Glossary

Absolute Timestamp
An absolute timestamp of an event is the timestamp of this event that is generated by the reference clock

Acceptance Test
A test that determines if a state in the problem space is a member of the solution set

Access Control
Access control is concerned with providing control over security critical actions that take place in a system. Providing control over actions consists of explicitly determining either the actions that are permitted by the system, or explicitly determining the actions that are not permitted by the system

Access Control Model
An access control model captures the set of allowed actions as a policy within a system

Accuracy
The *accuracy of a clock* denotes the maximum offset of a given clock from the external time reference during the IoD, measured by the reference clock

Acknowledged SoS
Independent ownership of the CSs, but cooperative agreements among the owners to an aligned purpose

Action
The execution of a program by a computer or a protocol by a communication system

Action Sequence
A sequence of actions, where the end-signal of a preceding action acts as the start signal of a following action

Activity Interval
The interval between the start signal and the end signal of an action or a sequence of related actions

Actuator
An actuator is an interface device that accepts data and control information from an interface component and realizes the intended physical effect at its placement in the physical environment

Agility (of a system)
Quality metric that represents the ability of a system to efficiently implement evolutionary changes

Architectural Style
The set of explicit or implicit rules and conventions that determine the structure and representation of the internals of a system, its data and protocols

Arrival Instant
The instant when the first bit of a message arrives at the receiver

Artifact
An entity that has been intentionally produced by a human for a certain purpose

Atomic Action
An atomic action is an action that has the all-or-nothing property. It either completes and delivers the intended

result or does not have any effect on its environment

Attribute

A characteristic quality of an entity

Authentication

The process of verifying the identity or other attributes claimed by or assumed of a subject, or to verify the source and integrity of data

Authorization

Authorization is the mechanism of applying access rights to a subject. Authorizing a subject is typically processed by granting access rights to them within the access control policy

Authority

The relationship in which one party has the right to demand changes in the behavior or configuration of another party, which is obliged to conform to these demands

Autonomous System

A system that can provide its services without guidance by another system

Availability

Readiness for service

Behavior

The timed sequence of the effects of input and output actions that can be observed at an interface of a system

Bottom Up Design

A hierarchical design methodology where the design starts at the bottom of the holarchy or formal hierarchy

Business Value

Overarching concept to denote the performance, impact, usefulness, etc. of the functioning of the SoS

Capability

Ability to perform a service or function

Cascade Effect

A cascade effect exists, if in a system with a multitude of parts at the micro level a state change of a part at the micro-level causes successive state changes of many other parts at the micro level such that the cumulative effect of the totality of these state changes results in a novel phenomenon

Causal Loop

A causal loop exists, if the emergent property at the macro-level causes a change of the state of the parts at the micro-level

Causal Model

Abstract model describing the causal dependencies between relevant variables in a given domain

Causal Order

A causal order among a set of events is an order that reflects the cause-effect relationships among the events

Channel

A logical or physical link that transports information among systems at their connected interfaces

Channel Model

A model that describes effects of the channel on the transferred information

Checked Message

A message is checked at the source (or, in short, checked) if it passes the output assertion

Ciphertext

Data in its encrypted form

Clock

A (digital) clock is an autonomous system that consists of an oscillator and a register. Whenever the oscillator completes a period, an event is generated that increments the register

Clock Ensemble

A collection of clocks, not necessary in the same physical location, operated together in a coordinated way either for mutual control of their individual properties or to maximize the performance (time accuracy and frequency stability) and availability of a time-scale derived from the ensemble)

Collaborative SoS
Voluntary interactions of independent CSs to achieve a goal that is beneficial to the individual CS

Communication Action
An action that is characterized by the execution of a communication protocol by a communication system

Communication Protocol
The set of rules that govern a communication action

Compatibility (full, Itom)
The Itom that is sent by the sender is received by the receiver without modification

Component
A subsystem of a system, the internal structure of which is of no interest

Computational Action
An action that is characterized by the execution of a program by a machine

Concept
A category that is augmented by a set of beliefs about its relations to other categories, i.e., existing knowledge, is called a concept

Concise State
The state of a system is considered concise if the size of the declared ground state is at most in the same order of magnitude as the size of the system's largest input message

Confidentiality
The absence of unauthorized disclosure of information

Configuration Interface (C-Interface)
An interface of a CS that is used for the integration of the CS into an SoS and the reconfiguration of the CS's RUIs while integrated in a SoS

Connected Interface
An interface that is connected to at least one other interface by a channel

Connection System/Gateway Component/Wrapper
A new system with at least two interfaces that is introduced between interfaces of the connected component systems in order to resolve property mismatches among these systems (which will typically be legacy systems)

Consistency
The property of a set of entities that see the same data at the same time

Constituent System (CS)
An autonomous subsystem of an SoS, consisting of computer systems and possibly of controlled objects and/or human role players that interact to provide a given service

Constraint
A restriction in the problem space

Construct
A non-physical entity, a product of the human mind

Consume/Produce (CP) Paradigm
At the sender, the communication system consumes the message from a sender queue and at the receiver the communication system adds the received message to a receiver queue

Context
The set of cultural circumstances, conventions or facts, and the time that surround and have a possible influence on a particular thing, construct, event, situation, system, etc. in the UoD

Context Compatibility
the same data (bit pattern) is explained in the same way at the sender and at the receiver

Context Incompatibility
the same data (bit pattern) is explained differently at the sender and at the receiver

Contract
  Agreement between two or more parties, where one is the customer and the others are service providers. This can be a legally binding formal or an informal "contract". It can be expressed in terms of objectives

Control Flow
  The flow of control signals when executing a protocol

Coordinated Clock
  A clock synchronized within stated limits to a reference clock that is spatially separated

Correct Message
  A message is correct if it is both timely and value correct

Critical Service
  A critical service is the service of a system that requires a specific criticality level

Criticality
  Criticality is a designation of the required criticality level for a system component

Criticality Level
  The criticality level is the level of assurance against failure

Cryptography
  The art and science of keeping data secure

Cyber-Physical System (CPS)
  A system consisting of a computer system (the cyber system), a controlled object (a physical system) and possibly of interacting humans

Cyber Space
  Cyber space is an abstraction of the Universe of Discourse (UoD) that consists only of information processing systems and cyber channels to realize message-based interactions

Cycle
  A temporal sequence of significant events that, upon completion, arrives at a final state that is related to the initial state, from which the temporal sequence of significant events can be started again

Data
  A data item is an artefact, a pattern, created for a specified purpose

Data Flow
  The flow of the payload data of a message from a sender to the receivers

Datagram
  A best effort message transport service for the transmission of sporadic messages from a sender to one or many receivers

Declared Ground State
  A declared data structure that contains the relevant ground state of a given application at the ground state instant

Decryption
  The process of turning ciphertext back into plaintext

Dependability
  The ability to deliver service that can justifiably be trusted

Design
  The process of defining an architecture, components, modules and interfaces of a system to satisfy specified requirement

Design for Evolution
  Exploration of forward compatible system architectures, i.e. designing applications that can evolve with an ever-changing environment. Principles of evolvability include modularity, updateability and extensibility. Design for evolution aims to achieve robust and/or flexible architectures

Design for Evolution in the context of SoSs
  Design for evolution means that we understand the user environment and design a large SoS in such a way that expected changes can be accommodated without any global impact on the architecture. 'Expected' refers to the

fact that changes will happen, it does not mean that these changes themselves are foreseeable

Design for Testability
The architectural and design decisions in order to enable to easily and effectively test our system

Design Inspection
Examination of the design and determination of its conformity with specific requirements

Design Walkthrough
Quality practice where the design is validated through peer review

Designer
An entity that specifies the structural and behavioral properties of a design object

Deterministic Behavior
A system behaves deterministically if, given an initial state at a defined instant and a set of future timed inputs, the future states, the values and instants of all future outputs are entailed

Diagnosis Interface (D-Interface)
An interface that exposes the internals of a Constituent System (CS) for the purpose of diagnosis

Directed SoS
An SoS with a central managed purpose and central ownership of all CSs

Downward Causation
The phenomenon that some novel macro-level properties have causal powers to control the micro-level properties from which they emerge

Drift
The drift of a physical clock is a quality measure describing the frequency ratio between the physical clock and the reference clock

Duration
The length of an interval

Dynamicity of a system
The capability of a system to react promptly to changes in the environment

Emergence
A phenomenon of a whole at the macro-level is emergent if and only if it is of a new kind with respect to the non-relational phenomena of any of its proper parts at the micro level

Encryption
The process of disguising data in such a way as to hide the information it contains

End Signal
An event that is produced by the termination of an action

Entity
Something that exists as a distinct and self-contained unit

Entourage of a CPS
The entourage is composed of those entities of a CPS (e.g., the role playing human, controlled object) that are external to the cyber system of the CPS but are considered an integral part of the CPS

Environment of a System
The entities and their actions in the UoD that are not part of a system but have the capability to interact with the system

Environmental Dynamics
Autonomous environmental processes that cause a change of state variables in the physical environment

Environmental Model
A model that describes the behavior of the environment that is relevant for the interfacing entities at a suitable level of abstraction

Epoch
An instant on the timeline chosen as the origin for time-measurement

Error
    Part of the system state that deviated from the intended system state and could lead to system failure

Error Containment
    Error Containment prevents propagation of errors by employing error detection and a mitigation strategy

Error Containment Region (ECR)
    A set of at least two Fault Containment Regions (FCRs) that perform error containment

Established Rule
    An observed consequence that often follows if a set of antecedent conditions applies

Event
    A happening at an instant

Event Variable
    A variable that holds information about some change of state at an instant

Event-triggered (ET) Action
    An action where the start signal is derived from an event other than the progression of time

Evolution
    Process of gradual and progressive change or development, resulting from changes in its environment (primary) or in itself (secondary)

Evolutionary Performance
    A quality metric that quantifies the business value and the agility of a system

Evolutionary Step
    An evolutionary change of limited scope

Evolvable architecture
    An architecture that is adaptable and then is able to incorporate known and unknown changes in the environment or in itself

Execution Time
    The duration it takes to execute a specific action on a given computer

Explained Emergence
    An emergent phenomenon that is observed at a macro level is explained emergent if a trans-ordinal law that explains the occurrence of the emergent phenomenon at the macro level out of the properties and interactions of the parts at the adjacent micro level is known (or has been formulated post facto)

Explanation
    The explanation of the data establishes the links between data and already existing concepts in the mind of a human receiver or the rules for handling the data by a machine

Explicit Flow Control
    After having sent a message, the sender receives a control message from the receiver informing the sender that the receiver has processed the sent message

External Clock Synchronization
    The synchronization of a clock with an external time base such as GPS

External Interface
    A Constituent System (CS) is embedded in the physical environment by its external interfaces

Failure
    The actual system behavior deviation from the intended system behavior

Failure Modes
    The forms that the deviations from the system service may assume; failure modes are ranked according to failure severities (e.g. minor vs. catastrophic failures)

Fault
    The adjudged or hypothesized cause of an error; a fault is active when it causes an error, otherwise it is dormant

Fault Containment Region (FCR)
    A Fault Containment Region (FCR) is a collection of components that

operates correctly regardless of any arbitrary fault outside the region

Fault Forecasting
The means to estimate the present number, the future incidence, and the likely consequences of faults

Fault Prevention
The means to prevent the occurrence or introduction of faults

Fault Removal
The means to reduce the number and severity of faults

Fault Tolerance
The means to avoid service failures in the presence of faults

Flexible Architecture
Architecture that can be easily adapted to a variety of future possible developments

Flow Control
The control of the flow of messages from the sender to the receiver such that the sender does not outpace the receiver

Formal Problem
A problem in a well-defined problem space

Frequency Drift
A systematic undesired change in frequency of an oscillator over time

Frequency Offset
The frequency difference between a frequency value and the reference frequency value

Function
A function is a mapping of input data to output data

Gateway
A transformation system in cyberspace

General Law
An inevitable consequence that follows if a set of antecedent conditions applies

Global Evolution
Global evolution affects the SoS service and thus how CSs interact. Consequently, global evolution is realized by changes to the Relied Upon Interface (RUI) specifications

Governance
Theoretical concept referring to the actions and processes by which stable practices and organizations arise and persist. These actions and processes may operate in formal and informal organizations of any size; and they may function for any purpose

Global Positioning System Disciplined Oscillator (GPSDO)
The GPSDO synchronizes its time signals with the information received from a GPS receiver

Granularity/Granule of a Clock
The duration between two successive ticks of a clock is called the granularity of the clock or a granule of time

Ground State
At a given level of abstraction, the ground state of a cyclic system is a state at an instant when the size of the instantaneous state space is at a minimum relative to the sizes of the instantaneous state spaces at all other instants of the cycle

Ground State Instant
The instant of the ground state in a cyclic system

Hierarchical Design
A design methodology where the envisioned system is intended to form a holarchy or formal hierarchy

Holarchy
A structure where holons at one level interact horizontally to form a novel holon at the next higher level

Holdover

The duration during which the local clock can maintain the required precision of the time without any input from the GPS

Holon

A two-faced entity in a non-formal hierarchy that acts externally at the macro-level as a whole while it is established internally by the interactions of its parts at the micro-level

Homogenous System

A system where all sub-systems adhere to the same architectural style

Human-Machine Interface (HMI) Component

A component of the CS that realizes the human-machine interface of a CS

Idempotent Action

An action is idempotent if the effect of executing it more than once has the same effect as of executing it only once

Implicit Flow Control

The sender and receiver agree a priori on a maximum send rate. The sender commits to never send messages faster than the agreed send rate and the receiver commits to accept all messages that the sender has sent

Incentive

Some motivation (e.g., reward, punishment) that induces action

Information

A proposition about the state of or an action in the world

Initial State

(i) an existing deficient state of affairs that needs a solution or (ii) a recognized opportunity that should be exploited or (iii) a formal statement of a question (academic story problem)

Input Action

An action that reads or consumes input data at an interface

Input Data

Data that is used as an input to a system

Insidious Message

A message is insidious if it is permitted but incorrect

Instant

A cut of the timeline

Instantaneous State Space

The state space of a system is formed by the totality of all possible values of the state variables at a given instant

Integrity

The absence of improper system state alterations

Interaction

An interaction is an exchange of information items at connected interfaces

Interface

A point of interaction of a system with another system or with the system environment

Interface Physical Specification (P-Spec)

Part of the CP-Spec that concerns the specification of exchanges with the physical environmental model

Interface Cyber-Physical Specification (CP-Spec)

Part of the interface specification that concerns interface properties at the cyber-physical interface layer

Interface Itom Specification (I-Spec)

Part of the interface specification that concerns interface properties at the informational interface layer

Interface Layer

An abstraction level under which interface properties can be discussed

Interface Message Specification (M-Spec)

Part of the CP-Spec that concerns the specification of messages exchanged with the cyber space environmental model

Interface Model
The interface model contains the explanation of the data sent or received over this interface and thus establishes the Itoms

Interface Properties
The valued attributes associated with an interface

Interface Service Specification (S-Spec)
Part of the interface specification that concerns interface properties at the service interface layer

Interface Specification
The interface specification defines at all appropriate interface layers the interface properties, i.e., what type of, how, and for what purpose information is exchanged at that interface

Internal Clock Synchronization
The process of mutual synchronization of an ensemble of *clocks* in order to establish a *global time* with a bounded *precision*

Internal Interface
An interface among two or more sub-systems of a Constituent System (CS)

Interval
A section of the timeline between two instants

Interval of Discourse (IoD)
The Interval of Discourse specifies the time interval that is of interest when dealing with the selected view of the world

Intra-ordinal Law
A new law that deals with the emerging phenomena at the macro level

Irrevocable Action
An action that cannot be undone

Itom
An Itom (Information Atom) is a tuple consisting of data and the associated explanation of the data

Jitter
The short-term phase variations of the significant instants of a timing signal

from their ideal position on the time-line (where long-term implies here that these variation of frequency are greater than or equal to 10 Hz) (see also wander)

Jitter of a Message
The duration between the minimal transport duration and the maximum transport duration

Key
A numerical value used to control cryptographic operations, such as decryption and encryption

Legacy System
An existing operational system within an organization that provides an indispensable service to the organization

Local Evolution
Local evolution only affects the inter-nals of a Constituent System (CS) which still provides its service according to the same and unmodified Relied Upon Interface (RUI) specification

Local I/O Interface (L-Interface)
An interface that allows a Constituent System (CS) to interact with its sur-rounding physical reality that is not accessible over any other external interface

Maintainability
The ability to undergo modifications and repairs

Managed Evolution
Evolution that is guided and supported to achieve a certain goal

Managed SoS Evolution
Process of modifying the SoS to keep it relevant in face of an ever-changing environment

Meet-in-the-Middle Design
A hierarchical design methodology where the top down design and the bottom up design are intermingled

Message
A data structure that is formed for the purpose of the timely exchange of information among computer systems

Message Variable
A tuple consisting of a syntactic unit of a message and a name, where the name points to the explanation of the syntactic unit

Message-based Interface Port
The message-based interface contains ports (i.e., channel endpoints) where message payloads can be placed for sending, or received message payloads can be read from

Meta Data
Data that describes the meaning of object data

Metric
Indicator used to quantitatively describe an attribute of the system, like throughput for performance or availability for dependability

Major Evolutionary Step
An evolutionary step that affects the Relied Upon Interface (RUI) Itom specification and might need to be considered in the management of SoS dynamicity and SoS emergence

Minor Evolutionary Step
An evolutionary step that does not affect the Relied Upon Interface (RUI) Itom Specification (I-Spec) and consequently has no effects on SoS dynamicity or SoS emergence

Modularity
Engineering technique that builds larger systems by integrating modules

Module
A set of standardized parts or independent units that can be used to construct a more complex structure

Monolithic System
A system is called monolithic if distinguishable services are not clearly separated in the implementation but are interwoven

Multi-Criteria Decision Analysis (MCDA)
MCDA is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making, allowing the evaluation of one or more decision alternatives in light of the multiple criteria

Multi-criticality System
A multi-criticality system has at least two components that have a different criticality

Nominal Frequency
The desired frequency of an oscillator

Non-Sparse Events
Events that occur in the passive interval of the sparse time

Now
The instant that separates the past from the future

Object
Passive system-related devices, files, records, tables, processes, programs, or domain containing or receiving information. Access to an object implies access to the information it contains

Object Data
Data that is the object of description by meta data

Objective
Values for the quality metrics to be attained

Observation of an Entity
An atomic structure consisting of the name of the entity, the name and the value of the attribute (i.e., the property), and the timestamp denoting the instant of observation

Offset of events
The offset of two events denotes the duration between two events and the position of the second event with respect to the first event on the timeline

Open System

A system that is interacting with its environment during the given IoD

Output Action

An action that writes or produces output data at an interface

Output Data

Data that is produced by a system

PAR-Message

A PAR-Message (Positive Acknowledgment or Retransmission) is an error controlled transport service for the transmission of sporadic messages from a sender to a single receiver

Payload of a Message

The bit pattern carried in the data field of the message

Period

A cycle marked by a constant duration between the related states at the start and the end of the cycle

Periodic System

A system where the temporal behavior is structured into a sequence of periods

Permission

Attributes that specify the access that subjects have to objects in the system

Permitted Message

A message is permitted with respect to a receiver if it passes the input assertion of that receiver. The input assertion should verify, at least, that the message is valid

Phase

A measure that increases linearly in each period from 0 degrees at the start until 360 degrees at the end of the period

Phase alignment

The alignment of the phases between two periodic systems exhibiting the same period, such that a constant offset between the phases of the two systems is maintained

Plaintext

Unencrypted data

Precision

The precision of an ensemble of synchronized clocks denotes the maximum offset of respective ticks of the global time of any two clocks of the ensemble over the IoD. The precision is expressed in the number of ticks of the reference clock

Primary Clock

A clock whose rate corresponds to the adopted definition of the second. The primary clock achieves its specified accuracy independently of calibration

Prime Mover

A human that interacts with the system according to his/her own goal

Private Key

In an asymmetric cryptography scheme, the private or secret key of a key pair which must be kept confidential and is used to decrypt messages encrypted with the public key

Problem

A perceived need to transform an initial state to a goal state

Property

A valued attribute

Property Mismatch

A disagreement among connected interfaces in one or more of their interface properties

Public Key

A cryptographic key that may be widely published and is used to enable the operation of an asymmetric cryptography scheme. This key is mathematically linked with a corresponding private key

Public Key Cryptography

Cryptography that uses a public-private key pair for encryption and decryption

Quality

The standard of something as measured against other things; the degree of excellence of something

Quality of Service
  The ability of a system to meet certain requirements for different aspects of the system like performance, dependability, evolvability, security or cost; possibly expressed in terms of levels and quantitatively evaluated through metrics

Raw Data
  The bit pattern that is produced by a sensor system

Read/Write (RW) Paradigm
  At the sender the communication system reads the contents of the message from a message variable and at the receiver the communication system writes the arriving message into a message variable, overwriting the old content of the message variable

Real-Time (RT) Transaction
  A transaction that must complete before a specified deadline

Real-Time System (RTS)
  A computer system for which the correct results must be produced within time constraints

Reasonableness Condition
  The reasonableness condition of clock synchronization states that the granularity of the global time must be larger than the precision of the ensemble of clocks

Receive Instant
  The instant when the last bit of a message arrives at the receiver

Reconfigurability
  The capability of a system to adapt its internal structure in order to mitigate internal failures or to improve the service quality

Reducible System
  A system where the sum of the parts makes the whole

Reference Clock
  A hypothetical clock of a granularity smaller than any duration of interest

and whose state is in agreement with TAI

Reference Monitor
  A reference monitor represents the mechanism that implements the access control model. A reference monitor is defined as: An access control concept that refers to an abstract machine that mediates all accesses to objects by subjects

Refined Data
  Data that has been created by a purposeful process from the raw data to simplify the explanation of the data in a given context

Reliability
  Continuity of service

Relied upon Interface (RUI)
  An interface of a CS where the services of the CS are offered to other CSs

Relied upon Message Interface (RUMI)
  A message interface where the services of a CS are offered to the other CSs of an SoS

Relied upon Physical Interface (RUPI)
  A physical interface where things or energy are exchanged among the CSs of an SoS

Relied upon Service (RUS)
  (Part of) a Constituent System (CS) service that is offered at the Relied Upon Interface (RUI) of a service providing CS under a Service Level Agreement (SLA)

Requirement
  A statement that identifies a necessary attribute, capability, characteristic, or quality of a system

Reservation
  A commitment by a service provider that a resource that has been allocated to a service requester at the reservation allocation instant will remain allocated until the reservation end instant

Reservation Allocation Instant
  The instant when a resource

reservation is allocated to a service requestor by a service provider

Reservation End Instant
The instant until a reservation is allocated to a service provider

Reservation Request Instant
The instant when a resource is requested by a service requestor

Resultant Phenomenon
A phenomenon at the macro-level is resultant if it can be reduced to a sum of phenomena at the micro-level

Risk
A measure of the extent to which an organization is threatened by a potential circumstance or event, and typically a function of (1) the adverse impacts that would arise if the circumstance or event occurs; and (2) the likelihood of occurrence

Robust Architecture
Architecture that performs sufficiently well under a variety of possible future developments

Robustness
Dependability with respect to external faults (including malicious external actions)

Role Player
A human that acts according to a given script during the execution of a system and could be replaced in principle by a cyber-physical system

RUI Connecting Strategy
Part of the interface specification of RUIs is the RUI connecting strategy which searches for desired, w.r.t. connections available, and compatible RUIs of other CSs and connects them until they either become undesirable, unavailable, or incompatible

Safety
The absence of catastrophic consequences on the user(s) and on the environment

Sampling
The observation of the value of relevant state variables at selected observation instants

Scenario
A scenario is a projected or imagined sequence of events describing what could possibly happen in the future (or have happened in the past)

Scenario-Based Reasoning (SBR)
Systematic approach to generate, evaluate and manage different scenarios in a given context

Second
An internationally standardized time measurement unit where the duration of a second is defined as 9 192 631 770 periods of oscillation of a specified transition of the Cesium 133 atom

Security
The composition of confidentiality, integrity, and availability; security requires in effect the concurrent existence of availability for authorized actions only, confidentiality, and integrity (with "improper" meaning "unauthorized")

Security Level
Specification of the level of security to be achieved through the establishment and maintenance of protective measures

Security Policy
Given identified subjects and objects, there must be a set of rules that are used by the system to determine whether a given subject can be permitted to gain access to a specific object. This is called the security policy

Semantic Specification
The specification that explains the meaning of the named syntactic units

Send Instant
The instant when the first bit of a message leaves the sender

Sensor

A sensor is an interface device that observes the system environment and produces data (a bit pattern) that can be explained by the design of the sensor and its placement in the physical environment

Service

The intended behavior of a system

Service Composition

The integration of multiple services into a new service is called service composition

Service Consumer

The component that requires a service

Service Discovery

Service discovery is the process where service consumers match their service requirements against the available Interface Service Specifications (S-Specs) in a service registry

Service Level Agreement (SLA)

A SLA defines a set of Service Level Objectives (SLOs), the price of the service, and compensation actions in case of failure to deliver a committed service

Service Level Objective (SLO)

A functional or non-functional objective that can be evaluated by observing the service provider to either achieved or not-achieved. Objectives are based on measurable quality metrics

Service Provider

The component that provides a service

Service Registry

The service registry is a repository of Interface Service Specifications (S-Specs) of service providers

Signal

An event that is used to convey information typically by prearrangement between the parties concerned

Situation assessment

Situation assessment is the process of achieving, acquiring or maintaining situation awareness

Solution Path/Plan

A path of intermediate states from the initial state to the goal state, considering the given constraints

Sparse Events

Events that occur in the active interval of the sparse time

Sparse Time

A time-base in a distributed computer system where the physical time is partitioned into an infinite sequence of active and passive intervals

Sphere of Control (SoC)

The sphere of control of a system during an IoD is defined by the set of entities that are under the control of the system

Stability

The stability of a clock is a measure that denotes the constancy of the oscillator frequency during the IoD

Start Signal

An event that causes the start of an action

State

The state of a system at a given instant is the totality of the information from the past that can have an influence on the future behavior of a system

State Space

The state space of a system is formed by the totality of all possible values of the state variables during the IoD

State Variable

A variable that holds information about the state

Statefull Action

An action that reads, consumes, writes or produces state

Statefull System
    A system that contains state at a considered level of abstraction

Stateless Action
    An action that produces output on the basis of input only and does not read, consume, write or produce state

Stateless System
    A system that does not contain state at a considered level of abstraction

Stigmergic Information Flow
    The information flow between a sending CS and a receiving CS where the sending CS initiates a state change in the environment and the receiving CS observes the new state of the environment

Stigmergy
    Stigmergy is a mechanism of indirect coordination between agents or actions. The principle is that the trace left in the environment by an action stimulates the performance of a next action, by the same or a different agent

Subject
    An active user, process, or device that causes information to flow among objects or changes the system state

Subsystem
    A subordinate system that is a part of an encompassing system

Supervenience
    The principle of Supervenience states that (Sup i) a given emerging phenomenon at the macro level can emerge out of many different arrangements or interactions of the parts at the micro-level while (Sup ii) a difference in the emerging phenomena at the macro level requires a difference in the arrangements or the interactions of the parts at the micro level

Symmetric Cryptography
    Cryptography using the same key for both encryption and decryption

Symmetric Key
    A cryptographic key that is used to perform both encryption and decryption

Syntactic Compatibility
    The syntactic chunks sent by the sender are received by the receiver without any modification

Syntactic Specification
    The specification that explains how the data field of a message is structured into syntactic units and assigns names to these syntactic units

System
    An entity that is capable of interacting with its environment and may be sensitive to the progression of time

System Architecture
    The blueprint of a design that establishes the overall structure, the major building blocks and the interactions among these major building blocks and the environment

System Boundary
    A dividing line between two systems or between a system and its environment

System Effectiveness
    The system's behavior as compared to the desired behavior

System Efficiency
    The amount of resources the system needs to act in its environment

System Performance
    The combination of system effectiveness and system efficiency

System Resources
    Renewable or consumable goods used to achieve a certain goal. E.g., a CPU, CPU-time, electricity

System-of-Systems (SoS)
    An SoS is an integration of a finite number of constituent systems (CS) which are independent and operable, and which are networked

together for a period of time to achieve a certain higher goal

Temporal Order
The temporal order of events is the order of events on the timeline

Thing
A physical entity that has an identifiable existence in the physical world

Threat
Any circumstance or event with the potential to adversely impact organizational operations (including mission, functions, image, or reputation), organizational assets, individuals, or other organizations through a system via unauthorized access, destruction, disclosure, modification of information, and/or denial of service

Tick
The event that increments the register is called the tick of the clock

Time
A continuous measureable physical quantity in which events occur in a sequence proceeding from the past to the present to the future

Timeline
A dense line denoting the independent progression of time from the past to the future

Timely Message
A message is timely if it is in agreement with the temporal specification

Timestamp (of an event)
The timestamp of an event is the state of a selected clock at the instant of event occurrence

Time-aware SoS
A SoS is time-aware if its Constituent Systems (CSs) can use a global timebase in order to timely conduct output actions and consistently—within the whole SoS – establish the temporal order of observed events

Time-Synchronization Interface (TSI)
The TSI enables external time-synchronization to establish a global timebase for time-aware SoSs

Time-Triggered (TT) Action
An action where the start signal is derived from the progression of time

Top Down Design
A hierarchical design methodology where the design starts at the top of the holarchy or formal hierarchy

Transaction
A related sequence of computational actions and communication actions

Transaction Activity Interval
The interval between the start signal and the end signal of a transaction

Transducer
An interface device converting data to energy or vice versa. The device can either be a sensor or an actuator

Trans-Ordinal Law
A Law that explains the emergence of the whole and the new phenomena at the macro-level out of the properties and interactions of the parts at the lower adjacent micro-level

Transport Duration
The duration between the send instant and the receive instant

Transport Specification
This part of the interface specification describes all properties of a message that are needed by the communication system to correctly transport a message from the sender to the receiver(s)

Trusted System
A trusted system or component is one whose failure can break the security policy

TT-Message
A TT-Message (Time-Triggered) is an error controlled transport service for the transmission of periodic messages from a sender to many receivers

Unexplained Emergence
An emergent phenomenon that is observed at the macro level is unexplained emergent if, after a careful analysis of the emergent phenomenon, no trans-ordinal law that explains the appearance of the emergent phenomenon at the macro level out of the properties and interactions of the parts at the adjacent micro level is known (at least at present)

Universe of Discourse (UoD)
The Universe of Discourse comprises the set of entities and the relations among the entities that are of interest when modeling the selected view of the world

Unmanaged SoS evolution
Ongoing modification of the SoS that occurs as a result of ongoing changes in (some of) its CSs

Utility Interface
An interface of a CS that is used for the configuration, or the control, or the observation of the behavior of the CS

Valid Message
A message is valid if its checksum and contents are in agreement

Validity Instant
The instant up until an interface specification remains valid and a new, possibly changed interface specification becomes effective

Value
An element of the admissible value set of an attribute

Value Correct Message
A message is value-correct if it is in agreement with the value specification

Variable
A tuple consisting of data and a name, where the name points to the explanation of the data

Virtual SoS
Lack of central purpose and central alignment

Vulnerability
Weakness in a system, system security procedures, internal controls, or implementation that could be exploited by a threat

Wander
The long-term phase variations of the significant instants of a timing signal from their ideal position on the time-line (where long-term implies here that these variation of frequency are less than 10 Hz) (see also jitter)

Worst Case Execution Time (WCET)
The worst-case data independent execution time required to execute an action on a given computer

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