

# VV&A Recommended Practices Guide

## Glossary

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*This document replaces the 10/15/01 version. It contains updated definitions and references. It corresponds to the web version of the VV&A RPG Glossary of the same date. It has been modified for printing.*

**A****abstraction**

1. The process of selecting the essential aspects of a simuland to be represented in a model or simulation while ignoring those aspects that are not relevant to the purpose of the model or simulation. The set of elements produced by this process. [33]
2. The act or process of separating the inherent qualities or properties of something from the actual physical object or concept to which they belong. [37]

**acceptability criteria**

A set of standards that a particular model, simulation, or simulation federation must meet to be accredited for a specific purpose; accreditation criteria. [6]

**accreditation**

The official certification that a model, simulation, or federation of models and simulations and its associated data are acceptable for use for a specific purpose. [3]

**accreditation agent**

The organization designated by the M&S Application Sponsor (user) to conduct an accreditation assessment for an M&S application. [2, 4, 6]

**accreditation authority**

1. The organization or individual responsible to approve the use of a model, simulation, or federation of simulations for a particular application. See [M&S application sponsor](#). [6]
2. An individual occupying a position with the appropriate rank, grade, responsibility and/or authority to accredit a model, simulation, or federation of models and/or simulations for a particular purpose or purposes. [4]

**accreditation information needs**

The scope and depth of information about a model, simulation, or simulation federation needed to demonstrate sufficient credibility for a particular application to the accreditation authority. [22]

## accreditation plan

1. The plan of action for certifying a model, simulation, or simulation federation as acceptable for specific purposes. [22]
2. The accreditation plan specifies the reviews, testing, and other accreditation assessment processes, as appropriate, needed to certify that the model or simulation has met the acceptability criteria. See [accreditation](#), [acceptability criteria](#). [22]

## accreditation process

The procedure followed by the M&S application sponsor (user) that culminates in the accreditation determination. [4]

## accreditation sponsor

The DoD Component or other organization with the responsibility for accrediting a model, simulation, or federation of models and/or simulations for a specific use or series of uses (e.g., for joint training or a Defense Acquisition Board milestone review). [4]

## accuracy

1. The degree to which a parameter or variable, or a set of parameters or variables, within a model or simulation conforms exactly to reality or to some chosen standard or referent. See [resolution](#), [fidelity](#), [precision](#). [33]
2. **Simulation.** Fidelity of the representations; quality and precision of the input data; how closely the results correspond to the intended view of reality (i.e., the referent). See [fitness](#). [22]

## aggregation

The ability to group entities while preserving the effects of entity behavior and interaction while grouped. See [disaggregation](#). [4]

## algorithm

A mathematical or otherwise logical representation of a system, entity, phenomenon, or process. See [model](#). [22]

## application

1. A modeling and simulation (M&S) application. A specific, individual project session that requires or uses an M&S to achieve its purpose. [2]

2. The specific use or purpose served by the execution of a model, simulation, or simulation federation. [33]

3. The problem to be solved or the specified use being addressed by a model or simulation. [22]

### **attribute**

A property or characteristic of one or more entities; for example, **COLOR**, **WEIGHT**, **SEX**. Also, a property inherent in an entity or associated with that entity for database purposes. [4]

### **authoritative data source**

A data source whose products have been verified, validated and certified. See [data validation](#), [data verification](#). [22, 33]

### **authoritative representation**

Models, algorithms, and data that have been developed or approved by a source that has accurate technical knowledge of the entity, phenomenon, or effects to be modeled. [33]

### **axiom**

1. A statement or proposition used in the premises of arguments and assumed as self-evidently true without proof. [17]

2. A well-formed formula that is stipulated rather than proven through the application of rules of inference. [19]

## **B**

### **battlespace**

Both the physical environment in which the simulated warfare will take place and the forces that will conduct the simulated warfare. All elements that support the front line forces (e.g., logistics, intelligence) are included in this definition of battlespace. [4]

### **behavior**

1. For a given object, how attribute value changes affect (or are affected by) the object attribute value changes of the same or other objects. [4]

2. The classical cognitive functions, as well as the effects of moderators such as stress, injury, fatigue, discomfort, motivation, and emotions. Any form of human representation, including individuals, aggregates of individuals and organizations. Also referred to as human behavior. [22]

### **behavior representation**

Representation of the classical cognitive functions, as well as the effects of such moderators as stress, injury, fatigue, discomfort, motivation, and emotions. Behavior representation includes any form of human representation such as individuals, aggregates of individuals, and organizations. Also referred to as human behavior representation. [22]

### **benchmark**

1. The activity of comparing the results of a model or simulation with an accepted representation of the process being modeled. [4]

2. An accepted representation or standard of a process being modeled or simulated against which the results of other models or simulations are compared or judged. See [benchmarking](#). [33]

### **benchmarking**

The comparison between a model's output and the outputs of other models or simulations, all of which represent the same input and environmental conditions [4, 29]

### **boundary condition**

The values assumed by the variables in a system, model, or simulation when one or more of them is at a limiting value at the edge of the domain of interest. Contrast with: [final condition](#), [initial condition](#). [4, 13]

## **C**

### **capability**

**Simulation.** What the model or simulation can do in terms of functional representations, behaviors, relationships, and interactions. See [fitness](#). [22]

**characteristic data**

Empirical, synthesized, or otherwise provided parameters describing the characteristics of the system or component being modeled or simulated, (e.g., gross vehicle mass, gear ratio, terrain resistance coefficient). See [parameter](#), [data](#). [33]

**common-use model and simulation (M&S)**

M&S applications, services, or materials provided by a DoD Component to two or more DoD Components. [3]

**computational model**

A model consisting of well-defined procedures that can be executed by a computer (e.g., a model of the stock market in the form of a computer program). See [mathematical model](#). [13]

**computer simulation**

A dynamic representation of a model, often involving some combination of executing code, control/display interface hardware, and interfaces to real-world equipment. [4]

**conceptual analysis**

The step in the federation development and execution process which establishes the conceptual framework for the federation. It feeds the design of the overall federation structure. The conceptual view of the objects and interactions that must be represented in the federation is key to identifying reuse opportunities in established Federation Object Models (FOMs), and high-level representation of the federation scenario refined during Conceptual Analysis also provides the basis for generation of a more detailed scenario instance during Federation Design/Development. [4]

**conceptual model**

**Simulation.** A [simulation conceptual model](#). [22]

**condition**

The values assumed at a given instant by the variables in a system, model, or simulation. See [boundary condition](#); [final condition](#); [initial condition](#); [state](#). [4, 13]

**consistency**

The condition of freedom variation or contradiction. [4, 9, 11]

**constant**

A quantity or data item within a model or simulation whose value cannot change during the course of execution. See [parameter](#), [variable](#), [data](#). [13]

**context**

1. The material surrounding an item that helps define its meaning. [35]
2. The circumstances in which a particular event occurs; the situation. [37]

**constraint**

A boundary or limitation imposed on a simulation by external forces, such as the objectives and requirements of the problem being addressed or the policies under which the simulation is expected to operate. [22]

**cooperative development**

A project in which two or more DoD Components share in domain research, technical studies, or technology development that may result in dissimilar M&S applications [3].

**correctness**

**Simulation.** Error-free code or software; appropriate authoritative input data. See [fitness](#). [22]

**credibility**

The relevance that the user sees in a model and the confidence that the user has that a model or simulation can serve his purpose. [22]

**D****data**

1. A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. [4, 6, 8]
2. Assumed, given, measured, or otherwise determined facts or propositions used to draw a conclusion or make a decision. [37]

**data attribute**

A characteristic of a unit of data such as length, value, or method of representation. [4, 10, 14]

**data element**

1. A basic unit of information having a meaning and sub-categories (data items) of distinct units and values (e.g., address). [4]
2. A single component of a data set. See [data](#), [data value](#). [22]

**data integrity**

In information processing, the condition in which data are accurate, current, consistent, and complete. [4, 9]

**data modeling**

The representation of data objects in a software system. [22]

**data producer**

The agency or organization responsible for gathering or developing data and assessing their quality. [25]

**data proponent**

The agency or organization that has primary responsibility for a data collection or database. The data proponent develops the requirement for the data. [2]

**data quality**

The correctness, timeliness, accuracy, completeness, relevance, and accessibility that make data appropriate for use. [4, 6, 8]

**data representation**

1. A format used to describe some type of data. [33]
2. A variety of forms used to describe a terrain surface, the features placed on the terrain, the dynamic objects with special 3-D model attributes and characteristics, the atmospheric and oceanographic features, and many other forms of data. [32]

### **data source**

1. A subject matter expert, group of subject matter experts, or organization who, because of either mission or expertise, collects or produces the data used in a model, simulation or simulation federation. [4, 22]
2. A document or publication that serves as an authoritative source of data used in a model, simulation, or simulation federation. See [authoritative data source](#). [33]

### **data validation**

The documented assessment of data by subject matter experts and its comparison to known values to determine its suitability for a specific purpose in an intended model or simulation. See [data verification](#), [validation](#). [2, 4, 5, 22]

### **data value**

A value associated with a data element. One of the allowable values of a data element. [4, 8, 9]

### **data verification**

1. **Data producer.** Use of techniques and procedures to ensure that data meet constraints defined by data standards and business rules derived from process and data modeling. [2, 4, 5, 22]
2. **Data user.** Use of techniques and procedures to ensure that data meet user-specified constraints defined by data standards and business rules derived from process and data modeling, and that data are transformed and formatted properly. [2, 4, 5, 22]

### **data verification and validation (V&V)**

The process of verifying the internal consistency and correctness of data and validating that it represents real world entities appropriate for its intended purpose or an expected range of purposes. The process has two perspectives: the producer and the user process. [6] See [data validation](#), [data verification](#).

### **deaggregate**

[Disaggregate](#). [4]

### **defect**

A problem in either the code or data used in a simulation that results in an error or failure. [22]

**dependent variable**

A variable whose value is dependent on the values of one or more independent variables. Contrast with [independent variable](#). [4]

**developer**

1. The agency that actually develops a model or simulation or the agency that is overseeing the M&S development by a contractor or federally funded research and development center (FFRDC). Also referred to as M&S developer. [4]
2. An individual, group or organization responsible for actually developing or modifying a simulation in accordance with design requirements and specifications. [22]

**development paradigm**

A pattern or template describing a development process. [22]

**development risk**

Risk related to the simulation development itself. Such risks typically relate to potential problems in meeting technical, schedule, or cost aspects of the simulation development or modification program. [22]

**disaggregate**

The activity that decomposes an aggregated entity into multiple entities representing its components. [4]

**disaggregation**

The ability to represent the behavior of an aggregated unit in terms of its component entities. If the aggregate representation did not maintain state representations of the individual entities, then the decomposition into the entities can only be notional. [4]

**distributed modeling and simulation (M&S)**

A disparate set of models and/or simulations operating in a common synthetic environment over a network with two or more nodes. [6]

**DoD M&S Resource Repository (MSRR)**

1. A geographically distributed and networked series of automated information systems that contain unclassified, classified, or both classified and unclassified data and information on M&S that is accessible by DoD-authorized users. [6]

2. A single DoD node, source or site that contains M&S data and/or information that may or may not be part of the DoD MSRR network. [6]

### **domain analysis**

The process of identifying, acquiring, and evaluating the information related to a problem domain to be used in specifying and constructing a model or simulation. [33]

### **domain**

The physical or abstract space in which the entities and processes operate. The domain can be land, sea, air, space, undersea, a combination of any of the above, or an abstract domain, such as an n-dimensional mathematics space, or economic or psychological domains. [4]

## **E**

### **effects**

Observable changes in model or simulation results based upon changes to input variables represented by algorithmic formulations that attempt to mimic real-world phenomena without precisely representing all factors that bear on the phenomena, (e.g., killer-victim scores, red kills, blue kills, stimuli to the user/trainee to prompt some activity or behavior). Effects and changes in effects are frequently the phenomena of interest to a user. See [output](#). [22]

### **empirical**

Pertaining to information that is derived from observation, experiment, or experience. [4]

### **entity**

A distinguishable person, place, unit, thing, event, or concept about which information is kept. [4, 20, 37]

### **environment**

The texture or detail of the natural domain (terrain relief, weather, day or night, terrain cultural features such as cities or farmland, sea states, etc.) and the external objects, conditions, and processes that influence the behavior of a system (such as terrain relief, weather, day or night, terrain cultural features, etc.). [4]

**equilibrium**

1. Steady state: A situation in which a model, process, or device exhibits stable behavior independent of time. [4]
2. A condition in which all acting influences are canceled by others, resulting in a stable, balanced, or unchanging system. [37]

**error**

1. The difference between an observed, measured, or calculated value and a reference value. [33]
2. An incorrect result of a model or simulation that occurs during testing or any time other than when in use for its intended purpose. See [failure](#). [22]

**error model**

1. A model used to estimate or predict the extent of deviation of the behavior of an actual system from the desired behavior of the system (e.g., a model of a communications channel used to estimate the number of transmission errors that can be expected in the channel). [13]
2. In software evaluation, a model used to estimate or predict the number of remaining faults, required test time, and similar characteristics of a system. [4]

**event**

1. A change of object attribute value, an interaction between objects, an instantiation of a new object, or a deletion of an existing object that is associated with a particular point on the federation time axis. Each event contains a time stamp indicating when it is said to occur. [4, 24]
2. An individual stimulus from one object to another at a particular instant in time. [33]

**exchange data**

All the data to be exchanged across the federation. [22]

**exercise**

The execution of a simulation configured with specific parameters, characteristic data, initial conditions, players, and external systems intended to represent a specific or general scenario. See [scenario](#), [simulation execution](#). [33]

**F****face validation**

The process of determining whether a model or simulation seems reasonable to people who are knowledgeable about the system under study, based on performance. This process does not review the software code or logic, but rather reviews the inputs and outputs to ensure that they appear realistic or representative. [4]

**failure**

An incorrect result or outcome of a model or simulation that occurs when the model or simulation is being used for its intended purpose. See [error](#). [22]

**fair fight**

A condition when the differences between the performance characteristics of two or more interoperating simulations have significantly less effect on the outcome of a simulated situation than the actions taken by or resources available to the simulation participants. [4, 33]

**fault**

An incorrect model, simulation, or federation component. [22]

**federate**

1. An individual model or simulation that is part of a federation of models and simulations. Federates may be distributed. [6]
2. A member of a High Level Architecture (HLA) federation. All systems and subsystems participating in a federation are called federates, e.g., federation managers, data collectors, C4I systems, instrumented ranges, sensors, simulations, passive viewers and other utilities. See [federation](#). [24, 22]

**federation**

1. A system of interacting models and/or simulations, with supporting infrastructure, based on a common understanding of the objects portrayed in the system. See [federate](#). [6]
2. A named set of interacting federates, a common federation object model, and supporting runtime infrastructure that are used as a whole to achieve some specific objective. Also referred to as [federation](#). [4]

3. A system of interacting federates, a common federation object model, and supporting infrastructure relying upon a common understanding of the simulated objects and used as a whole for some specific purpose. See [federate](#), federation object model (FOM), [federation objective](#), [simulation federation](#). [2, 24]

### **federation element**

An individual model or simulation that is part of a federation of models and simulations; federate. Federation elements may be distributed. See [federation](#). [2, 4]

### **federation execution**

The actual operation, over time, of a subset of the federates and the Runtime Infrastructure initialization data taken from a particular federation; the step of running executable code to conduct an exercise and produce the data required of the federation. See [exercise](#). [4, 24]

### **federation object model (FOM)**

An identification of the essential classes of objects, object attributes, and object interactions that are supported by a High Level Architecture (HLA) federation. In addition, optional classes of additional information may also be specified to achieve a more complete description of the federation structure and/or behavior. [4]

### **federation objective**

1. Statements intended as a foundation for generating federation requirements (i.e., translating high-level user expectations into more concrete, measurable federation goals). [23]

2. The statement of the problem that the establishment and execution of a federation addresses. The description of the problem domain implicit in the objectives statement is critical for focusing the domain analysis activities in the conceptual analysis phase. It specifies the top-level goals of the federation, and may specify the operational need or shortfall from which federation developers will derive a scenario for the federation execution. The federation objectives drive this specification, as the scenario development phase must utilize the statement of the objectives to generate a viable context for system evaluations intrinsic to the federation objectives. High-level testing requirements implied in the federation objectives may also drive the identification of well defined "test points" during development of the federation scenario. [4, 24]

### **federation of models and simulations (M&S federation)**

A [federation](#). [6]

## **fidelity**

1. The accuracy of the representation when compared to the real world. [4]
2. The degree to which a model or simulation reproduces the state and behavior of a real-world object or the perception of a real-world object, feature, condition, or chosen standard in a measurable or perceivable manner; a measure of the realism of a model or simulation; faithfulness. Fidelity should generally be described with respect to the measures, standards, or perceptions used in assessing or stating it. See [accuracy](#), [sensitivity](#), [precision](#), [resolution](#), [repeatability](#), [validation](#). [33]
3. The methods, metrics, and descriptions of models or simulations used to compare those models or simulations to their real-world referents or to other simulations in such terms as accuracy, scope, resolution, level of detail, level of abstraction, and repeatability. Fidelity can characterize the representations of a model, a simulation, the data used by a simulation (e.g., input, characteristic or parametric), or an exercise. Each of these fidelity types has different implications for the applications that employ these representations. [33]

## **fidelity management**

The process of monitoring and controlling the specification of fidelity characterizations and fidelity quantification. It also includes transforming fidelity characteristics from one stage to the next in the federation development and related verification, validation and accreditation processes. See [fidelity](#). [33]

## **final condition**

The values assumed by the variables in a component, system, model, or simulation at the completion of some specified duration of time; final state. See [boundary condition](#), [initial condition](#). [4,13]

## **final state**

A [final condition](#). [4, 33]

## **fitness**

1. Providing the capabilities needed or being suitable for some purpose, function, situation, or application. Fitness for use or purpose. [26, 36]
2. **Simulation.** Providing the capabilities, correctness, accuracy, and usability needed for the intended use or current application. [22]

## **formal language**

In logic, a set of symbols together with a set of formation rules that designate certain sequences of symbols as well-formed formulas, and a set of rules of inference (transformation rules) that, given a certain sequence of well-formed formulas, permit the construction of another well-formed formula. The symbols chosen vary from language to language, but typically they contain both logical constants and nonlogical vocabulary. For example, in the language of propositional calculus, the logical constants are truth-functional connectives and the nonlogical vocabulary consists solely of sentence letters; in predicate calculus, variable, predicates, and quantifiers are needed. The formation rules will naturally reflect the chosen vocabulary. The rules of inference govern only the manipulation of symbols, independently of any interpretation they may have. Although formal languages do not require at any state the notion of an interpretation, they are nevertheless constructed with interpretations in mind, and rules of inference that do not preserve truth, although not formally unsatisfactory, are of no interest. [19]

## **formal system**

A formal language together with a set of axioms. See [formal language](#), [axiom](#). [19]

## **formation rules**

In logic, the rules of a formal language for constructing well-formed formulas from symbols. [19]

# **G**

## **game**

A physical or mental competition in which the participants, called players, seek to achieve some objective within a given set of rules. [4]

## **general use model or simulation (M&S)**

Specific representations of the physical environment or environmental effects used by, or common to, many models and simulations; e.g., terrain, atmospheric, or hydrographic effects. [3]

## **granularity**

[Resolution](#). See [level of detail](#). [33]

**ground truth**

The actual facts of a situation, without errors introduced by sensors or human perception and judgment. [4]

**H****hard-wired data**

Data values implemented as part of the code (e.g., constants, set parameters). [22]

**heuristic**

1. Relating to or using a problem-solving technique in which the most appropriate solution of several found by alternative methods is selected at successive stages of a program for use in the next step of the program. [4]
2. Pertaining to experimental, especially trial-and-error, methods of problem solving where the resulting solution may not be the most desirable solution to the problem. [13]

**hierarchy**

A ranking or ordering of abstractions. [4, 24]

**High Level Architecture (HLA)**

Major functional elements, interfaces, and design rules, pertaining as feasible to all DoD simulation applications and providing a common framework within which specific system architectures can be defined. [4]

**human behavior representation (HBR)**

A model or simulation of any human function, any individual human, or any group or organization of humans. [22]

**I****imagined reality**

A concept that has no exact counterpart in the material universe, although parts of it may have counterparts in the material universe (e.g., a unicorn). Imagined reality may

have a nonzero intersection with but can never be a proper subset of material reality. [33]

### **implementation**

The means by which a model or simulation or portions of a model or simulation is realized. [4, 33]

### **independent variable**

A variable whose value is not dependent on the values of other variables. See [dependent variable](#). [13]

### **independent verification and validation (IV&V)**

The conduct of verification and validation of a model or simulation by individuals or agencies that did not develop the model or simulation. IV&V does not require complete organizational independence, but does imply a reasonable degree of organizational separation to assure unbiased analysis. [1, 2, 4]

### **information model**

A model that represents the processes, entities, information flows, and elements of an organization and all relationships among these factors. [4]

### **information**

Any communication or reception of knowledge such as facts, data, or opinions, including numerical, graphic, or narrative forms, whether oral or maintained in any medium, including computerized databases, paper, microform, or magnetic tape. [4]

### **infrastructure**

An underlying base or foundation; the basic facilities, equipment, and installations (e.g., systems and applications, communications, networks, architectures, standards and protocols, and information resource repositories) needed for the functioning of a simulation implementation. See [implementation](#). [4, 5, 18]

### **initial condition**

The values assumed by the variables in a component, system, model, or simulation at the beginning of some specified duration of time; [initial state](#). See [boundary condition](#), [final condition](#). [4, 33]

## initial state

An [initial condition](#). [4, 33]

## input

1. An event external to a system that modifies the system in any manner. [35]
2. Something introduced into a system or expended in its operation to attain a result or output. See [instance data](#). [37]
3. The externally supplied data to which a simulation responds and from which it calculates its output (e. g., operator controls, weapon detonation, wind speed, and direction). [33]

## instance data

Data values comprising the baseline set of conditions (and allowable dynamic updates) under which the simulation is initiated and executed; input data (e.g., kill rates, firing ranges, flight altitudes, movement rates) and output data. [22]

## instantiation

The representation of an abstraction by a concrete instance. [4]

## instrumentation

The insertion of additional code (probes or stubs) into the executable model to collect information about model behavior during execution. [22]

## interaction

1. An explicit action taken by an object that can optionally (within the bounds of the federation object model) be directed toward other objects, including geographical areas, etc. [4]
2. The way in which objects, components, systems, models, or simulations affect or influence the behavior of each other. [33]

## interoperability

**M&S interoperability.** The ability of a model or simulation to provide services to and accept services from other models and simulations and to use these the services so exchanged to enable these M&S to operate effectively together and completely without anomaly. [2, 5, 6, 33]

**J****Joint Modeling and Simulation (JM&S)**

Abstract representations of joint and Service forces, capabilities, equipment, materiel, and services used in the joint environment by two or more military services. [3, 6]

**K****knowledge**

1. The rules, environment, etc. that form the structure humans use to process and relate to information, or the information a computer system must have to behave in an apparently intelligent manner. [4]
2. The sum or range of what has been perceived, discovered, or learned. [37]

**L****latency**

1. The time required for a device to begin physical output of a desired piece of data once processing is complete. [4]
2. The time interval required for a simulation to begin its response to a stimulus after it has been presented with a stimulus or stimuli (e.g., input of data, occurrence of an event). [22, 33]

**legacy model; legacy simulation; legacy M&S**

Any model or simulation that was developed either in the past or for a different purpose. [22]

**level of detail**

[Resolution](#). [33]

**logical verification**

The identification of a set of assumptions and interactions for which the M&S correctly produces intended results. It determines the appropriateness of the M&S for a particular application and ensures that all assumptions and algorithms are consistent with the conceptual M&S. [4]

## M

### **management risk**

Development risks that involve problems associated with scheduling, resources, and requirements. [22]

### **material reality**

The material universe (or those parts of it) pertinent to a particular purpose. [22]

### **mathematical model**

1. A symbolic model whose properties are expressed in mathematical symbols and relationships (e.g., a model of a nation's economy expressed as a set of equations). Contrast with [software model](#). [4]
2. Any system of assumptions, definitions, equations, and algorithms that represents particular physical phenomena. See [model](#), [simulation](#), [conceptual model](#), [software model](#). [19]
3. A document describing the assumptions, definitions, equations, and algorithms that represent particular physical phenomena to be simulated for a specific application. [33]

### **measure of effectiveness (MOE)**

A qualitative or quantitative measure of aggregate performance or a characteristic of a model, simulation or system that indicates the degree to which it performs the task or meets an operational objective or requirement under specified conditions. See [measure of performance](#), [metric](#). [4, 22]

### **measure of outcome (MOO)**

A metric that defines how operational requirements contribute to end results at higher levels, such as campaign or national strategic outcomes. [4]

## **measure of performance (MOP)**

The measure of how the system/individual performs its functions in a given environment (e.g., number of targets detected, reaction time, number of targets nominated, susceptibility of deception, task completion time). It is closely related to inherent parameters (physical and structural) but measures attributes of system behavior. See [measure of effectiveness](#). [4]

## **metadata**

Information describing the characteristics of data; data or information about the meaning of data; descriptive information about an organization's data, data activities, systems, and holdings. [4, 8, 9, 10, 22]

## **metamodel**

A model of a model. Metamodels are abstractions of the M&S being developed, which use functional decomposition to show relationships, paths of data and algorithms, ordering, and interactions between model components and subcomponents. Metamodels allow the software engineers who are developing the model to abstract details to a level that subject matter experts can validate. [4]

## **methodology**

The system of principles, practices, and procedures applied to a specific branch of knowledge. [4]

## **metric**

1. A measure of the extent or degree to which a product possesses and exhibits a certain quality, property, or attribute. [4]
2. A process or algorithm that may involve statistical sampling, mathematical computations, and rule-based inferencing. Metrics provide the capability to detect and report defects within a sample. [11]

## **mission space**

1. The environment of entities, actions, and interactions comprising the set of interrelated processes used by individuals and/or organizations to accomplish assigned tasks. [4]
2. The battlespace in which a particular mission is performed. [33]

**model**

1. A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. See [simulation](#), [conceptual model](#), [software model](#), [mathematical model](#), [abstraction](#). [2, 3, 4, 6, 21, 30]
2. A geometry or feature assembly built in a relative coordinate system with the intent to multiply instances of the assembly at one or more world coordinate positions. [32]
3. A system that stands for or represents another typically more comprehensive system. [35]

**modeling**

The application of a standard, rigorous, structured methodology to create and validate a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. [4]

**modeling and simulation (M&S)**

The use of models and simulations, either statically or over time, to develop data as a basis for making managerial or technical decisions. This includes but is not limited to, emulators, prototypes, simulators, and stimulators. See [modeling](#), [simulation](#). [6]

**modeling and simulation (M&S) application sponsor**

The organization that accredits and uses the results or products from a specific application of a model or simulation. [6] See [user](#).

**modeling and simulation (M&S) developer**

The individual, group or organization responsible for actually developing or modifying a simulation in accordance with a set of design requirements and specifications. Also referred to as [developer](#). [4, 22]

**modeling and simulation (M&S) interoperability**

The ability of a model or simulation to provide services to and accept services from other models and simulations, and to use these exchanged services to operate effectively together. [3, 6] See [interoperability](#).

**modeling and simulation (M&S) program manager**

The individual, group, or organization responsible for managing and overseeing the development, modification, maintenance, and configuration management of a model, simulation, or federation as directed by the user or sponsor. [22]

### **modeling and simulation (M&S) proponent**

The DoD Component organization that has primary responsibility to initiate development and life cycle management of the reference version of one or more models and/or simulations. [6]

### **modeling and simulation (M&S) requirements**

The collection of requirements that a model, simulation, or simulation federation must meet to serve a particular purpose. M&S requirements include those from the problem domain, simulation domain, and user domain. See [problem domain requirements](#), [simulation domain requirements](#), [user domain requirements](#). [22]

### **modeling and simulation (M&S) user**

1. The individual, group, or organization that employs or will employ a model, simulation, or simulation federation, its products, or its services to achieve a set of objectives. The M&S user may also be involved in the evolution of such products and services. Also referred to as [user](#). [22]
2. The individual, group, or organization that uses the results or products from a specific application of a model or simulation. In a broader sense, the M&S user is the customer, the one for whom the M&S is assembled and developed, and also the one who makes the accreditation decision. Also referred to as [user](#). [22]

### **modeling and simulation (M&S) verification, validation, and accreditation (VV&A) repository**

A central library, catalog, registry, database, listing, or World Wide Web Internet site for VV&A data and information that may be part of DoD M&S Resource Repository. [6]

## **N**

### **notional data**

Speculative or theoretical data rather than actual data. [4]

**O****object**

A fundamental element of a conceptual representation for a federate that reflects the "real world" at levels of abstraction and resolution appropriate for federate interoperability. For any given value of time, the state of an object is defined as the enumeration of all its attribute values. [4]

**object model**

A specification of the objects intrinsic to a given system, including a description of the object characteristics (attributes) and a description of the static and dynamic relationships that exist between objects. [4]

**observable**

1. Capable of being observed systematically or scientifically; discernible. [37]
2. A physical property, such as temperature or weight, that can be observed or measured directly. [37]
3. A state variable, computable by a function or functions, or mathematical relation(s). [33]

**operational risk**

Risks that arise from using the incorrect outputs of a model or simulation that are believed to be correct. [22]

**original data**

The source data used by a resource producer to construct their initial abstract representation. [32]

**output**

1. Any change produced in the surroundings by a system. [35]
2. The data produced by a computer from a specific input. See [instance data](#). [37]
3. The aspects of the simulated system being modeled which are calculated during each pass in response to inputs and time passing, and normally output for external use;

values providing a snapshot of the current state of the simulated system (e.g., position, velocity, alive-or-dead). [33]

### **output validation**

The process of determining the extent to which the output (outcome distributions for the M&S and/or submodels) represent the significant and salient features of distributions or real-world systems, events, and scenarios. [4]

## **P**

### **parameter**

1. A constant or variable that distinguishes special cases of a general mathematical expression (e.g., the general form of the equation for a line,  $y = mx + b$  contains the parameters  $m$  and  $b$ , representing the gradient and  $y$ -intercept of any specific line). [19]
2. A constant in a mathematical program, not subject to choice in the decision problem, but one that could vary outside the control of the decisions. [28]
3. That which determines the structure of a system. Parameters themselves can be changed by inputs, but usually the parameters determine how input will be transformed into outputs. See [variable](#), [constant](#). [35]
4. A named characteristic of an interaction. [34]

### **perceived truth**

That subset of ground truth acquired or distorted by sensors, human perception, or judgment; the situation as perceived by an observer. See [ground truth](#), [perception](#), [truth](#). [33]

### **perception**

1. An observer's awareness or appreciation of objects, processes, or situations in the environment mediated through the observer's sensory organs. [35]
2. An observer's descriptions, hypotheses or constructs of the world of which they thereby become a part. [35]
3. Observation. [37]

## period

The time interval between successive events in a discrete simulation. [4]

## platform

A generic term used to describe a level of representation equating to vehicles, aircraft, missiles, ships, fixed sites, etc., in the hierarchy of representation possibilities. Other representation levels include units (made up of platforms) and components or modules (which make up platforms). [4]

## precision

1. The quality or state of being clearly depicted, definite, measured, or calculated. [19]
2. A quality associated with the spread of data obtained in repetitions of an experiment as measured by variance; the lower the variance, the higher the precision. [19]
3. A measure of how meticulously or rigorously computational processes are described or performed by a model or simulation. See [resolution](#), [sensitivity](#). [33]

## problem domain

1. Aspects of reality that a model, simulation, or simulation federation supplies at a particular fidelity in order to address a particular purpose (e.g., command and control, attrition, movement, and maneuver). See [domain](#), [simulation domain](#), [user domain](#), [fidelity](#). [22]
2. The representations of reality that a model or simulation must supply in order to address a particular purpose (e.g., command and control, attrition, movement, and maneuver). See [domain](#), [simulation domain](#), [user domain](#). [22]

## problem domain requirements

Descriptions of the type of real-world objects that a model, simulation, or simulation federation must represent, and the doctrinal missions for each entity the user wants represented. See [M&S requirements](#). [22]

## process

1. Something that affects entities (e.g., attrition, communications, movement). Processes have a level of detail by which they are described. [4]
2. A system of operations in producing something. [37]
3. A series of actions, changes, or functions that achieve an end or result. [37]

**program manager**

The military or civilian official responsible for managing a program to develop or modify a system. This program may employ a model, simulation, or simulation federation in the development process. [4]

**purpose**

The objective that a simulation or simulation exercise is intended to achieve; goal. See [application](#). [33]

**Q****qualitative data**

A non-numeric description of a person, place, thing, event, activity, or concept. [4]

**quantitative data**

Numerical expressions describing the values of object attributes upon which mathematical operations can be performed. [4, 10]

**R****reality**

The quality or state of being actual or true. [37]

**real world**

1. The set of real or hypothetical causes and effects that simulation technology attempts to replicate. When used in a military context, the term is synonymous with real battlefield to include air, land, and sea combat. Also referred to as real battlefield. [4].
2. One standard against which fidelity is measured that includes both imagined and material reality in order to accommodate assessment of simulation fidelity when future concepts and systems are involved. See [fidelity](#), [imagined reality](#), [material reality](#), [perceived truth](#). [33]

**reference data**

Descriptive information (metadata) about all the data used by a model, simulation, or federation, including data characteristics (e.g., resolution, fidelity, accuracy, completeness, relevancy, currency, appropriateness); specifications to which the data were developed or are provided; and factors describing data quality. [22]

**referent**

1. A codified body of knowledge about a thing being simulated. [33]
2. Something referenced or singled out for attention, a designated object, real or imaginary, or any class of such objects. [35, 37]

**repeatability**

A measure of the ability to be done again and again. [37]

**representation**

1. Something that stands in place of or is chosen to substitute for something else (e.g., representation of constituencies in government, linguistic representation of an event). [35]
2. Something that describes as an embodiment of a specified quality. [37]
3. The homomorphism of a group of abstract symbols into a group of more familiar objects. [19]
4. A model or simulation. [33]

**representational requirements**

The subset of the M&S requirements that specifically describes the required states or behaviors of the things the model or simulation represents, including the modeled entities, their properties, and their dependencies. [22]

**resolution**

1. The degree of detail used to represent aspects of the real world or a specified standard or referent by a model or simulation. See [granularity](#). [4, 37]
2. Separation or reduction of something into its constituent parts; [granularity](#). [37]

## runtime infrastructure (RTI)

The general-purpose distributed operating system software that provides the common interface services during the runtime of an HLA federation. [4]

## S

### scalability

The ability of a distributed simulation to maintain time and spatial consistency as the number of entities and accompanying interactions increase. [4]

### scenario

1. The description of an exercise. It is the part of the session database that configures the units and platforms and places them in specific locations with specific missions. [4]
2. An initial set of conditions and time line of significant events imposed on trainees or systems to achieve exercise objectives. [4, 13 ]
3. An identification of the major entities that must be represented by the federation, a conceptual description of the capabilities, behavior, and relationships (interactions) between these major entities over time, and a specification of relevant environmental conditions (e.g., terrain, atmospheric). Initial and termination conditions are also provided. [24]
4. A part of the modeling and simulation database that contains the force structure, its mission and plans, and the terrain area in which the simulated engagement occurs. [33]

### scope

The range of real or imagined world objects or conditions represented by a particular model, simulation or simulation exercise. See [real world](#), [imagined reality](#), [material reality](#). [33]

### semantics

1. The implied meaning of data to define what entities mean with respect to their roles in a system. [32]
2. The study of relationships between signs and symbols and what they represent to their interpreters. [37]

**sensitivity**

The ability of a component, model, or simulation to respond to a low-level stimulus. [27]

**simuland**

The system being simulated by a simulation. [4]

**simulation**

1. A method for implementing a model over time. [6]
2. A technique for testing, analysis, or training in which real-world systems are used, or where real-world and conceptual systems are reproduced by a model. [3, 6]
3. A method, software framework, or system for implementing one or more models in the proper order to determine how key properties of the original may change over time. See [model](#), [representation](#), [computer simulation](#). [33]
4. An unobtrusive scientific method of inquiry involving experiments with a model rather than with the portion of reality this model represents. [35]

**simulation conceptual model**

1. The developer's description of what the model or simulation will represent, the assumptions limiting those representations, and other capabilities needed to satisfy the user's requirements. [6]
2. A collection of assumptions, algorithms, relationships (i.e., architecture), and data that describe a Developer's concept about the simulation and its pieces from which the software that will make up the simulation can be built. [22]

**simulation domain**

Aspects of a simulation or simulation federation related to the implementation environment (e.g., time management, object interaction control, user interfaces, databases, report generators). See [problem domain](#), [user domain](#). [22]

**simulation domain requirements**

Descriptions of the hardware and software environment needed to implement a model or simulation (e.g., simulation architecture, software languages that must be used, simulation management capabilities, visualization capabilities, user interfaces, and interfaces to other simulation systems, C4I systems, operating requirements). See [M&S requirements](#). [22]

### **simulation entity**

An element of the synthetic environment that is created and controlled by a simulation application (e.g., tanks, submarines, carriers, fighter aircraft, missiles, bridges). A simulation application may control more than one simulation entity. [4, 13, 33]

### **simulation environment**

1. The operational environment surrounding the simulation entities including terrain, atmospheric, bathyspheric, and cultural information. [4]
2. All conditions, circumstances, and influences surrounding and affecting simulation entities including those stated in definition 1. [33]
3. An entire simulation framework including software, hardware, architecture, infrastructure, and interfaces where models or simulations are developed and executed. [33]

### **simulation execution**

The real-time execution of a simulation application. See [exercise](#). [33]

### **simulation federation**

1. A system of interacting models and/or simulations, with supporting infrastructure, based on a common understanding of the objects portrayed in the system. See [federate](#). [6]
2. A named set of interacting federates, a common federation object model, and supporting runtime infrastructure that are used as a whole to achieve some specific objective. Also referred to as [federation](#). [4]
3. A system of interacting federates, a common federation object model, and supporting infrastructure relying upon a common understanding of the simulated objects and used as a whole for some specific purpose. See [federate](#), federation object model ([FOM](#)), [federation objective](#). [2, 24]

### **simulation model**

A digital or physical realization of a conceptual model. A digital realization is a software implementation of a part or all of a conceptual model in a specific programming language based on some software design methodology; software model. A physical realization is a hardware implementation of part or all of a conceptual model (e.g., the layout of instrument panel in a mock-up or motion platform). [33]

### **simulation object model (SOM)**

A specification of the intrinsic capabilities that an individual simulation offers to federations. The standard format in which SOMs are expressed provides a means for federation developers to quickly determine the suitability of simulation systems to assume specific roles within a federation. [4]

### **simulation process**

The imitative representation of the actions of platform(s), munitions(s), and life form(s) by computer program(s) in accordance with a mathematical model. [33]

### **simulator**

1. A device or physical system that implements or performs simulation. See [simulation](#), [simuland](#), [software model](#), [mathematical model](#). [4, 33]
2. **Training.** A device that duplicates the essential features of a task situation and provides for direct human operation. [4]

### **software model**

The actual compilable and linkable software source code that implements algorithms and data flow representing one or more mathematical models; simulation model. See [model](#), [conceptual model](#), [mathematical model](#), [simulation model](#). [33]

### **stability**

1. Constancy of purpose; steadfastness; reliability; dependability. [4, 11]
2. Resistance to sudden change, dislodgment, or overthrow. [37]

### **standard**

1. A rule, principle, or measurement established by authority, custom, or general consent as a representation or example. [2, 4]
2. An accepted measure of comparison for quantitative or qualitative value; a criterion. [37]
3. Proposition of a norm or general pattern to be followed when constructing, operating, or testing a (technical) device. A standard contains a set of reference criteria for functional, structural, performance, or quality aspects of a device or for any combination of these. [35]

**state**

1. The internal status of a simulation entity (e.g. fuel level, number of rounds remaining, location of craters). [4]
2. A condition or mode of existence in which a system, component, or simulation (e.g., the pre-flight state of an aircraft navigation program or the input state of a given channel). [4]
3. The values assumed at a given instant by the variables that define the characteristics of a system, component, or simulation; system state. See [final state](#), [initial state](#), [steady state](#). [4, 33]

**state variable**

A variable that defines one of the characteristics of a system, component, or simulation. The values of all such variables define the state of the system, component, or simulation. [4]

**steady state**

A situation in which a model, process, or device exhibits stable behavior independent of time. [4]

**stimulate**

To provide input to a system in order to observe or evaluate the system's response. [4]

**stimulation**

The use of simulations to provide an external stimulus to a system or subsystem (e.g., using a simulation representing the radar return from a target to drive (stimulate) the radar of a missile system within a hardware/software-in-the-loop simulation). [4, 18]

**stimulator**

1. A hardware device that injects or radiates signals into the sensor system(s) of operational equipment to imitate the effects of platforms, munitions, and environment that are not physically present. [4]
2. A battlefield entity consisting of hardware and/or software modules, which injects signals directly into the sensor systems of an actual battlefield entity to simulate other battlefield entities in the virtual battlefield. [4]

**subject matter expert (SME)**

An individual who, by virtue of education, training, or experience, has greater than a journeyman's expertise in a particular technical or operational discipline, system, or process and has been selected or appointed to participate in the validation of a model or simulation. [22]

**system**

A collection of components organized to accomplish a specific function or set of functions. [4]

**T****tailoring**

The careful selection of V&V tasks to address the needs of the application. [22]

**technical data**

Scientific or technical information recorded in any form or medium (such as manuals and drawings). Computer programs and related software are not technical data; documentation of computer programs and related software are. Also excluded are financial data or other information related to contract administration. [4]

**technical risk**

The chance that the simulation will fail to meet development requirements and thus fail to be useful for its intended purposes. Technical risk involves potential defects in the simulation's structure, code, data, interfaces, or a combination of these that can cause the representation to fail. [22]

**time**

The measurable aspect of duration. Time makes use of scales based upon the occurrence of periodic events (e.g., the day, depending on the rotation of the Earth; the month, depending on the revolution of the Moon around the Earth; and the year, depending upon the revolution of the Earth around the Sun). Time is expressed as a length on a duration scale measured from an index on that scale. For example, 4 p.m. local mean solar time means that 4 mean solar hours have elapsed since the mean Sun was on the meridian of the observer. [4, 24]

**tolerance**

1. The maximum permissible error or the difference between the maximum and minimum allowable values in the properties of any component, device, model, simulation or system relative to a standard or referent. Tolerance may be expressed as a percent of nominal value, plus and minus so many units of a measurement, or parts per million. [27, 31, 36]
2. The character, state, or quality of not interfering with some thing or action. [26, 36].

**truth**

1. (a) Conformity to fact or actuality. (b) Faithful to an original or standard. (c) Reality; actuality. (d) A statement proven to be or accepted as true. [37]
2. (a) A property implicitly ascribed to a proposition by belief in or assertion of it; the denial is "falsity". (b) In the verification theory of truth, a correspondence between the proposition and the events, properties or objects to which it refers linguistically or operationally. (c) In the logical theory of truth, the coherence between that proposition and other propositions. (d) In the constructivist theory of truth, constructability implying the absence of paradox and contradiction. [34]

**U****unit**

1. An aggregation of entities. [4]
2. A basis of measurement. [4]

**usability**

**Simulation.** The existence and sufficiency of user-support features (e.g., manuals, training) that enable a user to properly execute a model or simulation and analyze and/or employ the results. See [fitness](#). [22]

**user**

1. The individual, group, or organization that employs or will employ a model, simulation, or federation, its products, or its services to achieve a set of objectives. The User may also be involved in the evolution of such products and services. Also referred to as [M&S user](#). [22]

2. The individual, group, or organization that utilizes the results or products from a specific application of a model or simulation. In a broader sense, the user is the customer, the one for whom the model or simulation is assembled and developed, and also the one who makes the accreditation decision. Also referred to as [M&S user](#). [22]

### **user domain**

The realm of knowledge describing a user's environment to which a model, simulation, or simulation federation will be applied. See [problem domain](#), [simulation domain](#). [22]

### **user domain requirements**

The intended purpose and methods of employing a model, simulation or simulation federation for a particular purpose; user domain. See [M&S requirements](#). [22]

## **V**

### **validation**

1. The process of determining the degree to which a model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model. [2, 3, 6, 21] See [fidelity](#), [purpose](#).

2. The process of determining the fitness of a model or simulation and its associated data for a specific purpose. [22]

### **validation agent**

The person or organization designated to perform validation of a model, simulation, or federation of models and/or simulations and the associated data. See [V&V agent](#). [6]

### **validation data**

The real-world facts used for comparison to validate the results of a simulation. These data come from empirical sources such as test ranges, live exercise results, or historical records, from outputs of other simulations that were previously validated, or from the knowledge of SMEs. [6]

### **validity**

1. The quality of maintained data that is found on an adequate system of classification (e.g., data model) and is rigorous enough to compel acceptance for a specific use. [4, 33]

2. The quality of being inferred, deduced, or calculated correctly enough to suit a specific purpose. [33]

### **variable**

A quantity or data item whose value can change. See [dependent variable](#); [independent variable](#); [state variable](#). Contrast with [constant](#). [4]

### **verification**

1. The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications. [3, 4, 6]
2. The process of determining that a model or simulation faithfully represents the developer's conceptual description and specifications. Verification evaluates the extent to which the model or simulation has been developed using sound and established software and system engineering techniques. See [validation](#). [2, 5]

### **verification agent**

1. The person or organization designated to perform verification of a model, simulation, or federation of models and/or simulations and the associated data. See [V&V agent](#). [6]
2. The organization designated by the M&S sponsor [user] to perform verification for a model, simulation, or federation of models and/or simulations. [4]

### **verification and validation (V&V) agent**

1. The individual, group, or organization designated by the V&V proponent (user) to verify and validate a model, simulation, or simulation federation. The V&V agent provides information to the accreditation agent to support the recommendation to accredit a model, simulation, or simulation federation for a specific purpose. See [validation agent](#), [verification agent](#). [2, 22]
2. The organization designated by the M&S sponsor (user) to perform verification and validation of a model, simulation, or federation of M&S. [22]

## **W**

### **well-formed formula**

In logic, a sequence of symbols from a formal language constructed according to the formation rules of the language. [19]

**X, Y & Z****References*****Policies and Standards***

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