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Anticipating uncertainty: The security of European critical outer space infrastructures

Phillip A. Slann

Lasne, Belgium

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ABSTRACT

Terrestrial societies are heavily dependent on Earth-orbiting satellites for the provision of services which many people now take for granted. However, with this dependence comes a need to preserve the transmission of these services whilst faced with a number of risks and dangers, including intentional interference, space debris and radiation emanating from space weather phenomena. The European Union (EU) has identified these services, along with the satellites and networks which provide them to its citizens, as critical infrastructures, indicating the need for their security. The article frames the EU's efforts to secure its critical outer space infrastructures, namely the draft International Code of Conduct for Outer Space Activities and the Space Situational Awareness programme, through the lens of anticipatory security. The article concludes that both these approaches to outer space security are predicated upon the precautionary acknowledgement of risks or threats and involve mostly preemptive measures alongside some elements of prevention.

1. Introduction[1]

21st Century terrestrial societies are heavily dependent on Earth-orbiting satellites for the provision of a wide range of services which many people now take for granted. The atomic clocks housed within satellites making up the Global Navigation Satellite Systems such as GPS or Galileo, are integral to the modern financial system, enabling synchronised timing across the globe. Equally, the increase in volume and safety of transport in the air, by sea or on the road is due in no small part to navigation and positioning services and to the augmentation of those services by in situ and orbital systems. In the area of environmental sciences remote sensing satellites have been used for decades to monitor changes in the Earth's climate and landscape, and the almost innumerable societal benefits accrued from the developments of Earth-orbiting satellites mean that these extra-terrestrial infrastructures – both the assets and the services that they provide – have become critical to contemporary modes of life.

The nature of the outer space environment means that security within the domain is markedly different to that which takes place on Earth. With the exception of those in geostationary orbit, satellites and other functioning man-made space objects do not remain in a fixed position relative to their ground control segments, introducing a mobility divorced from the largely static nature of terrestrial critical infrastructure hardware. Moreover, satellites' orbits are spread vertically over thousands of kilometres, although some altitudinal regions are more popular than others. The three dimensional spatio-temporal nature of outer space operations means that satellite security often involves orbital trajectory prediction in addition to assessment of the risk posed by a specific threat or danger. In other words, dangers must be assessed in terms of which satellites will be passing through the affected three dimensional region in order to gauge the extent to which they can be considered threatening. Consequently, in addition to historical experiences, calculations of risks to satellites are dependent upon data from Space Situational Awareness (SSA) programmes. The capacity to 'know' threats in outer space is thus limited by technological capabilities.[2]

E-mail address: phillip.a.slann@gmail.com.

[1] This article uses the following abbreviations: EU (European Union), LTS (Large Technical System), PPWT (Treaty on Prevention of the Placement of Weapons in Outer Space and the Threat or Use of Force against Outer Space Objects), SSA (Space Situational Awareness), UN (United Nations) and USSSN (United States Space Surveillance Network).

[2] For instance, concerns have been raised over the ageing US Space Surveillance Network (USSSN) and its continued capability to deliver accurate orbital trajectory data [5].

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There are a number of risks, threats and dangers for which satellite operators and manufacturers must plan. Of these, the more imminent or certain dangers include software or hardware malfunction, and intentional and unintentional interference through jamming – the blocking of transmissions between satellites and ground stations – or spoofing – malicious interference whereby persons impersonate a satellite's control centre – although the latter can be easily detected through error code checking routines [1]. Other, more novel and uncertain risks in this category include accidental collisions between satellites and space debris,[3] the intentional destruction of satellites through use of anti-satellite weapons, and interference with satellites caused by radiation from space weather phenomena. In addition, there are dangers with a higher degree of uncertainty regarding their nature or consequences; large-scale space weather events have occurred in the past, whilst there is a possibility that space debris will begin colliding with each other, leading to a cascade at some orbital altitudes. Although space weather events and collisions between satellites and debris are relatively common, extreme scenarios present a host of unknown factors or possible consequences.

The European Commission states that:

> [s]pace infrastructure is critical infrastructure on which services that are essential to the smooth running of our societies and economies and to our citizens' security depend. It must be protected and that protection is a major issue for the EU which goes far beyond the individual interests of the satellite owners [2].

The identification of outer space infrastructure as 'critical infrastructure' is indicative of its perceived importance to European societies in general. This association between the terrestrial and the extra-terrestrial is a microcosm of the European Union's (EU) wider involvement in outer space affairs, whereby the organisation has gradually recognised the importance of space assets to modes of life on Earth [3]. In addition, in the 7th Space Council resolution, the Council of the European Union calls upon 'the EU, [… the European Space Agency] and their Member States to undertake the necessary actions […] to protect satellites and satellite signals and to secure frequencies, taking into account emerging new threats to space assets' [4]. This statement reveals the objects it recognises as requiring protective measures, identifying what the EU perceives as the integral aspects of its outer space infrastructures.

The gradual recognition of the importance of outer space assets and their identification as components of critical infrastructures is a significant development in terms of outer space security. However, it is not the intention of this article to explore in great detail the materiality of outer space infrastructures. Instead the focus is upon the extent to which logics of anticipatory security exist within the draft International Code of Conduct for Outer Space Activities and the European SSA programme.

Despite the importance of satellites and their services to terrestrial societies, there has thus far been little academic scrutiny of the efforts undertaken by the EU to secure its outer space infrastructures. This article focuses upon the space segments of European critical outer space infrastructures and two anticipatory security measures through which the EU is attempting to secure them. The objective here is not only to promote discussion of anticipatory mechanisms of European outer space security – namely the draft International Code of Conduct for Outer Space Activities and the European SSA programme – but also to highlight the inherent spatio-temporal uncertainties associated with the security of assets outside the confines of the Earth's atmosphere. In applying prevention and preemption to the specific spatio-temporal context of outer space, this article additionally seeks to contribute to contemporary debates concerned with anticipatory security.

After introducing critical infrastructures using both EU policy definitions and academic discourses, the article frames Critical Infrastructure Protection and, in particular, Critical Infrastructure Resilience as forms of anticipatory security. This is followed by an analysis of the draft International Code of Conduct for Outer Space Activities and the European SSA programme as security mechanisms predicated upon preemptive and preventive anticipatory logics.

2. Designating critical infrastructures

'Infrastructure' is general terminology which can be loosely defined as pertaining to systems or structures which support the functioning of the state or society [7–9]. It thus ranges from transportation networks – such as railroads [10], motorways and bridges – to communication networks – such as satellite telecommunications, information and communications technology networks and fibre-optic cables. Some of these infrastructures may well be more important – or 'critical' – to a state or society than others. It should be emphasised that infrastructures are not only the assets or structures which communicate, distribute or relay services; rather, the term comprises of the entire system of assets and services. As such, infrastructure security is subject to a specific form of materiality predicated upon interconnectivity and 'intra-action' [7]. In addition, infrastructures are often complex entities, constituted of a number of systems which were not originally designed to function in tandem. Egan terms these particular infrastructures Large Technical Systems (LTSs), which 'will have developed through a planned, or more likely unplanned, "rafting" together of many different systems, each relying on the next for efficiency, stability and effectiveness' [11]. The complexity and interdependence of LTSs means that they are inherently vulnerable to failures within any part of the system [11], leading to a need for high degrees of reliability and resilience. Outer space infrastructures and the services they provide are pertinent examples of this 'rafting' as they underpin many of the acknowledged terrestrial critical infrastructures. This is underlined by the inclusion of the Galileo programme in a list of critical infrastructures providing inter-state and inter-sector interdependencies within Europe [12]. A failure in these outer space infrastructures could have a cascading effect upon other LTSs, leading to widespread malfunctions and failures in critical infrastructures across the globe.

In practice, states and institutions have their own definitions of critical infrastructure, although there are similarities between them. For instance, within Europe, critical infrastructure is defined by the Council of the European Union as:

> an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions [13].

The criticality of infrastructure then appears to be determined by the effect its damage or loss would have on the state in which it is based [14], an understanding which Burgess describes as 'necessarily *negative*' [15], insofar as it is based upon a worst-case scenario. In this manner, the value of an infrastructure is revealed

[3] Space debris is defined in the United Nations (UN) space debris mitigation guidelines as 'all man-made objects, including the fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional' [6].