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Press conference by Deputy Prime Minister, Minister of the Economy, Étienne Schneider, and former Director General of the European Space Agency (ESA), Jean-Jacques Dordain
Space Resources
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Étienne Schneider: First of all, I would like to welcome you to this press conference that is live-streamed on the website of the Luxembourg government.

As journalists watching from abroad are either English, German or French-speaking, I will hold the first part of this press conference in English and will then switch to Luxembourgish.

I'm joined by Jean-Jacques Dordain, the former Director General of the European Space Agency.

Ladies and gentlemen, today we are announcing an initiative actively positioning Luxembourg as a European hub in the exploration and use of space resources.

As you may know, the space industry is the perfect example of Luxembourg's commitment to diversify and innovate in advanced technologies. One of the country's biggest successes in space was the government-supported SES created in 1985, which is today the largest commercial satellite operator in the world. The creation of SES 30 years ago was the starting point of the space sector in Luxembourg. This audacious move, both politically and technically, has led to a tremendous economic success.

The development of the entire space industry in the Grand Duchy sends a clear message. Over the last decade, our country has been actively using space resources like the frequency spectrum and orbital positions on a geostationary arc. This has led to home-grown European and worldwide giants, namely RTL Group, Inmedia and SES in satellite communications.

And the message today is this: Luxembourg is the first European country to announce its intention to set out to form legal framework that ensures that private operators working in space can be confident about their rights to the resources they extract, for example rare minerals from asteroids.

In the near future, we seek to create an attractive framework to give assurances to investors interested in building a business by exploiting natural resources available in space.

This framework will ensure that commercial activities will be able to be implemented in a most efficient way while fully respecting international rules. Legal issues are very important. The current international legislation was adopted in the 60s, when space mining was mere science fiction. Today, these rules prohibit an appropriation of space and celestial bodies, but they do not exclude the appropriation of materials which can be found there.

Roughly, this situation is equivalent to the rights of a trawler to fish in international oceans. Fishermen own the fish they catch, but they do not own the ocean. Similar to the private broadcasting and satellite communication visions formulated decades ago and successfully implemented by the Grand Duchy of Luxembourg, these reflections may lead to a new chapter in the government's continued efforts to diversify the national economy and to further develop our space sector.

In the medium term, the Luxembourg government also sees in the development of space resource utilisation technologies many opportunities for its current national ecosystem of traditional space, but also for other terrestrial industries. The synergies with research and development activities in various fields, such as additive manufacturing, earth observation, robotics or artificial intelligence, promise to deliver significant socioeconomic benefits.

As the utilisation of space resources is very data-intensive, our state of the art ICT infrastructure, including over 20 highly secured data centres, excellent national and international connectivity, coupled with very low latency, are among Luxembourg's assets. Recently, Luxembourg decided to take part in the high-performance computing service and competence network as part of the European HPC programme.

Ultimately, in the long term, the innovative use of space resources could lead to a thriving new space economy and support the path of human expansion into our solar system.

Ladies and gentlemen, before today's announcement, it took a long, concerted effort getting us where we are today.

I would like to just mention a few milestones along the way.

I initiated this project in 2013, while having first exchanges on this subject with NASA's Ames Research Center in California. Subsequently, regular meetings took place, also with private US companies that are already active in this sector.

National space agencies have been associated with our initiative. The Ministry of the Economy held an international workshop entitled 'Towards the use of space resources in Luxembourg' one year ago. More than 120 participants coming from all over the world attended the event from both the public and private sectors. Major space agencies like NASA from the US, ESA from Europe, JAXA from Japan, CNES from France and DLR from Germany were present.

Luxembourg has also started specific discussions on that subject with ESA.

But the in-space utilisation of such materials might bring even more value. For instance, ice that can also be found on asteroids has tremendous value in space. Water can be turned into rocket fuel, allowing spacecrafts to refuel to extend their lifetime, or long distance flights to resupply and extend their trip.

Extraterrestrial mining is becoming an increasingly serious endeavour. Several private companies are active in this field and we are in close discussions with some of them. Namely, Planetary Resources and Deep Space Mining. These are two American asteroid mining front runners.

The US asteroid mining company Deep Space Industries has already chosen Luxembourg as location for its European base.

To conclude, Luxembourg is determined to become the first EU member state with a dedicated legal and regulatory framework on using space resources. We further aim to support the long-term economic development of new innovative activities in the space and satellite communications industries, as a key high-tech sector for Luxembourg.

In the very near future, we will come forward with a strategic action plan defining concrete measures for the coming years.

In this context, the government of Luxembourg is willing to invest in relevant R & D projects and consider direct capital investment in companies active in this field.

I would now like to pass the floor to Jean-Jacques Dordain, who is, as I said, the former Director General of the European Space Agency, and who will work together with us. And he will tell us a little bit his view on this Luxembourg initiative.

Jean-Jacques, please.

Jean-Jacques Dordain: Thank you, Minister.

So, just to say that the idea of Luxembourg to launch an initiative on space resources came as a surprise to me last July, when I visited the minister during a courtesy visit, after I had left ESA.

So, I was surprised, but curious. And I spent the summertime reading, consulting, working, and I came to the conclusion last November that it was a credible and a solid idea. And I have decided to participate and to contribute.

And why? First of all, working in space, we know asteroids, and asteroids are a big threat for the planet Earth, to the point that we are trying to track the asteroids, and especially to see which asteroids could be critical for a collision with the planet Earth.

On the other hand, shortage of critical materials and minerals on Earth is also a big threat, because the planet Earth is a finite world, and consuming materials and minerals is a threat.

The idea of Luxembourg has the beauty to transform two threats into an opportunity, an opportunity for planet Earth to extend its economical sphere without problems for its environment. Because, as you know, mining materials on Earth can have some impact on the environment. And this is a reason why I think that transforming threats into opportunities is certainly a good idea.

Number two. Since the threats are of a global dimension, the solutions must be global and call for cooperation on a global scale.

But on the other hand, since the opportunity opens new markets with potential profits, it calls for competition among entrepreneurs worldwide. Meaning that the first innovation of this approach is to combine cooperation with competition, and the second is to combine the power of the public sector with the responsibility of private entrepreneurs. So, the approach is very innovative.

Obviously, the idea of collecting space resources is not new. Jules Verne already had the idea; you can read *La chasse au météore* from Jules Verne, and you will see that he was already speaking of collecting resources in space. But at that time, it was science fiction.

Today, it is not science fiction anymore. That initiative is based on solid grounds. Very simply, the end-to-end process to collect and use space resources is made of several steps. And each of the steps has already been demonstrated.

Going to asteroids: done. JAXA has done that, ESA has done that, even on comets.

Landing on asteroids: done.

Collecting samples on asteroids: done.

Coming back with samples to Earth: done.

So all of that has already been done step by step. That does not mean that everything is clear. There will need to be some research, some technology, but the basics have already been done.

And there will certainly be an acceleration of this process, thanks to the decrease of the cost of space transportation – the costs are decreasing a lot these days – and also thanks to the international exploration programmes, which will come.

Because exploring space requires the use of space resources. Because, if you have to bring every kilo of water, every kilo of fuel, every kilo of food for astronauts, and so on, to space, you will not go very far. Meaning that the only chance to explore the solar system is to use the resources which are there in space.

And this is the reason why the ground is already solid, but will be more and more solid with this acceleration. So, technically there is no showstopper.

The economic value is real, has been assessed by a lot of different authors. But it is true that there is still some risk.

But, first of all, we have to compare the risk of not doing anything with the risk of doing something. And the risk of not doing anything is much higher.

Number two: the economic risk to exploit resources in space has to be balanced by the environmental risks of exploiting resources on planet Earth.

Number three: the risks that we are speaking about are under our control. This is to be compared to the risk of a collision with asteroids, which is not under our control, yet.

And anyway, going to space has always been risky, and I think that the space community is certainly the community which is the most expert in managing risks.

So, based on the same analysis and the same conclusions, a lot has already been initiated in the United States. The Space Act, signed by President Obama in November; NASA missions to asteroids with the Asteroid Redirection Mission. At an industry level, big industry such as ULA, the United Launch Alliance, has disclosed the Cis-Lunar 1000 structure; investors and their entrepreneurs and, the minister has already mentioned, Planetary Resources and Deep Space Industries. So, things are moving in the United States.

And it was about time to have an initiative in Europe. And I am glad that the first initiative is coming from Luxembourg.

It's not a total surprise that it is coming from Luxembourg, because first of all, as the minister has recalled, preliminary steps have already been taken. Luxembourg has already demonstrated that they are able to transform a *coup d'essai* into a *coup de maître,* with SES, for example, making SES a worldwide success.

And Luxembourg has also become the biggest contributor to ESA, relative to his GNP, in less than 10 years.

And finally, Luxembourg has a reputation of mediation, able to create momentum, particularly in Europe. Just take a look at the success of the ESA Council at ministerial level in 2014, under the chair of Minister Schneider. When the minister is committed, I can tell you that success is not far.

So, these are all the reasons why I shall contribute. And I shall support this initiative, because this initiative will give no excuse for European investors to go to California. I think that there will be a place in Europe called Luxembourg, where investors will find the right structures and the right regulations to invest.

So, now it's time for action, a collective action, obviously with the government of Luxembourg in the driving seat, but I am sure that it will create a momentum in Europe, a momentum in other countries of Europe, a momentum for entrepreneurs, investors coming to Luxembourg.

And this is what we shall do together in the next few months.

Étienne Schneider: Thank you very much, Jean-Jacques. I will now switch to Luxembourgish and afterwards you can ask your questions in whatever language.

Ladies and gentlemen, as I said earlier, thank you all for joining us at this morning's press conference.

Allow me to summarise in Luxembourgish what we have just discussed in English. Where did it all start? My first encounter with this subject matter was in 2013, when I was on an economic mission in America, specifically California. It was then that I established first contacts with NASA and came to realise that the entire space industry is in the process of positioning itself anew. And that a new era of space activity is taking shape.

I have to confess, when I first started talking to all the actors involved, I thought what they were describing was science fiction. Once you start talking to them in more depth, however, you realise that what we are launching here today and what is also happening in other places, particularly in the USA, is entirely realistic and important.

Of course when it comes to this subject matter, Luxembourg already has a pioneering track record, set in motion during the 80s when as a country we had the courage to found SES Astra, today a global leader in the satellite sector. Let us think back for a moment, think back also to the parliamentary debate that took place at the time, in which people warned against a company that launched satellites into space, claiming it to be terribly perilous for Luxembourg, as well as for humanity as a whole. And now if we consider what our country, respectively the world, would be like today without these satellite technologies, we realise that from time to time we must jump over our shadow and think a little outside the box and that from time to time we must also explore slightly more futuristic ideas.

As a result of those meetings in 2013, I then embarked on a series of discussions. I had further talks with people from NASA. I spoke to US companies about their projects in the space sector. I had discussions with a US congressman, who even made a special trip to Luxembourg to attend a conference that we organised in March last year. This conference welcomed 120 participants from all over the world with an active involvement in the space industry.

A high proportion and the most important of the international space agencies were present here in Luxembourg, from the USA, the European Union, France, Germany, Japan, all of them having made their way here because of their interest in what we are developing.

In addition, a year ago I became president, assuming the presidency together with Switzerland, of the European Space Agency and in doing so I of course got to know its Director General Jean-Jacques Dordain.

After numerous rounds of talks, interviews and brainstorming sessions, we have reached the conclusion that this can constitute a realistic, novel and future economic model for Luxembourg. Even if, as mentioned, it sounds a bit like science fiction to begin with.

Particularly since Luxembourg already has a lot of the prerequisites that would allow this sector to take off. I am referring to our entire IT sector. Our data centres, our latency, our infrastructures in general. I am referring to our research and development systems, which are of course of great importance in this context. I am referring to our already existing Space Cluster. As you know, around 30 companies in Luxembourg presently operate around SES in this sector. I am referring to the high-performance computing project we are currently involved in with the European Commission.

And, not least, I am also referring to Luxembourg's financial centre. Because all these projects, once they are translated into reality, will of course call for interesting finance models and require significant funds. Here too, I feel that Luxembourg is perfectly positioned to handle this.

What, more specifically, is the objective of this initiative? What will this activity look like in future?

Right now, Luxembourg is proposing to establish a legal and regulatory framework so as to provide some level of investment security to companies and businesses that establish themselves in Luxembourg and wish to engage in space exploration, respectively space mining. Meaning those wanting to access asteroids and planets to extract rare minerals and bring them back to Earth, for instance. We are aware of the fact that Earth is lacking in rare minerals. We are aware of the fact that costs are steadily rising as a result of the developments witnessed throughout the communication technology sector, an ever-increasing scarcity, because for every mobile phone, every device that we use, we need materials, we need minerals, which are nonetheless extremely limited here on Earth. Which is why they are called rare minerals. On top of that, the vast majority of the reserves are concentrated in one single country, namely China.

It is therefore important, when we look at how the world is evolving – firstly, in terms of population, how it will continue over the next decades, secondly, for our communication technologies, how they are developing at a meteoric pace – it is clear that we will in future be facing an enormous shortage of materials, which are nonetheless found in abundance on asteroids and planets.

The aim is therefore, on the one hand, to extract those materials and bring them back to Earth. As Mr Dordain stated, each individual phase has already been tested. Everything is technically possible.

But now we need to orchestrate the next step, to ensure that this is also economically possible and can be turned into a business model.

In order for this to succeed, however, we need clear legislation, which states that whatever is extracted and brought back to Earth can also be exploited for commercial use. We have the 1967 Outer Space Treaty, which regulates a number of space activities. However, the notion of bringing space commodities back to Earth was never touched upon, for the simple reason that it was unimaginable back then. The treaty does, however, prohibit nations from appropriating celestial bodies. Meaning we cannot fly to the moon, stick our flag in it and call it Luxembourg. That is not an option.

That said, the treaty does not explicitly state that commodities may not be brought back to Earth. And so we find ourselves in a situation similar to that of international waters, which also do not belong to anyone and which nobody is allowed to appropriate. Yet we are permitted to fish in them and take our fish home with us, respectively use it for commercial purposes.

And so, by this rationale, the American legislation was adapted a few months ago to make it clear that this can be done. And for a number of months now, Luxembourg has been analysing precisely this framework, with the help of international experts and the University of Luxembourg. We have Chinese experts, we have American experts, we have other experts, we have the University of Luxembourg of course, which is working with us on this and coordinating matters. In the coming months, we will be submitting a proposal as to what direction we intend to pursue with regard to the legislation.

This is thus one issue that requires explicit clarification so as to provide legal security to companies that will be engaging in this activity. This of course also has the ensuing great advantage that Luxembourg will be the only country within the European Union to have established clear regulations. The result being that companies operating in this sector – and by that I mean not just American ones with an interest in Luxembourg, but also European ones, of which there are plenty – will establish themselves in Luxembourg.

And now to the other matter. Which is of course that of research, allowing us to integrate all the components that we currently have into an effective tool. Here too we will naturally endeavour to find solutions in a series of PPPs, public-private partnerships.

Another point at issue is the utilisation of space resources in space itself. Let me explain.

We know that there is water on asteroids, that there is water on the moon, and we know that there is a huge cost associated for instance with getting water to space stations, such as the ISS, with sending any kind of material from Earth to space. As a rule of thumb, if you want to dispatch a kilo of materials from Earth to space, it will cost you 10,000 euro. That's per kilo.

Knowing the astronomical costs involved, the fact that every time an Ariane rocket such as the Ariane 5 is launched, it comes with a price tag of 120 million euro, you can see the call for a business model that says, come on, let's try to produce the maximum possible

amount of commodities that we require in space – be it to adapt our satellites or our space stations, be it for other activities – let's try to produce these in space itself.

I am referring to water that can be harvested for drinking, for space missions, for the astronauts. I am referring to water that can be converted into hydrogen for fuel, for instance for missions expected to cover further distances than what we have seen so far, with rockets being time and again restricted by their range, given that they can only carry a limited quantity of fuel.

This would allow us to have a pit stop, on the moon for instance, where we could refuel or produce and hand over new fuel.

All these rare minerals and materials found on all these celestial bodies can, thanks to today's 3D printing technology, be directly converted into the materials and tools that we need up there. I cite the example of a space station, I cite the example of satellites that require adapting. Today, if you need to adapt a satellite, you let it drop, or rather fly away, and simply launch a new one into space, at a cost that runs into the hundreds of millions. In future we will be able to adapt them in space.

All these ideas are possible. 3D printing is possible. We have robotics. We have the necessary IT to achieve all this. We have the technology to make hydrogen out of water. All of this is therefore possible.

In other words, we could save ourselves the exorbitant costs presently associated with launching all these commodities into space.

You need to realise that the utilisation, the toing and froing within space, is actually relatively straightforward and easy; in actual fact the most expensive and complex moment is the escaping of Earth's gravitational field on the way into space.

This business model is being developed and refined by a host of companies and it is Luxembourg's wish to be at the very heart of this activity.

I would also like to point out – and then I will give you an opportunity to ask the questions that I am sure you have – that we have set up an advisory board here in Luxembourg in order to examine all these complex matters in further depth with the experts and to ascertain which actors from the international scene we would like to come into contact with. Over the next years, we will be systematically developing this branch of the economy. In light of this, I am extremely happy that Jean-Jacques Dordain, former head of the European Space Agency, immediately agreed to join the advisory board.

I am also delighted that our advisory board will in the coming months be welcoming a hugely important person from NASA. We are likewise in contact with a key person from China.

Besides all this, of course, we have our Space Cluster, which we will also be involving and which has already voiced its excitement at being part of this project.

It is important in my eyes that this project take on an international dimension, that we as Luxembourg do not attempt to fly solo but that instead we attempt, from Luxembourg, to group together ideas and competences on a global scale.

This initiative sees us become the first in Europe to tackle such a project. I am of the opinion that this is a good idea, a good initiative. We should not be leaving this market, which is already worth billions and will only continue to skyrocket, to the Americans. We should be handling this ourselves and taking the initiative ourselves, much like we were brave enough to do back in the day with SES.

And now, over to you.

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