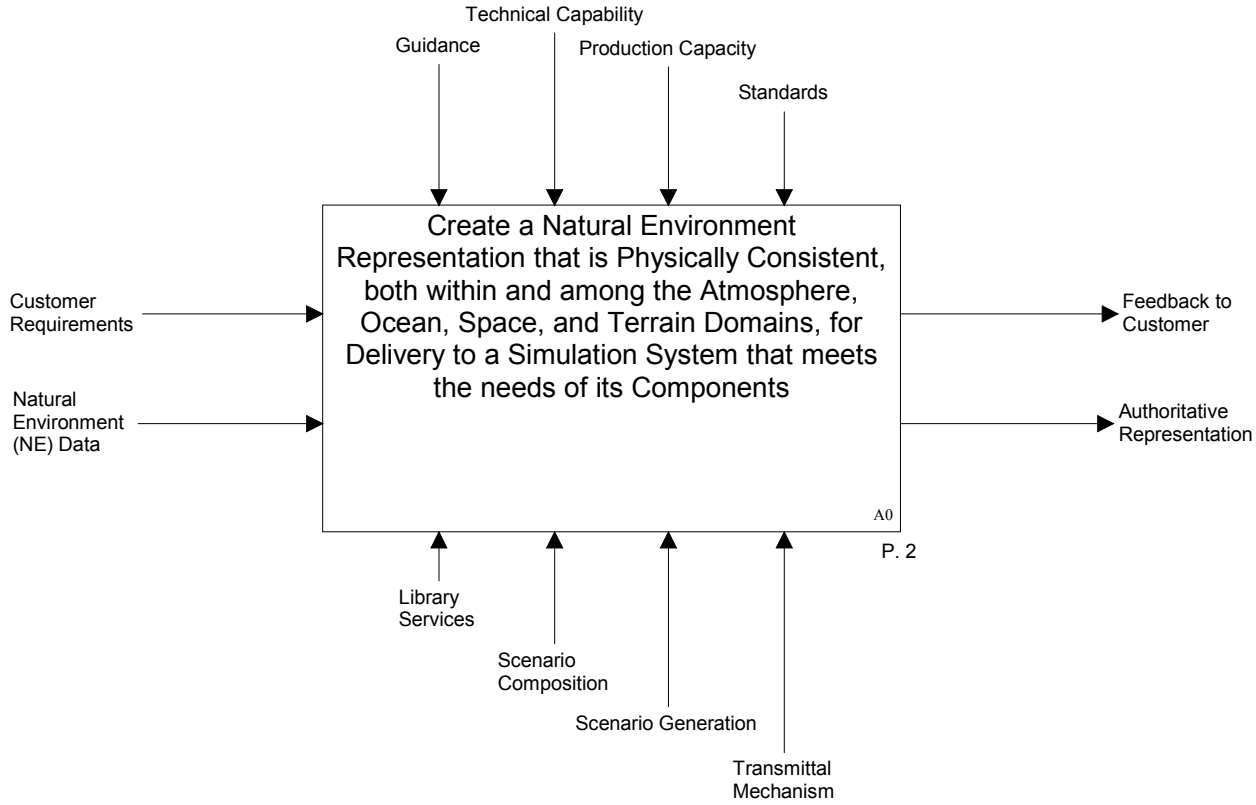

PURPOSE: Describe the processes and the linkages that are required between the individual domains, the DMSO/MSEA environmental projects, and the environmental providers in order to produce representations for each domain, ensure consistency within and among the domains, and deliver the needed information in a timely manner and in a standardized form

VIEWPOINT: DMSO INE PM and DoD Natural Environment Modeling and Simulation Executive Agents

NODE: A-0	TITLE:	NUMBER: P. 1

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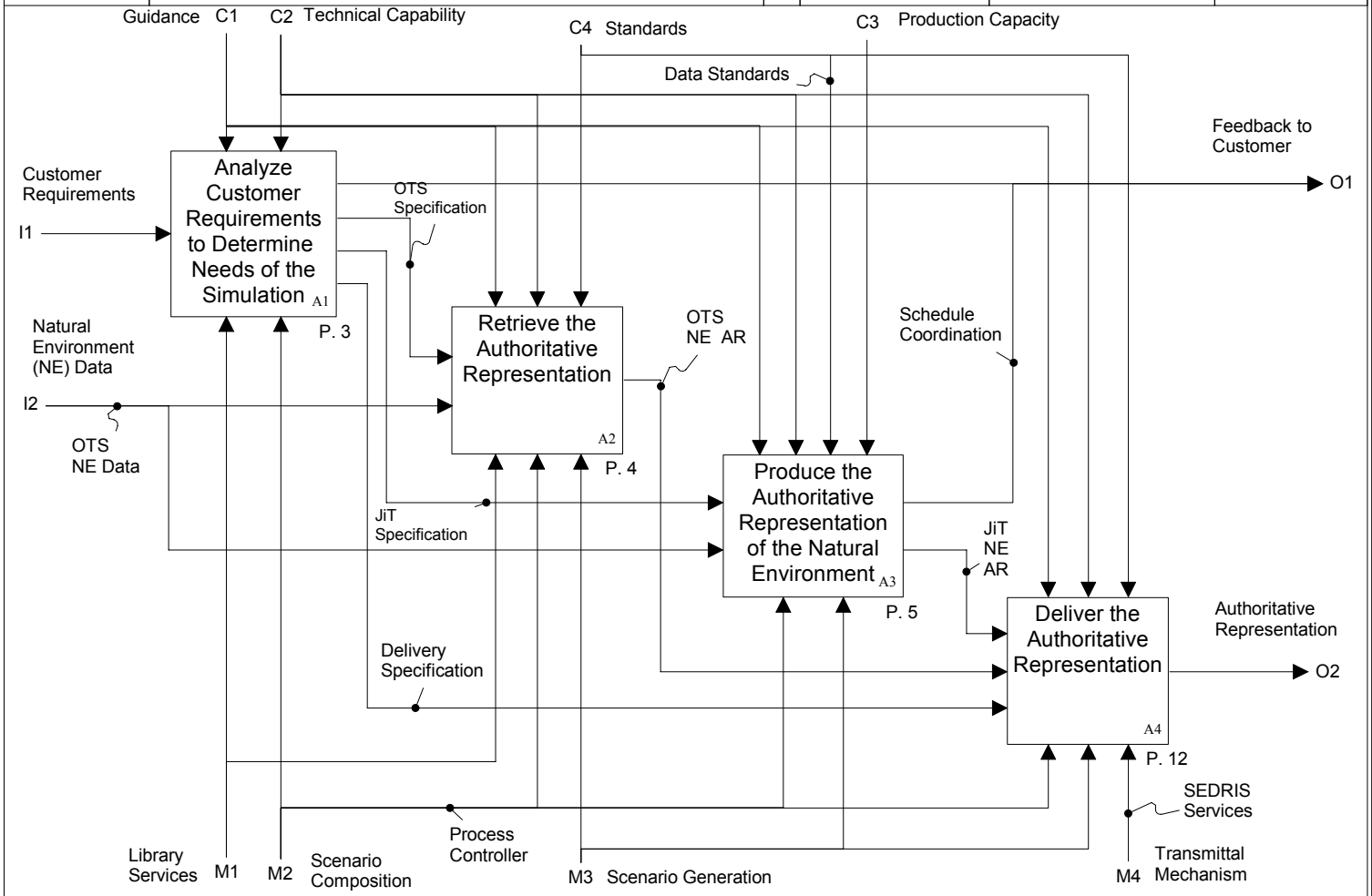

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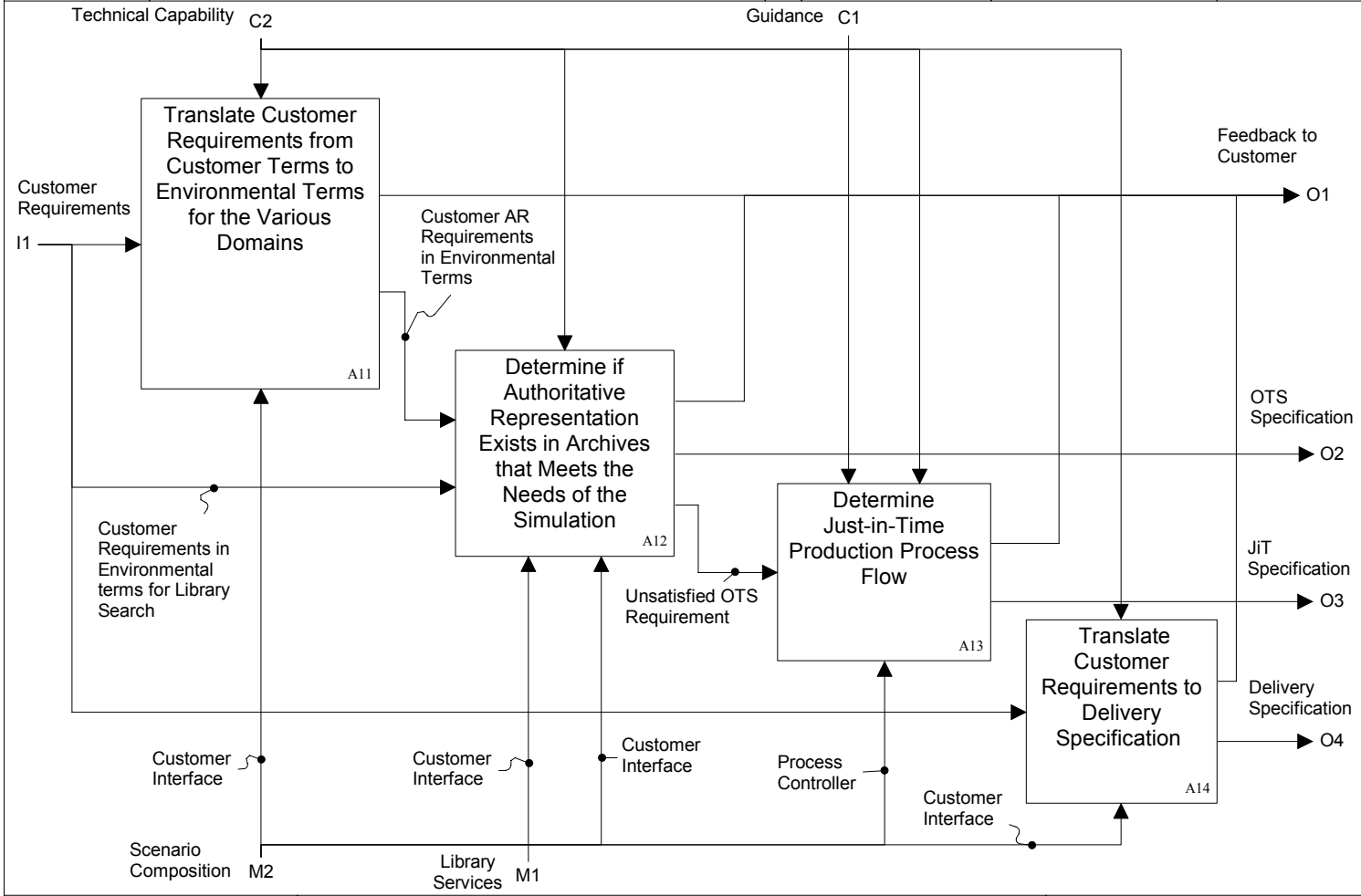

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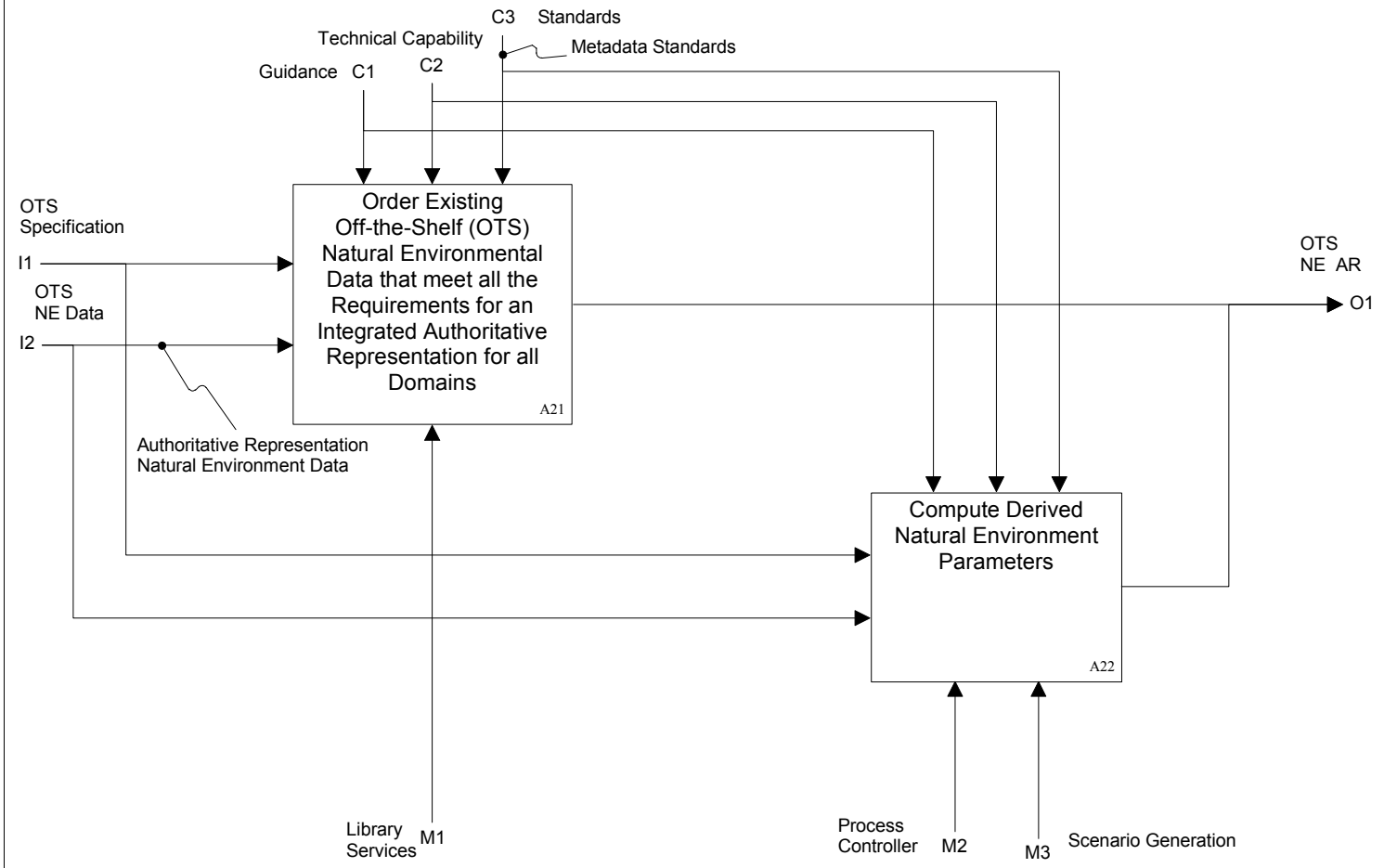

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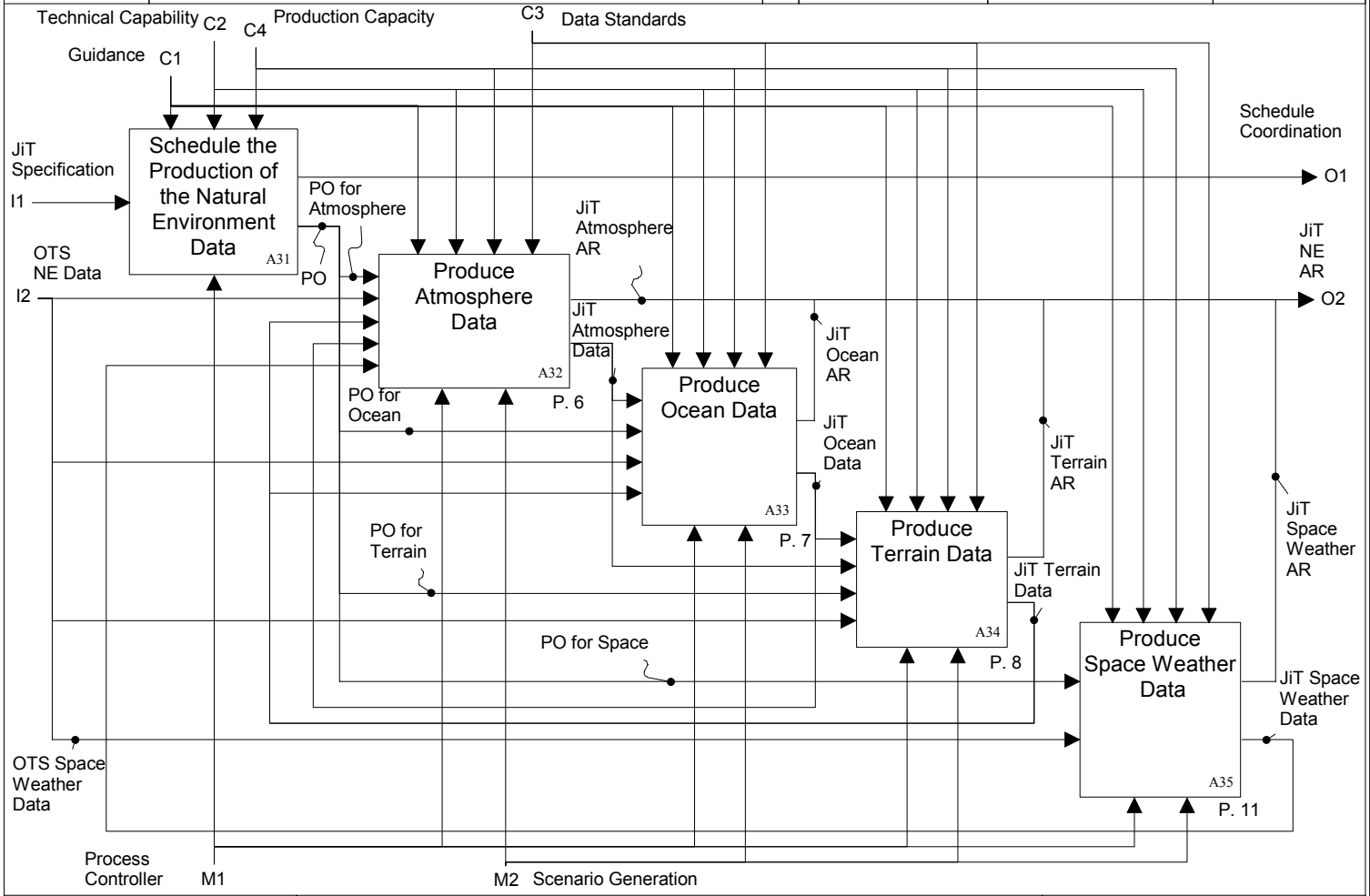

NODE: A3	TITLE: Produce the Authoritative Representation of the Natu...	NUMBER: P. 5

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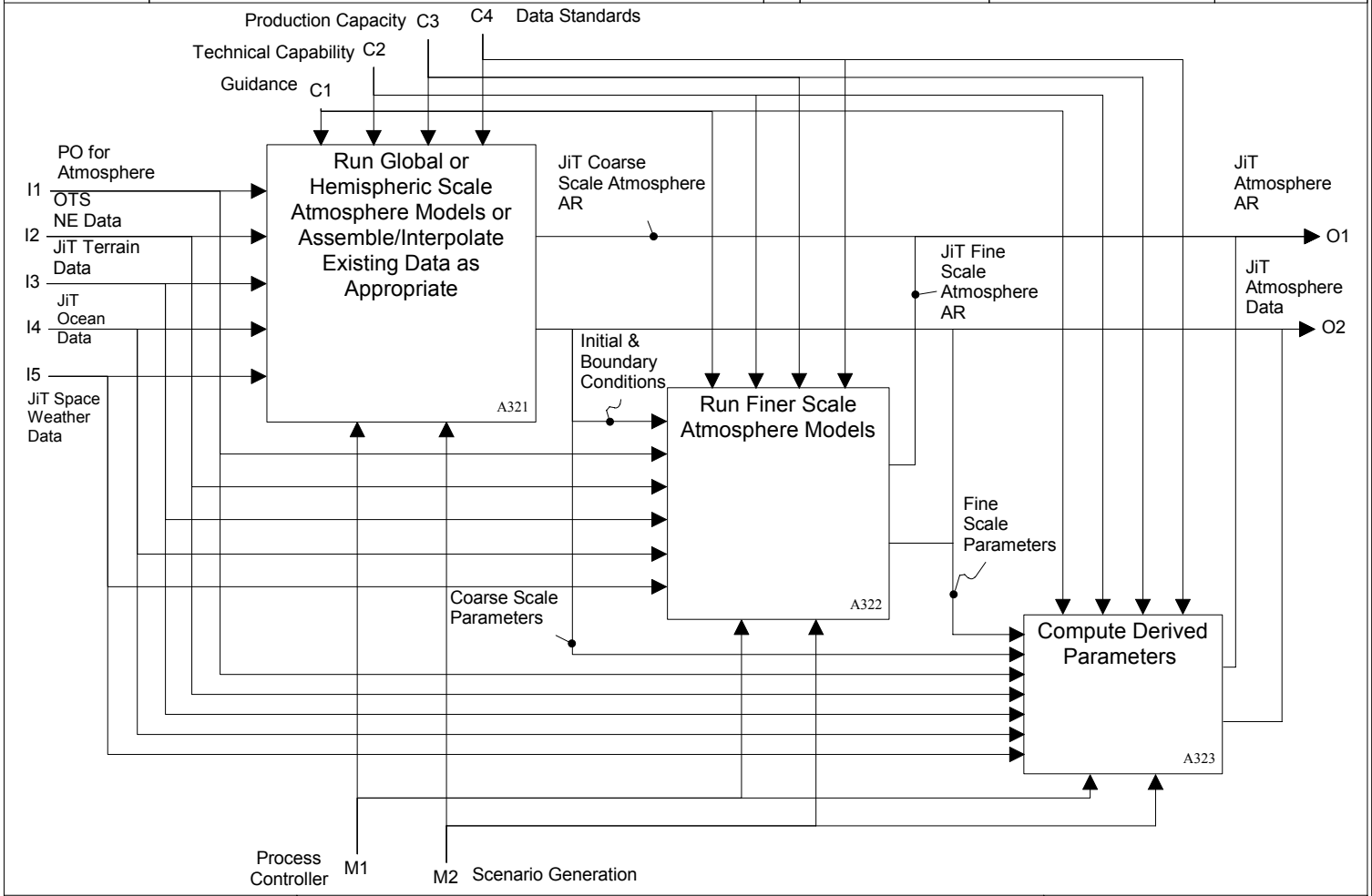

NODE: A32	TITLE: Produce Atmosphere Data	NUMBER: P. 6

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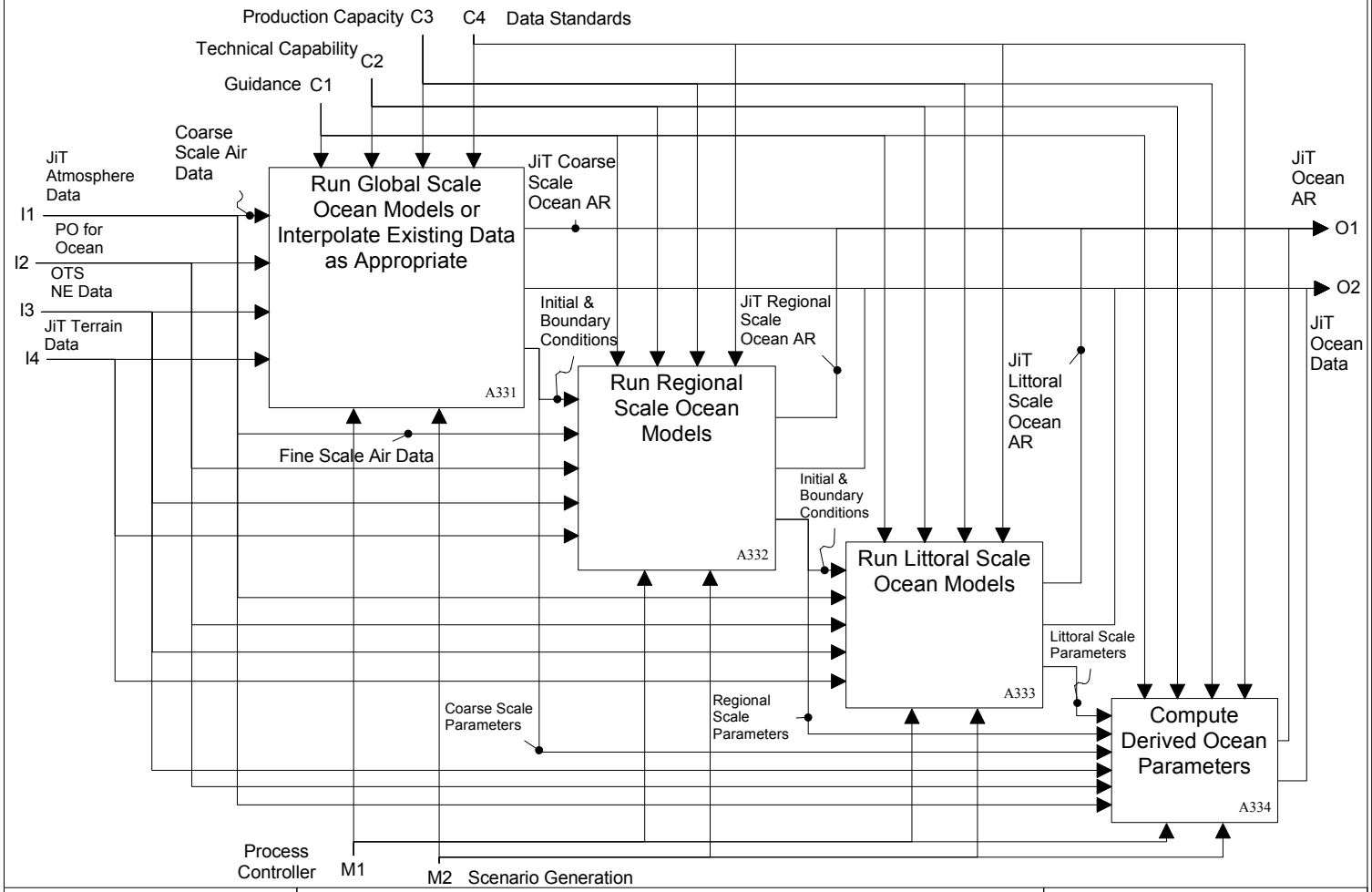

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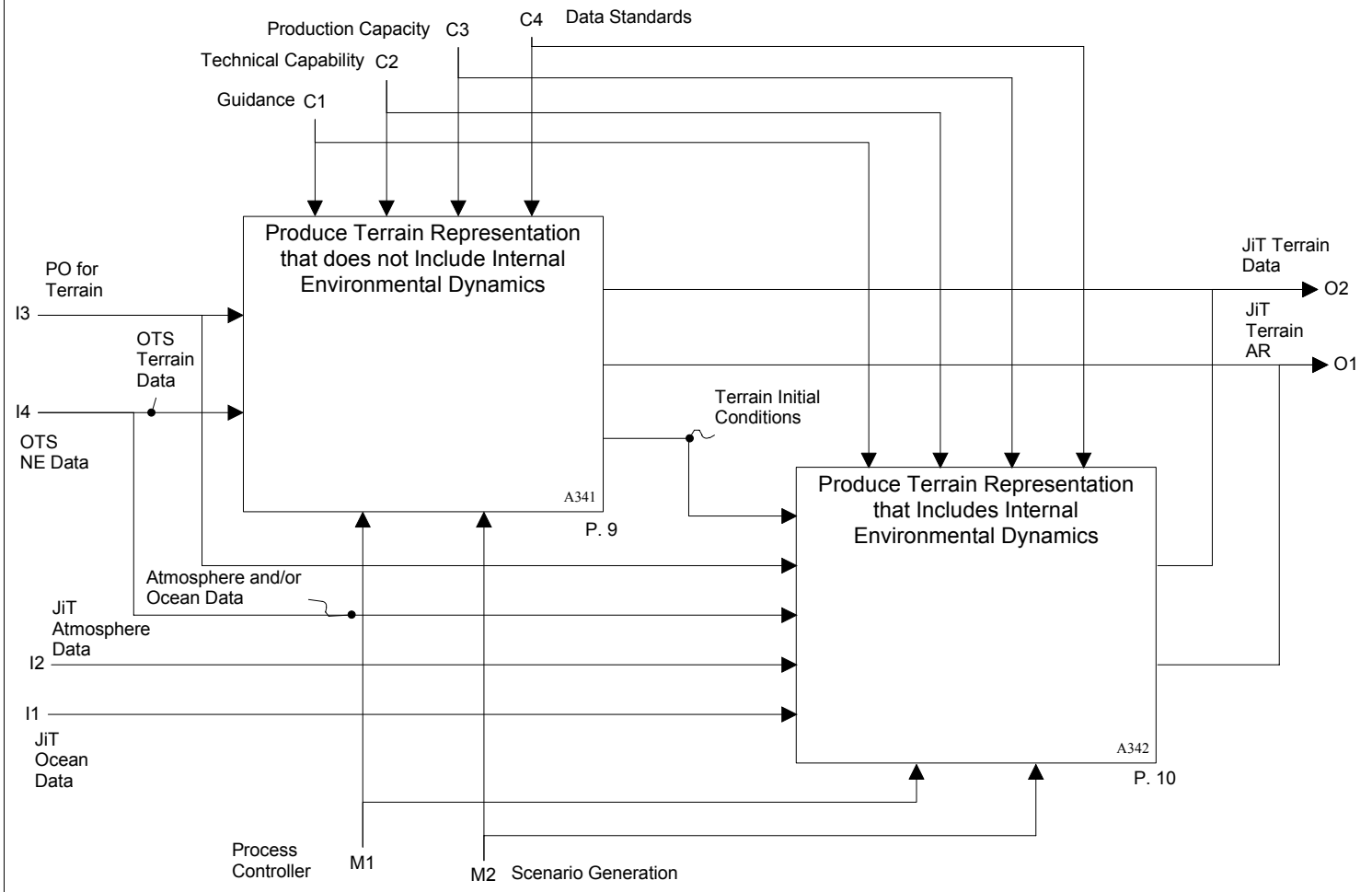

NODE: A34	TITLE: Produce Terrain Data	NUMBER: P. 8

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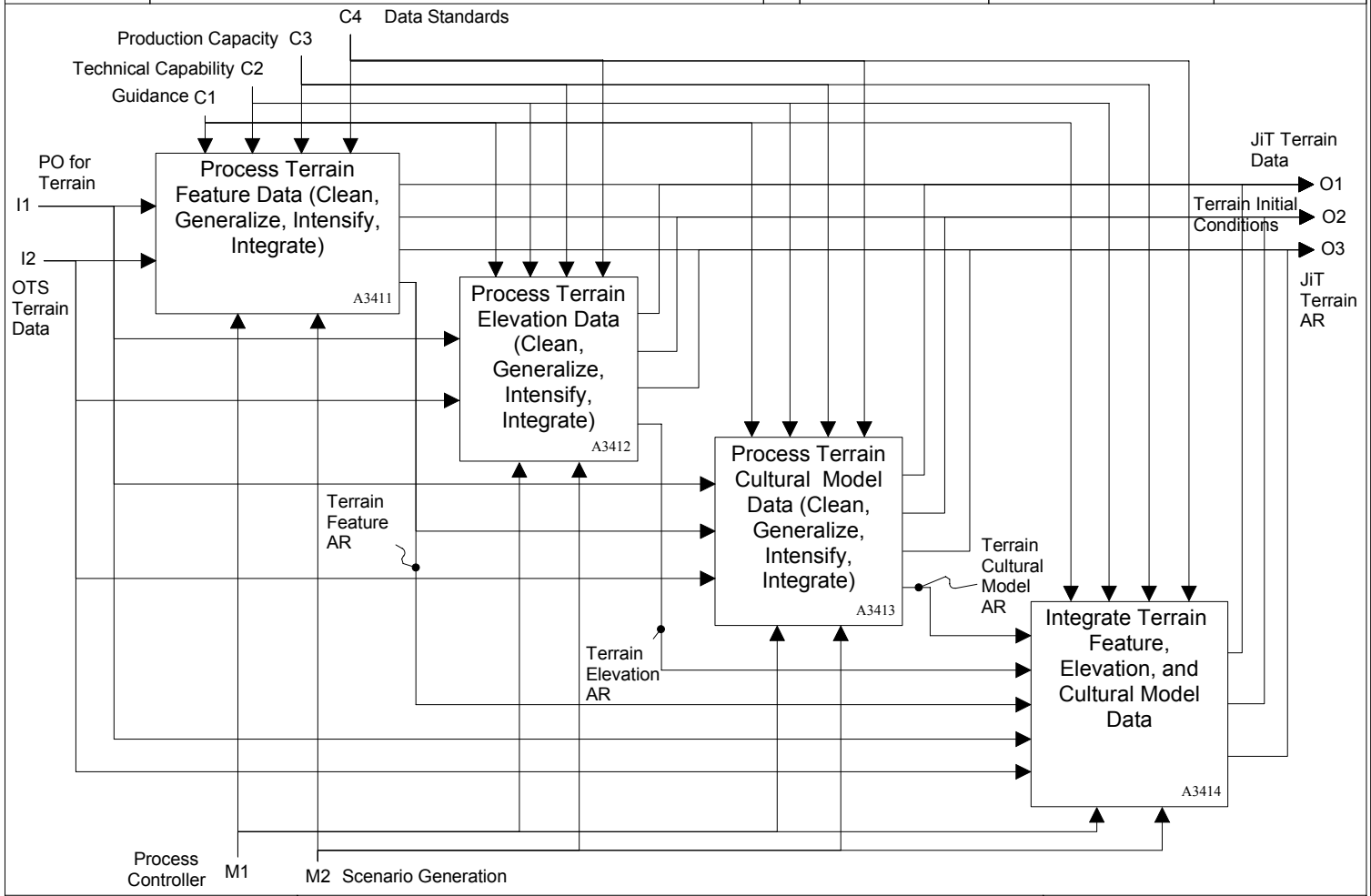

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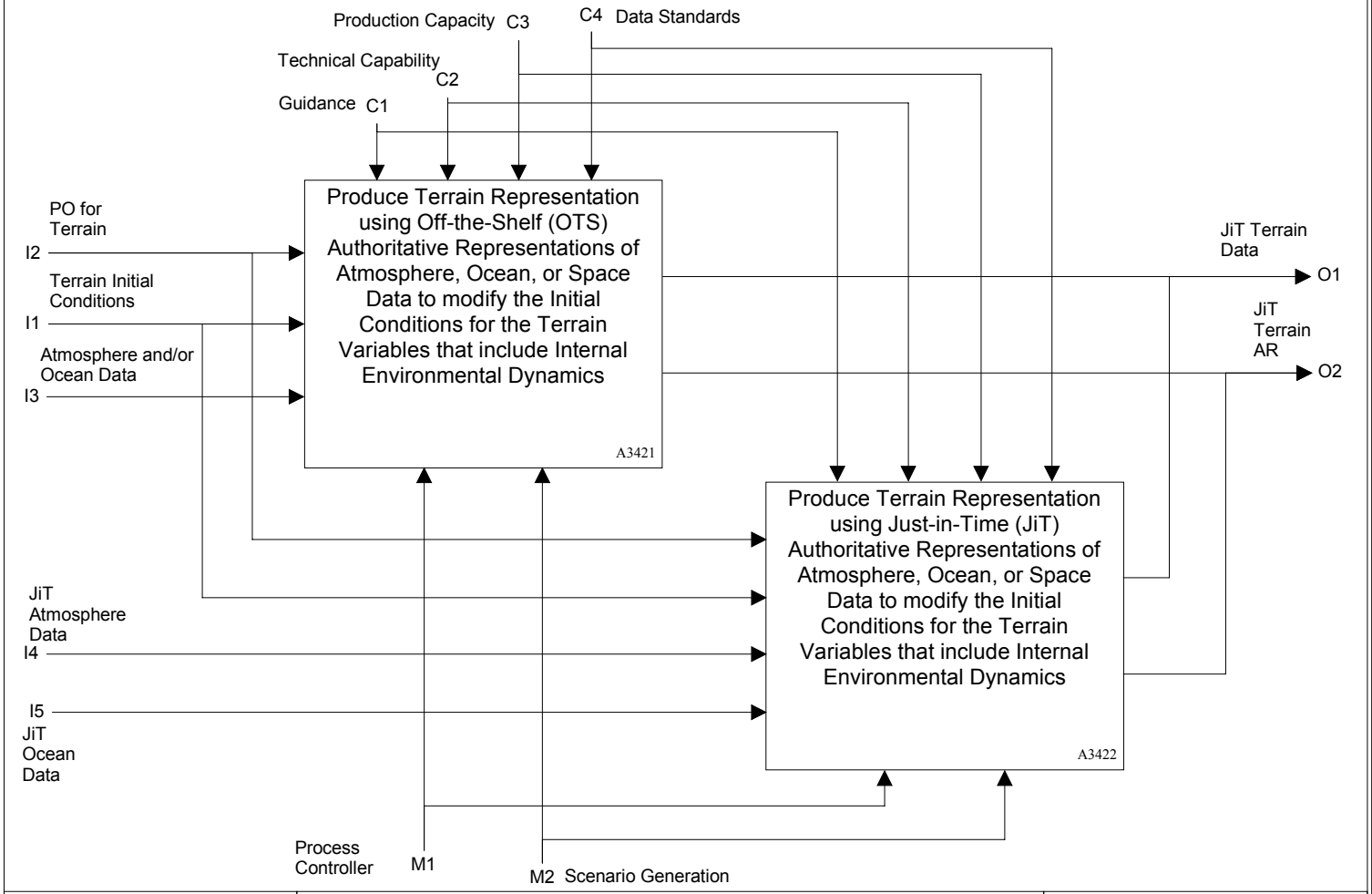

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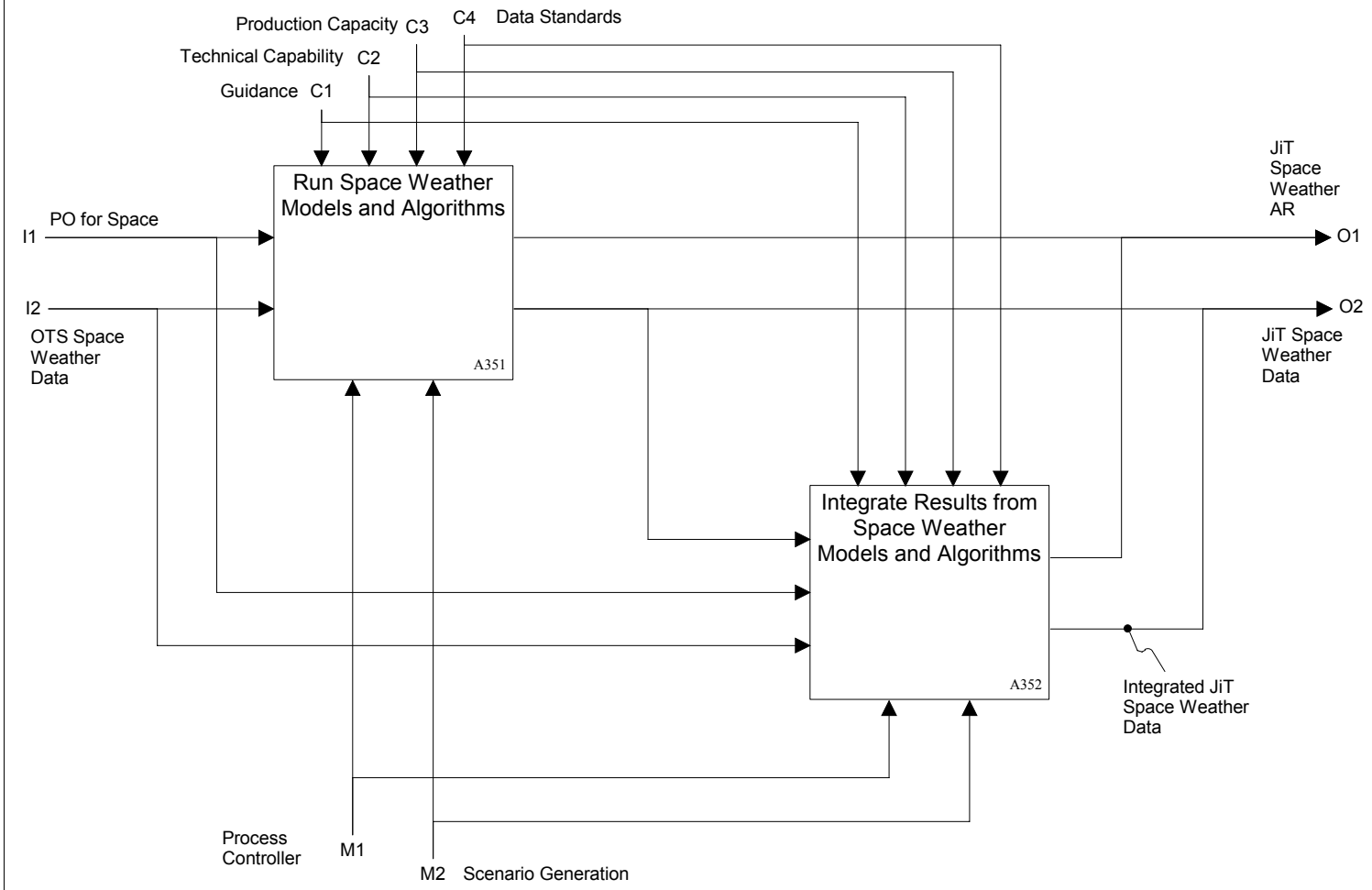

NODE: A35	TITLE: Produce Space Weather Data	NUMBER: P. 11

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ANNEX B - Analysis of IDEF0 Activities

What follows are expanded descriptions of each activity/process (the IDEF0 activity boxes).

Analyze Customer Requirements to Determine Needs of the Simulation (A1)

Prior to the simulation, customers with environmental requirements can interface with MEL Library Services to determine if what they need is available off the shelf (OTS). They can also interface with ESG when what they need is not available OTS or their requirements need to be translated to environmental terms. The results of the interactions are specification(s) to retrieve and/or produce what is needed. Feedback to the customer is used to ensure the proposed solution meets the needs of the simulation.

Translate Customer Requirements from Customer Terms to Environmental Terms for the Various Domains (A11)

The Scenario Composition Customer Interface must have the capability to guide the user through the specification of location, length of time, and desired conditions (to include parameters) for the scenario. Then, based on the simulation objectives and needs, determine the scale of the parameters of interest to specify what the Authoritative Representation (AR) is for the simulation application.

Determine if Authoritative Representation Exists in Archives that Meets the Needs of the Simulation (A12)

Through the Customer Interface(s), it would be determined if a satisfactory authoritative representation exists in the archives.

The Library Services Customer Interface uses a controlled search through metadata (data about data--not the actual data) records. Metadata describing previously produced scenarios will include information about the process used to produce them, the conditions contained within, and information about the resolution. The Scenario Composition Customer Interface can also interrogate and view actual data in selected databases to find matches for desired conditions and resolution.

Determine Just-in-Time Production Process Flow (A13)

This step is initiated when an off-the-shelf (OTS) data set matching the customer requirement does not exist. The Process Controller function determines which production process needs to be executed in what sequence or order to produce the required output and what the optimum flow should be. The outputs from this processing step are a JiT Specification as well as Feedback to the Customer. The JiT Specification will provide the information needed to generate a Production Order(s) (PO) to the appropriate production centers.

Translate Customer Requirements to Delivery Specification (A14)

Customers have choices as to the methods used to obtain environmental data. SEDRIS offers many services not available through other standard formats. A customer requesting a SEDRIS transmittal must determine how the completed integrated authoritative representation is to be encoded using the SEDRIS Data Representation Model (SDRM), the Environmental Data Coding Specification (EDCS), and the Spatial Reference Model (SRM). All three of these SEDRIS components enable flexibility in generating SEDRIS transmittals. In addition, SEDRIS transmittals may be segmented into stand-alone components that are individually useful and form part of an integrated transmittal. These four dimensions of transmittal flexibility must be suitably parameterized so that the customer receives a SEDRIS transmittal that not only contains the Authoritative Representation data requested but also organizes and presents those data in a fashion most suitable for efficient management and retrieval. There are four general parameter groups by which a SEDRIS transmittal may be specified.

The SDRM allows a variety of representations to describe any particular environmental "item." Features, data tables, geometry, images, and models are a few examples. Even if one simply assumed that a data table representation of a 4-D grid was appropriate for the requested environmental data, the transmittal could encode this as a series of time-indexed 3-D grids, a series of pressure-layer indexed 3-D grids (the 3rd dimension of the grid being time), or some mix of 1- or 2-D grids organized by both time and space. Depending on the needs of the customer, these different representations of the same, unambiguous, data might be more or less easy to use (e.g., compile into an application-specific runtime format). Thus, a customer knowledgeable of SEDRIS capabilities will be able to specify which major representational approaches should be adopted in preparing the SEDRIS transmittal**.**

The EDCS provides a well-specified mechanism for "naming" environmental "items" and "data." Customer specification of an environmental data transmittal should use these terms. To the extent that the Data Providers are incapable of furnishing their portion(s) of the requested Authoritative Representation data using EDCS terms, then translation is required to occur; in conjunction with decisions concerning the use of the SDRM, potentially the need may arise to specify what items within the EDCS are to be used to "name" environmental "items" and "data." For example, "Lighthouses" may be specified as either specific feature types or a more generic terminology of "Building" plus additional "Functional Use" attribution(s). In general, the customer needs to specify which decisions to make (between specific characterizations and more general characterizations with amplifying characteristics) and when they should be adopted in preparing the SEDRIS transmittal.

The SRM provides the ability to specify different spatial reference frames for environmental data including the ability to use multiple reference frames within a single Authoritative Representation transmittal. For example, a Joint simulation may require ocean data in Geodetic Coordinates, atmosphere data in Lambert Conformal Conic Coordinates, and terrain data in Universal Transverse Mercator Coordinates. Thus, the customer will be able to specify which spatial reference framework should be adopted for each type/group of environmental data in preparing the SEDRIS transmittal.

The ability to satisfy requirements with a single transmittal or multiple transmittals supports flexible, distributed AR production. It also allows the AR to be segmented into separate SEDRIS transmittals for use by different federation applications. For example, a data provider might be requested to separate the ocean acoustic data from ocean surface data (as separate sub-transmittals) such that the passive sonar simulator receives only the acoustic data transmittal and the surface ship simulator receives the ocean surface data transmittal. Alternatively, the customer may desire multiple related transmittals to be generated containing some overlap in data content. Either choice leads to greater efficiencies and flexibility for simulation management and runtime format compilation performance. Thus, the customer will be able to specify how the Authoritative Representation should be segmented into transmittals.

A customer requesting other standard environmental transmittal mechanisms (non-SEDRIS) will also be supported.

Retrieve the Authoritative Representation (A2)

In some cases, the data needed by customers may be readily available from OTS data providers who agree to advertise their holdings using standard metadata. Library Services functionality will enable searches and subsequent orders for these data.

Order Existing Off-the-Shelf (OTS) Natural Environmental Data that Meet the Requirements for an Integrated Authoritative Representation for all Domains (A21)

When a suitable data set is identified, an order option for that data set is available through Library Services.

Compute Derived Natural Environment Parameters (A22)

Occasions will exist when the OTS data available are suitable (they are for the correct regions, are for the proper times, and contain the proper conditions) but are not complete. In these cases, "value- adding" transformations like calculating derived parameters can be performed.

Produce the Authoritative Representation of the Natural Environment (A3)

When the required data are not available via OTS, production via designated Environmental Data Providers (DoD Operational Providers, non-DoD government data providers, or commercial data providers) is an available option. To authoritatively represent natural environmental effects, the data itself must be authoritative, i.e., the right data for its intended purpose. When more than one domain is needed, the processes used by the various domain providers must be coordinated since data from some providers are needed by other providers to ensure physical consistency. This "Integration" occurs through coordination among the providers and is facilitated by the Process Controller.

Schedule the Production of the Natural Environment Data (A31)

Producing the necessary data set will require a sophisticated capability. The Process Controller must determine each component of the integrated data set, find the "right" data to start the process to create the data, then coordinate the details with the appropriate Data Providers. Producing integrated data requires a complex set of processes involving data providers and environmental models at distributed resource sites for one or all environmental domains.

Produce Atmosphere Data (A32)

Designated Atmosphere Data Providers will be responsible for producing JiT Atmosphere Authoritative Representations of the atmosphere domain. These providers are responsible for providing the necessary production capacity, applying organic technical capabilities (hardware, software, and personnel) to produce the authoritative representations, and conforming to existing data standards. A production order from the Process Controller for atmosphere data along with the needed natural environment data [includes initial and/or boundary conditions] are the inputs for processing the JiT atmosphere authoritative representation. These representations will be consistent within the atmosphere domain (intra-domain). In addition, data from other environmental domains (space, ocean, or terrain) may be required to ensure consistency with these other domains (inter-domain). The scheduling coordination for these interactions will be facilitated by the Process Controller.

Run Global or Hemispheric Scale Atmosphere Models or Assemble/Interpolate Existing Data as Appropriate (A321)

This processing step is executed by Atmosphere Data Providers using global- or hemispheric-scale atmospheric models to integrate natural environment data (including weather and ocean observations, and solar flux) into a single, physically consistent, JiT Coarse-Scale Atmosphere Authoritative Representation. Underlying terrain and ocean fields are used in these numerical models. The process is initiated by a Production Order for Atmosphere from the Process Controller that includes specifications for geographic location, time frame, and parametric conditions. The Process Controller will direct JiT Terrain Data, output from Produce Terrain Data, as an input to this process in the following instances: (1) When required geospecific data are not off-the-shelf and are needed for JiT production, and (2) When geotypical data are required to ensure the atmosphere representation is physically consistent with the terrain domain. As required, the Process Controller will also direct JiT Ocean and Space Weather Data as inputs to this process. The output from this process also can serve as initial boundary conditions for a finer scale atmospheric model.

Run Finer Scale Atmosphere Models (A322)

For some simulations, coarse-scale global and hemispheric authoritative representations will not have sufficient spatial and/or temporal resolution. In this case, coarser scale models can provide initial boundary conditions for finer scale models. As with the Run Global or Hemispheric Scale Atmosphere Models process, this process can also accept inputs of JiT Terrain, Space Weather, and Ocean data.

Compute Derived Parameters (A323)

The output from the coarse- and finer-scale atmospheric models does not always include some of the parameters required by simulations. Therefore, further processing is sometimes required. For example, visibility may be affected by JiT Ocean Data such as aerosols. This process could run models or algorithms to generate value-added data (e.g., derived parameters, dispersion models).

Produce Ocean Data (A33)

Designated Ocean Data Providers are responsible for producing authoritative representations of the ocean domain. These providers will provide the necessary production capacity, applying organic technical capabilities (hardware, software, and personnel), with appropriate inputs of natural environmental data and abide by data standards, to provide ocean representations in support of modeling and simulation. These representations will be consistent within the ocean domain (intra-domain) from the shoreline to deep water, and from the air-sea-ice interface to the ocean bottom. Data from other environmental domains (atmosphere and terrain) may be required to ensure consistency both within (intra-domain) and among those domains (inter-domain). The scheduling coordination for these interactions will be facilitated by the Process Controller.

Run Global Scale Ocean Models or Interpolate Existing Data as Appropriate (A331)

Scenario Generation is accomplished by Ocean Providers using global-scale ocean models to integrate natural environment data (ocean and atmosphere observations, JiT air [coarse-scale air data] and terrain data, gridded ocean boundary conditions) into a single, physically consistent JiT Coarse-Scale Ocean Authoritative Representation. The process is initiated by a Production Order for Ocean from the Process Controller that includes specifications for geographic location, time frame, and parametric conditions. The Process Controller will coordinate JiT Air and Terrain Data as an input to this processing step. This action would occur when required geospecific data are not available, are needed for JiT production, and when geotypical data are required to ensure the ocean representation is physically consistent with the atmosphere and terrain domains. The output from this process also can serve as initial boundary conditions for a regional scale ocean model.

Run Regional Scale Ocean Models (A332)

For some simulations, coarse-scale authoritative representations will not have sufficient spatial or temporal resolution. In this case, coarser-scale global models can provide initial boundary conditions for regional scale models that are executed by an Ocean Data Provider during this process. As with the Run Global Scale Ocean Models process, this process can accept an input of JiT Air and Terrain data from other providers.

Run Littoral Scale Ocean Models (A333)

For some simulations, regional-scale authoritative representations will not have sufficient spatial and/or temporal resolution. In this case, regional-scale models can provide initial boundary conditions for littoral scale models that are executed by an Ocean Data Provider during this process. As with the Run Regional Scale Ocean Models process, this process must also be able to accept an input of JiT Air and Terrain data from other providers.

Compute Derived Ocean Parameters (A334)

The output from the global scale regional scale, and littoral scale ocean models does not always include some of the parameters required by simulations. Therefore, further processing is sometimes required. This process executes models or algorithms to generate value-added data (e.g., derived parameters, transmission models).

Produce Terrain Data (A34)

Designated Terrain Data Providers are responsible for producing Authoritative Representations of the terrain domain. They provide the necessary production capacity, apply organic technical capabilities (hardware, software, and personnel) with appropriate inputs of natural environmental data, and follow applicable data standards to provide terrain representations (with and without internal environmental dynamics) to support modeling and simulation. These representations will be consistent within the terrain domain (intra-domain) from the shoreline to the highest elevations and from the air-terrain interface to the deepest underground feature (e.g., mine shaft, well, cave). Data from other environmental domains (atmosphere and ocean) may be required to ensure consistency among these domains (inter-domain) particularly when internal environmental dynamics are considered. The scheduling coordination for these interactions will be facilitated by the Process Controller.

Produce Terrain Representation that does not include Internal Environmental Dynamics (A341)

This processing step integrates a variety of terrain data types and sources into a single physically and logically consistent terrain Authoritative Representation. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include:

- Specifications for the terrain representation content (e.g., location, spatial data density, feature and attribute content).

- Specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer, integrated rivers that flow downhill, level lakes, discrete trees and bushes, rivers with explicit bottoms constructed as geometry but with associated depth attribution, and topologically connected road and rail networks).

Scenario Generation is executed by Terrain Provider(s) and results in a temporally invariant representation of the terrain (e.g. river depth does not change over time, soil moisture is fixed,

and phenologic (seasonal) variation does not occur). In addition to the JiT Terrain Authoritative Representation, this step also results in JiT Terrain Data for subsequent use by other environmental domain models (e.g., terrain-atmospheric exchange models and near-ground transport or diffusion models) as well as Terrain Initial Conditions for generating a time-varying JiT Terrain Authoritative Representation.

Process Terrain Feature Data (Clean, Generalize, Intensify, Integrate) (A3411)

This processing step integrates a variety of terrain data types and sources into a single, physically consistent Terrain Feature Data. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include

- Specifications for the terrain feature representation content (e.g., location, spatial data density, feature and attribute content)

- Specifications for the resulting representation itself (e.g., urban regions with discrete buildings, individual trees and bushes, rivers with associated depth, width, bank slopes and heights attribution on a per-segment basis, and topologically connected road and rail networks).

This processing step is executed by Terrain Provider(s) and results in a temporally invariant representation of the terrain features (e.g. river depth does not change over time, soil moisture is fixed, and phenologic (seasonal) variation does not occur). Processing activities include but are not limited to:

- Cleaning, wherein source feature data sets are checked for internal consistency and errors corrected or erroneous features discarded (e.g., deletion or re-placement of bridges not correctly positioned and/or oriented with respect to related road/river intersections)

- Generalization, wherein cleaned feature data sets are spatially thinned (e.g., excessive numbers of location values along a road may be removed, resulting in slight changes in the road path, but significant changes in data volume and complexity) or have attribute ranges reduced through the collapsing of "adjacent values" (e.g., re-characterizing roads as primary- versus secondary-based on width, number of lanes, and surface material)

- Intensification, wherein either additional quantitative non-feature terrain data sources are used to increase the spatial or content quality of the terrain feature data (e.g., the extraction of additional transportation network features from imagery or the addition of additional terrain surface attribution based on multi-spectral data sources), or other qualitative terrain data sources and/or algorithms are used to increase the spatial or content quality of the terrain feature data (e.g., inferring characteristics of individual bridges from data about road type, gap width, and civil engineering construction practices)

- Integration, wherein terrain features from different sub-categories are organized into a single representation including explicit relationships between and among the features that were not present in the original terrain data sources (e.g., identifying dams as explicit interruptions to

the continuity of a river network and therefore water flow and riverine navigability, or developing a complete and exact coverage of the terrain extents characterizing the trafficability characteristics of all regions whether covered by vegetation, water, urban structures, or snow/ice).

Process Terrain Elevation Data (Clean, Generalize, Intensify, Integrate) (A3412)

This processing step integrates a variety of terrain data types and sources into physically consistent Terrain Elevation Data. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include:

- Specifications for the terrain feature representation content (e.g., location, spatial data density and vertical resolution/accuracy, inclusion of bathymetric data)

- Specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer with all polygons being three-sided, no square 10x10-km region with greater than 1200 polygons, and a maximal vertical surface error of 10 meters as compared to the terrain elevation source data).

This processing step is executed by Terrain Provider(s) and results in a temporally invariant representation of the terrain elevation surface (e.g. the coastline does not change over time as a result of along-shore currents and storm surge/erosion). Processing activities include but are not limited to:

- Cleaning, wherein source elevation data sets are checked for internal consistency and errors corrected or erroneous elevation data discarded (e.g. deletion or replacement of local spikes and data dropouts, removal of "corn rows" and other correlated data errors)

- Generalization, wherein cleaned elevation data sets are spatially thinned (e.g., an elevation matrix may be sub-sampled at a lower spatial density) or be re-represented in a different form (e.g., replacing a dense grid by a sparse sets of elevation points joined to form a complete coverage of polygons)

- Intensification, wherein either additional quantitative non-elevation terrain data sources are used to increase the spatial or content quality of the terrain elevation data (e.g., the extraction of denser elevation data from stereo imagery or synthetic aperture radar), or other qualitative terrain data sources and/or algorithms are used to increase the spatial or content quality of the terrain elevation data (e.g., inferring local slope and aspect characteristics from hydrologic flow data).

- Integration, wherein terrain elevation data from different densities or spatially adjacent locations are organized into a single representation including explicit relationships between and among different elevation density data sets covering the same regions (e.g., seaming together adjacent data sets into a broader seamless coverage or developing a multi-resolution terrain elevation model with correlated representation at varying spatial resolutions).

Process Terrain Cultural Model Data (Clean, Generalize, Intensify, Integrate) (A3413)

This processing step integrates a variety of terrain data types and sources into physically consistent Terrain Cultural Model Data. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include:

- Specifications for the terrain cultural model representation content (e.g., types, sizes, characterizations/attributes, texture content).

- Specification for the resulting representation itself (e.g., "hollow" shells with applied texture, multiple-elevation structures with interior walls, floors, halls and stairways, topology integrating enclosures and apertures).

This processing step is executed by Terrain Provider(s) and results in a temporally invariant representation of the terrain cultural models (e.g. models all represent fixed, usually undamaged, characterizations of the item of interest; street lights are all off (if they exist) and any moving parts are in fixed positions {e.g. the solar collectors face in a single direction}). Processing activities include, but are not limited to:

- Cleaning, wherein source cultural model data sets (if they exist) are checked for internal consistency and errors corrected or erroneous aspects discarded (e.g., deletion of erroneous or inapplicable textures, re-generation of incorrect geometry).

- Generalization, wherein cleaned cultural model data sets are spatially thinned (e.g., excessive numbers of geometric components are removed, resulting in slight changes in the overall cultural model but significant changes in data volume and complexity) or have attribute ranges reduced through the collapsing of "adjacent values" (e.g., re-characterizing buildings as industrial versus residential based on use and product type).

- Intensification, wherein either additional quantitative non-cultural model terrain data sources are used to increase the spatial, type, or content quality of the terrain cultural model data (e.g., the extraction of additional industrial structures from stereo imagery, or the addition of additional structural attribution based on multi-spectral data sources or engineering drawings), or other qualitative terrain data sources and/or algorithms are used to increase the spatial, type, or content of the terrain cultural feature data (e.g., inferring characteristics of wall construction from data about building type and civil engineering construction practices).

- Integration, wherein terrain cultural models from different sources are organized into a single representation including explicit relationships between different cultural models that were not present in the original terrain data sources, or the construction of new composite models from libraries of component models (e.g., different versions of the same cultural model that vary according to polygon complexity or damage state, or the creation of an airport facilities model from "stock" cultural model libraries of hangers, petroleum storage tanks, control towers, radomes, and terminal buildings).

Integrate Terrain Feature, Elevation, and Cultural Data (A3414)

This processing step integrates Terrain Feature Data, Terrain Elevation Data, and Terrain Cultural Model Data into a single physically consistent Terrain Authoritative Representation. Additionally, previously archived authoritative representations may be included in the integration process. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include:

- Specifications for the integrated terrain representation content (e.g., location, spatial data density, feature and attribute content).

- Specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer, integrated rivers that flow downhill, level lakes, discrete trees and bushes, rivers with explicit bottoms constructed as geometry but with associated depth attribution, and topologically connected road and rail networks).

This processing step is executed by Terrain Provider(s) and results in a temporally invariant representation of the terrain (e.g., river depth does not change over time, soil moisture is fixed, and phenologic (seasonal) variation does not occur). In addition to the JiT Terrain Authoritative Representation, this step also results in JiT Terrain Data for subsequent use by other environmental domain models (e.g., terrain-atmospheric exchange models and near-ground transport or diffusion models) as well as Terrain Initial Conditions for generating a time-varying JiT Terrain Authoritative Representation. For example, integration activities include changes in local terrain elevation configuration to ensure rivers flow downhill and roads have appropriate lateral and longitudinal slopes. Cultural Models and the surrounding terrain elevations may be co-adjusted to result in a consistent model "footer" and site surface configuration. Terrain surface attribution and surface polygons may be co-adjusted to ensure the boundaries between adjacent areas of differing attribution are not inappropriately irregular.

Produce Terrain Representation that Includes Internal Environmental Dynamics (A342)

This processing step integrates a variety of OTS Natural Environment Data types and sources, and time-invariant Terrain Initial Conditions as well as JiT Atmosphere Data and JiT Ocean Data into a single, physically and logically consistent time-varying JiT Terrain Authoritative Representation. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and include:

- Specifications for the terrain representation content (e.g., location, time period and temporal sampling rate, spatial data density, feature and attribute content, that coupled atmosphere-terrain and ocean-terrain phenomena are to be modeled)

- Specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer, integrated rivers that flow downhill and can exhibit flooding, level lakes whose levels may fluctuate, discrete trees and bushes that may have seasonally specific heights, densities and chlorophyll content / color, and beach erosion features that may change as a result of storm surges).

This processing step is executed by Terrain Provider(s) and results in a time-varying representation of the terrain. The resulting JiT Terrain Authoritative Representation is physically-consistent with the associated JiT Atmosphere and Ocean data sets thus resulting in a physically-consistent Terrain component within the integrated scenario.

Produce Terrain Representation using Off-the-Shelf (OTS) Authoritative Representations of Atmosphere and Ocean Data to Modify the Initial Conditions for the Terrain Variables that include Internal Environmental Dynamics (A3421)

This processing step integrates Terrain Initial Conditions and OTS Atmosphere and Ocean Data (previously archived authoritative representations) into a single physically consistent JiT Terrain Authoritative Representation. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and includes not only specifications for the integrated terrain representation content (e.g., location, spatial data density, feature and attribute content, that coupled atmosphere-terrain, ocean-terrain, and space-terrain phenomena are to be modeled) but also specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer, integrated rivers that flow downhill, level lakes, discrete trees and bushes, rivers with explicit bottoms constructed as geometry but with associated depth attribution, and topologically connected road and rail networks). This processing step is executed by Terrain Provider(s) and results in a temporally variant representation of the terrain (e.g. river depth and soil moisture changes over time as a function of precipitation and solar/wind-induced evapotranspiration, and phenologic (seasonal) variation in vegetation state occurs). Other environmental domain models (e.g., terrain-atmospheric exchange models and near-ground models) may subsequently use the JiT Terrain Authoritative Representation.

Produce Terrain Representation using Just-in-Time (JiT) Authoritative Representations of Atmosphere and Ocean Data to Modify the Initial Conditions for the Terrain Variables that include Internal Environmental Dynamics (A3422)

This processing step integrates Terrain Initial Conditions with JiT Atmosphere Data and JiT Ocean Data into a single physically consistent JiT Terrain Authoritative Representation. The constraints under which this integration occurs are determined from the associated Production Order for Terrain and includes not only specifications for the integrated terrain representation content (e.g., location, spatial data density, feature and attribute content, that coupled atmosphere-terrain and ocean-terrain phenomena are to be modeled) but also specifications for the resulting representation itself (e.g., a polygonal terrain surface representation of 10 polygons per square kilometer, integrated rivers that flow downhill, level lakes, discrete trees and bushes, rivers with explicit bottoms constructed as geometry but with associated depth attribution, and topologically connected road and rail networks). This processing step is executed by Terrain Provider(s) and results in a temporally variant representation of the terrain (e.g. river depth, soil temperature, and soil moisture changes over time as a function of precipitation and solar/wind-induced evapotranspiration, and phenologic (seasonal) variation in vegetation state occurs).

Produce Space Weather Data (A35)

This processing step produces and integrates a variety of space weather data types and sources into a single, physically and logically consistent time varying Space Weather Authoritative Representation. The constraints under which Scenario Generation occurs are determined from the associated Production Order for Space. This processing step is executed by Space Provider(s) and results in a time-varying representation of the space environment. The resulting Space Weather Authoritative Representation is not conditional upon activities in the other three natural environments. This step may result in JiT Space Weather Data for subsequent use by atmosphere models.

Run Space Weather Models and Algorithms (A351)

Designated Space Weather Data Providers perform this processing step and produce a variety of space weather data. The constraints under which this production occurs are determined from the associated Production Order for Space. Input comes from OTS archived data sources like the National Geophysical Data Center (NGDC). This processing step is executed by designated Space Weather Provider(s) and results in JiT Space Weather Data as possible input to atmosphere processes and Integrate Results from Space Weather Models.

Integrate Results from Space Weather Models and Algorithms (A352)

This processing step integrates a variety of space weather data types and sources into a single, physically and logically consistent time-varying Integrated JiT Space Weather Data and JiT Space Authoritative Representation. The constraints under which this integration occurs are determined from the associated Production Order for Space. This processing step is executed by designated Space Weather Provider(s) and results in a time-varying representation of the space environment. The resulting Space Weather Authoritative Representation is not conditional upon activities in the other three natural environment domains.

Deliver the Authoritative Representation (A4)

With coordination provided by the Process Controller, Environmental Data Providers are responsible for preparing the delivery of the Authoritative Representation of the environment to the customer. Customers will specify their requirements for delivery to include data transmittal mechanism(s) as part of the requirements process. Providers must have the ability to respond by providing the Authoritative Representations as either SEDRIS or non-SEDRIS transmittals. Multiple providers may be involved in the final generation of the transmittals. The scheduling coordination for the required provider actions and interactions will be facilitated by the Process Controller. Transmittal preparation may require conversion of environmental data into one or more customer-specified spatial frameworks. In addition to delivery to the customer, Authoritative Representation transmittals will also be archived by Library Services for subsequent OTS access and reuse.

Coordinate the Delivery of the Authoritative Representation (A41)

This processing step accepts a Delivery Specification and prepares one or more Delivery Orders. Delivery Specification includes specifications for both the transmittal mechanism to be used (e.g., GRIB, BUFR, VPF, or SEDRIS Transmittal Format) and the spatial framework(s) to be used for specific data sets (e.g., Lambert Conformal Conic using a spheroidal earth model for atmospheric data, or Geodetic using the WGS-84 ellipsoid and geoid for ocean data). In the case of SEDRIS Transmittal Format, the number and size of transmittals can also be specified. The resulting Delivery Order includes both provider-specific and transmittal mechanism-specific parameters. The latter may include specific data organizational requirements specified by the customer that need to be coordinated across the various providers (e.g., decomposition of the transmittal into specific types of GRIB files or the use of specific SEDRIS Inter-Transmittal References (ITR) constructs such that the required component data sets are logically organized when accessed by the customer).

Convert the Authoritative Representation(s) of the Natural Environmental Domain(s) to Customer-Specified Spatial Framework (A42)

This processing step accepts a Delivery Order plus JiT Natural Environment Authoritative Representations or Off-the-Shelf Natural Environment Authoritative Representations and prepares one or more customized Natural Environment Authoritative Representations. The step will generally be executed by multiple Providers--the same Providers that produced the data. Thus, the resulting customized Natural Environment Authoritative Representations are transformed from the native spatial framework of the provider to that specified by the customer. Such conversion may necessitate subsequent interpolation of gridded data to obtain a regular grid in the new coordinate system. Conversions supported will be In Accordance With (IAW) the SEDRIS Spatial Reference Model (SRM) (e.g., converting gridded atmospheric data from Lambert Conformal Conic using a spheroidal earth model to Geodetic using the WGS-84 ellipsoid). Interpolation methods will be validated for use with and specific to the data type (e.g., the use of bilinear interpolation for gridded elevation data). Software will be furnished to providers who will execute this capability as a post-processing step to their environmental data retrieval or generation process.

Prepare Coordination Transmittal with Associated Metadata (A43)

This processing step accepts a Delivery Order and prepares a Coordination AR Transmittal that describes how the transmittal(s) is organized. Delivery Orders include both provider-specific and transmittal mechanism-specific parameters. The latter may include specific data organizational requirements specified by the customer that have been coordinated across the various providers (e.g., decomposition of the transmittal into specific types of GRIB files or the use of specific SEDRIS DRM organizational constructs). There are several different options available in specifying SEDRIS transmittal delivery. The customer may desire that each domain data set be delivered separately by each provider. Alternatively the data could be delivered as a single transmittal. The customer then will be able to access the (typically multiple) physical data set(s) from the Providers using a single logical transmittal accessed according to the customer specified mechanism. Software will be developed to support the generation and management of

Coordination AR Transmittals. The Process Control function then will execute this capability in coordination with other actions in fulfilling the customer request. Software will also be developed to support non-SEDRIS Coordination AR Transmittal generation and management as needed.

Prepare the Data Transmittals (A44)

This processing step accepts a Delivery Order for Data and prepares transmittals for one or more Authoritative Representation Data Transmittals. Multiple providers generally will execute this step. The resulting customized Authoritative Representations are transformed from the native format of the Providers to that required by the request to allow data access according to the transmittal mechanism specified by the customer. Typically, this action would be based on the SEDRIS Transmittal Format (STF). The Delivery Order for Data Transmittals includes both provider-specific and transmittal mechanism-specific parameters. The latter may include specific data organizational requirements specified by the customer that have been coordinated across the various Providers (e.g., decomposition of the transmittal into specific types of GRIB files, or the use of specific SEDRIS Inter-Transmittal References (ITR) constructs such that the required component data sets are logically organized when accessed by the customer). The Coordination AR Transmittal prepared by a related processing step logically encapsulates the Authoritative Representation components being separately prepared by the providers. The customer then will be able to access the (typically multiple) transmitted physical data set(s) from the providers executing this processing step using a single, logical routing transmittal accessed according to the customer-specified mechanism.

This CONOPS ensures that the final product delivered to the customer--the Authoritative Representation--satisfies the requirements of the simulation for timeliness, appropriateness, and completeness. All Environmental Domain Data will be physically consistent. Customers using the INEARP can assume they are getting the right data for their intended use(s).

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Annex C - GLOSSARY OF TERMS

Atmosphere Authoritative Representation (A3) - A collection of natural environmental data that portrays the state (to include changes in state) of the atmosphere in a physically consistent manner, both internally to the atmosphere and across interfaces with the ocean, terrain, and/or space natural environmental domains. Its resolution is appropriate for the parameters of interest and their intended use. This is usually produced as a result of a Production Order (PO) for Atmosphere Data from the Process Controller to an atmosphere provider unless the authoritative representation already exists in an off-the-shelf (OTS) archive.

Atmosphere JiT Data (A3) - Output from an Atmosphere Data Provider that portrays the state of the atmosphere in a physically consistent manner and is a necessary input to processes by the Ocean and/or Terrain Providers in order to achieve physical consistency, i.e., inter-domain integration.

Atmosphere Providers (A3) - Also Atmosphere Operational Provider(s). A provider that obtains appropriate OTS environmental data, runs computer-based atmosphere environmental models, and delivers the information to other providers and to customers.

Authoritative Representation (A0) - Also Natural Environment Authoritative Representation (NEAR), JiT NE AR, and OTS NE AR. A collection of natural environmental data that portrays the natural environment in a physically consistent manner, within and among the space, atmosphere, ocean, and/or terrain domains. Its resolution is appropriate for the intended application. As delivered to the customer, the AR includes both the Data and the Metadata that describes the processes that were used to produce it as well as any subsequent changes to the data during preparation of the transmittal.

Customer Interface – The information screen(s) that allow a customer to initiate or affect part or all of the process to obtain ARs for the customer's needs. There are Interfaces at several locations and/or steps in the INEARP. The Library Services Customer Interface developed under MEL enables data discovery and delivery from archived resources. The Scenario Composition Customer Interface developed by ESG will have the capability to guide a customer through the requirements process such that the “needs” of the simulation application can be determined in environmental terms to “guide” the search through the archived data AND for the production process.

Customer Requirements (A0) - Also OTS and JiT Customer Requirements. The stated needs [objectives of the simulation] of a customer for scenarios of authoritative natural environmental data for a geographic location, duration, and desired conditions for interaction with simulation objects in a simulation. Customer requirements include information on parameters of interest, scale of the data, and transmittal mechanism.

Customer Requirements in Environmental Terms (A1) - User (customer) requirements received in customer terms translated into specific environmental terms for various domains using the capabilities in the ESG developed Customer Interface.

Data Standards (A0) - Unique names, definitions, characteristics, and representations of data documented, reviewed, and approved according to established procedures and conventions. Environmental Data Providers will conform to data standards.

Delivery Specification (A1) - Description of the customer's requirements for delivery to include the medium of transfer, transfer format (SEDRIS Transmittal or an environmental standard). When data are desired at grid spacing other than the authoritative representation for the conditions (parameters of interest) and the objectives of the simulation application, interpolations/extrapolations and/or conversions to a specific coordinate system can be performed. Changes from AR will be documented in Metadata. It also includes any other special handling instructions.

Environmental Data Providers - Organizations within the U.S. Government, notably the Department of Defense, that archive and make available environmental data, run computer-based environment models and algorithms, build to specification authoritative environmental data in coordination with other domain providers (Scenario Generation), and deliver/disseminate the resulting information to customers in support of modeling and simulation applications.

Environmental Effects - A measurable change in performance of a military system or other man-made entity (simulation object) due to the interaction with the natural environment. This interaction is represented as a direct influence of the environment on models of military systems, including sensors (active and passive), weapons and countermeasures, and/or units/platforms (e.g., ducting of acoustic energy by the ocean's vertical structure or impaired tank movement due to rain-soaked soil). Environmental effects models may be as simple as a "pass-through" of environmental state data to the military system model for calculation through a "look-up" table or as complicated as a transport and diffusion model which may require significant amounts environmental data and processing time to calculate effects data.

Environmental Impacts - A measurable change in the physical state of the natural environment caused by interactions with military systems, including active sensors, weapons and countermeasures, and/or units/platforms (e.g., bomb crater on runway, soil state changes due to traffic, acoustic noise caused by civilian shipping).

Environmental Internal Dynamics - The algorithms that model physical processes that cause spatial and temporal variations in environmental state variables. These processes may be represented by either distinct data sets that define the environmental state at a sequence of times or by algorithms implementing mathematical models of some form (e.g., deterministic or stochastic differential or difference equations). Changes in the state of the terrain (soil) due to changes in temperature and precipitation are examples that must be accounted for either before or during simulation runtime. The INEARP CONOPS deals with those that are known in production of the integrated data.

Environmental Models and Algorithms - The physics-based mathematical methods used to derive additional natural environment related data or to evolve the state of the natural environment over time in response to internal and external factors. Examples of these include

"emergent properties" such as geometric occlusion along a path, diurnal temperature, changes to visibility due to smoke caused by burning structures, blast damage due to munitions, and acoustic byproducts of movement.

ESG (Environmental Scenario Generator) - The ESG will provide integrated and physically consistent environmental data sets meeting a customer's requirements for an authoritative representation of the atmospheric, oceanic, terrain, and/or space natural environment for specified regions, time frames, and conditions. The ESG will automate the generation of logically integrated and physically consistent representations of the natural environment using the data and modeling resources available in the Master Environmental Library (MEL). The ESG provides the ability to locate desired environmental conditions in historical data archives, then orchestrates the production of scenario data bases based on those events.

Feedback to Customer (A0) - Information exchanged with the customer as part of the process to understand customer requirements in order to produce and deliver the necessary authoritative natural environmental representations. Feedback could include information like status reports on progress (Schedule Coordination) or information concerning production options such as a trade-off among cost, time to produce, and/or level of detail that would require interaction with the customer during the production process.

Guidance (A0) - Policy, directives, and doctrine that enable the accomplishment of an activity or do not preclude its execution. Services and/or Agencies designated to be environmental data providers and to provide production capability and capacity will operate under this Guidance.

Initial and Boundary Conditions - Environmental data produced by a modeling or transformation activity that is necessary for use in a subsequent model or transformation activity.

JiT (Just-in-Time) Production - Coordinated processes that provide customer-required scenario(s) of natural environmental data at the authoritative representation from provider(s) and delivered to the customer in time to meet the needs of the application. In this context, JiT is the customized production of what is needed when it is needed versus production Just-in-Case.

JiT Specification (A1) - Customer requirements that can not be met using Off-The-Shelf resources will be analyzed by the Process Controller to coordinate and schedule the JiT production requirements which will be passed to the appropriate Environmental Data Provider(s) for further processing.

Library Services (AO) – See also MEL. The technology to make Natural Environment Data readily available in Archives maintained by the Atmosphere, Ocean, Terrain, and Space Data Providers for M&S applications.

M&S Customers - Modeling and simulation application developers and users (warfighters) who are the customers for the natural environment authoritative representations made available by the INEARP.

Master Environmental Library (MEL) - The Defense Modeling and Simulation Office (DMSO)-sponsored Library Services capability for discovering and ordering environmental information. Through these services, users locate and order environmental information that resides distributed Environmental Data Providers sites

Natural Environment (NE) Data (A0) – Also OTS NE Data. The data in Off-the-Shelf (OTS) Archives that have been made available to the M&S community by MSEA-designated Environmental Data Providers through the Library Services capabilities of the Master Environmental Library (MEL). The collection of sensed, measured, derived, or modeled data describing the state of the natural environment and defining the measurable attributes/values used to describe the natural environment at a point in time. Specific values may, however, represent time-varying conditions (e.g., sea state is a synopsis of the constantly changing geometry of the ocean surface.

Ocean Authoritative Representation (A3) - A collection of natural environmental data that portrays the state (to include changes in state) of the ocean in a physically consistent manner, both internally to the ocean and across interfaces with the atmosphere and/or terrain natural environmental domains. Its resolution is appropriate for the parameters of interest and their intended use. This is usually produced as a result of a Production Order (PO) for Ocean Data from the Process Controller to an ocean provider unless the authoritative representation already exists in an Off-the-Shelf (OTS) Archive.

Ocean JiT Data (A3) - Output from an Ocean Data Provider that portrays the state of the ocean in a physically consistent manner and is a necessary input to processes by the Atmosphere and/or Terrain Data Providers.

Ocean Data Providers (A3) - Also Ocean Operational Provider(s). A provider that obtains appropriate OTS environmental data, runs computer-based ocean environmental models, and delivers the information to other providers and to customers.

OTS Specification (A1) - Identification and processing of customer requirements for natural environmental data that can be retrieved from existing archived resources.

Process Controller – A technology used in conjunction with the Customer Interface developed by the ESG to orchestrate the production of required environmental data to ensure physical consistency among and between domains at the proper resolution for parameters of interest and for the intended application. It uses the Library Services capabilities (catalog and warehouse) to discover and access archived OTS data from Environmental Data Providers. Data can be delivered as either SEDRIS transmittals or in native formats.

Production Capacity (A0) - The availability of the appropriate resources including infrastructure, personnel, and funding on a continuing basis to support timely production of the required data to support this CONOPS.

PO (Production Order) (A3) - A request from the Process Controller to one or more Environmental Data Provider(s) for Integrated Environmental Data – produced according to the

business rules determined by the Scenario Composition Process Controller being developed by the Environmental Scenario Generator (ESG).

Production Order (PO) for Atmosphere (A3) - A request from the Process Controller to an atmosphere provider for Atmosphere Data.

Production Order (PO) for Terrain (A3) - A request from the Process Controller to a terrain provider for Terrain Data.

Production Order (PO) for Ocean (A3) - A request from the Process Controller to an ocean provider for Ocean Data.

Production Order (PO) for Space (A3) - A request from the Process Controller to a space weather provider for Space Weather Data.

Scenario Composition (AO) – The mechanism that facilitates the orderly retrieval and/or production of integrated environmental data. The ESG Customer Interface and Process Controller capabilities are integral to this Mechanism. The Scenario Composition capability will enable some Customer Requirements to be satisfied without tasking Environmental Data Providers for Scenario Generation. In some cases, the ability to "produce" value-added data [Derived Parameters] during the extraction process from select archived databases will be available.

Scenario Generation (AO) – The actual production of the data for the scenarios for simulation customers that takes place at designated Environmental Data Providers. Significant capability and environmental expertise that exists within the DoD will be leveraged for M&S. The Process Controller developed by ESG will orchestrate this distributed production to ensure the right processes execute in the correct order using the right data to achieve physical consistency between domains. The DoD Natural Environment MSEAs will designate Environmental Data Providers for their domains to carry out Scenario Generation.

SEDRIS (Synthetic Environment Data Representation and Interchange Specification) Services (AO) - The DMSO-developed M&S standard data interchange mechanism used to represent and exchange environmental data between data providers and consumers. Services include support for all aspects of the land, sea, air, and space as well as various 2-D and 3-D model libraries required to support simulation applications. These characteristics may be represented as features, grids, geometry, images, and models, and may be organized in a variety of ways to improve both spatial and semantic data consistency both within and across the environmental domains. Data interchange is through the SEDRIS Transmittal Format (STF).

Space Weather Authoritative Representation (A3) - A collection of natural environmental data that portrays the state (to include changes in state) of the space weather in a physically consistent manner with resolution appropriate for parameters of interest and their intended use. Usually the result of a Production Order (PO) to a Space Weather Data Provider unless the authoritative representation already exists in an Off-the-Shelf (OTS) archive.

Space Weather Data Providers (A3) - Also Space Operational Provider(s). A provider that obtains appropriate OTS space data, runs computer-based space environmental models and algorithms, and delivers the information to atmosphere providers and customers.

Standards (A0) - Rules, principles, or measurements established by authority, custom, or general consent as a representation or example.

Technical Capability (A0) - An approved process that Environmental Data Providers employ to provide the Authoritative Representations for their domains.

Terrain Authoritative Representation (A3) - A collection of natural environmental data that portrays the state of the terrestrial environment in a physically consistent manner, both internally to the terrain and across interfaces with the atmosphere and/or ocean natural environmental domains. Its resolution is appropriate for the parameters of interest and their intended use. This is usually produced as a result of a Production Order (PO) to a Terrain Data Provider unless the authoritative representation already exists in an Off-the-Shelf (OTS) archive.

Terrain Elevation Authoritative Representation - Terrain elevation data constitute descriptions of terrain surface configuration including elevation values as well as local slope and aspect data. Typically, these characteristics are spatially represented in terms of grids, but may also appear as arbitrary collections of point values that may be organized as collections of terrain surface facets (polygons) for the region of interest. Terrain elevation authoritative representations are those that contain terrain elevation instance data at the resolution appropriate for the location(s) of interest and the intended use of the data.

Terrain Cultural Model Authoritative Representation - Terrain cultural model data constitute descriptions of localized terrain characteristics generally resulting from the impacts of human activities (e.g., construction) on the terrain, like buildings, roads, dams and canal locks. These characteristics are spatially represented in terms of three-dimensional geometric structures with associated feature data like structural materials, thickness, and the presence of penetrations like windows and doors. Additionally they may include detailed textural descriptions of their surfaces as images, and may consist of multiple sub-component cultural models (e.g., a collection of buildings constituting an industrial facility). Terrain cultural model authoritative representations are those terrain cultural model data sets that are appropriate for the data and their intended use.

Terrain Feature Authoritative Representation (A341) - Terrain feature data constitute descriptions of terrain characteristics including both localized features like hydrology, transportation networks, and vegetation, as well as regional attributes like soil type and moisture content. These characteristics are spatially represented in terms of collections of points, lines, and areas and may be organized using topology to improve spatial data consistency. Terrain feature authoritative representations are those terrain feature data sets that are appropriate for the data and their intended use.

Terrain JiT Data (A3) - Output from a Terrain Data Provider that portrays the state of the terrain in a physically consistent manner, and used as input to models executed by Atmosphere and Ocean Data Providers.

Terrain Data Provider(s) (A3) - Also Terrain Operational Provider(s). A provider that obtains terrain data from maps, imagery, and other sources to construct terrain databases and deliver them to other domain providers and to customers.

Transmittal Mechanism (AO) – Also STF (SEDRIS Transmittal Format) - An M&S standard data interchange format used to interchange descriptions of environmental characteristics between or among data providers and consumers. Such descriptions include all aspects of the land, sea, air, and space. They may be represented as features, grids, geometry, images, models, etc., and may be organized in a variety of ways to improve spatial, temporal, and semantic data consistency.

Unsatisfied OTS Requirement (A1) - After first being assessed to determine that OTS resources do not exist to satisfy the need, this customer requirement, is sent forward as a JiT Specification for further processing to determine JiT Production Order (PO) requirements.