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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 9490

Space systems — Space Traffic Coordination (STC)

ICS: 49.140

ISO/TC 20/SC 14

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Introduction

This Space Traffic Coordination document specifies requirements for the coordination of space traffic, which support the aim to promote the safe and efficient use of space. All spacefaring nations share a vested interest and responsibility to create conditions for a safe, stable, and operationally sustainable space environment.

A broad overview of the sections contained in this document is provided in [Figure 1](#).

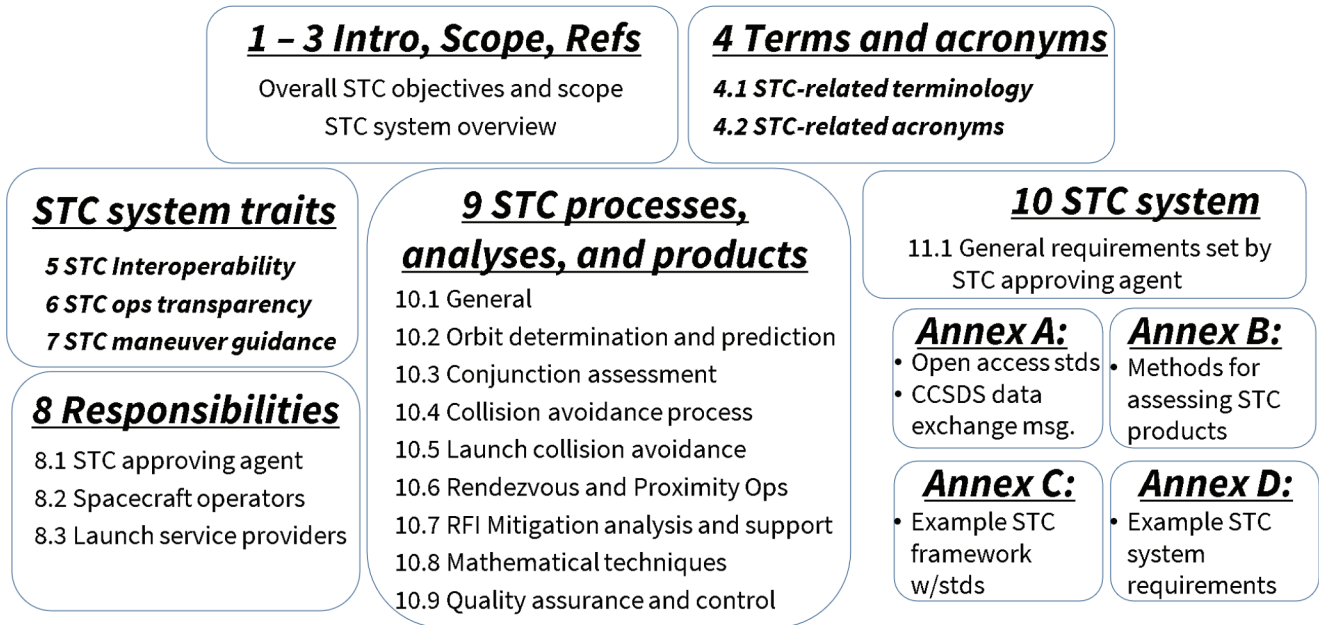


Figure 1 — Contents and topic areas contained in this STC standard, mapped to section numbers

Relationships between STC-relevant terms

To further clarify the interrelationships between many of terms defined above, see [Figure 2](#).

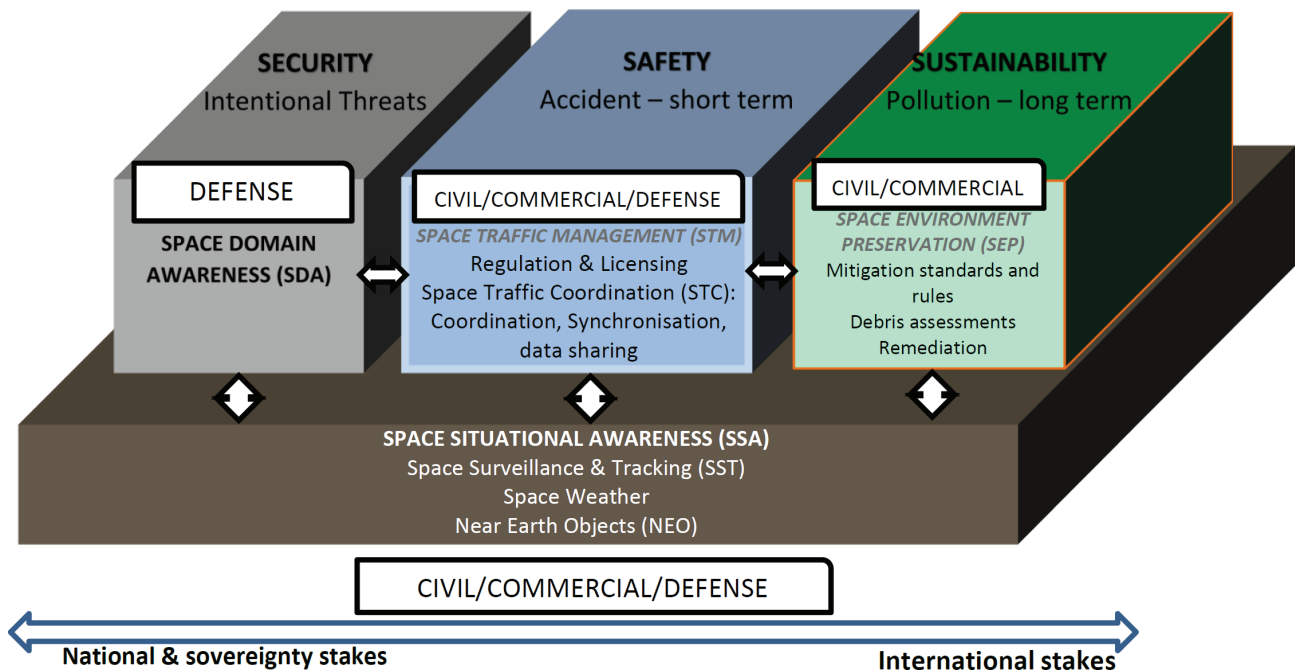


Figure 2 — Relationships between SDA, STM, STC, SEP and SSA ¹

An **STC system** also supports a spacecraft operators' compliance with relevant international standards. According to the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities,^[2] space data sharing and coordination (STC) is important for the safety, stability, and sustainability of operations in the space environment." STC will help facilitate flight safety, mitigates collision risk (for manoeuvrable spacecraft), and mitigates Radio Frequency Interference (RFI) for all phases of flight, spanning pre-launch safety assessment through manoeuvre plans, on-orbit collision avoidance, RFI mitigation support services, and mission disposal.

Another view of the relationship between SDA, SSA, SST, STC, and STM is shown using a Venn diagram as shown in [Figure 3](#).

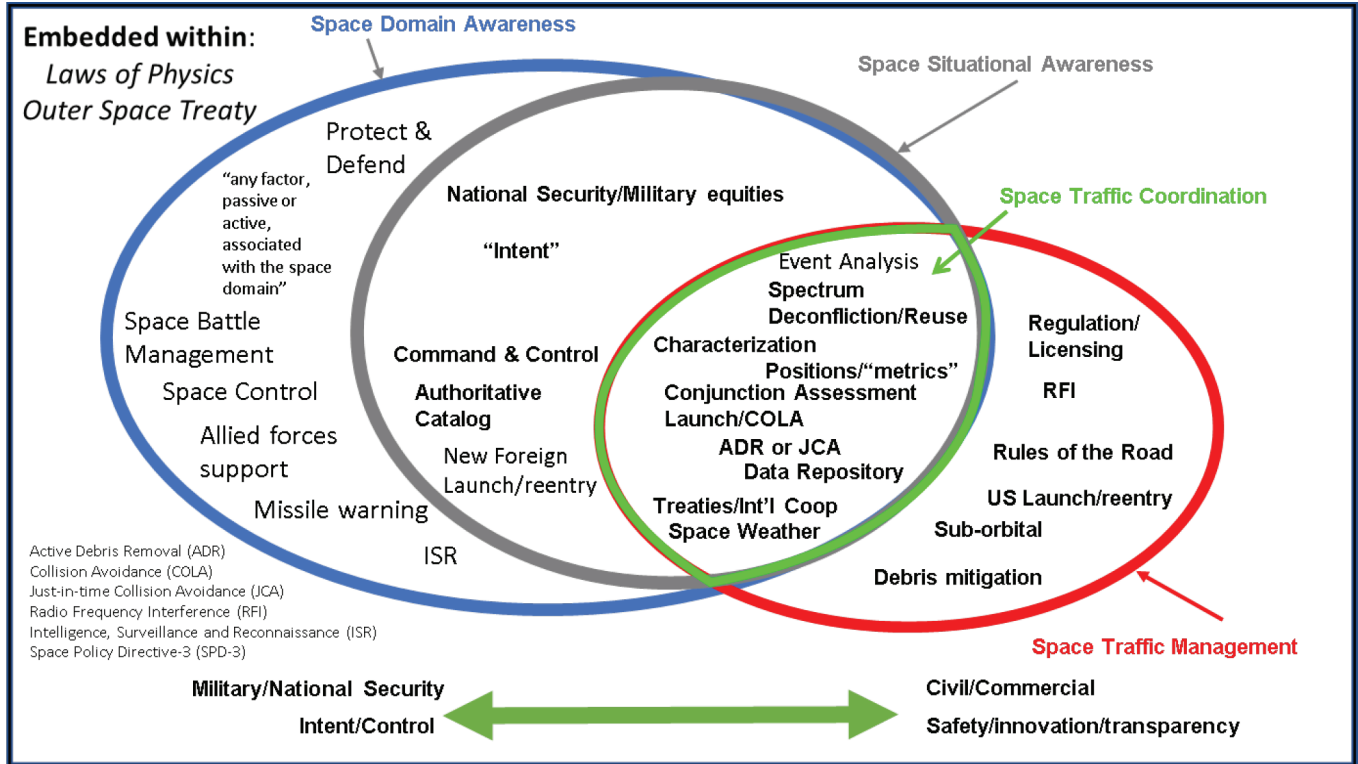


Figure 3 — Venn diagram of relationships between SDA, SSA, STM, and STC.

The range of STC systems is shown in [Figure 4](#). For example, in its simplest form, an STC system may be nothing more than a communications path (via text message, telephone call, email or fax) to convey, e.g., small amounts of operator or SSA data between operators, which we refer to as a **"Level 0 STC system."** In its most complex form, a **"Level 2 STC system"** is a data sharing and exchange portal as well as a processing and analysis centre that provides a place where STC service providers, spacecraft and launch service providers, and environment monitoring entities can pool their data for both information exchange and STC system analyses. A **Level 1 STC system** is focused on data exchange and may be collocated with an SSA system.

Accordingly, an STC system may consist of some, or all, of the elements shown in [Figure 5](#). A critical enabler in this figure is the "Standards and protocol-based interoperability layer, which allows different organizations to exchange, interpret and process data seamlessly.

Such coordination and synchronization are accomplished by spacecraft and launch service providers working and interacting collaboratively with both STC and **Space Situational Awareness (SSA)** service providers. This collaboration relies upon the central tenets of data exchange, communications, interoperability, and flight safety analysis capabilities provided by one or more **STC system(s)**.

Accordingly, an effective STC system must levy requirements on both the spacecraft and launch service providers, as well as any STC service provider(s). The effectiveness of the STC system relies upon coordination of space activities conducted by spacecraft and launch service providers and the exchange of STC and SSA information upon which their flight safety coordination is based.

The choice of one or more suitable STC system type(s) may largely be a policy decision. This standard provides requirements related to the many subsystems that an STC system may consist of, to include STC Servers and Network, STC Space Data Interfaces, STC Data Aggregation and Curation, STC Operations, STC Quality Control, and STC Algorithms and Metrics. These are designed to maximize STC analysis and service timeliness, accuracy, completeness, transparency, and are standards-based, progressive, and highly available to support the operators' risk mitigation decision-making processes.

This standard does not address issues of national sovereignty or inherently governmental functions implied by the term **Space Traffic Management (STM)**. The exact nature of and requirement for the bidirectional STC-to-STM feed indicated by [Figure 5](#) depends upon applicable STM policies and regulations. For example, an STC system can exchange information with STM system(s) to assist in STM monitoring and/or regulatory functions where required by an STM decision authority.

Aligned with the UN COPUOS Long Term Sustainability (LTS) guidelines, this standard emphasizes the need for comprehensive data sharing and exchange of information. It is understood that, where national laws and classifications prevent such exchanges, these data exchange requirements might not fully apply.

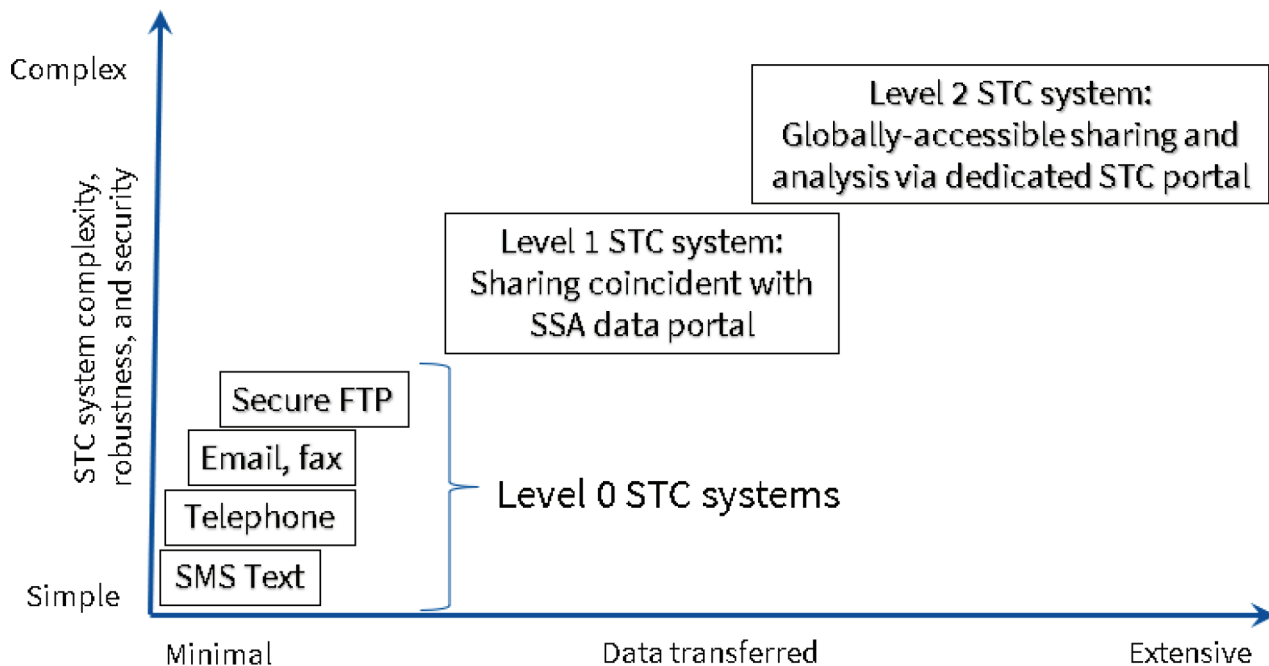


Figure 4 — Possible types of STC communication channels characterized by complexity, robustness, and security

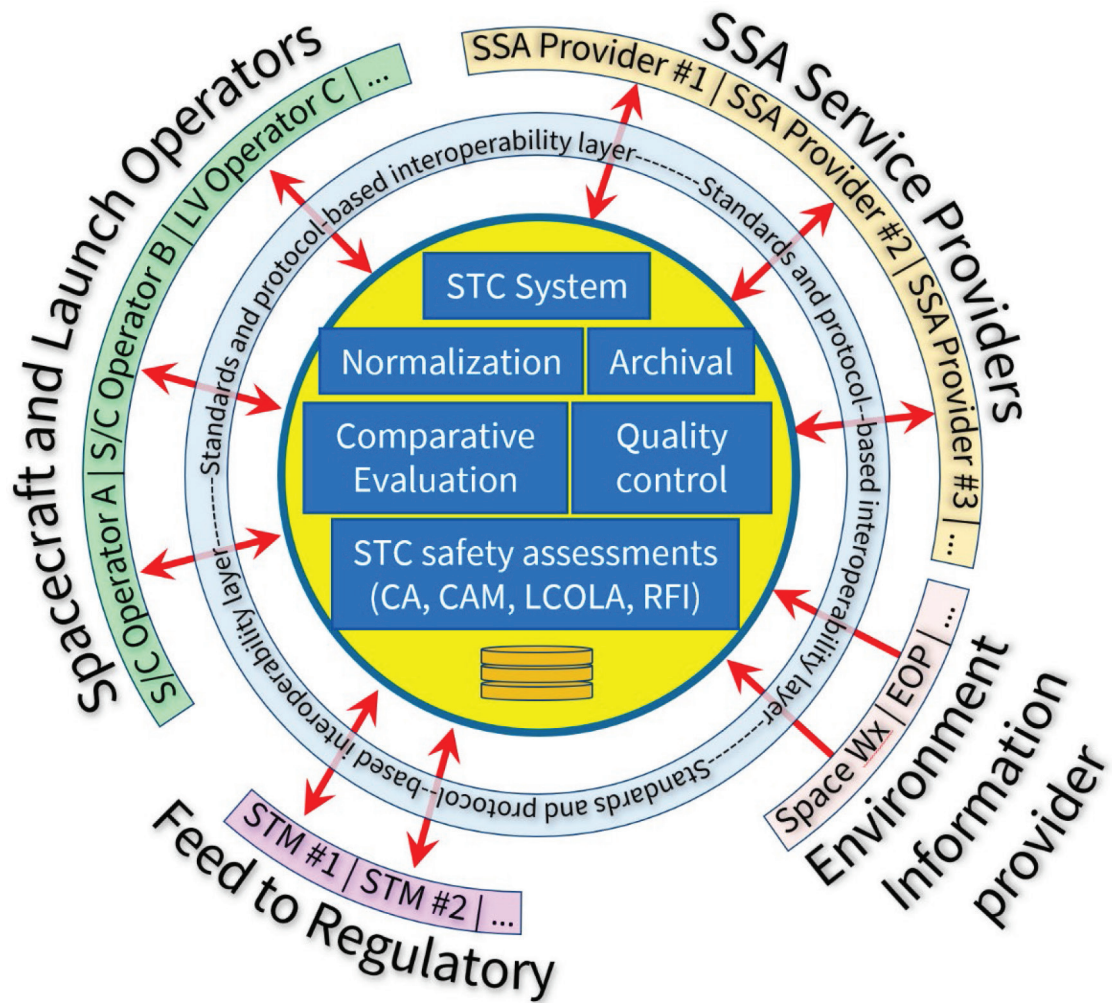


Figure 5 — Interactions by organizations for a dedicated Level 2 STC SYSTEM

Space systems — Space Traffic Coordination (STC)

1 Scope

This document addresses the essential elements and protocols needed for **Space Traffic Coordination** (henceforth referred to as “**STC**”). STC is critical to enhance the safety, stability, and sustainability of operations in the space environment.” STC enables flight safety, mitigates collision risk (for manoeuvrable spacecraft), and mitigates Radio Frequency Interference (RFI) for all phases of flight, spanning pre-launch safety assessment through manoeuvre plans, on-orbit collision avoidance, RFI mitigation support services, and mission disposal.

This document is designed to enable the effective coordination of space traffic from pre-launch safety assessment to disposal at the end of operation through norms, the effective monitoring, and mitigation of collision risk and RFI. The document is designed for state actors, spacecraft designers, spacecraft operators, and STC system developers and operators.

While this document applies to the range of orbital regions in which current STC and SSA systems can effectively track, monitor, and provide actionable data for space objects, it is envisioned that this document is generally applicable to all orbit regimes and for orbits around all central bodies and barycentres.

1.1 Breakdown of space safety constituents across ISO standards

The space flight safety-relevant topics of Space Traffic Coordination, on-orbit collision avoidance, and launch collision avoidance are closely related. To minimize duplication and maximize document consistency, the various content that serve as the basis for these three disciplines has been divided up as shown in [Figure 6](#).

• ISO 9490: STC • STC terminology • STC system, QC, IS, reliability • STC roles/responsibilities for launch providers, S/C operators, and SSA providers • STC & SSA services • Orbit determination, required accuracy, timeliness • Maneuverability RotR/ • Maneuver recommendations • Data exchange and launch, maneuver, anomaly, and fragmentations notifications • STC mathematical techniques	• ISO 23705: Avoid collision • Conjunction assessment and collision avoidance terminology • Risk mitigation strategies • Suggested collision miss distance and probability/risk metrics and associated minimum thresholds • Mathematical techniques: • Conjunction assessment • Collision probability • Linear, Non-linear, • Asymmetric, Max Prob • CAM planning, optimize • CA nomograms	• ISO 21740: LCOLA • LCOLA terminology: Safety LCOLA and Mission Assurance LCOLA • LCOLA launch window screening process • LCOLA products • Launch range coordination • LCOLA data exchange (LDM) • LCOLA mathematical techniques
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Figure 6 — Division of space safety operations content spanning several ISO standards

2 Normative references

The following documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6434, *Space systems — Design, testing and operation of a large constellation of spacecraft*¹⁾

ISO 14950, *Space systems — Unmanned spacecraft operability*²⁾

ISO 21740, *Space systems — Launch window estimation and collision avoidance*³⁾

ISO 22639, *Space systems — Design guidelines for multi-geo spacecraft collocation*⁴⁾

ISO 23705, *Space systems — Identifying, evaluating, and avoiding collisions between orbiting objects*⁵⁾

ISO 24113, *Space systems — Space debris mitigation requirements*⁶⁾

ISO 24330, *Space systems — Rendezvous and Proximity Operations (RPO) and On Orbit Servicing (OOS) — Programmatic principles and practices*⁷⁾

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

collision probability

quantification of the likelihood of two space objects impacting each other during a *conjunction* event

3.2

collision risk

product of *collision probability* and *collision consequence* for a space object experiencing a single *conjunction* event, or the aggregation of this combination for a space object experiencing multiple *conjunction* events

3.3

collision consequence

outcome of a collision between two space objects

Note 1 to entry: The outcome of a collision can be characterized in a number of ways, including the likelihood of catastrophic breakup, the number of debris fragments larger than a specified size or mass that might be generated, the lifetime of the resulting fragments,^[17] or some combination thereof.

1) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

2) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

3) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

4) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

5) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

6) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

7) accessed at <https://www.iso.org/committee/46614/x/catalogue/>

3.4**conjunction**

event where the positional separation between two objects is at a local minimum and that minimum is either (a) closer than a specified minimum distance threshold, (b) the estimated probability of collision at this local minimum exceeds a specified collision probability threshold, or (c) a combination of miss distance, probability, and/or other metrics (e.g., “risk”).

3.5**Constellation**

a set of spacecraft operating in a coordinated manner to create a single larger system, often based on a recurring spacecraft design and operating in similar orbits. (Ref. IADC space debris guidelines 2025, Revision 4).

Note 1 to entry: Examples include the space segments of satellite navigation systems or systems dedicated to global communication.

3.6**Earth Orientation Parameters (EOP)**

parameters that specify the orientation of the Earth with respect to one or more reference frames at one or more epochs of interest

3.7**ephemeris**

time history of positional and velocity (and optionally acceleration and covariance) state information

3.8**flight safety**

condition of travel through its medium where mission-terminating risks have been mitigated

3.9**higher airspace**

volume of airspace above altitudes where the majority of air services are provided today (i.e. above Flight Level FL 550)

3.10**higher airspace operations service provider**

service provider responsible for separation services for higher airspace operations that are unable to self-separate

3.11**large constellation**

system of a hundred or more spacecraft working together

Note 1 to entry: In addition to quantity, the spacecraft size, mass, complexity and function of the spacecraft also have a bearing on whether a constellation is regarded as “large,” as detailed in ISO 6434.

3.12**Launch Collision Avoidance**

process to identify, coordinate, and avoid conjunctions that can result in a collision between launching objects and other objects in space

Note 1 to entry: LCOLA processes are fundamentally different from on-orbit collision avoidance due to the on-ground ability to delay launch time by even a few seconds to make a large difference in close approach distance and collision probability, thereby mitigating collision risk. As well, LCOLA launch trajectories typically have much less trajectory accuracy than on-orbit spacecraft, e.g., as much as an order of magnitude worse due to unforeseen and unknowable variations in performance, winds aloft, and guidance errors prior to lift-off.

3.13**Level 0 Space Traffic Coordination system**

rudimentary communications path via text message, telephone call, email or fax to convey small amounts of operator or SSA data between operators

3.14

Level 1 Space Traffic Coordination system

mid-level portal primarily focused on data exchange

3.15

Level 2 Space Traffic Coordination system

globally accessible STC information sharing portal, storage, processing, and flight safety analysis endeavour supporting spacecraft and launch service providers, SSA data and information providers

3.16

Long-Term Sustainability (LTS) of Space Activities

ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations

Note 1 to entry: This definition is identical to that given in paragraph 5 of the UN COPUOS LTS guidelines, 2019.

3.17

normalization

process of converting or mapping data into a common reference frame, units, timing system, element or Cartesian set, and definitions so that analyses and comparisons may be accomplished meaningfully

3.18

Space Assigned Numbers Authority (SANA) Registry

numbers authority for the Consultative Committee for Space Data Systems (CCSDS), providing CCSDS with, "a standardized list of reference frames, element sets, timing systems, attitude specifications, spacecraft and orbit types, atmosphere and gravity models and spacecraft activity status

3.19

space data

information regarding the space environment or activities in the orbital space environment

3.20

space data repository

device, computer, database, or other storage system that allows the population, storage, retrieval, and manipulation of space data

3.21

space object catalog

one-to-one mapping between unique object identifiers and a unique description of what the object is

3.22

Space Domain Awareness

effective identification, characterization, and understanding of any factor, associated with the space domain that could affect space operations and thereby impact the security, safety, economy, or environment of a nation^[3]

Note 1 to entry: Other definitions for Space Domain Awareness may exist, but the version shown above is included to allow this document to differentiate between STC and SDA.

3.23

Space Environment Preservation

act of protecting, conserving, and sustaining the space operations environment, accomplished by space debris mitigation and remediation

3.24

Space Situational Awareness

Knowledge and characterization of the space environment to facilitate decisions that support safe, stable, and sustainable space activities^[1]

Note 1 to entry: Includes all artificial space objects (spacecraft, rocket bodies, mission-related objects and fragments), natural objects, asteroids (including Near-Earth Objects or NEOs), comets and meteoroids, effects from space weather, including solar activity and its radiation.^[3] Assessed risks include potential risks to humans and property in space, on the ground and in the air space due to accidental or intentional re-entries, on-orbit explosions and release events, on-orbit collisions, radio frequency interference, and occurrences that could disrupt missions and services.

3.25

Space Situational Awareness information

SSA data used to characterize the space environment.

Note 1 to entry: Includes all artificial space objects (spacecraft, rocket bodies, mission-related objects and fragments), natural objects, asteroids (including Near-Earth Objects or NEOs), comets and meteoroids, effects from space weather, including solar activity and its radiation^[3].

3.26

Space Situational Awareness Service Provider

entity that operates an SSA system to maintain an operational picture of the space environment and potential risks.

Note 1 to entry: SSA services can be provided by a combination of one or more commercial, governmental, non-governmental, or international entities, as well as by a mandated or delegated entity assigned by applicable national regulation.

3.27

Space Situational Awareness system

set of information gathering and exchange protocols enabling the characterization of the space environment and dissemination of its knowledge.

3.28

Space Surveillance and Tracking

detection, observation, monitoring, cataloguing and prediction of the movement of space objects and the identification and alerting of derived risks

Note 1 to entry: Space Surveillance and Tracking is generally accomplished through the operation and calibration of ground-based or space-based tracking sensors using radar, optical, or passive RF technology.

3.29

Space Surveillance and Tracking information

Products based on a set of processed space data used to characterize the movement of space objects

3.30

Space Traffic Coordination

cooperative planning, harmonization, data and information sharing, and synchronization of space activities to avoid collision and radio frequency interference during spacecraft and launch vehicle operations in space

Note 1 to entry: Definition adopted from “SPACE TRAFFIC MANAGEMENT TERMINOLOGY,” IAF STM Task Force^[1].

3.31

Space Traffic Coordination Service Provider

entity that operates the STC system pursuant to its obligations set by the relevant STC approving agent

Note 1 to entry: STC services can be provided by a combination of one or more commercial, governmental, non-governmental, or international entities, as well as by a mandated or delegated entity assigned by applicable national regulation.

3.32**Space Traffic Coordination system**

set of protocols, communications paths, information gathering and exchange, and may additionally include data fusion and SSA analytical services to facilitate flight safety, sustainability, and decision making

Note 1 to entry: An STC system can be described as being either “Level 0” (simple method to share limited amounts of data) (3.13), “Level 1” (focused solely on information gathering and exchange) (3.14), or at its most complete scope and reach as a “Level 2” STC system (3.15).

3.33**Space Traffic Coordination approving agent**

entity who sets requirements for, monitors, and approves the procurement, management, oversight, implementation, operations, performance evaluation, quality assurance, and monitoring functions of the Space Traffic Coordination system under their authority.

Note 1 to entry: The STC approving agent’s responsibilities can be handled by a commercial, non-governmental, governmental, or international individual or entity, as well as a mandated or delegated entity assigned by applicable national regulations.

3.34**Space Traffic Coordination participants**

set of entities that manage, operate, or use a Space Traffic Coordination System, including the STC approving agent, STC service provider, spacecraft and launch service providers, SSA and other STC entities, governments, and academia

3.35**Space Traffic Coordination system user**

entity that utilizes STC system products and services to inform and make operational decisions

Note 1 to entry: Spacecraft operators, launch service providers, Higher Airspace operators, SSA systems, other STC systems, and governments may all be STC system users.

3.36**Space Traffic Management**

set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and, where applicable, return from outer space to Earth free from physical or radio frequency interference^[4]

Note 1 to entry: STM contributes to a safer and more sustainable space operations environment, composed of (1) Space Traffic Coordination (STC), and (2) Regulation and Licensing, and dependent upon a foundation of continuous Space Situational Awareness (SSA)^[1].

3.37**State Actor**

entity participating in international space activities on behalf of a government

Note 1 to entry: While the roles of a State Actor could include that of regulator, spacecraft operator, launch service provider, and/or STC service provider, note that this standard does not address regulatory matters.

4 Symbols and abbreviated terms**4.1 Symbols**

(TBD)

4.2 Abbreviated terms

ADR	Active Debris Removal
CA	Conjunction Assessment
CAM	Collision avoidance manoeuvre
CCSDS	Consultative Committee for Space Data Systems
COLA	COLision Avoidance
FGUA	Fine-grained user access
GEO	Geostationary earth orbit
HAO	High altitude operations
HEO	High earth orbit
ISR	Intelligence, Surveillance and Reconnaissance
ITU	International Telecommunication Union
JCA	Just-in-time Collision Avoidance
LCOLA	"Launch Collision Avoidance" or "Launch COLA"
LEO	Low earth orbit
LTS	Long-Term Sustainability
LV	Launch vehicle
MEO	Medium earth orbit
O/O	Owner/Operator (i.e., of a spacecraft)
Pc	Collision probability
PoC	Point of Contact
RFI	Radio frequency interference
RotR	Rules of the Road
SANA	Space Assigned Numbers Authority
SAST	Static Application Security Testing
S/C	Spacecraft
SDA	Space Domain Awareness
SDR	Space Data Repository
SEP	Space environment preservation
SRP	Solar Radiation Pressure
SSA	Space situational awareness

STC	Space traffic coordination
STM	Space traffic management
TCA	Time of Closest Approach
UN	United Nations

5 STC system interoperability

5.1 General

There are several ways to promote interoperability of STC systems that State actors, spacecraft and launch service providers, STC service providers, and SSA service providers operate and/or depend upon. These include the development and widespread use of (1) common STC terminology, (2) consensus international data exchange formats, and (3) internationally accepted open-access data exchange mechanisms and/or repositories, in accordance with United Nations Guidelines for the Long-term Sustainability of Outer Space Activities^[2].

5.2 STC terminology

In order to promote interoperability and compatibility, STC participants should adopt and use the terminology, definitions, orbital element sets, attitude/orientation, orbit centres, organizations, time systems, reference frames. As well, STC participants should seek to standardize methods to refer to gravity models, and atmosphere models as defined in [Section 3](#) above as well as the SANA registry (https://www.sanaregistry.org/r/navigation_standard_registries) and^[5] and^[25].

5.3 International space operations and data exchange message standards

Consistent with UN COPUOS LTS^[6] Guideline A.2.f⁸⁾ and the operational practices of spacecraft and launch system providers and SSA service providers, STC participants shall use, where possible, international technical standards.

NOTE 1 The primary developer of STC-relevant consensus-based international standards related to data exchange that are open-access (freely available to everyone) is the Consultative Committee for Space Data Systems (CCSDS). CCSDS, which is space agency-led, and agency funded, publishes their standards via the CCSDS web portal (www.ccsds.org).

NOTE 2 ISO's Technical Committee 20, Subcommittee 13 (ISO TC20/SC13) works in partnership with CCSDS to co-publish relevant CCSDS standards on the ISO site (<https://www.iso.org/ics/49.140/x/>).

Note 3 See [Appendix A](#) for a listing and discussion of the Open-access international CCSDS data exchange standards. Especially noteworthy ones include ISO 19933 (Space systems — Format for spacecraft launch environment test report), ISO 26900 (Space data and information transfer systems — Orbit Data Messages), ISO 19389 (Space data and information transfer systems — Conjunction Data Messages), ISO 13541 (Space data and information transfer systems — Attitude Data Messages), ISO 13526 (Space data and information transfer systems — Tracking Data Message), and ISO 17107 (Space data and information transfer systems — XML specification for navigation data messages), [described in 34, 35, 37, 38, 40, 44, respectively].

5.4 International space data exchange mechanisms

Spacecraft operators and STC service providers should use bilateral and multilateral mechanisms, to include State Actor, commercial, and international entities, to exchange quality-controlled data that are readily accessible, easy to use, robust, secure, and have a high level of availability to share information where needed to support flight safety, relating to a spacecraft's orbit, attitude, tracking, launch, dimensions,

8) [States should] Consider ... using existing international technical standards, including those published by the International Organization for Standardization (ISO), the Consultative Committee for Space Data Systems and national standardization bodies."

mass, manoeuvre, orbit determination, points-of-contact, covariance, and ephemeris inclusive of planned manoeuvres and covariance information.

5.5 Arriving at a Shared Understanding with Multiple STC Systems

The process of coordinating space traffic is very complex, with the underlying SSA information based upon a long chain of space object detection, tracking, correlation, orbit determination and prediction, conjunction assessment, risk assessment, and collision avoidance. A single error or discrepancy in this entire processing chain can easily invalidate the results.

So it is no surprise that multiple STC systems may obtain different answers regarding collision risks and coordination of space traffic. [Section 5.5](#) provides requirements and guidance on how to achieve a shared understanding of these risks and potential mitigation strategies. These strategies will ease the merging of SSA information across national boundaries to support the goals of transparency, resilience, and interoperability.

6 Operational transparency

6.1 General

As called for in the Outer Space Treaty⁹⁾[\[7\]](#) and other relevant UN documents,[\[47\]](#) information sharing and exchange on space objects and events is important for the purposes of ensuring space safety and sustainability.

6.2 Exchange of information on orbital parameters of outer space objects and potential orbital conjunctions

Spacecraft operators and launch service providers shall exchange space data for the purposes of achieving effective flight safety threat identification and risk assessment, including planned manoeuvres, ephemerides inclusive of those manoeuvres, potential orbital conjunctions, spacecraft characteristics, and points-of-contact information with affected state actors and private sector STC systems and spacecraft operators, as specified in [Section 8](#).

Note 1 This is consistent with the goals of the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities^[2].

Note 2 From an STC and flight safety perspective, data to be shared are of two types: (1) orbital data that will be eventually discoverable by third-party SSA and therefore do not have a proprietary foothold, and (2) spacecraft and administrative data needed to make standard orbital safety calculations and collision risk assessments to facilitate collaborative resolution of serious conjunctions.

7 Manoeuvre recommendations and prioritization for when two manoeuvrable spacecraft are at risk of collision

7.1 Collision avoidance manoeuvre coordination

Collision avoidance manoeuvres should be coordinated with the other spacecraft operator(s).

NOTE This can be accomplished via bilaterally or multilaterally negotiated coordination protocols or agreements and implemented as applicable.

9) “In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities.”