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Chair: The Honourable John McKay





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• (0815)

[English]

**The Chair (Hon. John McKay (Scarborough—Guildwood, Lib.)):** I call this meeting to order. It's 8:15. I see we have quorum.

We still have conversations on the Conservative benches.

Let me run a show today. We're going to adjourn at 9:45. We're going to traipse over to room 420 to meet up with the Finnish delegation, and then the foreign affairs committee is going to join us. We will have a conversation with the Finnish delegation, which will last as long as members want it to last, frankly, but in the meantime, we actually have extra time in the first hour, which has now become an hour and 15 minutes.

We're waiting for Dr. Byers to come in, but we'll proceed with Dr. Steer and then we'll do a sound check Dr. Byers when he arrives.

I'm hoping to get to three rounds. We'll see how it plays out after two rounds.

With that, we'll ask Dr. Cassandra Steer, chair of the Australian Centre for Space Governance, who's coming to us by video conference, to begin.

Thank you for making yourself available. You have five minutes, please.

**Dr. Cassandra Steer (Chair, Australian Centre for Space Governance, As an Individual):** Good morning, Chair. Thank you so much for the invitation to contribute to this study.

My work in space security, space law and space governance spans Australia and North America. I'm particularly interested in what space middle powers can achieve, particularly when they collaborate together and also work with smaller blocs or blocs of smaller nations.

I'll focus on four things. The first is the implications of the commercialization of space; the second is how Canada can and, in fact, already does lead in bringing a gender lens to space security; the third is geopolitical impacts on space; and the fourth, if time allows, is why having a national space policy is essential. I know others have spoken to that.

Firstly, on the implications of the commercialization of space, we really need to think about space and space-based services a little bit all the time, a bit like the way we all think about cyber and cybersecurity a little all the time.

We're all conscious of how much cyberspace permeates our lives. We're all conscious that we need to have strong passwords and protect our personal information. We all understand the risks of cyberattacks and the need for cybersecurity for national security.

That's how we need to think about space a little bit, as well, all the time. It's permeating. It's ubiquitous. These space-based services are a part of our daily personal lives and a part of our national economic well-being, as well as our national security. It's still fairly early in the morning. You've probably used space at least 10 times this morning, and by this evening, you probably will have used it 20 to 40 times. That's how permeating it is, so space defence is important because space is important to Canada.

I'm not sure if others have spoken to this, but I think it's useful to also understand that space systems are made up of four segments.

There's the space segment, obviously—the satellite or the spacecraft that's in space. There's the ground segment, which is satellite dishes, receivers and data processing. There's the link segment, which is the communication link between satellites and the ground segment that's providing data on the way that we operate the satellites. The link segment is actually the most vulnerable to threats and interferences. The fourth segment is the human segment, so that's you and I, as users of space, the operators of space and decision-makers.

It's quite useful when we talk about space defence to really understand that all of these systems matter to us on earth and that, in fact, three of those segments are not even in space.

Also, as others have already stated to this committee, it's important to understand the degree to which the majority of space services are dual-use. A single space system is providing the same services, such as communications and navigation, both for military uses and civilian uses. This is largely because of how commercialized space has become. There are approximately 10,000 operational satellites in orbit today. As 75% of those are commercially owned and only about 580 of them are dedicated military satellites, space as a service has become the modus operandi. DND, like many militaries around the world, is purchasing space services from commercial providers.

Last month, in Ottawa, I co-led a workshop that was funded by DND, which was delivered by a consulting company I work with called SSCL, or Space Strategies Consulting Limited. The workshop was titled “Defending and Protecting Commercial Space Systems in Times of Tension and Conflict”. We discussed the need for clear contractual terms when it comes to the protections that commercial space providers need to build into their own systems. We discussed the threats faced by commercial systems from adversaries and then, importantly, the implications on civilians when there's a loss of service because of those kinds of threats and interferences. There will be a report coming out early next year about that.

This leads to my second point, which is how Canada can lead in bringing a gender lens to space security. There's globally recognized evidence that girls and women suffer disproportionately during armed conflict for a range of reasons. Then, because of the dual-use nature of those commercial space services, if there's a loss of service because of an attack, that impacts not only the armed forces depending on them but also the civilians who depend on those same services. That often leads to disproportionate impacts for women and girls. One example is when Russia undertook a cyber-attack against a U.S. commercial Viasat satellite in 2022.

As well, earth observation capabilities and communications capabilities can be deployed in a positive way in fulfillment of Canada's obligations under the UN gender, women, peace and security agenda to protect women's and girls' rights during armed conflict. Canada's been very proactive in advocating for gender-neutral language in UN space security discussions and submissions on including a gender lens in space security. There's an opportunity for DND to advance this agenda explicitly in its space strategy as part of its standard operating procedures and also to partner with countries like the U.S. and Australia, who are very keen to advance that agenda.

• (0820)

My time is very short, so I'll speak very briefly to the third point.

Given that this study includes the impacts of advancements in space on Canada's sovereignty and national security, it's important to understand the geopolitical drivers behind those investments in space. I think, in its simplest terms, space is just another domain in which geopolitics are playing out. The tensions we see playing out regionally and globally are playing out in this technological domain as well, and this is exactly why space diplomacy is so important.

Canada has an international reputation of being an effective space diplomat. It works together with allies and partners, including smaller nations, to advance the agenda of responsible behaviours at UN discussions in Geneva and in New York. It was the first country to join the U.S. in committing not to test direct-ascent anti-satellite weapons, and it's also very much recognized for bringing clarity on the international law applicable to space security in those international discussions.

I will leave my final point on the need for national space policy. Suffice it to say that I join others in advocating for that.

Thank you.

**The Chair:** Thank you, Dr. Steer.

It's good to see you again, Dr. Byers. You have five minutes, please.

• (0825)

**Dr. Michael Byers (Professor, University of British Columbia and Outer Space Institute, As an Individual):** Good morning, everyone.

My name is Michael Byers. I have held the Canada research chair in global politics and international law for two decades now. I co-direct the Outer Space Institute, which is a global network of experts working on cutting edge challenges in near-earth space.

Also of great relevance to this committee, I co-direct the MINDS space security network, which is a DND-funded network, through their academic network funding. It deals with cutting-edge issues concerning space security as it relates to Canada and Canada's national defence. I'm delighted to be here on this specific topic. It's exactly what I am working on right now.

I have two simple points, which I will elaborate on briefly. The first is that satellites will always be much easier to attack than to defend. They are acutely vulnerable. Second, Canada has several space companies that have satellite systems in orbit right now that are being used to support the Ukrainian military in an armed conflict with Russia. Nothing I'm telling you is secret. It's all public domain information. These are things you need to know.

In November of 2021, Russia destroyed a defunct Soviet-era satellite at 483 kilometres above earth to demonstrate its ability to use ground-based missiles against satellites. It created a lot of debris. It put both astronauts and cosmonauts on the International Space Station at some risk of collisions with debris, but Russia demonstrated its ability to do that.

Russia has been jamming satellite transmissions extensively for the last two years across eastern Europe, from Ukraine all the way up to the northern border between Norway and Russia. On the morning of the full-scale Russian invasion of Ukraine, Viasat, a U.S. company that was providing communications support to the Ukrainian military, suffered a massive cyber-attack. It went dark on the morning of the invasion. I could go on.

Even complex systems involving thousands of satellites, like SpaceX's Starlink, are vulnerable to all those system attacks, including a Cold War weapon called the [*Technical difficulty—Editor*] November 2021 test right in the middle of the constellation would cause SpaceX to have to engage in tens of thousands of collision-avoidance manoeuvres, thus rendering the system dysfunctional.

Satellites are not something we can actually defend, which is why things like space diplomacy are so incredibly important to remind Russia, to remind China, that we all are acutely vulnerable to things like debris in space and that irresponsible behaviour hurts everyone.

The second point—and this again is public record—is that we know that shortly after the Russian full-scale intervention, the CEO of MDA Space, Canada's largest space company, issued a press release saying that MDA was providing synthetic aperture radar imagery to support the Ukrainian military, incredibly useful imagery. It can produce high-resolution images at night through clouds and track Russian tank movements at night. That's fine. It's been a really important part of Canada's contribution to the Ukrainian effort.

Telesat operates communication satellites from geosynchronous orbit. It was revealed by the then defence minister that Telesat had a contract from the Canadian government to provide communications support to the Ukrainian military. One can presume that's ongoing.

As Dr. Steer said, this is quite normal. Lots of satellites are dual use. Lots of governments contract with commercial operators. The challenge is that, by engaging in this kind of support, arguably these Canadian companies are making their satellites legitimate targets under the laws of war and, therefore, potentially implicating Canada in a role in the conflict that we might not want. We've been working really hard to avoid any direct conflict with Russia. We've been working really hard to avoid triggering article 5 of the North Atlantic Treaty. These satellites bring us very close to the line of actually being directly engaged in that conflict.

● (0830)

I would encourage members of this committee to think about how Canada should respond if, for instance, RADARSAT-2, the principal satellite used by MDA to support the Ukrainian military, was in fact shot down by a Russian missile. What would that mean for Canada's involvement in the conflict? How would we respond?

The next time we get into a situation like this, what kind of considerations would we want to make when deciding whether to allow a Canadian company to engage in this kind of role? It all happened very quickly in February and March of 2022. I'm not saying the wrong decisions were made, but we found ourselves much more involved in the conflict than I think decision-makers realized at the time. These are new issues and new areas, but satellites bring us very close to the front line in terms of providing support for things like targeting in conflicts that we're otherwise trying to stay out of.

With those two points—that we can't really defend satellites and that some of these satellites, in the way they are used, are bringing us into foreign armed conflicts—I'll leave it there and wait for questions from the members.

Thank you very much.

**The Chair:** Thank you, Dr. Byers and Dr. Steer. You've both given us a great deal to think about.

We'll start off our six-minute round with Mrs. Gallant.

You have six minutes, please.

**Mrs. Cheryl Gallant (Renfrew—Nipissing—Pembroke, CPC):** Dr. Byers, NATO, as you note, struggled for a number of years to decide whether or not...and what would constitute triggering article 5. Because it's dual use, has there been any discussion in terms of applying article 5 to a satellite attack?

**Dr. Michael Byers:** I don't have security clearance, so I don't know whether those discussions have taken place between NATO militaries. I do know—it's public record—that NATO spends a lot of time on space security and that there are Canadian officials who are based at NATO in Europe dealing with these issues, so my assumption is that, yes, it has been considered.

I would suggest that one simple change to make, and it may already have been made, is that, if Canadian companies are going to be involved in supporting a foreign military, they should not tell anyone about this. It was quite remarkable that the CEO of MDA issued a press release in March 2022 to announce MDA's involvement in the conflict. That was a very bad decision, with all respect to the CEO. A lot of people were scrambling. Mistakes were made in those early weeks of the Ukraine war. That was a mistake. It put a big bull's eye on the side of a billion-dollar Canadian satellite that supports not only military operations but also a whole range of civilian operations—everything from ice navigation in the Canadian Arctic to climate change research. The list goes on and on.

The problem with dual-use satellites is that, if you lose one because of involvement in an armed conflict, not only do you risk an escalation of the conflict, but you also lose all the incredibly important civilian uses of that piece of equipment.

Again, the answer to the question is that I assume it's been talked about. I am not allowed to know.

**Mrs. Cheryl Gallant:** Dr. Byers, were you to have security clearance and you knew the answer to my question, would you be able to share it with this committee?

**Dr. Michael Byers:** No. Of course not.

**Mrs. Cheryl Gallant:** Why is that?

**Dr. Michael Byers:** It's because the record of this committee, the transcript of this evidence, is public domain.

**Mrs. Cheryl Gallant:** All right. Thank you, Dr. Byers.

Are there any emergency preparedness measures aside from redundancy in space? Are there measures in place ready to execute to protect the Canadian public should there be a hostile attack on one of our satellites?

**Dr. Michael Byers:** Thank you for the question.

My first point, about the fact that satellite systems are always easier to attack than to defend, actually goes to the point of redundancy in space. I don't think redundancy in space is much of a protection, at least in terms of having hundreds or thousands of satellites in a single system spread around in a single orbital shell. One of the recommendations that my colleague Aaron Boley and I have made to the Department of National Defence and other NATO militaries is that they distribute their satellite systems across multiple altitudes to spread them out and make them less vulnerable. That is one simple answer to this problem.

In terms of our vulnerability in the day-to-day operations of civilian and military systems in Canada, we should keep non-satellite systems operating. To give you a simple example, we are incredibly dependent on global positioning satellites. The American GPS system is central to the Canadian economy to the point that commercial airliners are heavily dependent on GPS. For reasons I don't understand, we are removing the ground-based air navigation systems that used to exist before GPS so that more and more, we don't have a backup. If Russia or another hostile state were to somehow take down a GPS or interrupt its operations through some kind of jamming system or in-space attack, we would have a total catastrophe in civilian aviation in Canada, so don't take out those ground-based systems.

We have redundancies. Don't take out the fibre optic cables because you're relying on satellite systems. The more we have different kinds of systems in different places providing redundancy, the better we will be protected, not just against hostile attacks but against something like a massive solar storm that could also take out thousands of satellites.

Let's keep the ground-based systems in place. Don't think we can save money by removing them and just relying on satellites.

• (0835)

**Mrs. Cheryl Gallant:** I'll bring that clip out the next time my family complains about my map collection.

When the outer space treaty is violated, what types of actions can be taken to ameliorate it?

**Dr. Michael Byers:** The question applies to all of international law. International law is respected and followed 99.9% of the time. Sometimes, you get a bad actor that chooses to violate a rule or a treaty.

In the case of Russia, it is now a pariah state. It's subject to widespread sanctions. It's facing NATO providing massive numbers of weapons and amounts of other support to Ukraine as it fights its defensive battle. Russia is paying a price for its illegalities, not just with regard to the outer space treaty but with regard to things as simple as the United Nations Charter and the prohibition on the use of force—

**The Chair:** Okay. Unfortunately we're going to have to leave the answer there.

Mr. Collins, you have six minutes, please.

**Mr. Chad Collins (Hamilton East—Stoney Creek, Lib.):** Thanks, Mr. Chair.

Good morning and welcome to our witnesses.

Dr. Byers, I'll start with you on space debris. I was formerly a member of our science committee and wanted to undertake a study on space debris. What I found fascinating about that subject was that many of the agreements that govern space are decades old. They were nation-to-nation when they were signed in the sixties and seventies, and not a lot has changed in updating those agreements or signing new multilateral agreements that would address not just space debris but other governance-related matters in space.

The question I have for you is this. You've talked about some of the threats that are posed to our commercial infrastructure in space as well as our military infrastructure in space when it comes to space debris. I'm just wondering what recommendations you have for the committee in relation to possibly updating those agreements or continuing along the line of the tacit, soft agreements that are in place that govern this whole issue related to space debris and how we deal with it.

After that, I have a supplementary question related to the same issue, but I'll ask you this first.

**Dr. Michael Byers:** That's actually a very tough question. Thank you for it.

You're right. The major multilateral treaties concerning space were all negotiated and adopted in the 1960s and 1970s and have proven to be remarkably resilient, but they've been supplemented by lots and lots of co-operation. For instance, in Canada, we're heavily reliant on a satellite-based search and rescue system called Cospas-Sarsat. It was created in 1979 at the height of the Cold War in partnership with the Soviet Union, France and the United States, and saves thousands of lives worldwide each year. Russia and China are still participating in that system.

There is [*Technical difficulty—Editor*] space station. Indeed, an American astronaut launched on a Russian Soyuz rocket from Kazakhstan just a few months ago as evidence of that continued co-operation.

Internationally, at the United Nations committee on the peaceful uses of outer space, there's still co-operation taking place. Canadian diplomats are playing a central role, I should say. We have very effective diplomatic representation at United Nations bodies dealing with space. At that level, things are actually pretty good.

With regard to space debris specifically, there are two things that people need to realize. First of all, you can't avoid space debris. Our tracking systems, our radar systems, our telescope systems can only detect pieces of debris that are roughly eight centimetres across or larger. There are millions and millions of pieces that are too small to detect all going at 17,000 kilometres an hour. The piece the size of a paint fleck can destroy a billion-dollar satellite. You can't avoid space debris, and you can't clean it up. You can clean up the big pieces but not the small pieces. At least, theoretically, you could clean up the big pieces.

As a result of this, there is a situation of mutually assured destruction in low-earth orbit where you have all this debris. Any country, any actor that engaged in an action that created tens of thousands, hundreds of thousands of additional pieces of debris would be putting its own satellites at severe risk. There is a self-interest in avoiding catastrophic collisions and the use of anti-satellite missiles on the part of those states that are heavily dependent on space. The United States, China, European countries, Canada and even Russia have a very strong interest in avoiding the creation of much more debris.

My big concern into the future is that there are countries that are not very dependent on space that are acquiring the capacity to cause a lot of debris in space. I'm thinking about Iran, and I'm thinking about North Korea. When North Korea develops the ability to launch half a million steel pellets into low-earth orbit to create a pellet ring, we have a serious problem.

This is all part of arms control. It's part of our attempt to restrain rogue nations like Iran and North Korea. We do it with nuclear weapons. We now do it with parts of space.

• (0840)

**Mr. Chad Collins:** Dr. Byers, I'm sorry. I think I have less than a minute left.

I've read some of your stuff, and you talked about it just being a matter of time within the next decade that it's likely someone on earth will be killed by debris that's re-entering the atmosphere. I read an article earlier that, at a Saskatchewan farm, SpaceX equipment fell onto a field. Thankfully, no one was injured. A Florida family had a piece of space asset that went through their roof and into their living room, I think.

Can you talk about how a space policy should address these issues, knowing that we really have no guardrails right now that protect people around the world from some of the infrastructure that's finding its way back to earth?

**Dr. Michael Byers:** A year ago, the Outer Space Institute partnered with the International Civil Aviation Organization to look into the risk to commercial airliners from re-entering space debris. A piece of debris that is just 300 grams could fatally damage a Boeing 777 or an Airbus A350, so 300 people could die as a result of a collision with a piece of space debris re-entering through earth's atmosphere. It's an extremely low probability with a very high consequence.

How do you reduce the risk? One of the ways you reduce the risk is that you stop launch providers from abandoning rocket stages in orbit after they engage in a launch. You demand, you require, that they engage in what's called a controlled re-entry and put that rocket body into the South Pacific Ocean where it doesn't pose a risk to anyone. We've been advocating for a controlled re-entry regime. I know that the U.S. Space Force will now only contract for a launch if the company can assure them that the rocket stages will come back in a controlled way and go into the ocean.

• (0845)

**The Chair:** I'm sorry to keep interrupting, but unfortunately, this is a six-minute round, not a 10-minute round.

Madame Normandin is next. She will speak *en français*, so make sure your computers are set to the translation mode, if you need it.

Madame Normandin, you have six minutes please.

[Translation]

**Ms. Christine Normandin (Saint-Jean, BQ):** Thank you very much.

Thank you to both witnesses for being here.

I'll be alternating between the two of you so you can take breaks.

Ms. Steer, I'm going to start with you.

You talked about the importance of cyber-hygiene when it comes to the use of space. We discussed cyberspace and the fact that humans could become a vector for entry into a computer system, which confirms the importance of this cyber-hygiene.

When it comes to space, to what extent should ordinary citizens also be aware? Is it the same as it is for cyberspace? For example, in the space domain, how can I, as a citizen, become a risk, the vector for an attack or something like that?

[English]

**Dr. Cassandra Steer:** Thank you very much for the question.

If it's okay, I'll respond in English. It's just better for everybody.

It's very important to understand that, in fact, cyber-attacks are the greatest risk to space systems. Of the direct-ascent anti-satellite weapons that Michael Byers mentioned, there are only four countries that have demonstrated that capability. It's a highly unlikely kind of interference precisely because of the debris it creates and the risk that it creates to their own capabilities. Cyber-attacks and other forms of link segment interference, like jamming and sending a false spoofing signal, are happening every single day already.

In terms of the risk of a citizen becoming a vector in that, the risk is very low. We're not likely to accidentally interfere with that link, but we are at risk of losing out on the service when there are those cyber-attacks. Again, it's the example of Russia launching a cyber-attack on the U.S. Viasat satellite in 2022, deliberately. It had the desired effect of interfering with communications, not only for the Ukrainian forces but also for all Ukrainian citizens and for many citizens in neighbouring countries as well.

I think there needs to be a greater level of awareness of that. I advocate a lot for space literacy. I do a lot of executive education for the Australian government and, together with SSCL, for the Canadian government. There's a space fundamentals course that you all can take to get a greater understanding of what those risks are.

As individuals, there's probably not a lot we can do in terms of cyber-hygiene or protection, but there's a great deal we can do in terms of raising the understanding of the risks and of our uses of those space systems.

[*Translation*]

**Ms. Christine Normandin:** Thank you very much.

My next question is for you, Mr. Byers. I want to come back to my colleague Mrs. Gallant's question about the use of article 5. This question was also asked about cyberspace, and often the problem is determining what triggers the article. That doesn't seem to apply as much to satellites.

However, I would like you to tell us about the damage that can be caused by an attack on a satellite. Indeed, we know that, in the case of cyberspace, attacks on critical infrastructure can be extremely serious and even deadly, as in the case of a water purification station.

What is the risk when it comes to satellite attacks and infrastructure? Can the damage be as significant as the damage caused by cyber-attacks?

**Dr. Michael Byers:** Thank you very much for your question.

[*English*]

Again, I will respond in English, just because it's better for everyone.

The first thing to realize is that invoking article 5 is a decision that NATO states will make. If there were an attack on, let's say, a Canadian commercial satellite like RADARSAT-2, one of the first decisions that the Canadian government would have to make is whether it would treat this as an armed attack that would trigger the NATO obligation.

My guess is that in the situation involving a single satellite, we would not invoke article 5. It would be an attack on an important piece of Canadian infrastructure, but it would not be an attack within Canadian territory. We would be conscious that invoking article 5 would signal that we were into a direct conflict with a nuclear-armed state, which would seem to be highly undesirable. It's a self-judging invocation. That's the first thing to say.

The consequences, however, could be very serious. RADARSAT-2 is the principal source of revenue for Canada's largest space company. I don't know whether its bottom line could handle losing such an important revenue-generating piece of equipment. Then there are all of the users who make use of RADARSAT-2—everything from oil companies using the imagery to monitor pipelines, looking for slumping of ground and looking for erosion problems around their equipment and their operations in remote areas, to the Canadian Coast Guard icebreakers navigating

the Northwest Passage, trying to avoid multi-year ice. The list goes on and on.

Yes, it would be a very serious thing in terms of being just as important as a piece of critical infrastructure located on the ground here in Canada.

• (0850)

[*Translation*]

**Ms. Christine Normandin:** Okay.

I would like you to clarify, for example, what it would mean for human life. My question was more about that. I understand the economic impact of a satellite attack, but what is the potential danger to human life?

[*English*]

**Dr. Michael Byers:** In terms of RADARSAT-2, there would be some implications on our ability to do things like sea-ice monitoring, which enables us to resupply Arctic communities, so there are some direct implications. The more serious ones, however, would come with regard to commercial satellite operations.

If we think about SpaceX's Starlink constellation, it is now providing essential services across northern Canada. There are pizza box-sized terminals outside lots of buildings in Nunavut, the Northwest Territories and the Yukon now, and we're seeing greater dependence on the satellite system. Institutional subscribers have a backup. They will have a subscription to a geosynchronous satellite service, but SpaceX is becoming more and more important.

There are several complications of that.

**The Chair:** Again, I'm having to—

**Dr. Michael Byers:** One is the vulnerability of the system.

**The Chair:** —interrupt. I apologize again.

Being dependent on Elon Musk does not give me warm fuzzies.

Ms. Mathyssen, you have six minutes.

**Ms. Lindsay Mathyssen (London—Fanshawe, NDP):** Thank you, Chair.

I want to thank both of the witnesses as well for appearing with us today.

Ms. Steer, you've written at length about the need to create binding international agreements to prevent the militarization of space and the need to specifically prevent the testing of direct-ascent, anti-satellite missile systems.

We've seen that other nations—Russia, the U.S., India—have tested these systems. Can you talk about the impact of why it's so important to prevent future testing?

**Dr. Michael Byers:** Was that question for me or to Cassandra?

**Ms. Lindsay Mathyssen:** I'm sorry. That was for Ms. Steer.



**Dr. Cassandra Steer:** Canada was, as I mentioned, the first country to join the U.S. in committing not to test those direct-ascent, anti-satellite weapons, or DA-ASATs. We now have 37 countries around the world that have made that unilaterally binding commitment. Under international law, when a state makes a unilateral statement like that, it is binding upon itself.

On top of that, we have the UN General Assembly, where I think there are something like 130-something countries that voted in favour of the notion of a moratorium on testing those DA-ASATs. That doesn't mean that they're then bound. That's a political expression. As to whether or not we need to have a binding treaty on that, those are exactly the discussions ongoing right now, in fact, this very week at the UN in New York, and there will be a new open-ended working group that will look at what kind of non-binding agreements we can come up with—so norms of behaviour—and whether there is the potential to have a treaty that might prohibit it.

I'm actually of the mind that a treaty is not necessarily the outcome that we want. The point is, as Dr. Byers also mentioned, the amount of debris that's created. There are four countries that have tested them. In each case, there's an enormous uncontrollable amount of debris that is created. The Chinese test in 2007 still has some debris today that is in orbit. Thousands of pieces of debris are created, and things are moving at seven kilometres per second in low-earth orbit. As Dr. Byers said, something the size of a fleck of paint can be lethal to a satellite. It's uncontainable.

One of the reasons I don't think that a treaty is necessary is that the laws of international armed conflict will tell us that, if we are in an armed conflict on earth, it is prohibited to use non-discriminate weapons, and there is an impossibility in determining what the impact will be of creating that amount of debris on all of the satellites that the world depends on. Therefore, it is by definition indiscriminate. You're not able to target just a military objective. You're also impacting civilians and civilian infrastructure.

That also goes a little bit to the questions that we've heard around what the impacts are of cyber-attacks on humans and indeed on the question of whether an attack would be considered something sufficient to trigger article 5 of the NATO Treaty. It all depends on the effects of those kinds of attacks. When we're talking about DA-ASATs, they create debris, and it is impossible to contain the debris, so we do not know what the effects will be. However, we do know that at some stage that debris is going to hit something.

When it comes to cyber-attacks and these non-kinetic interferences, what is the physical effect of that attack on a satellite system? Is that cutting off people's communications? Is it impacting search and rescue? Is it impacting satellite systems that are part of the control system of water systems for the city, for example? Is that going to impact food security because of the dependencies on those satellite systems? It's all about the physical effects in the real world.

We know both from how the laws of armed conflict apply to cyber and how we think they apply to space, that as soon as we have something that is sufficient in terms of its effects in the physical world, we can determine that it is sufficient to say it is an armed attack, but it is a case-by-case decision.

• (0855)

**Ms. Lindsay Mathysen:** In terms of those conversations that are continually happening, are we adequately, though, getting to a point of holding that de-escalation when we see other nations? This would be for both witnesses. Is Canada doing everything it can within those mechanisms to consistently hold on to that de-escalation specifically?

**Dr. Cassandra Steer:** I think that Canada is doing an outstanding job in that sense, and this is what I said at the beginning of my opening comments with regard to the important role of middle powers.

Canada is recognized as a very strong space diplomat. It took a very active part in the first open-ended working group that ran for two years. It was also one of just 22 nations that took part in a group of governmental experts, which just closed off earlier this year and came up with a consensus report, which was no small achievement. The open-ended working group was unable to come up with any kind of consensus report—even one simply stating that it met on these dates and these countries took part—because it became politicized. To be frank, Russia refused to agree on any consensus to release a report.

However, we did get to a consensus report in that smaller group of governmental experts, and Canada was one of the countries that worked very hard to achieve that. I would highly recommend that you all read that report. It's not very long. It goes into whether or not we need to have binding treaties and into whether or not we can also keep working on non-binding norms of behaviour to, indeed, de-escalate.

Canada is doing an outstanding job. Right now, there is a proposal to have two new open-ended working groups, one focusing on treaties and one focusing on non-binding norms. That is just going to completely dilute the process and make it impossible for smaller nations to participate that don't have large enough delegations to take part in two parallel processes. Therefore, Canada is working very hard with a lot of other countries. The vote will take place next week in New York as to whether or not those two open-ended working groups can be merged into one.

I think one other thing that Canada does exceptionally well is the corridor diplomacy and behind-closed-doors diplomacy, where it works with smaller nations to make sure that there is shared understanding, to strategize about how to really push that vote forward to get a single open-ended working group, and to also, outside of the UN multilateral discussions, keep working together with other nations on space literacy, space—

**The Chair:** Unfortunately, we have to leave it there.

Mr. Allison, you have five minutes.

**Mr. Dean Allison (Niagara West, CPC):** Thank you, Mr. Chair.

I want to talk a bit about AI. I realize that it's not necessarily specifically your area of expertise, but I would love to get your thoughts.

Dr. Steer, what do you think about the developments in artificial intelligence in the defence sector as it relates to space?

**Dr. Cassandra Steer:** I think this is something that is not gaining sufficient attention, to be quite honest.

Satellite systems are more and more dependent on AI for various aspects. Some of it is just about the data processing. Earth observation satellites are gathering enormous amounts of data, and AI is used to process some of that data. However, if that's being used to then feed into military decision-making, we need to know that there is sufficient trust in those decision-making models and those automated models.

A lot of the space traffic management is dependent on AI. Again, it's over 10,000 operational satellites and well over 130 million pieces of debris, some of which, as Dr. Byers said, is too small for us to even track. AI is increasingly used as a space traffic management tool to have satellites perform collision avoidance movements and to try to predict where there might be collisions.

All of this is really necessary because of the physical speed in space, the amount of data that we're using and our dependencies on satellites. However, I don't think there is sufficient understanding about what risks that brings, particularly if that's going to feed into military decision-making for targeting, for navigation of one's own troops on land, at sea or in the air, for communications, and for understanding the movements of adversaries. AI is becoming more and more a part of that decision-making chain. When it's built into satellite systems, we don't have enough opportunities, I think, or enough proactive mechanisms for those working on the AI systems and those who are space experts to really be bringing those two worlds together. There are high risks, I think.

• (0900)

**Mr. Dean Allison:** Thank you.

I'll continue the question then.

As AI continues to grow, certainly in all aspects of our lives, in the military and in space, let's talk a bit about cybersecurity as it relates to that. Do you think that Canada is ready to tackle some of these challenges in this complex world of AI?

**Dr. Cassandra Steer:** I think that's a question we could pose to every country.

I would say yes and no for the reasons I just said. However, I do think that there are strengths, and this goes more to what we can be doing to defend and protect satellite systems, whether those are commercial or sovereign. One of the challenges is the competition for the skill set. The people with the technical understanding are probably going to take jobs in the private sector, where they're higher paid. It's hard to get them to come into government jobs, civilian or military, so that is one challenge.

My fear is that none of us is really fully prepared, but I think that we really need to be bringing those worlds together. We need cyber experts, AI experts, space technology experts and then the governance experts of those different areas all working in the room together.

**Mr. Dean Allison:** Thank you.

In what ways do you think government can create the advantage for Canada when it comes to technology in terms of AI? In what

ways can the government do a better job in order to take advantage of this?

**Dr. Cassandra Steer:** Unfortunately, I think it comes back to procurement, which I know is an issue this committee has heard a lot about.

When you have relatively small companies in space, in AI and in cybersecurity.... Probably in cybersecurity they do better at this, but certainly in space and AI, oftentimes, the government wants to see those companies demonstrate the technological readiness level of their capabilities by having other clients first. That's a near impossibility.

For those kinds of capabilities, they're only going to find other clients if the government has already procured their capabilities. It has to go the other way around. The government has to be prepared to be the first client. That's difficult when there are low appetites for risk. I think, given the speed of these technologies, that's just something the government is going to have to somehow become prepared to do.

**Mr. Dean Allison:** I think the U.S. is a good example. They are always there, making sure that they invest in their technology. I think that's probably not a bad example.

I have one last question then.

We started looking at investing money into AI in particular, or AI infrastructure. Are there any particular investments you would recommend as a starting point or that would be more important than others to get going on, when it comes to technology, artificial intelligence and infrastructure?

Where would you think is a great place to start?

**Dr. Cassandra Steer:** I'd have to admit that I wouldn't have sufficient expertise to say what areas of AI in particular.

I could comment more, perhaps, on the mechanisms to do that, because I don't think the government itself has to then become an expert in AI technologies either. It needs to have in place mechanisms to be able to test those out.

One example, again, from the U.S., is the CASR. It's about bringing commercial space providers into the defence architecture in a way that they can start to test out and model these capabilities before they decide whether or not to buy them. That helps the commercial providers to understand what the military and defence's needs are. It helps defence to understand where the technologies are at already and what the limitations might be, as well as the opportunities. Together, they can move toward potential solutions.

I think mechanisms like that are going to help to solve—

**The Chair:** Thank you, Mr. Allison.

Ms. Lambropoulos, you have five minutes, please.

**Ms. Emmanuela Lambropoulos (Saint-Laurent, Lib.):** Thank you, Chair.

Thank you to both of our witnesses for being here to answer some of our questions on this really important topic. I'll start with Dr. Byers.

You spoke about how satellites bring us close to the front line when it comes to wars. You spoke about how there's one satellite in particular that Canada is currently using for its war efforts to help Ukraine. If Russia were to do anything to interfere with that, would it not be considered an act of war? If so, would it not be like an attack on NATO?

I'm wondering what your thoughts are here.

• (0905)

**Dr. Michael Byers:** Thank you.

That is the article 5 issue that we discussed 20 minutes ago. It could be characterized [*Technical difficulty—Editor*]—

**Ms. Emmanuella Lambropoulos:** I'm sorry, we lost you for a good few seconds there.

**The Chair:** Would you please back up?

**Dr. Michael Byers:** This is the article 5 issue, which is self-judging. Canada could characterize such an action as an act of war—as an armed attack—or it could choose not to. There would be an attribution issue with regard to some kinds of attacks, but not with regard to others. A ground-based missile launched from Russia would quite clearly be attributable.

Again, my point is that we need to think hard in advance. We give permission to satellite companies to provide such support in a foreign armed conflict, whether or not we are prepared to be making these tough decisions later. Do we want to be in a direct conflict with a nuclear-armed state because we gave permission to a Canadian satellite company to provide support to frontline operations in a foreign armed conflict?

That's the question. It's a policy question. We need to get in front of this and decide what our criteria are for giving permission to Canadian companies to support foreign militaries.

**Ms. Emmanuella Lambropoulos:** I understand. Thank you very much.

Dr. Steer, I guess you could weigh in on this. It's a point of clarification, and I'm wondering if you can help me understand a little better.

You said that generally, if an attack is made on one satellite, there are perhaps repercussions on others. That's what I understood. Is it possible for a country to attack only one satellite and not have fear that it would affect its own as well?

**Dr. Cassandra Steer:** It really depends on the vector of attack, and this is why it's important to understand that space systems are made up of those four segments.

If it is a kinetic, physical attack on one satellite, then our concern is what the debris is going to do to other satellites in space. In fact, as I mentioned, the much greater threats are ground-based and link-based like jamming a communications satellite link; spoofing and sending a false navigational link so you don't know where you are, where your adversaries are or where your target is; dazzling an earth observation satellite so it can't gather the information it's trying to gather; and cyber-attacks. These non-physical, non-kinetic attacks are much more prevalent, much more useful, in fact, and

much harder to attribute, so they're also much more effective in times of tension and warfare.

In those senses, you're often attacking a different part of the system than just a satellite. The reason people keep talking about distributed architecture and what Spacelink has done is that, when you have many satellites, it no longer matters if you target one single satellite or one single link, because the other satellites can take the place of that, and service can continue to be provided. The more complex you make your architecture, the harder it is to attack, which is a defensive mode.

I don't know if that answers your question.

**Ms. Emmanuella Lambropoulos:** Thank you. You gave a lot of good information there. I appreciate that.

I would like to ask you another question, Dr. Steer. You spoke about the fact that women are disproportionately impacted when it comes to armed conflict and that we should be thinking about this when looking at space and how we're dealing with that.

Can you give us a little more in terms of how this helps us understand space a little bit differently? Can you give us what recommendations you would have for Canada take on in order to make sure that we're moving that agenda forward?

**Dr. Cassandra Steer:** Because of the dual-use nature of all of these systems, because civilians are impacted when a dual-use system is targeted, we have to think about what the impacts on civilians are.

In many conflict situations, women and girls are already, for example, denied access to school, so their only access to schooling might be through having access to the Internet. They might lose absolute communications with each other as family units during the conflict situation. They might lose access to navigate to sources of water, for example. In cases where women and girls are being physically targeted with gender-based violence and sexual violence, earth observation satellites can help to gather timely, real-time evidence and information that would then aid Canadian troops to intervene.

It's both about how they're impacted negatively and also about how we can use space systems to positively ensure that Canada is implementing what its obligations are under its national action plan for the women, peace and security agenda. Canada is the first country to have explicitly included space in that national action plan, which I think is outstanding.

I think—

• (0910)

**The Chair:** Unfortunately, again, I'm going to have to interrupt the answer here.

Madame Normandin, you have two and a half minutes.

[*Translation*]

**Ms. Christine Normandin:** Thank you very much, Mr. Chair.

Since Ms. Lambropoulos just stole my question, so I'm going to move on to the next one.

My question is for you, Mr. Byers.

You talked about the importance of redundancy. You also talked about not getting rid of our ground-based systems, which can be used as replacements for satellite-based systems.

I'd like to hear your thoughts on two things. You said that these structures should be maintained. Should we also invest in more ground-based systems, on the one hand? On the other hand, I imagine that these ground-based systems are already used for other purposes.

Is there priority use for emergencies or domestic uses, if there is a problem with satellites? How would it work if, all of a sudden, ground-based systems had to be used as a replacement?

[English]

**Dr. Michael Byers:** That's an excellent question. I could give dozens of examples of how we have existing redundancies and how we could build more redundancies into our system. Let me give you just a simple example.

In the case of the reliance on GPS, as I have mentioned, Canada and the United States are removing a lot of our ground-based air navigation systems, because GPS is just as good and cheaper. Pilots are accustomed to using GPS for all kinds of operations. The problem is that, if GPS is off-line, if it's not accurate because of a solar storm or if jamming is occurring and it's a low-visibility day at Toronto Pearson airport, the pilots are then 100% reliant on ground-based systems for their approaches. If you were to take out that ground-based system, then the pilots would effectively be blind in low-visibility situations.

Now, no one is proposing to take the ground-based system out of Toronto Pearson airport, but we are taking ground-based systems out of a lot of smaller airports across Canada and the United States. On a normal day, 364 days a year, that's absolutely fine, but on that one day when the GPS is not functioning properly, perhaps because of a solar storm, the pilots are then in a more difficult situation. We want maximum safety with regard to essential functions like transportation. You keep the ground-based systems. You provide the redundancy.

It's the same thing with fibre optic cables. Just because we're reliant on satellites and they're absolutely fantastic, we shouldn't cancel our plans to build a fibre optic cable to Iqaluit. We should have redundant systems as much as possible.

Space is great, but if you get too reliant on one domain and you lose it for whatever reason, then you're in a real pickle. Wise policy-making is always looking to ensure backups. That's all I'm asking for here.

**The Chair:** Thanks very much.

Ms. Mathysen, you have two and a half minutes.

**Ms. Lindsay Mathysen:** I'm sorry. Just to clarify, we're doing a third round as well. Is that right?

**The Chair:** Likely—

**Ms. Lindsay Mathysen:** Hopefully...?

**The Chair:** —if we're a little tight.

**Ms. Lindsay Mathysen:** Okay.

Dr. Byers, just to expand upon what was just said, we also then would be at risk of losing the skills in terms of people's ability to read those older systems, I guess you would call them, or those backup systems in favour of GPS. Is the human component of being able to understand them or read them or use them being lost as well?

● (0915)

**Dr. Michael Byers:** Yes, presumably it is. I remember having a conversation in September 2019 with a very senior U.S. Navy official who was reporting on a NATO naval exercise that took place off the coast of Norway. The Russians had jammed GPS throughout the NATO exercise. This senior U.S. officer was pleased with that, because his personnel on the U.S. Navy ships had to get out their sextants and do it the old-fashioned way in terms of navigation. The Russians had actually improved the exercise by causing this problem and rendering GPS unreliable through jamming.

Yes, we need to maintain the old ways. For instance, we need to know how to navigate an oil tanker from Vancouver out into the Pacific Ocean without GPS. We need to make sure that our ships' pilots know how to use the ground-based lighthouse systems to navigate their ships and not become too dependent on computer screens and global positioning systems.

That's a general issue. As we move further and further into digital technologies, we need to make sure we don't lose the old ways of doing things. If the Internet were lost, if satellites were lost, we wouldn't want to go back to the Stone Age. We'd want to go back to the 1990s.

**Ms. Lindsay Mathysen:** I'm not sure how much time I have left, but I'll just say, then, that it would be incumbent upon the federal government to also continue to invest in lighthouses, I would assume, which they are not.

**The Vice-Chair (Mr. James Bezan (Selkirk—Interlake—Eastman, CPC)):** Thank you.

Mr. Stewart, you have five minutes please.

**Mr. Don Stewart (Toronto—St. Paul's, CPC):** Thank you, Chair.

Thank you to the witnesses.

Dr. Byers, you talked about space junk and space debris. It's something, I think, that's been talked about for a long time. I'm wondering what the operators of spacecraft do to protect themselves from space debris. I'm not hearing about a lot of collisions or damage, or maybe I'm just not reading the right publications.

**Dr. Michael Byers:** They do several things. First of all, they will often choose to put their satellites at altitudes that have less congestion, less debris. That's one strategy, where you position your satellites and your satellite system.

Some operators build shielding into their satellites and build in redundancies. Instead of having just one electrical wire connecting two components, you have two electrical wires, so if that tiny paint fleck of space debris were to cut one of the wires, you'd have a backup that would keep the satellite operational. The more shielding you put in and the more redundancies you put in, the greater the cost of your satellite.

One of the big problems today is that some operators, led by SpaceX, have adopted the consumer [Technical difficulty—Editor] thousands of mass-produced, low-cost satellites with no redundancies. Then they have an operational life of just four or five years. Just like your cellphone, they throw it away after four or five years and send it into a re-entry trajectory.

**Mr. Don Stewart:** Is there a point, like a forecast point, where we're going to reach maximum saturation of artificial satellites in space?

**Dr. Michael Byers:** There is something called the Kessler syndrome, which hypothesizes that once you get a certain rate of collisions and debris creations, you create a kind of death spiral, an ongoing cascade of debris, which eventually destroys the orbit where this is happening. It's indeed possible that we're in the early stages of this Kessler syndrome already and that in some altitudes, some orbital shells, we've gone beyond the carrying capacity and we will eventually lose access.

However, we need to combat that by insisting that satellites are capable of withstanding small debris hits by having redundancies and by having shielding, that they're built to last and that they're built for the conditions of space.

**Mr. Don Stewart:** Let's talk about Iran for a second. You mentioned earlier that the countries that don't rely on space would be the ones most incentivized to mess up our space assets. I think you specifically mentioned Iran. Have you heard from intelligence out there that Iran is actually preparing a mission to launch these space pellets to create this pellet ring to disrupt our space communications?

• (0920)

**Dr. Michael Byers:** No, I haven't. I don't have access to classified information, so I just can't comment on that.

I do want to seize the opportunity to say that I'm not worried about China engaging in such an attack because China has the exact same interest that western countries do in keeping space a safe place for its satellites. There's a huge opportunity for diplomacy with China on this issue. Of course, we can walk and chew gum when it comes to a great power like China. We can stand fast and build up our defences while co-operating with China on discrete issues where there is a shared interest, and this is one of them.

**Dr. Cassandra Steer:** I wonder if I might briefly interject and say that I actually don't believe there's any country on earth that is not dependent on space capabilities. There are different levels of dependency, but I think that actually reduces the likelihood of these kinetic attacks because they will be compromising their own dependencies.

**Mr. Don Stewart:** Dr. Byers, earlier you mentioned MDA's RADARSAT and how it's important to us and to other countries.

How does our aerospace industry, in general, compare to others on the global stage in terms of size and sophistication?

**Dr. Michael Byers:** Canada was the third country in space. We had our first satellite in space in 1962, and we have legacy companies that have grown and evolved and are global players now. Telesat, with regard to communications, is a world leader, currently building a very robust communications constellation in low-earth orbit that actually follows the kinds of recommendations—

**Mr. Don Stewart:** If we are 4% of the world's economy, are we more than 4% of the space industry?

**Dr. Michael Byers:** I don't know about that exact number, but I do know that we have a couple of major players.

Yes, we can build more. It is a competitive environment and these are systems that are essential for any 21st-century economy.

I want to emphasize that we have several world leaders and we have companies that are emerging as world leaders, like Canadensys, which is building a lunar rover for the Canadian Space Agency right now. With Telesat, MDA Space and Canadensys, we have some significant players.

Should we have more? Of course we should. Is the United States ahead of us? Absolutely—

**The Chair:** We're going to have to leave it there.

Mr. Powlowski, you have the final five minutes.

**Mr. Marcus Powlowski (Thunder Bay—Rainy River, Lib.):** Professor Byers, you've talked about Canadian satellite companies allowing the Ukrainian military to use their satellites and the possibility that these would become legitimate targets and bring Canada into an international conflict. This gives rise to the policy question of whether we should allow it.

How much are satellites an exception? Canada also produces LAVs that we sell or donate to Ukraine. We produce some optic systems to help Ukrainian drones. They could, theoretically, be legitimate targets, but I guess those would be built on Canadian soil. If the Russians were to attack Canadian soil, that's a different thing. However, we have to get them to Ukraine, so they're going to go through international waters anyhow. Isn't that a comparable situation?

How much are satellites an exception in international law?

**Dr. Michael Byers:** Let me say from the outset that I actually support the provision of satellite services from Canada to the Ukrainian military. What's happening through the Russian invasion is an almost existential issue of international security, so I support what's happening.

My point is that I'm not sure that careful consideration was given in March 2022 as to the possible implications of allowing companies like MDA and Telesat to provide frontline support. What I mean by frontline support is communications and targeting imagery that are actually used in targeting. It creates potential risks. Not only is the satellite potentially a legitimate target, so is the ground station. Where is the ground station? It's in Richmond, B.C.

I don't think that Russia wants to escalate the conflict by bringing NATO into a direct armed conflict. I think that's holding Russia back from targeting western satellites like RADARSAT-2, but Russian decision-making is not something we should be reliant on. We shouldn't be reliant on Russia exercising restraint. We should be carefully considering all of these possible implications—

• (0925)

**Mr. Marcus Powlowski:** I'm sorry. Can I just interrupt? I think I'll get to something that follows on from this.

In terms of the policy question, Ukraine is not acting contrary to international law. Russia certainly is violating the most fundamental principles of international law by attacking a sovereign international state. This leads me to the question: The Ukrainians can and do get assistance from commercial satellites. How about the Russians? The Russians can certainly pay companies to use their satellites.

Do we know if this is happening? What can we do to prevent that in international public or private law?

**Dr. Michael Byers:** This is a form of export controls. I can assure you that it's very carefully scrutinized. There have been instances in the past.

A few years ago, Iran launched a missile attack on a U.S. base in Iraq and was reliant on imagery provided by a western satellite company when planning its attack. Fortunately, the United States' intelligence services were able to penetrate those communications, knew that the attack was coming and were able to move most of their personnel out of harm's way.

Yes, there are unscrupulous western companies that will sell imagery or communications to anyone. Regulators need to be on top of this, monitor it and punish it when it occurs. That's an export control issue, essentially.

What I'm concerned about is that we essentially have Canadian companies that are acting like private military contractors in providing support to a foreign armed conflict. That has implications that need to be very carefully considered in advance. It would be like having a Canadian company send mercenaries to fight on the front line in Ukraine. Would we want to approve that? What would be the possible implications?

I'm not sure that those kinds of discussions and careful policy considerations occurred in March 2022. The next time we get into this situation, I would hope that we would have a playbook for how to analyze what the right decision is on the part of the Canadian government.

**Mr. Marcus Powlowski:** Dr. Steer, do you want to add anything related to that? I'm sorry that we haven't given you any time.

**Dr. Cassandra Steer:** Thank you so much.

You asked to what extent satellites are the exception, and I think there is something different in the sense that the services they provide are not geographically limited. If Canada provides a lab or even sends over some explicitly military equipment, of course, that equipment itself, in the course of warfare, becomes a target, but it's less likely that Canadian soil becomes a target.

Satellites that are in space are beyond national jurisdiction, and the services they're providing are not just within the geographical limitations of one country or one area. They're global...or they're international, in any case. On the fact that they are dual use, under the laws of armed conflict, you can only target a military object. You cannot target a civilian object, but if something is providing services for both military and civilian purposes, it probably is a legitimate target.

The next question that has to be asked, though, is this: What is the proportionality of the means of interfering with that service, and what are the implications then going to be for civilians? That's the whole point of the laws of armed conflict.

**The Chair:** Unfortunately, again, I'm having to cut people off. I sort of feel badly, but I don't.

Colleagues, we have 15 minutes and we have 25 minutes' worth of questions in a third round. I'm assuming we want to go to a third round, so up next for three minutes is Mr. Bezan.

**Mr. James Bezan:** Thank you.

My question is for Dr. Steer.

You mentioned a group of 22 nations that worked together to produce a report and that we should read it. What was that report again?

**Dr. Cassandra Steer:** That is the group of governmental experts who met under the banner of the UN to discuss the advancement of the prevention of an arms race in outer space, and the report came out just in August of this year.

**Mr. James Bezan:** We'll make sure our analysts find and circulate that.

Secondly, you said there are 22 nations that are part of that. Is that correct?

**Dr. Cassandra Steer:** That's right. It's a closed group. The open-ended working group is one in which every country that's part of the UN can participate. The group of governmental experts is a selected closed group, and Canada was one of the countries.

**Mr. James Bezan:** Okay. Out of our adversaries, were China, Russia, Iran or North Korea members of that group?

**Dr. Cassandra Steer:** China and Russia both were, yes.

**Mr. James Bezan:** You come from Australia, so you're in kind of an advantageous position, being a member of AUKUS. We talk about artificial intelligence, we talk about quantum computing, we talk about machine learning and we talk about cybersecurity.

Is AUKUS's pillar two also going to be digging in on providing those types of capabilities to space assets by the three nations that are currently members of AUKUS?

• (0930)

**Dr. Cassandra Steer:** That is what a lot of us who understand how these technologies intersect are really hoping for. I think AUKUS was put together in a great rush. To be quite frank, the entire Australian government knew nothing about it until the public announcement was made by the Prime Minister. It was not taken through the proper procedures, and I think everyone just went, “nuclear submarines,” and it was only later that we started to really try to unfold what that means for all the other kinds of technological dependencies and potential capability opportunities there are.

Yes, it will fall under pillar two, but that's taken a great deal of advocacy and work from a lot of different sectors.

**Mr. James Bezan:** Both of you, as witnesses, have talked about the danger in turning satellites into space junk and the vulnerabilities that creates and the existential threat to life here on earth.

However, the big concern that we've had at this committee is the use of EMP, or electromagnetic pulse, and what that can take out. Definitely there'd be collateral damage to infrastructure of existing nations. I would think for countries like North Korea or Iran, which have limited space capabilities, using an EMP would have little detrimental impact upon their own nations. They would take the calculation that it would be greatly damaging to western democracies.

Is there a way to defend against that, and if so, how?

**Dr. Cassandra Steer:** I actually take a bit of a critical stance on the assertion that this is likely, because I think we can't underestimate just how dependent, as I said, every country is. They may not have their own satellites in space, but neither does Australia have sovereign satellites in space. We have some commercial ones, but our Internet, our telecommunications and our navigation are parts of our everyday lives, even in developing countries and even in these countries where people have concerns about their political motivations.

I think the risk of their bombing space back to the stone age is actually quite low. That said, we can't predict political decisions. They might be willing to take a bigger risk.

**The Chair:** Thank you, Mr. Bezan.

Ms. Lapointe, you have three minutes.

**Ms. Viviane Lapointe (Sudbury, Lib.):** Professor Byers, my riding is Sudbury. It's a mining town, so all things mining are of interest to me. Your book, *Who Owns Outer Space?*—which is a great title, by the way—explains that the 1967 outer space treaty says that exploration and resources of space should be shared by all people on earth, but space mining is a challenging legal framework. Can you elaborate on this issue?

**Dr. Michael Byers:** Yes. It's my interpretation of the outer space treaty that it does not actually address the issue as to whether commercial space mining is allowed or not allowed. That issue was left until later—and fair enough, it was 1967—but that issue is the centrepiece of some pretty important international diplomacy right

now. It's not just whether commercial space mining is allowed, but if it is allowed, then what are the restrictions on that? What are the necessary safety and security considerations? How do you coordinate between different actors, for instance, on the moon? That's at the heart of diplomacy these days.

There is a working group at the United Nations committee on the peaceful uses of outer space, which is engaged in a multilateral investigation of this very issue. Canada has a lot that it can bring to the table—our expertise in terrestrial mining, obviously, and in multilateral diplomacy, finding compromise and bringing everyone to an agreement in what is a consensus-based organization.

I just want to use this opportunity, however, to point out that mining in space will be a thousand times more difficult than mining on the surface of the planet. The safety and security elements of this issue of space mining are something that need to be front and centre. Lest we get caught up in the excitement about the possible economic benefits—there's a lot of enthusiasm, a lot of hype with regard to space mining—I would like to remind people that this is an extremely dangerous and difficult environment with extreme distances, the vacuum of space. Challenges, like lunar dust alone, make me hesitate on a lot of the proposals we hear about. There will be a future for space mining one day, but it's not coming quickly, despite what a lot of entrepreneurs would want you to believe.

• (0935)

**Ms. Viviane Lapointe:** You mentioned the importance of diplomacy in your response. With the increasing discussions that we're having around space as a potential military domain, what policies or diplomatic measures would you advise Canada to support to prevent that weaponization of space?

How do you see Canada engaging with allies to promote space as a peaceful domain while ensuring national security?

**Dr. Michael Byers:** I don't want to imply any criticism of Canada's diplomats. I think they're doing an exceptional job in this domain, but there are some things I would like to see more of, and one is engagement with China and India on these issues. India is also a significant space power. We obviously have difficult relations with China and India on other issues, but we have shared interests with regard to space. Diplomacy isn't about talking with your friends. It's about talking with your adversaries. It's about finding opportunities and compromise. As a middle power, those kinds of bilateral and track-two conversations with China and India could help move this ball down the field. Again, it's not easy.

**The Chair:** Again, I'm sorry to keep interrupting here.

Madame Normandin, you have 90 seconds.

[*Translation*]

**Ms. Christine Normandin:** Thank you very much.

Ms. Steer, I have a question for you.

There has been a lot of talk about the consequences of attacks under international law, but are forums adequate for what could be accidents between allied countries? Are potentially accidental activities somewhat under the radar, or are they not addressed?

[*English*]

**Dr. Cassandra Steer:** There's a lot of discussion about the need for transparency and communication around particular activities in space, particularly as we see more space counter-operations—satellites being able to sidle up to each other, either to repair them or interfere with them. The need to communicate intent and have transparency and confidence-building measures precisely to avoid...if that's what you meant by accidental interferences or misreadings of what those activities are.

[*Translation*]

**Ms. Christine Normandin:** Let's imagine disputes arise in the public domain, more so than in the defence domain. Are there appropriate forums to deal with them? If so, are allied countries participating adequately?

[*English*]

**Dr. Cassandra Steer:** There probably aren't sufficient forums for that. There are more and more discussions about needing to have points of contact. We need to have better sharing of information about space debris and space objects, but there isn't sufficient international governance around this. There are a lot of discussions to try to advance that in the UN—multilaterally, bilaterally and minilaterally—and there is a lot of involvement of the private sector, because they very much need to be involved. It's not under the radar in the sense that there is awareness that the forums are insufficient, but we're not quite there yet in terms of having those mechanisms of engagement.

**The Chair:** Thank you.

We'll go to Ms. Mathysen for 90 seconds.

**Ms. Lindsay Mathysen:** Ms. Lapointe asked a bit about what I was going to ask. I'm totally going to pun this out, but I want to drill down a little bit more on that resource extraction.

**Voices:** Oh, oh!

**Ms. Lindsay Mathysen:** I couldn't help myself. It's the coffee.

Dr. Steer, maybe you can talk about this. In terms of the U.S.-led Artemis accords on this and the potential resource extraction interests that the Americans are leading, are the Artemis accords different?

What should Canada be concerned about in that regard on resource extraction?

**Dr. Cassandra Steer:** I think Michael's right that the outer space treaty left it a little bit open to interpretation. It is prohibited to appropriate in space. If you ask any country where other countries or

companies have come in to take their natural resources, they will say that is appropriation.

There are debates as to whether or not the Artemis accords themselves are perhaps—some countries would say—a violation of the outer space treaty. The U.S. has simply said that it is their interpretation of the treaty that space mining is lawful and will take place. Any country that has signed on to the Artemis accords has thereby agreed with that definition, which includes Canada. It includes Australia. Australia is one of just three countries that have signed both the Artemis accords and also the 1979 moon agreement, in which it said that no entity can own any part of the moon, and that, if space mining is about to take place, we need to have an international regulatory regime in place.

There are discussions ongoing at the committee on peaceful uses of outer space. There are three or four different regimes, and China and Russia have their own alternative regimes. We just don't quite know what the outcome is going to be.

● (0940)

**The Chair:** Thank you.

Mr. Bezan, you have three minutes.

**Mr. James Bezan:** Thank you

I just want to follow up quickly on a couple of things. First of all is RADARSAT and the use of it in Ukraine. I was a member of the government back in 2015, and we had rigorous debate on whether or not to provide RADARSAT images to Ukraine in 2015. We made that decision, and I was proud to be part of it.

In 2016, of course, with the government of the day under Stéphane Dion as foreign minister, the Liberals cancelled that, which was directly seen as a reset or an appeasement of Putin. For six years, we argued from the Conservative side that we should reinstate that, which finally happened under the former minister of national defence, Minister Anand, and something that we applaud. It is necessary to have that intelligence-gathering capability so Ukraine knows what's happening on its doorstep.

When talking about RADARSAT, our understanding is that National Defence has only one satellite dedicated to ISR, intelligence, surveillance and reconnaissance.

I ask this to you both. I know, Dr. Steer, that you work directly with the Department of National Defence.

Mr. Byers, you, from a NORAD perspective, have been studying this issue for a long time.

For our own Arctic sovereignty but also for our NORAD relationship, does Canada need to have more dedicated ISR satellites?

I'll start with Dr. Steer and then go to Dr. Byers.



**Dr. Cassandra Steer:** I would say, yes, Canada does need more sovereign ISR satellites. At the same time, Canada benefits from being part of CSpO, the combined space operations initiative, which started as a Five Eyes alliance but now includes Germany, France, Italy and Japan. That is about sharing space-based intelligence.

Canada is a middle-sized economy. It's a middle power. It can't do everything. No country can do everything on its own in space these days.

I also think that space technology collaboration can be used as a policy lever for other interests. However, when it comes to ISR needs in particular, yes, Canada needs more dedicated sovereign capability, but it can also continue to benefit from that international partnership.

**Dr. Michael Byers:** If I could just add—

**Mr. James Bezan:** I am also asking from a standpoint of NORAD, particularly the Canadian relationship with NORAD and how we can bring space-based ISR satellites into that conversation.

**Dr. Michael Byers:** If I could just add, we do have RADARSAT Constellation. I focused my comments on RADARSAT-2 because it's a commercial satellite, but we do have three very capable radar satellites that are owned by the Canadian Space Agency and are essentially tasked by the Department of National Defence.

I presume they're involved in supporting Ukraine also, but I've been focused on the issue of a commercial company providing support to frontline operations because that raises some really complex issues that need to be addressed by policy, as you've indicated was done after the annexation of Crimea in 2014.

**The Chair:** Thank you, Mr. Bezan.

Just in our final few seconds here, over the course of this study, I've been concerned about the dual use of this technology, particularly that it's largely directed to commercial use, but with sometimes incidental military use. Occasionally that's reversed, but behind all of this technology and behind all of these companies are sometimes individuals who make erratic decisions, to put it generously.

I don't think I need to elaborate with Mr. Musk, but we did see that Mr. Bezos, with his Blue Origin technology, had an interview with Mr. Trump, and shortly thereafter, The Wall Street Journal didn't publish their opinion. Of course, that's not connected.

I would be interested in your thoughts, because we have gotten ourselves into a huge dependence on a very small group of individuals, which has created a vulnerability for all of our nations. I'd be interested in your reflections on that vulnerability.

● (0945)

**Dr. Cassandra Steer:** If could start, I would say that I think Elon Musk is an outlier. Other countries' commercial space companies don't have a monopoly over orbits and don't have the richest man in the world at their helm, who's having, essentially, state visits internationally.

He's a bit of an outlier, but I think that means we need—

**The Chair:** But a very important outlier.

**Dr. Cassandra Steer:** Absolutely, and that's why Canada needs to then decide, to what extent do we want our nation to be dependent on Starlink as a specific capability. It helps in connecting remote communities, for example, but what could Canada be putting in place to make sure that it does not become reliant on a capability provided by an outlier individual?

I think the commercialization of space is not only inevitable, but we've crossed the Rubicon in terms of asking if we want to engage with commercial actors. It's just the way it is; 75% of systems globally are commercially provided. DND buys commercial services, and that is going to continue to increase. Rather than question whether we want that relationship, we have to look at what the implications are.

I mentioned the workshop that we held in Ottawa last month. There will be a report coming out that delves into these issues in great detail and identifies further areas for further research. I would be more than happy to simply pass that report on to Andrew or to the chair to—

**The Chair:** That would be very beneficial.

I see Dr. Byers is itching to get in on this question.

**Dr. Michael Byers:** Yes. The Canadian government gave Telesat an extra billion dollars for its Lightspeed constellation very shortly after Elon Musk limited Starlink coverage in the Black Sea, thus compromising the ability of the Ukrainian military to target the Russian fleet in the Black Sea.

I connect those two developments. I think the Canadian government acted responsibly. We need our own sovereign communications constellation, and Telesat and MDA are building that for us right now.

The answer is, yes, we do need to reduce our dependency on large companies, especially those led by mercurial, inconsistent people, like Mr. Musk, but we have started that response already. I look forward to Telesat Lightspeed filling a big gap by providing us with that increased security and independence.

**Dr. Cassandra Steer:** Hear, hear!

**The Chair:** On behalf of the committee, I want to thank you both for this absolutely fascinating conversation.

**An hon. member:** And a little spooky.

**The Chair:** A little spooky, that's right, yes, on Halloween. None of us are going to dress up as space assets though. Although I have to say that occasionally, I think the opposition is from outer space.

With that, I just, again, want to thank you. This has been very helpful.

Dr. Byers, it's good to see you again, and I'm glad to see the caffeine really cut in and you articulated your positions quite well.

With that, colleagues, we'll adjourn and go to visit our friends from Finland.

Thank you.

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