The Hague Code of Conduct and Space

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The Hague Code of Conduct

In committing to the Hague Code of Conduct (HCoC), the 143 subscribing states to this inclusive and multilateral instrument acknowledge the importance of controlling ballistic missile proliferation. Yet because of the dual nature of ballistic technologies, this instrument also plays a role in relation to satellite launchers. The analysis of space-related regulations in the HCoC is not often explored. However, as a growing number of countries are developing space capabilities, it is useful to recall the provisions of the Code on promoting the use of outer space for peaceful purposes.

This paper considers the dual approach of the Code by analysing the similarities between launchers and ballistic missiles in light of new technical developments, and assessing the risk of missile technology proliferation. It also assesses the new trends and developments in the space sector that may have an impact on the ability of the HCoC to remain relevant in its efforts to curb the proliferation of ballistic launchers.

Subscribing to the HCoC in no way restricts the development of national space capabilities. On the contrary, this instrument contributes, in addition to United Nations General Assembly (UNGA) resolutions, in increasing confidence and favouring access for all to peaceful technologies and activities.

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GLOSSARY

ASAT: Anti-satellite

CBM: Confidence-building measure

HCoC: Hague Code of Conduct against Ballistic Missile Proliferation

ICBM: Intercontinental ballistic missile

IRBM: Intermediate range ballistic missile

LEO: Low Earth orbit

MTCR: Missile Technology Export Control

SLV: Space launch vehicle

START: Strategic Arms Reduction Treaty

TEL: Transporter erector launcher

UNGA: United Nations General Assembly

UNSC: United Nations Security Council

WMD: Weapon of mass destruction

Introduction

While its title emphasises its focus on missiles, the Hague Code of Conduct against Ballistic Missile Proliferation (HCoC) also addresses the question of space, with Article 2f recognising that '*states should not be excluded from utilising the benefits of space for peaceful purposes, but that, in reaping such benefits and in conducting related cooperation, they must not contribute to the proliferation of Ballistic Missiles capable of delivering weapons of mass destruction*'. Based on this provision, it is therefore important to analyse and understand the links between the HCoC, outer space and ballistic missile proliferation.

As space became an area of strategic activity from the beginning of the Cold War onwards, and space technology made significant contributions to scientific knowledge, international economic competitiveness, and national and international security, an international space legal regime gradually emerged. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), which entered into force on 10 October 1967, is the legal foundation of international space law.

While it does not define the scope of 'outer space', this landmark treaty acknowledges outer space as a common heritage of humankind, and forbids any state from claiming sovereignty over it. This core stipulation is enshrined in Article II of the treaty, which designates outer space a *res communis omnium*.[1] The treaty also prohibits the placement of weapons of mass destruction (WMD) in outer space, on the Moon or on other celestial bodies. This stipulation is an acknowledgement of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water adopted four years earlier in 1963. While the 1967 text prohibits the placement of WMD in space, conventional weapons are beyond its scope.[2]

As the space industry grew rapidly during the Cold War, it was inextricably linked to the development of rocket technology for military purposes. As such, the Soviet Union and the United States (US) used the German V2 missile for the conquest of space but also to found their own ballistic missile programmes. The space domain and ballistic missile systems were therefore connected from the start. This interdependence between space and ballistic missile technologies was reinforced when the Soviet Union launched the R-7 Semyorka, the world's first intercontinental ballistic missile (ICBM), into space on 21 August 1957. In October that same year, they launched the Sputnik satellite, with a rocket derived from the R-7 Semyorka. These events were a landmark moment, as the two blocs recognised the dual purpose of launching technologies and embarked on

1. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, United Nations, 10 October 1967, available from https://www.unoosa.org/pdf/publications/STSPACE11E.pdf.

2. The placement of weapons in space may relate to what is called the weaponisation of space. The weaponisation of space differs from the militarisation of space, which means the use of space for military purposes, i.e. the development of satellites that assist the armed forces with operations on Earth.

a space and ballistic missile race.

As WMD proliferation emerged as a central security issue at the end of the Cold War, the proliferation of delivery vehicles also became an issue of concern, and brought a new focus to the dissemination of missiles but also to space launch vehicle (SLV) programmes.[3] This link is acknowledged in Article 2f of the HCoC, with Article 2g further adding that '*Space Launch Vehicle programmes should not be used to conceal Ballistic Missile programmes*'.[4]

Although the HCoC does not replace a legally binding treaty dealing with outer space, the Code remains the only multilateral mechanism for promoting transparency regarding SLV launches and space programmes. This paper therefore seeks to understand how the transparency and confidence-building measures (CBM) enshrined in the HCoC can promote the development of peaceful space operations while preventing the proliferation of ballistic missiles. It is also important to understand how the HCoC can strengthen space security in a context of latent conflict potential, but also the democratisation of the use of outer space.

To answer these questions, this paper considers the role of the HCoC in the field of international outer space regulations and how this multilateral, politically-binding text can promote the peaceful use of space. It also analyses the existing relationships between space launchers and ballistic missiles, detailing their growing similarities but also their specific features. Finally, it examines the ability of the HCoC to adapt to the emergence of new actors and new military and commercial practices in outer space in order to avoid ballistic missile proliferation combined with a new space race.

The HCoC: Fostering transparency and confidence-building measures to support the peaceful use of outer space

Although the HCoC does not regulate activities in space, several articles in its text focus on outer space. The HCoC makes explicit reference to the international space framework and aims to promote the peaceful use of outer space by requiring the establishment of CBM between parties.

The relationship between the HCoC and international space law

The HCoC is not negotiated and concluded under the auspices of the United Nations (UN), but the text has many connections with the UN. In its first sentence, the Code reaffirms a commitment to the UN Charter and stresses the role and responsibility of the UN in the field of international peace and security. HCoC members further commit to the UN Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States taking into

3. Paul Meyer, 'The Launch Pad Seminars: Episode 3 | Rockets, Missiles, and Space,' UN Institute for Disarmament Research (UNIDIR) webinar, timestamp: 6:49, 10 June 2020, available from https://www.youtube.com/watch?v=ymK7Luz8NtE.

4. Ibid.

particular Account the Needs of Developing Countries, adopted by the United Nations General Assembly (UNGA) in 1996.[5] This resolution reminds space powers to comply with Article I of the Outer Space Treaty in that they must carry out their space activities for the benefit of the international community as a whole, fostering international cooperation on an equitable and mutually acceptable basis.[6]

The cornerstone of international space law is the 1967 Outer Space Treaty, which is implemented by other sectoral international treaties (see Figure 1). To promote the peaceful use of outer space, signatories to the HCoC resolve to '*ratify, accede to or otherwise abide by*'[7] several texts of international space law, namely the 1967 Treaty, the Convention on International Liability for Damage Caused by Space Objects, and the Convention on Registration of Objects Launched into Outer Space. Two other international space conventions are not covered by the HCoC as they do not deal specifically with space launches: the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, and the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.

Even for countries with no space programme, ratifying these treaties remains a strong symbol of a political commitment to promote the right to use space for peaceful purposes. At present, of the 143 signatories to the HCoC, 89 have acceded to, signed or ratified the 1967 Outer Space Treaty; 57 have signed or ratified the Registration Convention; and 55 have done so for the Space Liability Convention.[8] Of

Treaty	Entry into force	Member states (as of March 2022)	HCoC members that have signed the Treaty
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies	10 October 1967	111	89 (100% of the eight HCoC spacefaring countries)
Convention on International Liability for Damage Caused by Space Objects	1 September 1972	96	57 (62% of the eight HCoC spacefaring countries)
Convention on Registration of Objects Launched into Outer Space	12 November 1974	72	55 (87% of the eight HCoC spacefaring countries)

Figure 1: Treaties governing the activities of states in the exploration and use of outer space that HCoC members must ratify, accede to or otherwise abide by.

5. UN General Assembly Resolution 51/122, adopted 13 December 1996, available from http://www.unoosa.org/oosa/oosadoc/data/resolutions/1996/general_assembly_51st_session/ares51122.html.

6. Marietta Benkö and Kai-Uwe Schrogl, 'History and impact of the 1996 UN declaration on "space benefits," *Space Policy*, vol. 13, no. 2, May 1997, p.139-143.

7. Article 3 of the HCoC.

8. The number of state parties to an international treaty can be found on the United Nations Treaty Collection, available from https://treaties.un.org/.

the 89 HCoC signatory states that have signed or ratified the Outer Space Treaty, 67 operate at least one satellite in space in 2021.

Of these 67 satellite-operating nations, 45 have signed the Registration Convention and 36 have signed the Space Liability Convention. These figures show that the HCoC subscribing states currently involved in space activities have a strong record of participation in the main international space treaties and conventions. The eight spacefaring countries that have signed the HCoC – namely France, India, Japan, New Zealand, South Korea, Russia, the US and the United Kingdom (UK) – have all ratified the Outer Space Treaty, but not all of them have ratified the Space Liability Convention or the Registration Convention.

The relationship between the HCoC and the UN is not only enshrined in the Code, but UN bodies themselves have also referred to the text in various UNGA resolutions: these have supported the HCoC on a regular basis since 2004, with the latest such resolution adopted in December 2020.[9] This resolution calls on UN member states, in particular those possessing SLV and ballistic missile capabilities, to subscribe to the Code in order to strengthen the core international space law principle of using space for peaceful purposes. The international community strongly supported the 7 December 2020 resolution: 176 UN member states voted in favour, the highest vote for the HCoC in this multilateral forum since 2004, and 33 non-subscribing states voted in favour, showing their support for the principles and commitments underlying the HCoC.

The UNGA has also reaffirmed the principles of the HCoC by stating that '*States should not be excluded from utilizing the benefits of space for peaceful purposes, but that in reaping such benefits and in conducting related cooperation they must not contribute to the proliferation of ballistic missiles capable of carrying weapons of mass destruction*'.[10]

Promoting transparency and curbing the diversion of space technologies for ballistic missile programmes

In addition to requiring that its subscribing states adhere to or comply with the major texts of international space law, the HCoC sets out a general framework for best practice within national space programmes in order to prevent ballistic missile proliferation. The Code is not, however, designed to regulate the use of space by states more generally or even impede national space programmes. The text only sets out broad principles for preventing SLV programmes from being used to conceal the acquisition of ballistic missiles capable of delivering WMD.

Article 3d of the HCoC requires subscribing states to exercise the necessary vigilance when cooperating and assisting with the SLV programmes of states that have not subscribed to the Code, to prevent them

9. UN General Assembly Resolution A/RES/75/60, 'General and Complete Disarmament: the Hague Code of Conduct Against Ballistic Missile Proliferation,' adopted 7 December 2020, available from https://www.nonproliferation.eu/hcoc/wp-hcoc/uploads/2021/01/A_RES_75_60_E.pdf.

10. Ibid.

from contributing to the proliferation of WMD delivery systems. The HCoC also recognises the need for transparency measures regarding ballistic missiles and SLV programmes.

Subscribing states are therefore subject to the same politically-binding obligations in relation to their national space programmes as for their ballistic missile programmes. For example, they are required to fill out annual declarations on their SLV and ballistic missile programmes as well as send pre-launch notifications (PLN) for both kinds of objects in order to ensure that scientific and civilian launches are not mistaken for missile attacks. These notifications must include information such as the SLV class, the planned launch notification window, the launch area and the planned direction. In addition, subscribing states are encouraged to invite international observers to their SLV launch sites. Such visits have been organised by three countries so far: Norway in 2004,[11] Japan in 2005,[12] and France in 2011.[13]

Hague Code of Conduct – Example of a pre-launch notification

- HCoC number
- General class: such as SLV, ICBM or SLBM
- Launch area
- Planned launch notification window
- Planned direction
- Single or multiple launches
- Additional information

These politically-binding measures increase the security of all states by fostering mutual trust. As such, the HCoC plays a key role in maintaining predictability and stability for its subscribing states. For example, notification from a state of a future SLV or ballistic missile launch benefits all HCoC members, as it enables them to estimate its trajectory without necessarily possessing radar technology.

Although most of these countries have neither SLV capable of putting their satellites into orbit nor ballistic missile technologies, all satellite-owning states are affected by the actions of others. This is why a set of transparency and confidence-building measures is needed for all in order to ensure the use of space for peaceful purposes for everyone on Earth.

Advantages for states in joining the HCoC: Between national benefits and shared interest

During the Cold War, space was seen as the realm of the great powers, but it is now increasingly accessible to a variety of states

11. Camille Grand, 'Le code de conduite de La Haye: 10 ans de lutte contre la prolifération balistique,' *Observatoire de la non-prolifération*, no. 74 (2013), available from https://www.nonproliferation.eu/hcoc/wp-hcoc/uploads/2020/11/ONP201301HorsSerie.pdf.

12. Ministry of Foreign Affairs of Japan, 'The International Observation Visit to JAXA Tanegashima Space Center as Confidence-Building Measures of the Hague Code of Conduct against Ballistic Missile Proliferation (HCOC),' November 2005, available from https://www.mofa.go.jp/policy/un/disarmament/missile/visit0511.html.

13. Hague Code of Conduct, 'Visit of Europe's spaceport in Kourou,' 15 May 2021, available from https://www.nonproliferation.eu/hcoc/visit-of-europes-spaceport-in-kourou/.

on all continents. Ghana, for example, launched its first satellite in 2017[14] with the support of the Japanese space agency JAXA, and Tunisia launched its first satellite in March 2021.[15] Access to space for commercial, civilian and military purposes is thus becoming easier and more widespread. Almost half of the HCoC subscribing states have sent at least one satellite into outer space (69 out of 143 member states) and this number can be expected to rise as space applications become more important and diverse. Satellites are fundamental for states as they enable the development of communications, surveillance, and positioning. They are of scientific, technological, commercial, educational and industrial interest, but also provide crucial support to military forces on Earth. New activities enabled by developments in space include monitoring processes for environmental issues such as responding to natural disasters, air quality monitoring, deforestation and crop monitoring.[16] Countries therefore want to develop their space activities not solely as a symbol of power or for military interests, but primarily because such activities are useful for everyday life and constitute a driver of socioeconomic development

With the development of new space activities and satellite imagery, the historical link between the space and military domains is gradually being undone in favour of a shift towards commercial and tech applications. Several small satellites (smallsats and cubesats) are being built and

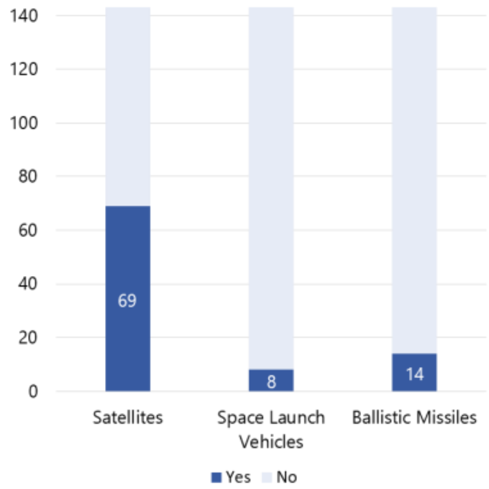

Figure 2: Number of HCoC subscribing states owning satellites, SLV and ballistic missiles.

monitored by students on university programmes for educational and research purposes, in various fields including biology, medicine and science.[17] Space activities have wide ranging societal and economic implications: as the costs of entry and access to space have reduced in recent years, many countries are looking to develop their own space policies with the objective of reaping the civilian benefits of space.

Most of these new players do not have SLV

14. BBC, 'Ghana launches its first satellite into space,' 7 July 2017, available from https://www.bbc.com/news/world-africa-40538471.

15. Satellite Prome, 'Tunisia to launch first satellite on March 20,' March 2021, available from https://satelliteprome.com/news/tunisia-to-launch-first-satellite-on-march-20/.

16. Nicolas Kasprzyk, Emmanuelle Maitre, Xavier Pasco, and Noel Stott, 'The Hague Code of Conduct against Ballistic Missile Proliferation: Relevance to African states,' Institute for Security Studies Policy *Brief 90*, September 2016, available from https://media.africaportal.org/documents/policybrief90.pdf.

17. European Space Agency, 'Technology CubeSats,' last accessed 21 July 2021, available from http://www.esa.int/Enabling_Support/Space_Engineering_Technology/Technology_CubeSats.

New applications in space: The example of the COVID-19 crisis

Over the last decade, record numbers of space objects have been registered with the UN, reflecting the growing interest of all types of actors in playing a greater role in space exploration and innovation. The list of space applications with consequences for life on Earth is almost unlimited and many are currently under development.

For example, in response to the COVID-19 crisis, three space agencies – NASA (US), JAXA (Japan) and ESA (Europe) – have jointly developed a new instrument that uses Earth observation data to show the impacts of the pandemic on Earth. This tool is a valuable asset in understanding the environmental and economic impacts of COVID-19.[18]

technologies to launch their satellites, and depend on foreign spacefaring countries for their launches. Given the difficulty of developing launchers, most of these countries are currently focusing on development of their satellite capabilities and do not plan to develop autonomous launching capabilities. However, for various reasons, including sovereignty, economic profitability and prestige, some states are seeking to develop their own SLV and spaceports, such as Brazil with its VLM launcher[19] and the Philippines with its OrbitX company founded in 2019, which is currently developing its own SLV, the Haribon SLS-1.[20]

In the short to medium term we can also expect to see an increasing number of countries and private actors capable of launching satellites. As far as spaceports are concerned, many countries such as the UK, Sweden and Norway are currently planning and developing commercial spaceports to conduct future space launches.[21] Given the growing numbers of stakeholders and operational systems, it is important that any states developing their own launchers, and even states that merely have satellites, conclude multilateral agreements promoting the peaceful use of space. The growth in the number of spacefaring actors, whether governmental or private, will increase the relevance of CBM mechanisms such as the Code.

In 2021, four countries owning SLV and 23 others with satellites in orbit remain outside the HCoC. The four spacefaring nations are China, Iran, Israel and the Democratic People's Republic of Korea (DPRK): countries that have also developed ballistic missiles and may fear that agreeing to transparency measures, even modest, may be detrimental to their national security.

For other states, especially those that

18. NASA, 'NASA, Partner Space Agencies Amass Global View of COVID-19 Impacts,' *Release 20-067*, 24 June 2020, https://www.nasa.gov/press-release/nasa-partner-space-agencies-amass-global-view-of-covid-19-impacts/.

19. Pedro da Cás, Carlos Veras, Olexiy Shynkarenko, and Rodrigo Leonardi, 'A Brazilian space launch system for the small satellite market,' *Aerospace*, 12 November 2019, available from https://www.mdpi.com/2226-4310/6/11/123/htm.

20. Deyana Goh, 'Interview: Founder of OrbitX on sustainable launches, the Philippines' space industry,' *SpaceTech Asia*, 1 November 2020, available from https://www.spacetechasia.com/orbital-exploration-philippines/.

21. PWC, 'Main trends & challenges in the space sector,' December 2020, available from https://www.pwc.fr/fr/assets/files/pdf/2020/12/en-france-pwc-main-trends-and-challenges-in-the-space-sector.pdf.

nurture ambitions to set up their space programmes, one reason for not subscribing to the HCoC may be the fear that it will constrain the development of their space capabilities and infringe their sovereignty. This argument is often raised by emerging countries that are developing space technologies and do not want to be constrained by an international text, and is a criticism also associated with the Missile Technology Control Regime (MTCR). Finally, some non-subscribing states do not want to commit to a multilateral pre-notification regime but agree to more modest bilateral provisions on the pre-notification of ballistic missile tests. This is notably the case with Pakistan (bilateral agreement with India)[22] and China (bilateral agreement with Russia).[23]

Unlike other texts such as the MTCR, the HCoC is a text open to all, rather than only

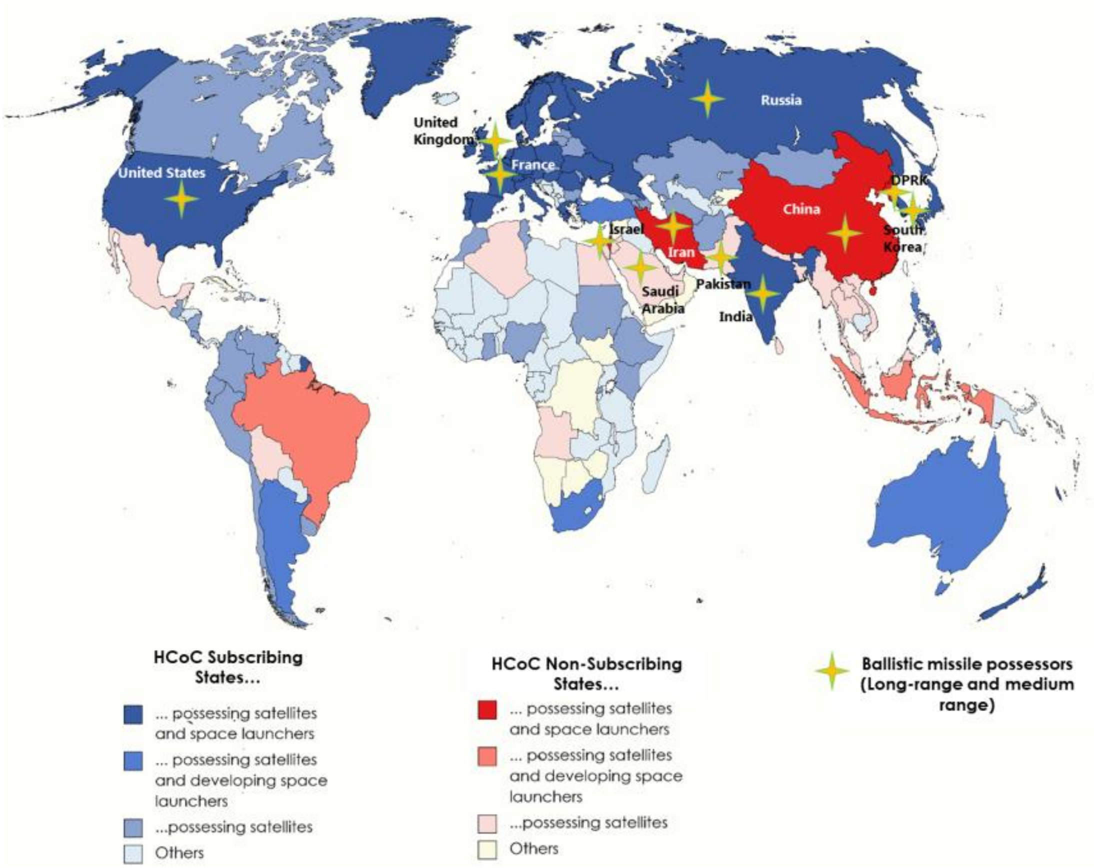

Figure 3: Space operators (SLV and/or satellites) and ballistic missile operators around the world.

22. Stimson, 'Agreement Between India And Pakistan On Pre-Notification of Flight Testing of Ballistic Missiles,' 25 October 2012, available from https://www.stimson.org/2012/agreement-between-india-and-pakistan-on-pre-notification-of-flight-tes/.

23. Russian News Agency, 'Russia-China deal on notifying of missile launches shows mutual trust, Moscow says,' 15 December 2020, available from https://tass.com/politics/1235205.

to states with ballistic missiles and SLV. While almost half of all HCoC members have no satellites in outer space, they still recognise the relevance of transparency measures for space activities, and are sensitive to WMD proliferation. Joining the HCoC in no way prevents states from using space for peaceful civilian purposes, as illustrated by the fact that New Zealand, a subscribing state since 2002, started commercial launching activity on its territory in 2018. New Zealand's space programme is based on a rather unique business model, as it is mainly a commercial venture and is New Space-driven. Rocket Lab, a private company founded in the country in 2006, is the main actor in the New Zealand space programme and even built a spaceport in 2016 for its activities. In 2016, the New Zealand Space Agency was also founded.[24] On the same model, PLD Space, a Spanish company created in 2011, is developing reusable launchers for commercial and scientific purposes, with its first launch scheduled for 2021 or 2022. Like New Zealand, Spain has been a HCoC member since November 2002, and the fact that it has signed the Code in no way restrains or impedes its development of public but also private space programmes.

Today, satellites are indispensable but also very vulnerable. The international community has realised that the security of national space assets depends on a collective effort based on transparency and CBM. By joining the HCoC, countries can access other states' declarations and know when their neighbours are going to launch an SLV, which increases predictability and international stability and reduces misinterpretation. The HCoC therefore directly contributes to increased transparency in space and better implementation of best practice.

This however constitutes a collateral benefit or side effect of an instrument whose aim is mainly to regulate ballistic missiles. It is *because* of the similarities between launchers and missiles and *because* of the dual nature of many technologies developed within the framework of these programmes that peaceful space launching activities are included in the scope of the Code. It is therefore important to recall the technical links between these technologies and to analyse how space programmes may be connected to the acquisition of offensive military systems.

The technical relationship between SLV and ballistic missiles

An analysis of the HCoC shows that the text provides similar provisions for SLV and ballistic missiles, implying that these two types of rockets share similarities. These parallels between SLV and ballistic missiles were rapidly acknowledged as a proliferation concern by experts and politicians following the end of the Cold War. A 1988 hearing before the US Senate Subcommittee on International Security, Proliferation, and Federal Services concluded that '*with regard to ICBMs […] The technologies used in military and*

24. Marçal Sanmartí, 'Is the New Zealand commercial space success story a model for other countries?,' *The Space Review*, 19 October 2020, available from https://www.thespacereview.com/article/4048/1.

civilian space launch systems have always been inextricably intertwined [...] Space launch technologies have, therefore, always been dual-use technologies'.[25] There are however key distinctions between the two types of object, and the fears of systematic diversion of space launching technologies towards missile programmes have in many cases been exaggerated. It is therefore useful to assess the links between the two kinds of rockets, their interrelatedness and the dynamics at stake as new technologies are developing and creating new challenges and opportunities in this area.

How do SLV and ballistic missiles work?

While the HCoC does not define the term ballistic missile, it can be understood as an '*unmanned, actively guided, rocket-propelled vehicle that can be fired [...] along a parabolic trajectory*'.[26] Ballistic missiles are often considered the '*delivery system of choice for nuclear weapons and they are also associated with the delivery of chemical and biological weapons'*.[27] However, as several major international armed conflicts and non-international armed conflicts have shown, ballistic missiles can also be launched carrying conventional charges.[28] A space launch vehicle, meanwhile, '*is a propelled vehicle used to transport a payload or humans from the Earth's surface to space*'.[29] The entry into outer space of satellites depends on the use of multistage space launch vehicles, which thrust the satellite into the desired orbit.[30] The essential elements of an SLV are its structure, propulsion, staging, guidance and control system, and payload. The majority of SLV take off from land sites on a launch-pad but a few are air-launched: in January 2021, the US successfully put a satellite into orbit with the LauncherOne SLV, which was dropped at high altitude by a Boeing 747-400. Sea launches are also possible, as

25. US Senate, 'Hearing before the Subcommittee on International Security, Proliferation, and Federal Services on the benefits of commercial space launch for foreign ICBM and satellite programme,' Committee on Governmental Affairs, last updated 21 May 1998, available from https://www.govinfo.gov/content/pkg/CHRG-105shrg49589/html/CHRG-105shrg49589.htm.

26. Aaron Karp, *Ballistic Missile Proliferation: The Politics and Technics,* Oxford: Oxford University Press, 1996.

27. Kolja Brockmann, 'Controlling ballistic missile proliferation: Assessing complementarity between the HCoC, MTCR and UNSCR 1540,' *HCoC Research Paper No. 7*, June 2020, available from https://www.nonproliferation.eu/hcoc/controlling-ballistic-missile-proliferation-assessing-complementarity-between-the-hcoc-mtcr-and-unscr-1540/.

28. Stéphane Delory, 'Ballistic missiles and conven tional strike weapons: Adapting the HCoC to address the dissemination of conventional ballistic missiles,' *HCoC Research Paper* No. 6, January 2020, available from https://www.nonproliferation.eu/hcoc/ballistic-missiles-and-conventional-strike-weapons-adapting-the-hcoc-to-address-the-dissemination-of-conventional-ballistic-missiles/.

29. Sergueï Grichkov and Laurent de Angelis, *Guide des lanceurs spatiaux*, 3rd edition, Tessier & Ashpool, 2012.

30. There are various orbits, such as the Low Earth Orbit (LEO) between 500 and 2000 km above Earth, the Medium Earth Orbit (MEO between 2000 and about 35,000 km above Earth, the Geostationary Earth Orbit (GEO), a circular orbit located at about 36 000, and the High Earth Orbit (HEO), above the altitude of GEO. Other orbits also exist such as the Molniya orbit and Tundra orbit (highly elliptical orbits), the polar orbit and the sun-synchronous orbit.

illustrated by China, which put several satellites into orbit in 2020 from a mobile platform in the Yellow Sea with a Long March 11H SLV.

The structure of the SLV must be as light as possible but also strong enough to resist stress during acceleration.[31] SLV use either solid or liquid propellants[32] such as kerosene or liquid hydrogen, which must be maintained at a -250°C temperature. Nowadays, solid engines are usually strapped to a liquid-fuelled SLV to enhance thrust at the beginning of a launch. An expendable launch system is made up of several stages that are discarded as the flight progresses: each stage has its own rocket engines and is jettisoned and disintegrated when the fuel is empty and the next stage is ignited.[33] Several projects are currently working on building single-stage-to-orbit, or reusable, SLV stages. In March 2022, SpaceX broke a new recorded as it managed to use the same Falcon 9 booster for the 12th time.[34]

Ballistic missiles are rockets with an arching trajectory, which are guided in the initial phase, before falling onto their target on Earth. Ballistic missiles differ from cruise missiles[35] in that they have a ballistic trajectory and go into outer space.[36] Ballistic missile flights are broken down into various phases: the launch phase, the boost phase (lasting a few minutes), the midcourse phase (the longest phase), and the terminal and re -entry phase (less than a minute). Ballistic missiles generally use solid propellant, which is easier to use, safer and cheaper than liquid fuel. While solid propellants need minimal maintenance and are compatible with instant readiness, liquid propellants require more complex engine systems such as a cooling system and are not well suited to rapid launches.

The links between SLV and ballistic missiles

Similarities between SLV and ballistic missiles

During the 1988 US Senate hearing referred to above, the participants concluded that both SLV and ballistic missiles uses similar technologies in terms of their staging mechanisms, propellants, insulation, motors,

31. Propellant generally makes up 80% or more of the total weight of a SLV, meaning that an empty SLV is relatively lightweight.

32. Solid propellants are more stable and more easily stored than liquid propellants. However, they have the disadvantage that once combustion has started, it cannot be stopped.

33. NASA, 'Orbital debris FAQ factsheet,' last accessed 21 July 2021, available from https://www.nasa.gov/news/debris_faq.html.

34. Jeff Foust, 'SpaceX sets reuse and payload mass records in Starlink launch,' SpaceNews, 19 March 2022, https://spacenews.com/spacex-sets-reuse-and-payload-mass-records-in-starlink-launch/.

35. Center for Arms Control and Non-Proliferation, 'Fact Sheet: Ballistic vs. Cruise Missiles,' May 2017, available from https://armscontrolcenter.org/wp-content/uploads/2017/04/Ballistic-vs.-Cruise-Missiles-Fact-Sheet.pdf.

36. 'Ballistic' means influenced only by gravity and the speed acquired by an initial acceleration force (during the first phase).

thrust systems and nozzles.[37] However, other technologies such as the payload separation or control system are not applicable to both types of rockets and need to be examined on a case-by-case basis.

First and foremost, similarities between an SLV and a ballistic missile can be found in their shape and also during the boost phase of a ballistic missile, just after its launch. Like an SLV, a ballistic missile jettisons its first and second stages when emptied of fuel. Another similarity is shown in Figure 4: like an SLV, an ICBM goes into outer space, where it can reach the height of a LEO[38] satellite before coming down to Earth during its terminal phase. Unlike LEO satellites at this height and due to its speed, an ICBM does not enter into orbit, but falls back to Earth to hit one or more targets. SLV and ballistic missiles therefore employ very different trajectories to fulfil their missions.

Major differences between SLV and ballistic missiles

There are also considerable differences between the two technologies in terms of their objective, power, precision in insertion and capacity. The major technical difference is linked to the payload and its purpose, as SLV do not carry a (nuclear or conventional) warhead. Another historical difference between missiles and SLV arises from their design: a missile is a small rocket with a heavy payload, while an SLV is a heavy rocket carrying a small payload.

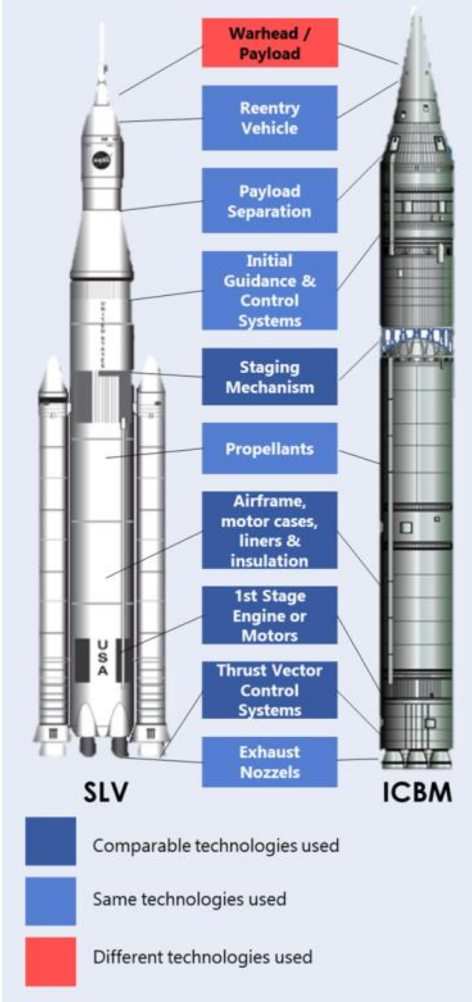

Figure 4: Technical differences between an SLV and an ICBM, FRS.

37. US Senate, 'Hearing before the Subcommittee on International Security, Proliferation, and Federal Services on the benefits of commercial space launch for foreign ICBM and satellite programme', op. cit.

38. According to the European Space Agency (ESA), LEO is normally at an altitude of less than 1000 km but can be as low as 160 km above Earth: European Space Agency, 'Low Earth Orbit', 2 March 2020, available from https://www.esa.int/ESA_Multimedia/Images/2020/03/Low_Earth_orbit.

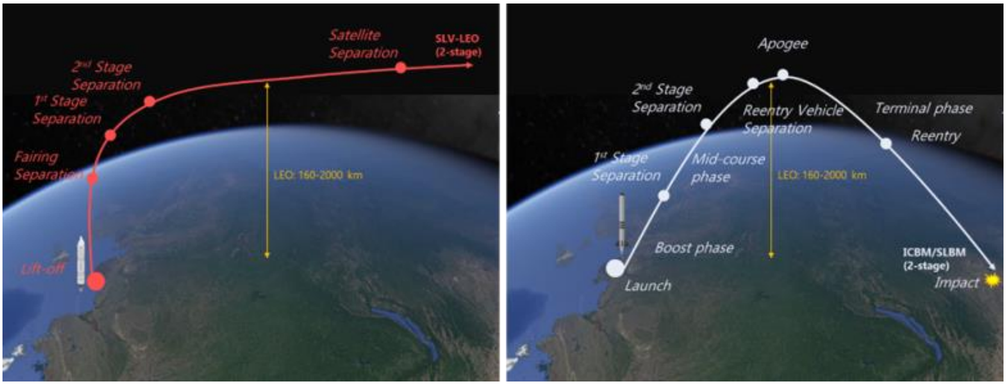

Figure 5: Comparison of the trajectories of an ICBM (in white) and an SLV (in red), FRS.

In the past, fuel type was also an indicator of the type of launcher. Solid fuel was associated with ballistic missiles, while liquid fuel was used for space launches. However, this distinction is no longer relevant, as both kinds of fuel are used for both ICBM and SLV.

In addition, for ballistic missiles, unlike SLV, re-entry must be monitored for the payload to reach its target with the required precision. The delivery vehicle is designed to survive the high temperature, friction and stress of atmospheric entry. This is why a ballistic missile is protected by a heat shield. Among the factors to be taken into account, the angle of entry into the upper layers of the Earth's atmosphere is also a mandatory criterion for the missile to carry out its mission correctly.

Ballistic missiles are designed to be launched within minutes, in any weather, and can be mobile. By contrast, SLV require days of preparation and are launched from existing facilities. SLV also require optimal weather (wind, rain, and temperature) and very precise conditions (launch window). Until recently, SLV were almost always launched from a launch-pad while missiles were deployed and launched from submarines, aircraft or even road-mobile vehicles. Finally, ballistic missiles must rely on mobility, concealment and quick preparation to avoid destruction before launch. As we will see, this distinction is becoming blurred as several countries including Iran[39] and China[40] are using transporter erector launchers (TEL), usually dedicated to missiles, for space launches. Still, SLV and ballistic missiles remain different in many ways: although the dual nature of certain technologies may be key to supporting a ballistic missile development programme, this convergence

39. Space Watch Global, '#SpaceWatchGL perspectives on Iran's satellite launch: Fabian Hinz on the Qased satellite launch vehicle,' April 2020, available from https://spacewatch.global/2020/05/spacewatchgl-perspectives-on-irans-satellite-launch-fabian-hinz-on-the-qased-satellite-launch-vehicle/.

40. Andrew Jones, 'Chinese state-owned firms preparing to launch new commercial rockets,' *Space News*, 26 February 2019, available from https://spacenews.com/chinese-state-owned-firms-preparing-to-launch-new-commercial-rockets/.

is neither automatic nor systematic.

Can a ballistic missile be turned into an SLV and vice versa?

While the links between ballistic missiles and SLV have been demonstrated, it is important to assess practical examples of countries converting an SLV programme into a weapon, and also to study whether the opposite case – where a ballistic missile is converted into an SLV – is an attractive option for countries working on these technologies.

Country	Ballistic missile	SLV
USSR/Russia	R-7 Semyorka	Soyuz
USSR/Russia	UR-100N	Rokot, Strela
USSR/Russia	R-36	Tsyklon-2, Dnepr
United States	Atlas D	Atlas LV-3B
United States	Titan I and Titan II	Titan III
United States	Minuteman II	Minotaur I
United States	Peacekeeper	Minotaur III and Minotaur IV
China	Dong Feng 3	Long March 1
Iran	Shahab-3	Safir

Figure 6: Conversion of different ballistic missiles into SLV (non-exhaustive list).

Conversion of a ballistic missile into an SLV

Examples of SLV based on ballistic missiles include the USSR R7 family of space launchers, which were derived from an ICBM. Many ICBM-derived rockets were used for several manned missions during the Cold War.[41] The majority of the R7 family of launchers have now been decommissioned and only a few Soyuz launchers remain in operation. As an alternative to the destruction of the R-36M ICBM[42] after the Strategic Arms Reduction Treaty (START) was signed between the US and the USSR, Soviet scientists tried to convert the weapon for commercial purposes and produced the Dnepr SLV,[43] which was used for launching satellites into outer space.[44]

In the US, the Atlas LV-3B was an SLV derived from the SM-65D Atlas ballistic missile, the first operational US ICBM. The Atlas LV-3B carried satellites but also crewed spacecraft during Project Mercury (1958-1963). After their decommissioning, Titan I ICBM were also converted to become the Titan III SLV, launching satellites in the 1980s.[45] In the 1990s, following the signature of START, the US phased out the

41. The Soyuz launcher was notably used to send Yuri Gagarin into space: Nola Taylor Redd, 'Yuri Gagarin: First Man in Space,' *Space*, 12 October 2018, available from https://www.space.com/16159-first-man-in-space.html.

42. Russian Space Web, 'R-36M missile,' last accessed 21 July 2021, available from http://www.russianspaceweb.com/r36m.html.

43. Russian Space Web, 'The Dnepr launcher,' last accessed 21 July 2021, available from http://www.russianspaceweb.com/dnepr.html.

44. William Graham, 'Russian Dnepr conducts record-breaking 32 satellite haul,' *Nasa Space Flight*, 21 November 2013, available from https://www.nasaspaceflight.com/2013/11/russian-dnepr-record-breaking-32-satellite-haul/.

45. The Editors of Encyclopaedia Britannica, 'Titan rocket,' *Britannica*, last updated 23 September 2019, available from https://www.britannica.com/technology/Titan-rocket.

450 Minuteman II ICBM. The Minotaur I SLV made its first flight in 2000, using the first two stages of the Minuteman II missile with two smaller solid propellant stages strapped -on.[46] The same conversion operation was carried out on the decommissioned Peacekeeper ICBM, withdrawn after START II, resulting in the Minotaur III and IV, which made their first flight in 2010.[47]

Like its US and Soviet counterparts, China's first SLV, the Long March 1, was based on a ballistic missile, the Dong Feng 3 IRBM.[48] As for Iran, a country with major ambitions for its space programme,[49] its Safir SLV is derived from the Shahab-3 IRBM. Its first stage is very similar to the single-stage ballistic missile, but it also has a specially designed second stage.[50]

These non-exhaustive examples show that some ballistic missiles have been successfully converted into space launchers for civilian activities. ICBM and IRBM cannot, however, be used as they are to launch satellites, but have to be modified. The countries mentioned have also developed several other classes of SLV completely unrelated to ICBM design.

Converting an SLV into a ballistic missile: An issue for WMD delivery systems proliferation?

This question is a particularly significant one, since the transformation of an SLV into a ballistic missile *de facto* increases the proliferation of delivery systems that can potentially carry WMD. From a technical point of view, however, converting an SLV into a weapon is complex: SLV are very heavy and it would therefore be difficult to deploy any missile derived from SLV on a mobile launcher due to their weight.[51] In addition, states must overcome several crucial technological obstacles to convert SLV into ballistic missiles, as heat-shielded rocket and re-entry vehicle technologies are essential for a ballistic missile to function. An SLV can be converted to a ballistic missile but this would require a new design and a new configuration, and it would have to succeed in a flight test programme to validate its operational functioning.

In 1998, Gary Milhollin, founder of the Wisconsin Project on Nuclear Arms Control, testified to the US Congress that cooperation between the US and countries developing space programmes could

46. Gunter's Space Page, 'Minotaur-2 (OSP-TLV),' last accessed 21 July 2021, available from https://space.skyrocket.de/doc_lau_det/minotaur-2.htm.

47. Norbert Brügge, 'MM-Minotaur - I,' B14643, last accessed 21 July 2021, available from http://www.b14643.de/Spacerockets_2/United_States_2/MM-Minotaur/Description/Frame.htm.

48. John M. Logsdon, 'Long March,' *Britannica*, last updated 15 May 2020, available from https://www.britannica.com/technology/Chang-Zheng.

49. Elizabeth Howell, 'Iran launches new rocket on suborbital test flight: report,' *Space*, 17 February 2021, available from https://www.space.com/iran-tests-new-rocket-zoljanah.

50. Steven A Hildreth, 'Iran's Ballistic Missile and Space Launch Programs,' *Congressional Research Service*, 6 December 2012, available from https://fas.org/sgp/crs/nuke/R42849.pdf.

51. Dinshaw Mistry and Bharath Gopalaswamy, 'Ballistic Missiles and Space Launch Vehicles in Regional Powers,' *Astropolitics*, vol. 12 no. 2, 11 July 2012.

contribute to the spread of technologies also needed for missile development.[52] Two years later, he even added that '*Once a country can deploy a large satellite in a precise orbit, it has mastered the technologies needed to hit a major city with a ballistic missile*'.[53]

Milhollin pointed to the example of the Indian space programme, initiated in 1969 in cooperation with the US and France, demonstrating that India used the first stage of its first rocket (named SLV) to develop the Agni ballistic missile family. He also highlighted that A.P.J. Abdul Kalam, the head of the Indian space project and the country's former president, played a key role in the development of the Indian ballistic missile system.[54] For Milhollin as well as Richard Speier,[55] the example of India proves that, by underestimating the links between space launchers and missile proliferation,[56] helping a country build SLV is by extension '*helping it build missiles*'.[57]

Other countries may be interested in exploiting the synergies between the two types of technologies. Iran thus tested its new Zoljanah SLV in February 2021,[58] raising many questions about the dual nature of the rocket and its possible contribution to an ICBM programme. Indeed, in 2008, Iran launched an SLV which is '*believed to make use of a modified version of Iran's most advanced ballistic missile system, the Shahab-3, as its first stage*'.[59] In the August after the launch, the White House stated that '*the Iranian testing of rockets is troubling and raises questions about their intentions*'.[60] Over ten years later, this question is still unresolved: for international lawyers,[61] Iran's satellite launches and SLV

52. Gary Milhollin, 'Testimony: Cooperation in Space and Missiles Before the House Committee on Science, 'Wisconsin Project on Nuclear Arms Control, 25 June 1998, available from https://www.wisconsinproject.org/testimony-of-gary-milhollin-cooperation-in-space-and-missiles-1998/.

53. Gary Milhollin, 'The Link Between Space Launch and Missile Technology: Presentation at the Asia-Pacific Center for Security Studies,' Wisconsin Project on Nuclear Arms Control, 16 March 2000, available from https://www.wisconsinproject.org/the-link-between-space-launch-and-missile-technology/.

54. A.P.J. Abdul Kalam was even nicknamed Missile Man and is considered the father of the Indian space programme, the Indian ballistic missile programme, and also of the Indian nuclear bomb.

55. Richard Speier is a consultant on non-proliferation and counterproliferation issues. He was involved in negotiating the MTCR.

56. Richard Speier, 'U.S. Space Aid to India: On a "Glide Path" to ICBM Trouble?,' *Arms Control Association*, March 2006, available from https://www.armscontrol.org/act/2006-03/features/us-space-aid-india-glide-path-icbm-trouble.

57. Gary Milhollin, 'The Link Between Space Launch and Missile Technology: Presentation at the Asia-Pacific Center for Security Studies,' op. cit.

58. Elizabeth Howell, 'Iran launches new rocket on suborbital test flight: report,' op. cit.

59. Peter Crail, 'Iran space launch raises missile concerns,' *Arms Control Association*, September 2008, available from https://www.armscontrol.org/act/2008-09/iran-nuclear-briefs/iran-space-launch-raises-missile-concerns.

60. France 24, 'US finds Iran rocket launch "troubling",' 18 August 2008, available from https://www.france24.com/en/20080818-us--iran-rocket-launch-satellite-united-states.

61. Elena Ćirković and Jonathan McDowell, 'Defining military activities in outer space: the launching of the Iranian satellite Nour 1,' *European Journal of International Law: Talk!,* 10 June 2020, available from https://www.ejiltalk.org/defining-military-activities-in-outer-space-the-launching-of-the-iranian-satellite-nour-1/.

developments do not violate the 2015 Joint Comprehensive Plan of Action (JCPOA) or UN Security Council (UNSC) Resolution 2231. This is because the launches are considered to be peaceful, non-aggressive and for the purposes of space exploration, even if the SLV are launched by the Islamic Revolutionary Guard Corps (rather than the civilian Iranian Space Agency). The launch of a satellite by Iran does not constitute an ICBM test *per se*, and in the view of several scholars, the international community must be careful not to overstate the risks posed by Iran's satellite launches, given that it does not constitute a breach of UNSC Resolution 2231.[62]

Concerned about the possibility of similar transfer from a space programme to a ballistic programme, the George W. Bush administration imposed sanctions (Executive Order 13382, June 29, 2005)[63] on the China Great Wall Industry Corporation (CGWIC), a Chinese company whose mission is to provide commercial satellite launch services. According to the US government, this company was contributing to the development of missiles capable of delivering WMD by exporting technologies to proliferating countries such as Iran. These sanctions were lifted three years later, on 19 June 2008, but the State Department '*continue[s] to follow very carefully the actions of CGWIC, to verify that its words are matched by vigorous non-proliferation deeds*'.[64]

This type of sanction had already been imposed in the past: in the 1990s, the US administration imposed sanctions on the Chinese Ministry of Aerospace Industry, on the grounds that the country was engaging in missile technology proliferation activities by exporting electronics, military aircraft and also space systems to Pakistan.[65]

The international community has also reacted strongly to the development of the North Korean space programme and its launch of several satellites. On 22 January 2013, the UNSC voted in favour of Resolution 2087 condemning the space launches, as the DPRK used ballistic missile technologies for its SLV.[66] In this resolution, the UNSC explicitly linked SLV to ballistic missiles and imposed sanctions (Annex 1 and 2) on several officials of the Korean Committee for Space Technology,[67] the

62. Michael Elleman, 'Why Iran's satellite launch does not amount to an ICBM test,' *IISS*, 17 January 2019, available from https://www.iiss.org/blogs/analysis/2019/01/iran-satellite-launch.

63. US Department of State, 'Executive Order 13382,' 29 June 2005, available from https://2009-2017.state.gov/t/isn/c22080.htm.

64. US Department of State, 'Sanctions lifted from China Great Wall Industry Corporation,' 19 June 2008, available from https://2001-2009.state.gov/r/pa/prs/ps/2008/jun/106102.htm.

65. Federation of American Scientists, 'State Department Issued Public Notice of MTCR Sanctions Against China. State Department Public Notice of August 24 outlining the imposition of missile proliferation sanctions against entities in China and Pakistan. (930826),' 25 August 1993, available from https://fas.org/nuke/control/mtcr/news/930826-300846.htm.

66. UN Security Council, Resolution 2087, S/RES/2087 (2013), 22 January 2013, available from https://www.undocs.org/en/S/RES/2087%20(2013).

67. The National Aerospace Development Administration, created in 2013, has taken over the functions and responsibility of the Korean Committee for Space Technology but is also under Security

former agency responsible for the DPRK's space programme. The UNSC stated that the North Korean space programme was not peaceful as it concealed ballistic missile tests. The DPRK's ballistic missile programme is however already much more advanced than its space programme, and the SLV tests do not appear to be truly fundamental to the development of the country's ICBM programme.

While an SLV may possibly contribute to a ballistic missile programme, it does not directly follow that a state developing its space programme can automatically deliver a conventional weapon or WMD on Earth. According to some scholars,[68] space launches can provide training and experience for missile experts who might contribute to a future ICBM development effort. However, these potential contributions will not significantly shorten the time or reduce the expense required to create a militarily viable long-range missile.

From a different perspective, ArianeGroup,[69] a French joint venture, is the main manufacturer and designer of both the Ariane 5 and 6 SLV and the French M51 ballistic missiles, highlighting the similarities in the industrial manufacturing process of the two launchers. This trend is explained by economic reasons: France took the decision to centralise its industrial manufacturing of SLV and missiles and has taken advantage of the dual-use technologies to draw on economies of scale.

The general trend in other countries has been to convert military ballistic missiles into satellite launchers, rather than SLV to ballistic missiles.[70] However, in the light of certain technological developments, such as the emergence of light launchers, the distinction between ballistic missiles and SLV is becoming increasingly blurred, which could lead to a new source of proliferation of ballistic delivery systems. In addition to light launchers, other new uses developed by space operators also raise the question of a potential new risk of proliferation of ballistic technologies

The HCoC and the evolution of commercial and military activities in outer space

In addition to the emergence of new countries with satellites in orbit, the rapid evolution of the space domain includes access to outer space by new actors that are revolutionising space technologies. New practices have direct consequences on the international governance of the space sector. Outer space may become a future battlefield in the coming years, as illustrated

Council sanctions (see UN Security Council, Resolution 2270, 2 March 2016, available from https://undocs.org/S/RES/2270(2016).).

68. Michael Elleman, 'Why Iran's satellite launch does not amount to an ICBM test,' op. cit.

69. ArianeGroup, 'About Us | Company Profile,' last accessed 21 July 2021, available from https://www.ariane.group/en/about-us/company-profil/.

70. Péricles Gasparini Alves, 'The transfer of dual-use outer space technologies: confrontation or cooperation?,' *PhD dissertation*, University of Geneva, 2001, available from http://www.unige.ch/cyberdocuments/theses2001/GaspariniP/these_front.html.

by the recent decision of the North Atlantic Treaty Organization (NATO) to recognise space as a new operational domain,[71] and a scenario of military escalation cannot be ruled out. Instruments of regulation such as the Code therefore need to adapt to new paradigms in order to preserve their relevance in the medium to long term.

The Code and new actors in outer space: Light launchers, New Space and new commercial practices

In addition to the growing number of countries interested in acquiring launching technologies, the New Space that is currently emerging is characterised by various trends, including the rise of new (especially private) actors, but also new technological breakthroughs that are allowing states to operate in outer space more easily. Two of these new technological developments are especially significant for the HCoC. Firstly, the development of light launchers, which are less expensive and less heavy than traditional SLV, raises several questions because of their similarities with ballistic missiles. Secondly, the emergence of private companies in the space field affects space governance.

The development of light launchers and small satellites

Light launchers are SLV capable of putting small satellites below 500 kg into orbit in LEO.[72] Since the beginning of the conquest of space, 160 launchers have been classified as light launchers[73] and in 2021, around 10 light launchers are considered to be operational. Alongside light launchers, micro-launchers are also increasingly being developed, capable of putting microsatellites (10 to 100 kg) and nanosatellites (from 1 to 10 kg) into orbit. In the last two years, for instance, several micro-launchers have been developed in China, by New Space companies as well as public entities.[74]

While heavy-lift and super heavy-lift SLV are still the prerogative of the major space powers, these countries have also realised the value of light launchers and micro-launchers.[75] For example, in 2018, Japan

71. Alexandra Stickings, 'Space as an Operational Domain: What Next for NATO?,' *RUSI Newsbrief*, 15 October 2020, available from https://rusi.org/publication/rusi-newsbrief/space-operational-domain-what-next-nato.

72. PWC, 'Micro-launchers: what is the market?,' February 2017, available from https://www.pwc.fr/fr/assets/files/pdf/2018/11/space/pwc-micro-launchers-what-is-the-market.pdf.

73. New Space Index, 'Small Satellite Launchers,' last accessed April 2021, available from https://www.newspace.im/launchers

74. Ivan Li, 'China successfully conducts first launch of Smart Dragon-1 small satellite launch vehicle,' *Nasa Space Flight*, 17 August 2019, available from https://www.nasaspaceflight.com/2019/08/china-first-launch-smart-dragon-1-small-satellite-vehicle/.

75. Florence Gaillard-Sborowsky, Isabelle Sourbes-Verger, and Jean-Jacques Tortora, 'Petits satellites - Petits lanceurs: Etude des évolutions technologiques et économiques, analyse de leurs implications stratégiques et du positionnement français/européen,' Fondation pour la Recherche Stratégique, 1 March 2018, available from https://www.irsem.fr/data/files/irsem/documents/

launched the SS-520 SLV, the smallest orbital launcher in the world (2.5 tons with a 3 kg satellite on board).[76] Another example is the Electron SLV, developed by Rocket Lab, a US company created in New Zealand, which is only 17 metres in height. In

Figure 7: Japan SS-520 light launcher, Credits: Aerospatium.

comparison, the Minuteman III ICBM is 18 metres high and the ESA Ariane 5 SLV 50 metres high.[77]

The emergence on the market of new countries and private companies has revolutionised the demand and supply of SLV. These new actors are primarily focused on reducing the costs of space activities, via the miniaturisation of satellites but also their launchers. The increasingly rapid development of light launchers has consequences for international security. These SLV could be mistaken for ballistic missiles during their launch phase as the two rockets are very similar in their shape, height and weight.[78] This technological breakthrough creates uncertainty, and this is why transparency measures, and more specifically the HCoC PLN mechanism, are crucial.

The development of light launchers in terms of security also raises the potential risk of the diversion of technologies, as these launchers increasingly rely on missile-related technologies, particularly regarding their propulsion, guidance, flight dynamics, structures and control, with the specifications and characteristics of light launchers resembling those of IRBM and ICBM. The risk of light SLV being converted into ballistic missiles should not be underestimated. At present, there is little benefit for a country that already possesses ballistic missiles to convert a light SLV into a missile. Light SLV do not therefore pose an immediate risk of proliferation but there may be a potential risk in the long run, as their development could lead to an increased number of technologies and components produced and exchanged internationally that could fall prey to illegal

document/file/2991/PSPL%20FINAL.pdf.

76. Andrew Liptak, 'Japan's space agency just launched the tiniest rocket to carry a satellite into orbit,' *The Verge*, 3 February 2018, available from https://www.theverge.com/2018/2/3/16968756/japan-space-agency-jaxa-ss-520-teeny-tiny-rocket.

77. CNES, 'Ariane 5 Technical features,' 20 November 2020, available from https://ariane5.cnes.fr/en/technical-features-0.

78. Xavier Pasco and Stéphane Delory, 'Light launchers and microsatellites: towards a risk of ballistic proliferation under the guide of spatial development?,' Fondation pour la Recherche Stratégique, February 2017, available from https://www.nonproliferation.eu/hcoc/wp-hcoc/uploads/2017/02/Light-launchers-and-micro-satellites.pdf.

transfers.[79] For example, Japan has developed the Epsilon SLV, a solid-fuel rocket, which has been subject to cyberattacks and data leaks, posing the question of the risk of misuse and diversion for military purposes[80].

The emergence of New Space

While states used to have a monopoly over the outer space sector, private actors are now playing an increasingly important role. The term New Space refers to these new private actors, who are redesigning the paradigm for space activities and international governance of outer space.[81] It encompasses new entrants but also innovative industrial approaches, new markets, new investments and finally an increasing number of spacefaring nations. Over the last decade, there has been an amplifying effect regarding New Space, as the development of business activities builds investor confidence, resulting in a virtuous circle that increases private sector activities in outer space.

The entry of private companies into outer space raises the question of the implementation of national obligations with respect to the HCoC. Launches themselves remain the responsibility of states which, if signatories to the HCoC, must report them by submitting PLN. In terms of the filing of annual declarations and PLN, the increase in space launches by private companies is not challenging in itself but requires effort on the part of states in which SLV developed by New Space companies are being launched several times a week. Over the coming years, this number is bound to continue to increase, especially in the US, where SpaceX rocket launches take place at very short intervals, several times a month. In 2021, SpaceX completed thirty space launches: far more than any national space agency. In accordance with Article VI of the Outer Space Treaty,[82] these launches fall under the jurisdiction of states and by extension HCoC subscribing states must send PLN for private launches

The emergence of new business practices and new technologies

As far as technical developments are concerned, the HCoC makes explicit reference in Article 4(a)(ii) to '*expendable*

79. UNDIR, 'Supporting diplomacy: clearing the path for dialogue,' UNIDIR Space Security Conference Report, 29 May 2019, available from https://swfound.org/media/206814/unidir-space-security-report-2019_for-publication.pdf.

80. Matteo Emanuelli, 'Epsilon Rocket Data Stolen by Hackers,' *Space Safety Magazine*, 5 December 2012, available from https://www.spacesafetymagazine.com/aerospace-engineering/cyber-security/epsilon-rocket-data-stolen-hackers/.

81. Airbus, 'New Space: Europe should shape the future of space,' last accessed 21 July 2021, available from https://www.airbus.com/public-affairs/brussels/our-topics/space/new-space.html.

82. '*States parties to the Treaty shall bear international responsibility for national activities in outer space [...] whether such activities are carried on by governmental agencies or by non-governmental entities. The activities of non-governmental entities in outer space shall require authorization and continuing supervision by the appropriate State Party to the Treaty*'.

Space Launch Vehicle programmes,' referring to launch vehicles that can be launched only once. However, more and more private companies are developing partially reusable launch systems and the objective over the next few years is clearly to develop fully reusable launch systems. Many tests of SpaceX's Starship[83] reusable launch vehicles are underway and while the SLV is not yet operational as of 2021, it could be in the coming years. The text of the HCoC may therefore require modification to ensure that reusable launchers are covered in the mechanism.

Other practices being considered by private companies are likely to complicate the application of the HCoC to space activities in the coming years. SpaceX CEO Elon Musk has publicly stated that the company wants to use its Starship SLV for Earth-to-Earth travel, making it possible to complete long-distance trips in less than an hour.[84] The same concept is also being considered by other companies such as Venus Aerospace,[85] and even by public entities, such as the US Air Force and US Space Force, which recently launched the Rocket Cargo programme.[86] This programme aims to use rockets for Earth-to-Earth transport missions capable of carrying up to 100 tonnes of military supplies around the globe in the future. Interestingly, while space programmes were largely derived from military projects during the Cold War, this points to a reverse trend, with a military project being inspired by the practices of New Space actors. This use of an SLV for

Figure 6: Starship, SpaceX reusable heavy-lift reusable vehicle, on the launch pad, January 2021. Credits: Jared Krahn.

Earth-to-Earth travel blurs the difference between a ballistic missile and SLV, as the trajectory would become that of a ballistic missile, and thus raises the question of the classification of these new types of rocket. If

83. SpaceX, 'Flight Test: Starship SN15,' last accessed 21 July 2021, available from https://www.spacex.com/vehicles/starship/.

84. Thomas Burghardt, 'Preparing for "Earth to Earth" space travel and a competition with supersonic airliners,' NASA Space Flight, 26 December 2020, available from https://www.nasaspaceflight.com/2020/12/earth-to-earth-supersonic-airliners/.

85. PRNews Wire, 'Venus Aerospace closes on $3 million in seed funding,' 3 March 2021, available from https://www.prnewswire.com/news-releases/venus-aerospace-closes-on-3-million-in-seed-funding-301239617.html.

86. Stephen Clark, 'New military program to study using huge rockets for global cargo delivery,' *SpaceFlightNow,* 4 June 2021, available from https://spaceflightnow.com/2021/06/04/new-military-program-huge-rockets-for-global-cargo-delivery/.

and when these rockets are deployed, international space legislation will need to clarify the nature of these flying objects.

Apart from adapting the HCoC to emerging business practices, the development of new industries and actors in the space sector raises the question of the increased risk of ballistic proliferation due to the dual nature of space technologies. As New Space is evolving very rapidly, with the emergence but also disappearance of many private sector actors, this new private market may create new channels for technology transfer, which could lead to increased proliferation risks.[87] This issue is notably raised by the use of 3D printing technologies. The Electron light SLV, for example, developed by Rocket Lab, currently relies on a 3D-printed rocket engine. Ballistic missile manufacturers are also increasingly looking to 3D printing.[88] This use of additive manufacturing has implications for proliferation in that components and parts can be 'exported' without any physical transfer, as they are intangibly modelled on computers. Exports can be made via data transfer, and these computer-modelled 3D technologies can be stolen through a cyberattack. For these reasons, the Wassenaar Arrangement[89] has added 3D printing technologies to its control list, and in 2017, MTCR members recognised that '*3D printing technology poses a major challenge to international export control efforts*'.[90]

Companies operating in the space sector, whether they are start-ups or large companies, are aware of the sensitive nature of their activities, and in particular of the risk of proliferation of dual-use technologies. Moreover, there are instruments through which states can fulfil their international non-proliferation obligations without impeding the development of the activities of space companies. *Ex ante* controls such as licences or custom controls enable export verification by national authorities for tangible goods.[91] Other instruments exist for intangible knowledge transfers such as military classification of information, a legal protection that limits the risk of misuse.

87. Jakub Pražák, 'Dual-use conundrum: Towards the weaponization of outer space?,' Acta *Astronautica*, 5 January 2021, available from https://www.sciencedirect.com/science/article/abs/pii/S0094576520307943.

88. Leonardo, 'Missiles produced with 3D technology,' Leonardo, 14 January 2016, available form https://www.leonardocompany.com/en/news-and-stories-detail/-/detail/missili-prodotti-tecnologia-3d.

89. The Wassenaar Arrangement is a global multilateral export control regime for conventional weapons and sensitive dual-use goods and technologies which entered into effect in September 1996. It is designed to promote transparency, exchange of views and information and greater responsibility in transfers of conventional arms and dual-use goods and technologies.

90. Margaret Besheer, 'UN: Terrorists using 'Dark Web' in pursuit of WMDs,' *Voice of America*, 28 June 2017, available from https://www.voanews.com/europe/un-terrorists-using-dark-web-pursuit-wmds.

91. Arnaud Idiart, 'The role of intangible transfer of technology in the area of ballistic missiles – reinforcing the Hague Code of Conduct and the MTCR,' *HCoC Research Paper*, Fondation pour la Recherche Stratégique, July 2017, available from https://www.nonproliferation.eu/hcoc/wp-hcoc/uploads/2018/01/Food-for-thought-paper_Idiart.pdf.

That said, full control of intangible transfers may remain difficult to implement and may require a global overhaul of existing export control mechanisms.

The HCoC transparency and confidence-building measures and the weaponisation of outer space

Alongside the development of commercial practices to benefit from various space applications, tensions above Earth are leading to what is referred to as the weaponisation of space. The weaponisation of space can be defined as '*weapons placed in space and those on Earth capable of targeting space assets, as well as weapons which transit in outer space*'.[92] This weaponisation of space encompasses several types of weapon, such as kinetic weapons capable of destroying a satellite by a strike. These kinetic attacks may consist of launching a missile towards a satellite in outer space or an attack on the control and command centres of a satellite in orbit. Missiles launched towards a satellite are known as anti-satellite weapons (ASAT), and have been developed since the Cold War. There are also cybernetic weapons, which use lasers or electromagnetic interference (jamming or spoofing) to disrupt a satellite for a specific or definitive period, without physical destruction of the satellite. These weapons can be used either from Earth or from another satellite.[93]

These technologies and weapons are not new: they were already on the agenda almost as soon as the first satellites were placed into orbit and gave rise to several R&D programmes during the Cold War space race, including space interceptors as part of the Strategic Defense Initiative (SDI) developed in 1983. Other space weapon programmes were considered by the US (Brilliant Pebbles,[94] and more recently the Redesigned Kill Vehicle[95]) and the USSR (Istrebitel Sputnikov, 'satellite fighter'), but were never operationalised.

While the major space powers proclaim a policy of restraint with regard to offensive weapons in space, they are at the same time testing ASAT missiles. To date, four countries have conducted at least one direct -ascent kinetic ASAT weapons test against their own satellites: China (2007), the US (most recently in 2008), India (in 2019) and Russia (most recently in 2021). Although it is difficult to identify the exact number of US and Russian ASAT tests, both countries

92. Nayef Al-Rodhan, 'Weaponization and outer space security,' *Global Policy*, 12 March 2018, available from https://www.globalpolicyjournal.com/blog/12/03/2018/weaponization-and-outer-space-security.

93. Todd Harrison, Kaitlyn Johnson, Joe Moye, and Makena Young, 'Space Threat Assessment 2021, » *CSIS*, April 2021, available from https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210331_Harrison_SpaceThreatAssessment2021.pdf?gVYhCn79enGCOZtcQnA6MLkeKlcwqqks

94. A system of thousands of missiles placed in orbit capable of detecting and colliding with ICBM during their phase in outer space.

95. An interceptor launched by a missile capable of destroying an ICBM during its phase in space.

started to invest in ASAT weapons at the very beginning of the conquest of space in the 1960s.

These ASAT weapons need to be analysed in the light of the provisions of the HCoC: while the Code does not explicitly refer in its text to ground-launched ASAT weapons, ASAT missiles developed by the major powers are likely variants of ballistic missiles: the Chinese Dong Neng-2 ASAT, for example, may be a variant of the Dong Feng 21 IRBM.[96] While the HCoC does not technically define a ballistic missile, the fact that an ASAT missile has its target in outer space and not on Earth does not preclude it from being considered a ballistic missile under the Code. As such, subscribing states probably all agree on the fact that they are required to provide pre-notification of ASAT missile launches under the HCoC system and list them in their annual declarations.

In addition, several scholars are calling for an '*expansion of transparency [measures in the HCoC] with regard to launches of SLV for military purposes: even a general description of payload could help alleviate concerns of some countries [...] about the "space-based strike weapons" and of these and other countries about progress in antisatellite weapons'.*[97]

The space environment is currently characterised by minimal international regulation, which is limited to forbidding the placement and use of WMD. The international definition of the term 'peaceful use of outer space' only prevents the manufacture and placement of WMD in orbit. Kinetic weapons, however, and particularly ASAT missiles, carry a risk for all space operators as the destruction of a satellite generates extensive space debris that remains in orbit and can damage or destroy another country's space asset.[98]

Although some initiatives have emerged, such as the European Code of Conduct for Outer Space Activities and the Draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPTW), proposed by China and Russia,[99] to date none have come to fruition. Therefore, there is currently no universal text that legally limits the development of conventional weapons in space. The US Artemis Accords,[100] which entered into force at the end of 2020, are a non-legally-

96. Brian Weeden, 'ASAT tests in space - The case of China,' *Secure World Foundation*, 16 August 2013, available from https://swfound.org/media/115643/china_asat_testing_fact_sheet_aug_2013.pdf.

97. Nikolai Sokov, 'The Hague Code of Conduct: Multivector Expansion,' *VCDNP*, 15 October 2019, available from https://vcdnp.org/the-hague-code-of-conduct-multivector-expansion/.

98. Nivedita Raju, 'A proposal for a ban on destructive anti-satellite testing: A role for the European Union,' *EU Non-Proliferation and Disarmament Consortium, Non-Proliferation and Disarmament Paper 74*, 28 April 2021, available from https://www.sipri.org/sites/default/files/2021-04/eunpdc_no_74.pdf.

99. Michael Listner and Rajeswari Pillai Rajagopalan, 'The 2014 PPWT: a new draft but with the same and different problems,' *The Space Review*, 11 August 2014, available from https://www.thespacereview.com/article/2575/1.

100. NASA, 'The Artemis Accords: Principles for cooperation in the civil exploration and use of the Moon, Mars, comets and asteroids for peaceful

binding text that proposes ten principles (for example concerning transparency, debris and space resources) with the intent of overseeing the exploration of space. However, as of April 2022, only seventeen countries have signed the agreement.

As such, with its 143 members, the HCoC remains the only multilateral text that can curb non-peaceful behaviour in outer space. The HCoC does not prohibit the development or use of technologies such as ASAT weapons, but HCoC member states are required to *'exercise maximum possible restraint in the development, testing and deployment of ballistic missiles in the interest of global and regional peace and security'.* This general rule could therefore be applied to space weapons and could contribute to restricting a number of potentially destabilising behaviours.

Conclusion

While the core role of the HCoC is to curb the development of ballistic missiles, the text also acknowledges that regulating space technologies is essential in order to combat ballistic missile proliferation. The idea is not to impose restrictions on the right of using outer space for peaceful purposes, but to limit the risk of diversion.

The emergence of new private and public actors, the decrease in costs and the attractiveness of the space sector are disrupting the *status quo* in outer space. While space has historically been one of the primary spheres of interest for defence activities, many countries are taking advantage of a favourable situation for space development, whether to send satellites or even develop indigenous SLV for civilian purposes. These new players are not automatically leading to a negative change in outer space governance, but the absence of regulation and agreement on responsible practice may lead to an increase in risks and malicious practices. In the coming years, more countries could become spacefaring without necessarily developing a parallel ASAT missile programme. For example, one of the most recent multilateral initiatives regarding the issue of weaponisation of space and the promotion of the peaceful use of outer space is the 2020 Joint Declaration of the Community of Latin American and Caribbean States (CELAC) on the Peaceful Use of Outer Space. This joint declaration acknowledges that no CELAC member states will place '*on Earth or in space any weapons that could attack space systems in orbit, or to place in space weapons that could attack targets on Earth'*[101] and reaffirms the need for political and technical cooperation in the space sector.

However, while the field of outer space is evolving very quickly, both in terms of civil and military applications, it is noticeable that international law is struggling to adapt

purposes,' 13 October 2020, available from https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf.

101. CELAC, 'Declaración Conjunta de la Comunidad de Estados Latinoamericanos y Caribeños sobre el uso Pacífico del Espacio Ultraterrestre,' 2020, available from https://ppt-celac.sre.gob.mx/es/comunicados-especiales-e-intervenciones/declaraciones-especiales/24-declaracion-conjunta-de-la-comunidad-de-estados-latinoamericanos-y-caribenos-sobre-el-uso-pacifico-del-espacio-ultraterrestre.

to these new practices. The UN agencies responsible for space activities (the Committee on the Peaceful Uses of Outer Space and the Conference on Disarmament with its Prevention of an Arms Race in Outer Space initiative) are forums where dialogue is no longer possible, as they are bogged down in conflicting national interests. Moreover, the 1967 Outer Space Treaty does not regulate the issue of the weaponisation of space. The international community has not united around attempts to develop new international regulations, such as the Chinese and Russian PPTW treaty. Moreover, as technology regarding outer space is moving rapidly, negotiating a legally binding treaty is extremely difficult and is seen by some as too rigid a way to respond to the rapid developments in the sector.

In this context, non-binding international instruments designed to develop a framework of best practice and principles of responsible behaviour and promote transparency and confidence-building seem all the more pertinent. These soft law texts are more flexible and easier to adapt to reality than legally binding treaties. Easier to negotiate and more inclusive, these instruments may appear more attractive to states, which may feel less constrained by international regulations.

In accordance with international law, particularly the 1967 Outer Space Treaty and the 1996 General Assembly Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, the HCoC does not affect any future decision to develop space programmes.[102] Several examples show that HCoC subscribing states that do not have a space programme at the time of joining the Code can develop one years after signing the Code, whether their programme is purely public or involves New Space actors operating under state jurisdiction. Multilateral transparency and confidence-building measures are thereby compatible with the development of a national space programme.

However, technological innovations may require such an instrument to adapt in order to remain pertinent. More specifically, the HCoC subscribing states may usefully consider specific elements that may need to be addressed to meet the new challenges created by both recent and anticipated developments in the field:

- Subscribing states could publicly specify the type of launchers that are included in the scope of the Code and specifically refer to ASAT weapons. Positively affirming their inclusion in the Code, stating whether or not they have been pre-notified in the past, and ensuring that they are pre-notified in the future would in particular serve to show the commitment of subscribing states to the relevance of the instrument. It would display their willingness to ensure that the HCoC plays its role as a CBM to avoid misinterpretation of such

102. HCoC, 'Welcome package for outreach events 2018-2021,' last accessed 21 July 2021, available from https://www.nonproliferation.eu/hcoc/wp-hcoc/uploads/2021/02/Welcome-Package_EN-final-27012021.pdf.

launches and answer some of the criticism from non-subscribing states that the scope of the Code is currently too restricted and that its implementation could be improved.

- Subscribing states could envisage widening the HCoC's CBM, which are currently restricted to 'expendable' launch vehicles, as SpaceX's activities show that reusable rockets may become common in the near future.[103] While the current wording is consistent with the characteristics of the objects that have been developed until now, it may be useful to open up the reporting mechanism to include reusable space launchers.

- More generally, the HCoC community should pursue its efforts to engage with newcomers to the field, especially private companies and start-ups, and ensure that they are aware of the risks of proliferation. While most of these discussions take place in the framework of the MTCR, the HCoC's quasi-universal membership makes it a pertinent forum for discussing these issues with private sectors. Beyond the main manufacturers located on the territory of MTCR partners, a network of contractors operating all over the globe may be concerned by the risk of diversion of dual-use items, immaterial data hacking, and 3D printing espionage in the field of space launching technologies and may want better information and engagement.

- Finally, the international community as a whole could learn from the HCoC and its implementation over the past twenty years and consider it as a model for CBM concerning other problematic developments linked to the weaponisation of space.

With the annual resolutions adopted by the UNGA, the HCoC is currently the only international text that addresses transparency in outer space. Unlike other international texts concerning outer space governance, the majority of the international community has endorsed the HCoC, whether they are spacefaring countries, countries with satellites or countries with no satellites yet in orbit. Although the HCoC is not only focused on spacefaring countries and SLV launches, the transparency and confidence-building measures it promotes encompass the whole international community, reinforcing international space security. □

103. Mathieu Bataille, 'Le HCoC et le développement de programmes spatiaux,' Le Code de conduite de La Haye: mesure de confiance et instrument de sécurité partagée, Séminaire régional, 31 mars 2021.

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Previously published

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- Katarzyna Kubiak, 'Harnassing Transparency Potential For Missile Non-Proliferation,' *HCoC Papers n°9*, FRS, December 2022.
- Antoine Bondaz, Dan Liu and Emmanuelle Maitre, 'The HCoC and China,' *HCoC Papers n°8*, FRS, October 2022.
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THE HAGUE CODE OF CONDUCT

The objective of the HCoC is to prevent and curb the proliferation of ballistic missiles systems capable of delivering weapons of mass destruction and related technologies. Although non-binding, the Code is the only universal instrument addressing this issue today. Multilateral instrument of political nature, it proposes a set of transparency and confidence-building measures. Subscribing States are committed not to proliferate ballistic missiles and to exercise the maximum degree of restraint possible regarding the development, the testing and the deployment of these systems.

The Fondation pour la Recherche Stratégique, with the support of the Council of the European Union, has been implementing activities which aim at promoting the implementation of the Code, contributing to its universal subscription, and offering a platform for conducting discussions on how to further enhance multilateral efforts against missile proliferation.

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