Legal Perspective of GNSS Signals Failure Caused by Interference Through Jamming and Spoofing
PRESENTATION CONTENTS

1- The Technical Aspects of Satellites and Satellite Signal Interference.

2- Legal Frameworks Governing Satellites and Intentional Interference.

3- Intentional Interference under the UN Charter.

4- Lawful Responses to Satellite Signal Interference.

5- Effect of jamming and spoofing on GNSS signals on the Air traffic management.
Jamming: the term most often associated with intentional disruption of satellite communications, refers to temporary interference of radio signals or communications between a satellite and its receiver or users on the ground. It is accomplished by overpowered signals sent to and received by the satellite by emitting noise or using a second signal at the same frequency or higher power, preventing the receiver from collecting the real signal.

Spoofing: is similar to jamming. Instead of drowning out the real signal, a usable but false signal is emitted, mimicking the characteristics of a true signal so the user receives a fake (or spoofed) signal. The goal of spoofing is to fool or mislead the end user by providing fake signals.

In the case of either jamming or spoofing, the jammer must operate in the same radio frequency bands as the system being jammed.
The Technical Aspects of Satellites and Satellite Signal Interference

Possibility of jamming and spoofing

Technically speaking, interfering with a satellite is easy, inexpensive, and can be accomplished by using commercially available equipment. Anyone with commercial satellite communications equipment can jam satellite communications. (example of GPS jamming).
There are two types of satellite jamming:

**Orbital jamming** involves beaming a conflicting signal toward a satellite. The original signal is drowned out by the jamming signal so the original signal does not reach the satellite and cannot be rebroadcast to users. When this occurs, the original signal is overridden and disrupted for users everywhere, which can impact a large number of users because satellites operate in groups of channels. When one signal is disrupted, all signals in the same group can be affected, thereby cutting off services to all users in the satellite’s footprint, which can cover multiple continents.

**Terrestrial jamming** occurs at a specific place on the Earth near the targeted receiving station and involves using equipment that is easy to purchase, use and conceal. Rather than targeting the satellite, terrestrial jamming targets specific terrestrial users.
How to locate the jammer?
The jammer must locate via signal tracking systems; jammer does not have to
be located near the receiver to produce a signal nor need to know the location
of the receiver to be jammed. The jammer must only be located within the
satellite’s footprint or broadcasting area and have the ability to direct its signal
to the receiver.
Thus, as long as the jamming activity is within the footprint of the satellite,
which can span over multiple countries, the jammer will not necessarily
physically violate the territorial integrity of another State to effectuate a
disruption.
Legal Frameworks Governing Satellites and Intentional Interference

1-International Telecommunications Law

2-International Space Law (ISL).

3-International Humanitarian Law (IHL).
1-International Telecommunications Law

ITU Constitution provides:

The Member States are bound to abide by the provisions of this Constitution, the Convention and the Administrative Regulations in all telecommunications office and stations established or operated by them which engage in international services or which are capable of causing harmful interference to radio services of other countries.

Article 45 of the ITU Constitution also prohibits harmful interference.

All Stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations.
1-International Telecommunications Law

**Article 15** of the ITU Radio Regulations provides:

All Stations are forbidden to carry out unnecessary transmissions, or the transmission of superfluous signals, or the transmission of false or misleading signals, or the transmission of signals without identification. ...Transmitting stations shall radiate only as much power as is necessary to ensure a satisfactory service.

If satellite signal interference or jamming occurs, Member States are obligated to comply with ITU provisions and cooperate with others to eliminate harmful interference through bilateral negotiations.
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**Dispute resolution**

If negotiations fail, the affected State may attempt arbitration as specified under Article 41 of the ITU Convention or seek dispute resolution pursuant to Article 56 of the ITU Constitution. However, neither Article 41 nor Article 56 has ever been used.
2. International Space Law (ISL)

- Outer Space Treaty

- The Liability Convention,

- The Registration Convention,

- Court Of International Justice
2. International Space Law (ISL)

In addition to the ITU framework, International Space Law (ISL) also governs activities of satellites and satellite communications. Initiated in the 1950’s, ISL was formally codified in the 1960’s and 1970’s as a result of the launch of Sputnik I, world’s first artificial satellite. Today, the fundamental norms applicable to outer space are found in five treaties and several non-binding principles and declarations. Together, these documents establish the primary principles, rules and legal system for all activities conducted in outer space.
2. International Space Law (ISL)

- **Outer Space Treaty**

Article III of the Outer Space Treaty dictates that all State Parties must carry on outer space activities “in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promotion international cooperation and understanding,

Article VI also holds States internationally responsible for space activities of both State and non-State entities, including all activities involving satellites and satellite communications.

Article VII provides that States launching or procuring the launching of an object into space are: internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.
2. International Space Law (ISL)

- The Liability Convention,

Even though the Outer Space Treaty and the Liability Convention do not clearly address financial recovery for the full range of damages resulting from satellite signal interference, a State remains liable under international law if it breaches any international obligation.

- The Registration Convention,

Under the Registration Convention, which establishes the link between State and spacecraft, a “launching state” (defined as the State that either launches or procures the launch of a space object, or a State from whose territory or facility an object is launched) must register the object in its domestic registry and with the UN.

Court Of International Justice

Finally, in the Chorzow Factory Case, the Permanent Court of International Justice laid down the principle that a State committing an unlawful act must make reparation for the damages caused.
3- International Humanitarian Law (IHL):
- Armed conflict and satellite interference.
- Interpretation of IHL.
- Hague treaties address the behavior of belligerents and the means & Geneva Conventions focus on protecting personnel involved in international armed conflicts.
- The UN Security Council (IAC & NIAC).
- Signal interference permissible under IHL & NIAC.
3- International Humanitarian Law (IHL):
- Armed conflict and satellite interference.
- Due to the interconnected nature of civilian and military communication systems, it is almost impossible to differentiate between purely civilian systems and purely military systems or limit the effects of an attack to only military targets.
- To illustrate an impact of satellite communication disruptions, one need only to consider the impacts of a 1996 incident involving a programming error with the GPS constellation. Six seconds after an erroneous time was accidentally entered into the system, over 100 cellular networks were shutdown, taking hours and even days to recover.
- However, potential catastrophic scenarios, such as disruptions of critical financial infrastructures, collisions between aircraft or even losing communication capabilities with remotely piloted aircraft carrying weapons could occur.
Legal Frameworks Governing Satellites and Intentional Interference

3- International Humanitarian Law (IHL):

- Interpretation of IHL.
- IHL frameworks do not specifically address satellite signal interference as a means or method of warfare, they do set forth legal boundaries with which all States are obliged to comply within any armed conflict. The principles of IHL have developed as a result of international agreement that armed conflict is subject to specific legal constraints and must be conducted in accordance with minimum international standards.

Hague treaties address the behavior of belligerents and the means & Geneva Conventions focus on protecting personnel involved in international armed conflicts

Initially rooted in customary law, IHL is now codified within a variety of rules and treaties including the Hague and Geneva Conventions and the Additional Protocols of 1977. In simple terms, Hague treaties address the behavior of belligerents and the means and methods of warfare including the lawfulness of weapons and targeting whereas the Geneva Conventions focus on protecting personnel involved in international armed conflicts, and addressing such issues as prisoners of war, civilians and wounded combatants.
3- International Humanitarian Law (IHL):
- The UN Security Council (IAC&NIAC).

If satellite signal interference is conducted in the context of an IAC, its use and application is subject to specific rules for IAC as set forth within the IHL normative framework. Likewise, if interference is utilized in an NIAC, the rules applicable to NIAC would apply.

Signal interference permissible under IHL & NIAC
If satellite signal interference were employed against commercial communication satellites and their signals for such purposes, the targeting of civilians and these civilian objects would be permissible under IHL, regardless of the unlawfulness of the jamming and spoofing activities under the ITU or ISL frameworks.
Intentional Interference under the UN Charter

1. Interference Conducted by State Actors

2. Assessing Satellite Signal Interference under the Effects-Based Approach
1. Interference Conducted by State Actors

Having discussed satellite signal interference as an unlawful act under the ITU and ISL frameworks, as an unlawful intervention, as a prohibited use of force under Article 2(4) of the UN Charter, and as an armed attack under Article 51 of the UN Charter,

Article 51 And Right Of Self Defense

UN does not ban all use of forces and it outlaws the aggressive use of forces.

Article 2(4) the corner stone of peace.

All members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the Purposes of the United Nations.
1. Intentional Interference under the UN Charter

- Interference Conducted by State Actors
  - Exceptions to Article 2(4) the cornerstone of peace.

  A) right of self defense
  B) Actions authorized by the Security Council
2. Assessing Satellite Signal Interference under the Effects-Based Approach

- Satellite signal interference is similar to computer network attack (CAN).

- Satellite signal interference characterized as a use force boundary attack according to the following:

While satellite signal interference has never been publicly declared to be an unlawful "use of force" or an "armed attack" by any State, it is likely when or if it is, it will be assessed by the resulting consequences and effects.

1) Severity of the Damage:
2) Immediacy of the Consequences:
3) Directness:
4) Invasiveness:
5) Measurability of the Damage:
6) Presumptive Legitimacy:
7) Military Character:
8) State Involvement:
2. Assessing Satellite Signal Interference under the Effects-Based Approach

Example Now consider a situation where satellite signals directing commercial airliners are disrupted and two planes collide and crash within a heavily populated city.
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Lawful Responses to Satellite Signal Interference

1. Remedies for Internationally Wrongful Acts under State Responsibility

2. Countermeasures

3. The International Court of Justice
Remedies for Internationally Wrongful Acts under State Responsibility

In any case of State responsibility for an internationally unlawful act, victim States are entitled to reparations as set forth in the Articles on Responsibility of States for Internationally Wrongful Acts (ASR).

A) Reparations can take the form of restitution,
B) Compensation, or
C) Satisfaction,
D) Either singly or in combination.
E) Usage of force nor breaching any existing treaty or customary law
F) Retorsions, including severing diplomatic relations, imposing trade embargos, closing their borders to the offending State, as well as engaging in countermeasures.

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2. Countermeasures

The purpose of countermeasures is to induce a wrongdoing State to comply with its international obligations, not to create new non-rectifiable situations.

Specific prerequisites and conditions apply for countermeasures must be:

A) In response to a prior wrongful act taken by another State
B) Directed against the State committing the wrongful act
C) Additionally, the injured State must have called upon the offending State to make reparation for it.
D) Countermeasures must also be proportionate to the act and reversible.
E) Finally, countermeasures must be terminated as soon as the responsible State complies with its obligations.
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Effect of jamming and spoofing on GNSS signals on the Air traffic management

1- Legal aspects of Air traffic management based on GNSS(Satellite Based Augmented System)(SBAS).
   - Intersection between air and space law
   - Claim of ATM service provider against signal service provider:

2- The need for GNSS international Liability regime.
   - Simplify the claims process and could also
   - Offer a clear solution to the issue.

3- The need for model agreement of GNSS signal provision.
   - Liability clause
   - Dispute clause
   - Obligatory insurance
Questions?
More Information?
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Thank you