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Space Traffic Management as a sine qua non prerequisite for the sustainability of outer space activities: Evaluating Regulatory Patterns Provided by the Airspace Paradigm

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The evolution and proliferation of human activities in outer space, as well as the involvement of the private sector in this area have brought to the forefront of international consultations the issue of Space Traffic Management (STM).

1)WHAT IS SPACE TRAFFIC MANAGEMENT?

2006 IAA “Cosmic Study on Space Traffic Management”:

STM → **“the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical or radio-frequency interference”.**

UNCOPUOS LSC, 2017: STM implementation → *sine qua non* prerequisite for the sustainability of Outer Space.

1) WHAT IS SPACE TRAFFIC MANAGEMENT?

STM:

→ situational awareness,
→ traffic regulation and enforcement,
→ traffic control.
These functions: performed at **launch, on-orbit,** and upon **re-entry.**

STM → administration of **near-Earth outer space**.

2) WHY STM IS NECESSARY?

→Collision risks into orbit.

In 2016, 4.256 satellites into orbit, 4.39% increase.

UCS → 1.419 operational satellites.

IAA CS: Risks → “high level and ever growing number of launches from more and more launch sites and spaceports, the participation of non-governmental entities, the positioning of satellite constellations, [the] increase in space debris and the advent of reusable launch vehicles”.

2) WHY STM IS NECESSARY?

Additional concern: Small sats (app. 7% of the satellites in orbit)

1/5 of CubeSats will remain in orbit more than a quarter-century.

➔ 2017 LSC Report: « the space environment is becoming increasingly complex and congested, owing to the growing number of objects in outer space, the diversification of actors in outer space and the increase in space activities... all of those factors increased the chances of potential collisions in outer space...».

3) HOW IS STM LINKED TO SUSTAINABLE DEVELOPMENT?

UNISPACE+50 thematic priority Nº 2 “Legal regime of outer space and global space governance: current and future perspectives”:

“(c) Studying legal mechanisms… to cope with… perspectives of space traffic management and an enhanced exchange of information on space objects and events…”

(c) Studying legal mechanisms to foster an international regime of responsibility and liability to cope with **present and future challenges to the safety, security and sustainability of outer space activities** and **the safety of space operations, perspectives of space traffic management and an enhanced exchange of information on space objects and events.** Specific consideration is to be given to current practical concerns of the international community, **such as in-orbit collisions and interferences.** In particular, there should be an assessment of the need for **enhanced registration and notification procedures** and their institutional requirements under the registration and notification platform maintained by the Office for Outer Space Affairs;

3) HOW IS STM LINKED TO SUSTAINABLE DEVELOPMENT?

Thematic priority No 3, “Enhanced information exchange on space objects and events”:

“Objective: Define and develop requirements for enhanced information exchange and notification procedures under the United Nations Register of Objects Launched into Outer Space, taking into account… the future guidelines for the long-term sustainability of outer space activities… Identify cooperation mechanisms to support this objective. Encourage capacity-building and outreach activities on transparency and confidence-building measures”.

3) HOW IS STM LINKED TO SUSTAINABLE DEVELOPMENT?

UN COPUOS Guidelines 4, 12 and 13 on the Long-Term Sustainability of Outer Space Activities:

→ equitable, rational and efficient use of the radio frequency spectrum,

→ improvement of accuracy of orbital data and of sharing of orbital information

→ promotion of the collection, sharing and dissemination of space debris monitoring information.

4) CAN ATM SERVE AS A MODEL FOR STM?

Analogies ATM – STM:

→ 3-D spaces (sea: 2-D space);
→ High velocities;
→ Over the high seas, freedom of overflight, no sovereignty.

4) CAN ATM SERVE AS A MODEL FOR STM?

ICAO: ATM → "the dynamic, integrated management of air traffic and airspace — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties" (ICAO Doc. 9854-AN/458).

4) CAN ATM SERVE AS A MODEL FOR STM?

- The ATM system → provision of services;
- ATM comprises airspace, aerodromes, aircraft and humans;
- ATM separates flight from hazards, within capacity limits, making optimum use of all system resources;
- ATM is based on realistic expectations of human capabilities;
- ATM infrastructure → independent of reference to any specific technology (ICAO Doc. 9854-AN/458).

4) CAN ATM SERVE AS A MODEL FOR STM?

The fundamental distinction in air traffic is between **national airspace** and **international airspace**.

States have “complete” and “exclusive sovereignty” in NAS (Article 1 1944 Chicago Convention).

Within **national airspace**, Air Traffic Management is regulated through domestic legal provisions (Article 11 CC).

4) CAN ATM SERVE AS A MODEL FOR STM?

In international airspace (over the high seas) → freedom of overflight reigns (87 UNCLOS, (*a contrario*) 1, 2, 12 CC.

Article 12 para. 3 CC: **"over the high seas, the rules in force shall be those established under this Convention"** → SARPs embodied in the 19 Annexes to the Chicago Convention.

ATM **over the high seas** → a model for STM?

4) CAN ATM SERVE AS A MODEL FOR STM?

Pursuant Article 38 CC, States must comply with ICAO ISs unless they notify their differences to ICAO within 60 days:

"In the case of amendments to international standards, any State which does not make the appropriate amendments to its own regulations or practices shall give notice to the Council within sixty days of the adoption of the amendment to the international standard, or indicate the action which it proposes to take".

4.1) THE ATM CONCEPT

Air Navigation Regions, divided into **Flight Information Regions (FIRs)** on the basis of a **Regional Air Navigation Plan** (RAN Plan), agreed by the States of the Region.

Within a FIR, a "competent authority" provides for:

the **flight information service** (safe and efficient conduct of flights); and
the **alerting service** (aircraft in need of search and rescue aid)

These two services, together with the **air traffic control service**, are known as the **Air Traffic Services (ATS).**

4.1) THE ATM CONCEPT

The **FIR** airspace expands below **flight level 195,** and within it we find other airspaces: **ATZ** (aerodrome Traffic Zone), **CTR** (Control Zone), **TMA** (Terminal Control Area), **AWY** (Airway). The Flight Information Region is an uncontrolled airspace. The authority which manages this airspace is the FIC (Flight Information Center).

4.1) THE ATM CONCEPT

Co-existence of civil/military users: Annex 11, 2.17, 2.18 (Civil/ military coordination)

2.17 Coordination between military authorities and air traffic services

2.17.1 Air traffic services authorities shall establish and maintain close cooperation with military authorities responsible for activities that may affect flights of civil aircraft.

…

2.17.3 Arrangements shall be made to permit information relevant to the safe and expeditious conduct of flights of civil aircraft to be promptly exchanged between air traffic services units and appropriate military units.

4.1) THE ATM CONCEPT

Co-existence of civil/military users: Annex 11, 2.17, 2.18 (Civil/ military coordination)

2.18 Coordination of activities potentially hazardous to civil aircraft

2.18.1 The arrangements for activities potentially hazardous to civil aircraft, whether over the territory of a State or over the high seas, shall be coordinated with the appropriate air traffic services authorities. The coordination shall be effected early enough to permit timely promulgation of information regarding the activities in accordance with the provisions of Annex 15.

4.1) THE ATM CONCEPT

Co-existence of civil/military users: Annex 11, 2,17, 2.18 (Civil/ military coordination)

Key: Timely exchange of information between military and civil users!

4) CAN AIR TRAFFIC MANAGEMENT (ATM) SERVE AS A MODEL FOR THE DEVELOPMENT OF STM?

ATM → a complex but integrated system of traffic administration. **The experience shows that this system proved to be effective.** ATM is an efficient, legal/technical regime of air traffic administration established by ICAO and mainly regulated by ICAO's international standards.

4) CAN AIR TRAFFIC MANAGEMENT (ATM) SERVE AS A MODEL FOR THE DEVELOPMENT OF STM?

As exposed, ATM constitute and integrated traffic management system that could be a source of ideas and solutions for STM. Its main characteristics are the following:

1) Advanced international cooperation;
2) Centralised supervision (ICAO) of a de-centralised TM system (Management of ATS, FIRs by States);
3) Institutionalized exchange of information between users (aircraft) and the competent authorities;
4) Classification of airspaces for the purposes of ATS provision (Annex 11, 2.6);
5) Constant monitoring of civil fights allover the world;
6) Increased civil/military coordination.

5) LAUNCH, RE-ENTRY: TOWARDS A UNIFORM TMS?

Outer space extends vertically beyond airspace! ➔ launch and/or re-entry phases take place in airspace, thus affecting its use by airspace users!

It follows that, as far as launch and re-entry operations are concerned, STM:

- **Either should be co-ordinated with ATM; or**
- **It has to be provided by the –same- ATS providers.**

5.1) INTEGRATING SPACE OPERATIONS INTO AIRSPACE TM: THE FAA PARADIGM

The Commercial Space Launch Act of 1984, as amended and re-codified at 51 U.S.C. 50901 - 50923 (the Act), authorizes the Department of Transportation (DOT) and, through delegations, the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation (AST), to oversee, authorize, and regulate both launches and reentries of launch and reentry vehicles, and the operation of launch and reentry sites when carried out by U.S. citizens or within the United States. The Act also directs the FAA to encourage, facilitate, and promote commercial space launches and reentries by the private sector, including those involving space flight participants.

55.1) INTEGRATING SPACE OPERATIONS INTO AIRSPACE TM: THE FAA PARADIGM

Increasing commercial space activities occurring in the National Airspace System (NAS) led the FAA to identify a need for more efficient management of the NAS with respect to commercial space operations.

Current methods for integration of aviation and space activities employ a segregation approach, in which hazard areas are constructed around launch and reentry operations and sections of airspace are closed to other users.

Mission objectives and vehicle characteristics dictate the extent of the closure in terms of location, duration, and volume of airspace affected.

5) LAUNCH, RE-ENTRY: TOWARDS A UNIFORM TMS?

FAA has developed an approach to integrating commercial space launch and reentry operations into NAS.

Upfront planning to minimize the effect of launches/ reentries on the system's performance without jeopardizing the vehicle operator's opportunity for mission success.

FAA has successfully applied this approach to a number of launch, reentry, and amateur rocket activities.

5.1) INTEGRATING SPACE OPERATIONS INTO AIRSPACE TM: THE FAA PARADIGM

An integrated Space and Air Traffic Management System (SATMS):

→a conceptual "aerospace" environment in which space and aviation operations are seamless and fully integrated in a modernized, efficient National Airspace System (NAS)

→ an integrated system that increases protection for civil aircraft against space hazards (Columbia).

6) ON-ORBIT TM: "ENTRY-LEVEL" GEO STM THROUGH THE ITU

ITU → indirectly, "elementary" on-orbit TM in the GEO.

Satellites and spacecraft use radio frequencies. ITU allocates specific orbital slots in order for satellites/ spacecraft to avoid radio frequency interferences.

6) ON-ORBIT TM: "ENTRY-LEVEL" STM THROUGH THE ITU

ITU provides in practice a basic traffic management regime in this specific area (GEO).

Pre-launch notification, separation of satellites (to avoid interferences).

Nevertheless, everything else in orbit is left to the discretion of the relevant operator.

CONCLUDING:

1) The main feature, and the basic need for space traffic management at present, is to avoid collisions in orbit. Collision avoidance improves on-orbit safety, contributes to the protection of the space environment and, consequently, constitutes a decisive step towards the long term sustainability of outer space. Space traffic management (STM) is the principal tool to achieve this avoidance. Thus, on-orbit STM becomes an indispensable tool towards the long-term sustainability of outer space activities.

2) Timely exchange of information is in the heart of an efficient on-orbit STM. This is further reinforced by UNISPACE +50 thematic priorities 2 and 3, as well as the already adopted COPUOS Guidelines 4, 12 ans 13 on the Long-Term Sustainability of Outer Space Activities.

CONCLUDING:

3) The established ICAO mechanism for ATM, mainly based on the concept of FIRs and an advance civil/military coordination scheme, can serve as a model for an efficient STM. What is more, launch and re-entry phases of space operations essentially share airspace with the “air” users. Current segregation can change to an integration of the relevant services than can be mutually beneficial. The FAA’s integrated Space and Air Traffic Management System (SATMS) scheme can be a paradigm of the shape of things to come.

4) In the GEO, an “elementary” on-orbit STM is provided by the ITU through the allocation of orbital slots in order for radio frequency inteeferences to be avoided. There is still a lot of work to be done, eventually in line with the ATM institutions and standards.