# FINAL DRAFT
# International Standard

# ISO/FDIS 9490

# Space systems — Space Traffic Coordination (STC)

ISO/TC **20**/SC **14**

Secretariat: **ANSI**

Voting begins on:
**2026-07-10**

Voting terminates on:
**2026-09-04**

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Published in Switzerland

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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# Introduction

This 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.

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 radio frequency interference (RFI). The document is designed for state actors, spacecraft designers, spacecraft operators, and space data sharing and coordination (STC) system developers and operators.

Figure 1 clarifies the interrelationships between space domain awareness (SDA), space traffic management (STM), space traffic coordination (STC), space environment preservation (SEP) and the foundation of space situational awareness (SSA) that SDA, STM, and SEP draw upon.

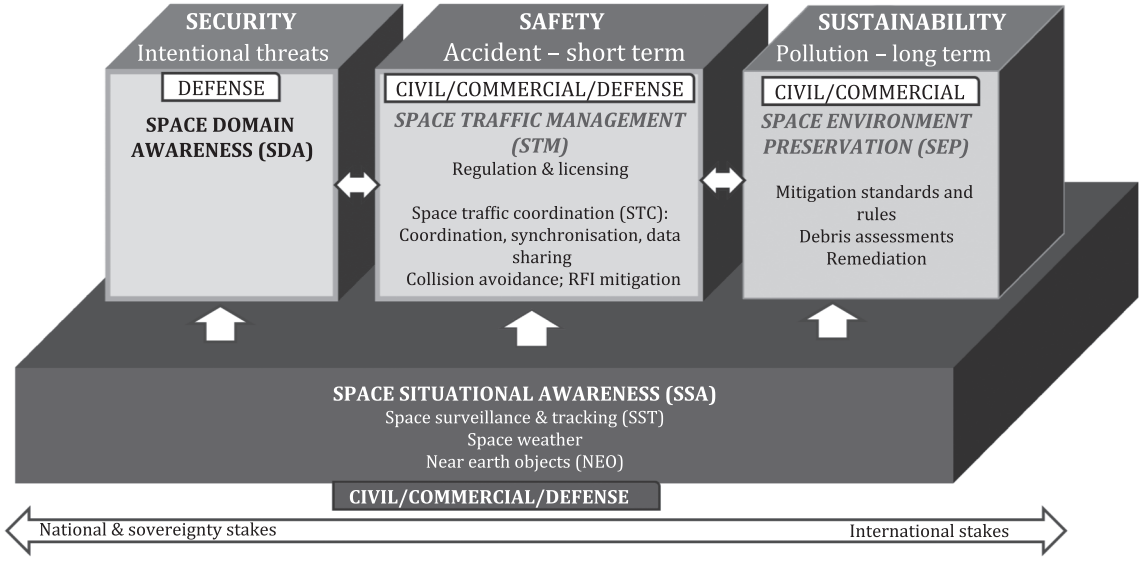



**Figure 1 — Relationships between SDA, STM, STC, SEP and SSA**

[SOURCE: Reference [1], reproduced with the permission of the authors.]

An STC system also supports a spacecraft operators' conformity with relevant international standards. According to the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities[2], STC is important for the safety, stability, and sustainability of operations in the space environment. STC helps facilitate flight safety, mitigates collision risk (for manoeuvrable spacecraft), and mitigates 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 relationships between SDA, SSA, STC, and STM is shown using a Venn diagram as shown in Figure 2.

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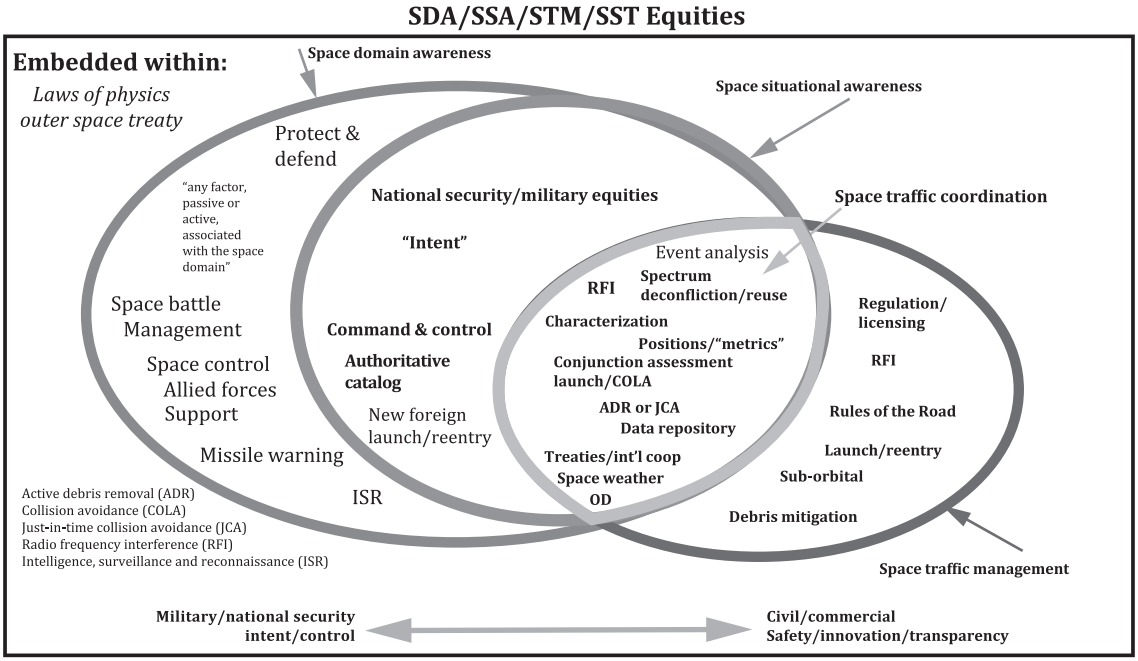



**Figure 2 — Venn diagram of relationships between SDA, SSA, STM and STC**

The range of STC systems is shown in Figure 3. For example, in its simplest form, an STC system can be nothing more than a communications path (via text message, telephone call, email or fax) to convey, for example, small amounts of operator or space data or information between operators, which is referred 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 operators, 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 can be collocated with an SSA system. This document focuses on requirements applicable to any STC system. A set of example topics and system requirements for more complex level 2 STC systems can be found in Annex D.

Accordingly, an STC system can consist of some, or all, of the elements shown in Figure 4. 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 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 operators 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 operators 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) can largely be a policy decision. This document provides requirements related to the many subsystems that an STC system can consist of, to include STC servers and network, STC space data and space information 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 document, with its STC and derived comprehensive data sharing and exchange requirements, does not address issues of national sovereignty, security, defence, classification, or other inherently governmental functions implied by the term space traffic management. The exact nature of and requirement for the bidirectional STC-to-STM feed indicated by Figure 4 depends upon applicable STM policies and regulations.

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For example, an STC system can exchange information with STM system(s) to assist in STM monitoring and regulatory functions where required by an STM decision authority.

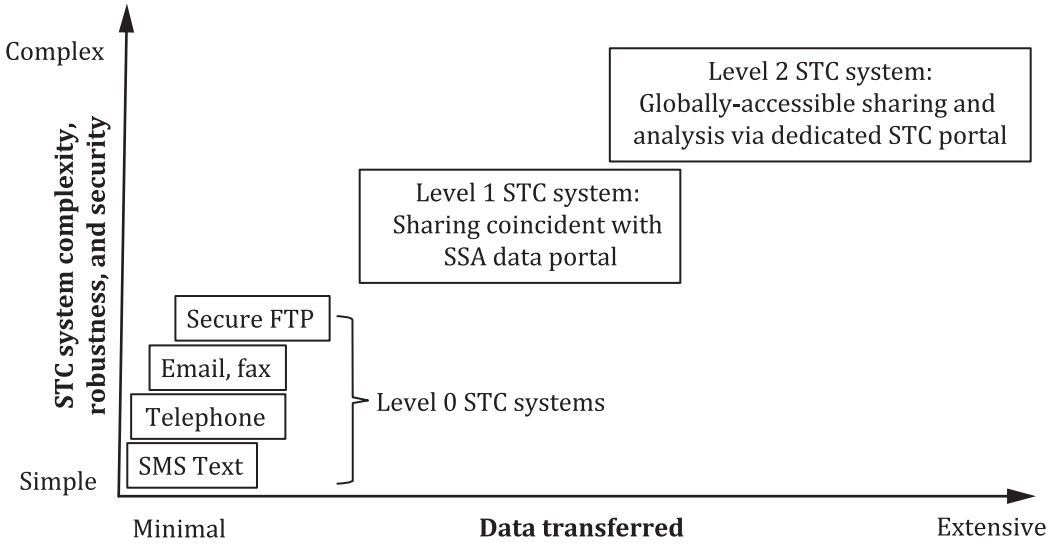



**Figure 3 — Possible types of STC communication channels characterized by complexity, robustness, and security**

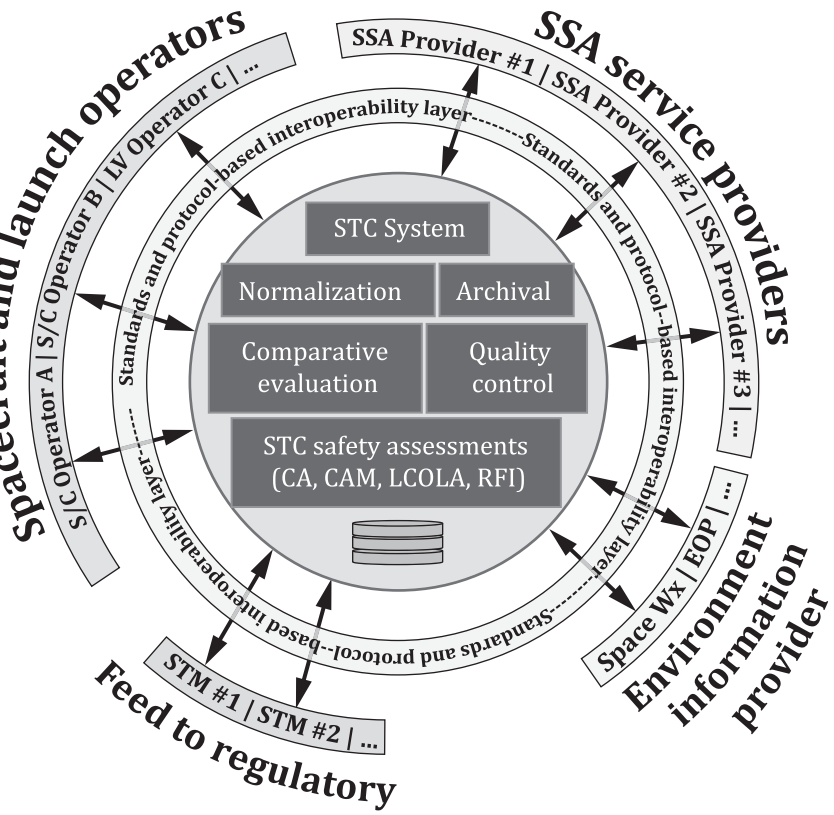



**Figure 4 — Interactions by organizations for a dedicated level 2 STC system**

The space flight safety-relevant topics of STC, 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 5.

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- **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

**Figure 5 — Division of space safety operations content spanning this document, ISO 23705 and ISO 21740**

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# Space systems — Space Traffic Coordination (STC)

## 1 Scope

This document addresses the essential elements and protocols needed for space traffic coordination (STC).

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

## 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 23705, *Space systems — Identifying, evaluating, and avoiding collisions between orbiting objects*

## 3 Terms and definitions

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

ISO and IEC maintain terminology 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* (3.4)

**3.2**
**collision risk**
product of *collision probability* (3.1) and *collision consequence* (3.3) for a space object experiencing a single *conjunction* (3.4), or the aggregation of this combination for a space object experiencing multiple conjunctions

**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 several ways, including the likelihood of catastrophic breakup, the number of debris fragments larger than a specified size or mass that can be generated, the lifetime of the resulting fragments[17], or some combination thereof.

**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* (3.1) threshold; or

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c) a combination of miss distance, probability, and other metrics (e.g., “risk”)

**3.5**
**constellation**
set of more than one spacecraft, operating in a coordinated manner by the same entity or linked entities, to create a single larger system, often based on a recurring spacecraft design and operating in similar orbits

EXAMPLE Space segments of satellite navigation systems or systems dedicated to global communication.

[SOURCE: IADC space debris guidelines 2025, modified — EXAMPLE has been added.]

**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 most air services are provided (i.e., above flight level FL 550), extending to altitudes where atmospheric density can no longer sustain lift through aerodynamics or buoyancy

**3.10**
**large constellation**
system of a hundred or more spacecraft working together, operated by the same entity or linked entities

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* (3.5) is regarded as “large,” as detailed in ISO TS 6434.

**3.11**
**launch collision avoidance**
**LCOLA**
process of mitigating the risk of collision between the newly launched objects resulting from a space launch and any space objects in their path

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* (3.1), thereby mitigating *collision risk* (3.2). Also, LCOLA launch trajectories typically have much less trajectory accuracy than on-orbit spacecraft, for example, 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.

**3.12**
**level 0 STC system**
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* (3.23) data between operators

**3.13**
**level 1 STC system**
level 1 space traffic coordination system
mid-level portal primarily focused on data exchange

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**3.14**
**level 2 STC system**
level 2 space traffic coordination system
globally accessible STC-information-sharing portal, storage, processing, and *flight safety* (3.8) analysis endeavour supporting spacecraft and launch service providers, *SSA* (3.24) data and information providers

**3.15**
**long-term sustainability**
**LTS**
ability to maintain the conduct of activities indefinitely into the future in a manner that realizes the objectives of equitable access, in order to meet the needs of the present generations while preserving the environment for future generations

[SOURCE: UN COPUOS LTS guidelines 2019, modified — "of space activities" deleted]

**3.16**
**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 can be accomplished meaningfully

**3.17**
**operational mission**
any instant in time during which a spacecraft or launch vehicle orbital stage carries out the tasks or functions for which it has been designed and deployed, other than its disposal

Note 1 to entry: While a spacecraft carries out orbit raising or orbit descent without carrying out the main tasks or functions for which it has been designed and deployed, it should be considered as not being in its operational mission.

**3.18**
**space data**
metric measurements or observations which can be processed to provide *SSA information* (3.24) which characterizes the space environment or activities within it

**3.19**
**space data repository**
**SDR**
device, computer, database, or other storage system that allows the population, storage, retrieval, and manipulation of *space data* (3.18) and *SSA information* (3.24), where relevant

**3.20**
**space object catalogue**
one-to-one mapping between unique object identifiers and a unique description of what the object is

**3.21**
**space domain awareness**
**SDA**
effective identification, characterization, and understanding of any factor, associated with the space domain that can affect space operations and thereby impact the security, safety, economy, or environment of a nation

Note 1 to entry: Other definitions for space domain awareness can exist, but this definition allows this document to differentiate between *STC* (3.30) and SDA.

[SOURCE: "Space Power: Doctrine for Space Forces", modified — Note 1 to entry added.]

**3.22**
**space environment preservation**
**SEP**
act of protecting, conserving, and sustaining the space operations environment, accomplished by space debris mitigation and remediation

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**3.23**
**space situational awareness**
**SSA**
knowledge and characterization of the space environment to facilitate decisions that support safe, stable, and sustainable space activities

Note 1 to entry: SSA 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 can disrupt missions and services.

[SOURCE: Reference [1], modified — Note to entry added.]

**3.24**
**SSA information**
space situational awareness information
insights into space environment or activities within it, derived from the processing of *space data* (3.18) via astrodynamics, estimation techniques, risk assessments, statistics, machine learning, and other analytical techniques

Note 1 to entry: SSA information 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]

**3.25**
**SSA service provider**
space situational awareness service provider
entity that operates an *SSA system* (3.26) 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.

**3.26**
**SSA system**
space situational awareness system
set of information gathering and exchange protocols enabling the characterization of the space environment and dissemination of its knowledge

**3.27**
**space surveillance and tracking**
**SST**
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.

**3.28**
**space traffic coordination**
**STC**
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

[SOURCE: Reference [1]]

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**3.29**
**STC service provider**
space traffic coordination service provider
entity that operates the STC system pursuant to its obligations set by the relevant *STC approving agent* (3.33)

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.

**3.30**
**STC system**
**space traffic coordination system**
set of protocols, communications paths, information gathering and exchange, data fusion and *SSA* (3.24) analytical services to facilitate *flight safety* (3.8), sustainability, and decision making

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

**3.31**
**STC approving agent**
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* (3.32) under its 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.

**3.32**
**STC participants**
space traffic coordination participants
set of entities that manage, operate, or use a *space traffic coordination system* (3.32), including the *STC approving agent* (3.33), *STC service provider* (3.31), spacecraft and launch service providers, *SSA* (3.24) and other *STC* (3.30) entities, governments, and academia

**3.33**
**STC system user**
space traffic coordination system user
entity that utilizes *STC system* (3.32) products and services to inform and make operational decisions

Note 1 to entry: Spacecraft operators, launch service providers, *higher airspace* (3.9) operators, *SSA systems* (3.27), other STC systems, and governments can all be STC system users.

**3.34**
**space traffic management**
**STM**
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.

Note 1 to entry: STM contributes to a safer and more sustainable space operations environment, composed of:

a) *space traffic coordination (STC)* (3.30);

b) regulation and licensing, and dependent upon a foundation of continuous *space situational awareness (SSA)* (3.24). [1]

[SOURCE: Reference [4], modified — Note to entry added.]

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**3.35**
**state actor**
entity participating in international space activities on behalf of a government

Note 1 to entry: While the roles of a state actor can include that of regulator, spacecraft operator, launch service provider, and *STC service provider* (3.31), this document does not address regulatory matters.

**3.36**
**system**
set of interrelated or interacting elements

# 4 Symbols and abbreviated terms

## 4.1 Symbols

| | |
|---|---|
| $A_{Target}$ | effective area of the target [ $m^2$ ] |
| $E_{EntranceAperture}$ | the point source irradiance reaching the tracking sensor aperture [W/m$^2$] |
| $d_{SunToTarget}$ | distance from the sun to the target [m] (e.g., 1 AU = $1{,}495\,978\,706\,6\times10^{11}$ $m$) |
| $d_{TargetToSensor}$ | distance from target to tracking sensor [ $m$ ] |
| $dia_{Target}$ | effective diameter of the target, [ $m$] |
| $E_{Sun}$ | exoatmospheric solar irradiance, nominally 1 380 [ $W/m^2$ ] at 1 AU |
| $E_{Target}$ | target irradiance at tracking sensor without atmospheric loss [W/m$^2$] |
| $E_0$ | ref. visual magnitude (Vega) irradiance [$2{,}778\,94\times10^{-8}$ $W/m^2$ ] |
| $F$ | general shadowing term accounting for the penumbra region's influence [unitless, 0 < F ≤1, 0 = umbra, and 1 = full sun illumination] |
| $I_{Sun}$ | solar intensity ≈ $3{,}088\,374\,161\times10^{25}$ [ $W$ / $sr$ ] |
| $I_{Target}$ | intensity of reflected energy from target treated as a point source [W/sr] |
| $Phase(\varphi)$ | geometric reflectance phase function [unitless, 0 < $Phase(\varphi)$ ≤1] |
| $\varphi$ | critical angle to the sun (CATS) from sun to the tracking sensor, as shown in Fig. C-5 and referenced to the observed target [rad] |
| $\pi$ | pi constant |
| $\rho$ | reflectance of the target [between 0 (none) and 1 (perfect reflectance)] |
| $\tau_{Atmosphere}$ | effective transmission of the atmosphere [unitless, 0 < τ ≤ 1] |

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