Space Policy 31 (2015) 5–12

Contents lists available at ScienceDirect

Space Policy

journal homepage: www.elsevier.com/locate/spacepol

Legal and policy aspects of space situational awareness☆

Stefan A. Kaiser

LL.M. (McGill), Heinsberg, Germany

ARTICLE INFO

Article history:
Received 15 March 2014
Received in revised form
5 November 2014
Accepted 9 November 2014
Available online 4 December 2014

Keywords:
Space situational awareness
Space debris
Types of data & information
Cooperation
Data exchange policy
Civil – military issues
Quality of data and information
Responsibility
Liability
Registration of space objects
Space traffic management

ABSTRACT

With the rising number of man-made space objects, space situational awareness becomes increasingly important for space faring nations. International cooperation and exchange of data and information are prerequisites. Different forms of cooperation are possible and national policies have an impact. New players of the information industry can take over roles in space situational awareness. This article examines how principles like international cooperation, responsibility, liability and the obligations to register space objects under the existing space treaties apply to space situational awareness.

1. Space situational awareness

1.1. Definition

There is neither a definition of space situational awareness in a legally binding international instrument,[1] nor is there a consensual definition among technical experts. The term is derived from 'situational awareness'. This concept originates from complex and dynamic environments, like aviation, complex machinery, medicine and the military. In plain language, it is the up-to-date knowledge about what is happening within a given space and time. It is the purpose of situational awareness to project relevant events into the future in order to avoid threats or to plan actions. Due to the dynamics and complexity of the orbital movements of the increasing number of space objects including space debris and its interactions, the military was first to apply the concept of situational awareness to space activities. In the meantime, also the civilian world has become interested in space situational awareness. Today, space situational awareness is generally considered as the understanding and maintained awareness of[2]

- man-made objects orbiting the Earth, including spacecraft, rocket bodies, mission-related objects and fragments;
- the space environment, comprising natural objects, including near Earth objects and meteorites, man-made effects on the space environment and space weather, including solar activity and radiation[3]; and

☆ This article is written in a personal capacity and shall not be attributed to any organization with which the author is affiliated.

E-mail address: stefanakaiser@aol.com.

[1] The European Commission avoids using the term 'space situational awareness', but use the concept of 'space surveillance and tracking (SST)', for which they define the terms 'SST sensor', 'SST data' and 'SST information', see Article 2 (4) to (6), Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishing a Framework for Space Surveillance and Tracking Support.

[2] User Expert Group of ESA SSA requirement study, cited after del Monte, *A European Approach to Space Situational Awareness*, Fourth European Space Weather Week, Brussels, 5–11 November 2007.

[3] The European Space Agency lists the following areas to form part of space weather: solar weather, ionospheric weather, geomagnetic conditions, space radiation, heliospheric weather, see <http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/Space_Weather_-_SWE_Segment> Space weather is not only important for its direct threats against humans in outer space and operational space objects, e.g. solar activity affecting radio communication of satellites, but also for its changes of the orbital parameters of all orbiting objects.

http://dx.doi.org/10.1016/j.spacepol.2014.11.002
0265-9646/

- possible threats, including risks to humans and property on the ground and in the air space due to accidental or intentional re-entries, on-orbit explosions and release events, on-orbit collisions, and capabilities disrupting missions and services.

1.2. Space situational awareness system

As conceived today, a space situational awareness system consists of three principal elements and activities:

- the collection of data and information, typically including the detection and tracking by ground-based and space-based optical and radar sensors, and collection by other sources, like registration information and exchanges with other public and private bodies including satellite operators;
- the arrangement of the collected information in a systematic manner, typically by keeping and updating a data base or catalogue of all space objects and space debris, including their orbital parameters[4]; and
- computer processing capacity to predict the status, events and threats in the future, most importantly to issue reliable conjunction information, i.e. predicting with a useful probability collision conflicts among man-made and possibly also natural space objects.

The quality of a space situational awareness system depends on the combination of these three elements. The precision of the sensor data is important for determining the exact position of a space object at a given time. The comprehensiveness of a data base is the requirement for establishing conjunction information for conflicts among as many objects as possible. Conjunction predictions are reliable only when future positions of objects can be precisely predicted. Lack of precision of any of the said three elements does not only add errors, but multiplies them! Imprecise conjunction information cannot be compensated by lowering the threshold for conjunction warnings. To the contrary, it would lead to an inflation of false alarms and render such conjunction information useless.

1.3. Existing systems and components

1.3.1. USA

Currently, the most comprehensive work on the field of space situational awareness is achieved by the U.S. Under the current U.S. National Space Policy (2010) the Secretary of Defence and the Director of National Intelligence are responsible for space situational awareness not only for military purposes, but also to support civil space agencies and commercial and foreign space operations.[5] Based on this, the Space Surveillance Network (SSN) operates a worldwide sensor network and provides the information to the Joint Space Operations Center (JSpOC) under the superior command of the U.S. Strategic Command (US STRATCOM). With these data inputs, the JSpOC catalogues Earth orbiting man-made objects and combines them with other information[6] to provide space situational awareness. By January 2014 the JSpOC tracked more than 16,000 objects. About five percent thereof were functioning payloads or satellites, eight percent rocket bodies, and about 87 percent space debris and inactive satellites.[7] In 2009 US STRATCOM took responsibility for the 'SSA Sharing Program' for providing space situational awareness services and information to, and obtaining the same from, foreign States and U.S. and foreign commercial entities.[8]

1.3.2. Russian Federation

The Russian Federation operates the second largest network of space situational radar sensors based on its military missile warning system and situated at locations all over the former Soviet Union. The radar sensors are supplemented by the optical 'Okno' tracking facility in Tajikistan and the International Scientific Optical Network (ISON), a cooperative network of optical instruments managed by the Russian Academy of Sciences consisting of 33 facilities in 14 countries with more than 60 telescopes. The ISON network collects routinely measurements of more than 1800 objects in the geostationary region and of more than 1400 objects in highly elliptical orbits.[9]

1.3.3. Europe

Despite space surveillance sensor capabilities like the French GRAVES and the German TIRA, there is no European-wide space situational awareness system. The European Space Agency (ESA) has implemented Space Situational Awareness as an optional ESA programme currently approved until 2019 and with limited funding. It is the purpose of this ESA programme to unify existing assets and capabilities and to develop new infrastructure. The programme covers the areas of space weather, near-earth objects and Space Surveillance and Tracking (SST).[10] For the period from 2014 to 2020 the European Parliament and Council have decided to establish a SST support programme.[11] However, this proposed SST support programme seems to deviate from ESA's programme and neither supports the development of new sensors, nor does it create a mandatory cooperation programme. In case Member States of the European Union who possess relevant sensors decide to cooperate voluntarily, this support programme establishes policy, offers limited financial support by way of grants and mandates the participation of the European Union Satellite Centre.[12]

1.3.4. China

China is believed to possess a network of phased-array radar tracking stations, but information is classified. The most prominent

[4] The orbital parameters inserted into the object data base consist of seven elements: epoch, inclination, right ascension of ascending node, argument of perigee, eccentricity, mean motion and mean anomaly. These seven elements define the position of a space object relative to the earth at a given time. Sometimes 'drag' is added as an optional eighth element to better calculate the degradation of the object's orbit due to atmospheric friction.

[5] Space Policy of the United States of America, 28 June 2010, p. 13, 14: "The Secretary of Defense and the Director of National Intelligence, in consultation with other appropriate heads of departments and agencies, shall: … Maintain and integrate space surveillance, intelligence, and other information to develop accurate and timely SSA. SSA information shall be used to support national and homeland security, civil space agencies, particularly human space flight activities, and commercial and foreign space operations".

[6] Such other information is for example intelligence and reconnaissance data.

[7] Factsheet USSTRATCOM Space Control and Space Surveillance, http://www.stratcom.mil/factsheets/11/Space_Control_and_Space_Surveillance/.

[8] 10 USC § 2274. Information is provided through the website www.space-track.org following acceptance of the terms of a User Agreement.

[9] http://unoosa.org/pdf/pres/stsc2014/tech-26E.pdf.

[10] http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/About_SSAThe European Parliament had taken the initial step into that direction "by supporting the creation of a European space surveillance system leading to space situational awareness to monitor the space infrastructure, space debris and, possibly, other threats …" and by supporting the possibility to fund a European space situational awareness system from EU funds; see sections 20, 21, European Parliament Resolution (2008/2030(INI)), 10 July 2008.

[11] Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishing a Framework for Space Surveillance and Tracking Support, *supra* note 1.

[12] Articles 5 to 8, *ibid*.