# Committee on the Peaceful Uses of Outer Space: Legal Subcommittee

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**Fifty-third session**

879th meeting
Monday, 24 March 2014, 3.10 p.m.
Vienna

*Chair*: Mr. Kai-Uwe Schrogl

*The meeting was called to order at 3.06 p.m.*

**Mr. K. Schrogl** (Chair). Good afternoon, distinguished delegates, please take your seats. I now declare open the 879th meeting of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space.

This afternoon, we have reconvened for the symposium on the theme "Regulatory needs for very small satellites", organized by the International Institute of Space Law and the European Centre for Space Law.

Immediately after the symposium this afternoon at 6 p.m., all delegates are invited to attend a reception, hosted by the International Institute of Space Law and the European Centre for Space Law on the 4th floor of this Building C.

Distinguished delegates, I will shortly suspend this meeting of the Subcommittee. Before doing so, I would like to inform delegates of our schedule of work for tomorrow morning. We will meet promptly at 10.00 a.m. At that time, we will continue our consideration of agenda item 4, "General exchange of views". Under this agenda item, I will invite the Chair of the Working Group on the Long-term sustainability of outer space activities, of the Scientific and Technical Subcommittee, to inform this Subcommittee of the progress achieved by the Working Group in the period leading up to and during the fifty-first session of the Scientific and Technical Subcommittee, held in February this year. We also will begin our consideration of agenda items 5, "Information of the activities of international intergovernmental and non-governmental organizations relating to space law", and 6, "Status and application of the five United Nations treaties on outer space."

We will hear one technical presentation tomorrow morning, by the representative of Luxembourg, entitled "Space activities and regulatory framework of Luxembourg: an overview in relation to the application for membership in the United Nations Committee on the Peaceful Uses of Outer Space".

I would also like to remind delegations to provide the Secretariat with any additional requests for technical presentations by tomorrow, Tuesday the 25th, close of business. Speaking notes for technical presentations should be provided to facilitate simultaneous interpretation.

Are there any questions or comments on this proposed schedule?

*I see none.*

I now invite Ms. Tanja Masson-Zwaan, president of the International Institute of Space Law and Mr. Sergio Marchisio, president of the European Centre for Space Law to come to the podium and Chair the symposium on "Regulatory needs for very small satellites".

The meeting will be adjourned at the end of the symposium, until 10:00 a.m. tomorrow morning.

***** Symposium *****

**Mr. S. Marchisio** (President, European Centre for Space Law) Distinguished delegates, ladies and gentlemen, this is an honour and pleasure for us, the presidents of the European Centre for Space Law and the International Institute for Space Law to introduce this symposium — the 2014 symposium — on "Regulatory needs for vary small satellites".

We know that since the launch of the first nanosatellite, small satellites proved regularly to be useful, beneficial and cost-effective tools. Small satellites offer great potentials to gain responsive, low-cost access to space within a short time frame for institutions, companies, regions and countries beyond the traditional big players in the space arena. For this reasons, small satellites are been preferred by students and educational institutions, amateur radio operators, small and developing countries, international aid agencies and, most recently, by defence agencies and satellite operators, who are examining the deployment of constellation clusters instead of conventional application satellites.

Beyond this framework, the symposium and the IISL, and ICSL symposium for 2014, is aimed at

addressing the legal aspects of this tendency — the increased use of small satellites — because we think that these legal aspects are sometimes underestimated and apart from studies that are going on, on how national legislations deal with this particular categories of satellites, there is, we believe, the need for some more deep study and analysis of this phenomenon. We will have a panel experts today to deal with this issue and at this point I would like to thank you for your attendance and to give the floor to my co-Chair, the president of IISL, Professor Tanya Masson-Zwaan, you have the floor.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you very much Sergio. Also, on behalf of the International Institute of Space Law, I would like to welcome you to this annual symposium, jointly organized by IISL and ECSL, which has become a long-standing tradition and we are extremely grateful to the Legal Subcommittee for inviting us once again to organize this symposium, and I believe that we have, in consultation with the Office, also picked a topic that will be very interesting. There is, as Professor Marchisio indicated, a strong increase in the use of small satellites, be it by universities, education institutions, but also more and more in a commercial application. Even though there are many concerns, none the least of which are not the legal concerns, there are also great benefits to be had of this new application of space technology and can, in the end, benefit the use of outer space for human kind, which is of course, the purpose of the rules governing outer space use as we know them. Therefore we have designed a programme today with six speakers and I want to mention also that in connection with the symposium today, there will also be another symposium to be held next Saturday at the University of Vienna, so the two events are organized in combination with each other, and we hope that with that we can provide you with a very complete picture of all the aspects that are of relevance in this respect.

So, we have several presentations that will address, not only the practical issues, but also the legal aspects of the use of small satellites, such as their authorization or their registration and rules concerning debris and we will also have a practical story of Austria — a case study. So, without further ado, we should move to the presentations. Each presenter will have approximately 15 minutes. We hope to have some time for a discussion as well, and I want to end by introducing the Rapporteur of this symposium, who is Mr. Edmond Boulle of the European Centre for Space Law. As you might know, we always publish the report of these symposia on the website of the ISSL and also in the proceedings and I believe a report will also be included in the ECSL newsletter, which you can find outside on the table, as well.

With that, I would like to introduce our first speaker, who is seating at the far right of the table. It is Mr. Abe Bonnema, who is one of the co-founders of a Dutch company specialized in small satellites, called ISIS — Innovative Solutions In Outer Space, and we are very happy to have you here to enlighten us, first of all on all the practical aspects and definition, purposes and projects, so that's a mouth-full, but we look forward to hearing you present us that. You have the floor Abe.

**Mr. Abe Bonnema** (Innovative Solutions In Space) Thank you. It is an honour to be here and it is an honour to be asked, as a very small company, to introduce you to this new generation of very small satellites, and I will probably have way too many pictures in the presentation, but that was what we tried to do.

Very briefly on who we are. We are a very small company; started as a spin-off from Delft University of Technology when we developed a nanosatellite project called Delfi-C3 back in 2006. From that we started growing a commercial company, whereas we had five people when we started, and now, after about eight years, we are 50 people, developing small satellites and all their aspects. So, we are we call a vertically-integrated company where we have a lot different nationalities, a lot of different types of engineers working on building new small satellites and launching them and operating them.

I will briefly go over where we are. We are very international-oriented, as I said. We are based in the Netherlands we also have an office in South Africa and all customers are worldwide. Well, no need to explain here that space business is a worldwide business.

We do all that we need to do in-house to develop small satellites and launch them and operate them. That makes us unique in the sense that we also understand everything that is required to build and launch an operator satellite from scratch. That includes all the legal and all the other aspects are to it. So, we develop our own products and — no need to go over all the details — we launch our own satellites and we launch satellites for customers and we build complete mission for which we build new applications.

Now, this topic is about very small satellites and I wanted to start out with a definition of what is a very small satellite? you might ask yourselves — small is how small? Well, size does matter in that sense. Many of you might know Envisat, which is one of the European largest satellites every launch, right. On the left of it you see the university satellite from Delft

University, which is just a cubeSat — really, a big difference. This is a large satellite — obviously — but a couple of decades ago people starting working on smaller satellites and this is what they now call a small satellite, but to give you an indication the size of what we are working on, that's that. Just give me one second — because I did bring some hardware. And that's real size. So, this is a model of a cubeSat — a 3 unit cubeSat — and this is what we built — launched in these blue containers on rockets and with that you can actually do quite a lot already.

Just a bit on the definitions there. If we talk about very small satellites, we talk about up to 10, maybe 20 kilograms. This might be slightly larger, but that's about it. So, what makes them different from any other satellite, or is it just another smaller type of what we've been dealing with before? Well, it makes them very different: in the way that they are built, the technology that is used, the costs vs. the risk and who develops and what we use them for.

Just to over that a bit — the traditional space industry develops new technology specifically for space. For these types of satellites it is actually the other way around. We all know how much is being put into developing new phones. So, if the phone industry puts billions of dollars into that, why don't we use that in space technology as well? why should we spend another billion to try and develop just that one little piece of equipment that will work in space? rather as we can try that with whatever is being done right now on Earth. We build them with modularity, so every piece of equipment that we use on one satellite, we also use in the next one and the next one, so we get to series productions, which is not done before. We are in a community where transparency is a key thing. Transparency in the line of pricing, of cost, available technology, but also in the market. What does the market do? where does the market want to go?

The timelines for developing such satellite are also different from the 10 or 15 years to build a large scientific satellite. Typically 1 one to maybe 1.5 years you can have one of these developed and launched. And that is why it is also open — as was mentioned already — to universities, to new institutes, who would like to develop their own satellite, and now suddenly, with this new technology, they can do that.

If you talk about cost — cost is always a driver — I don't expect you to be able to read all of these specifications there, but you might be able to see it later — just to give you an indication, one of these satellites can be fully built, launched, operated for about a year for under a million euros. That is a different ball game than from what we have seen so far in the larger space industry.

So, that opens up a new philosophy as well. We all know about risk, but risk in this sense, may also be a positive thing if it comes with a lower financial risk. We have a technical risk; the satellite might fail due to the technology that is used, that is not necessarily developed for space, but we can accept that as long as the financial risk is lower. Not going into all the details of that, but that is one of the reasons why you see a lot of developments with people now working on multiple satellites and then quite large in numbers — and I'll get to that.

The various developers here are traditionally the universities. As you can imagine, if you can build a satellite for a few hundred thousand euros, suddenly, as a university, you might be able to do that, with just your piece of equipment on board or just your experiment. That was how the cubeSats and the nanosatellites started more than 10 year ago. Nowadays, they are followed by small industry, defence, indeed, who see the opportunity that they can use these for fast response, and even the large space integrators are now using these types of small satellites to work on proving new technology.

There is also a different way of how we launch these satellites. Typically, they are what we call piggy-backing on a large launch vehicle. So, every launch vehicle a bit of excess capacity and we use that excess capacity to put a couple of these or many of these on that same launch. That does mean that you need to have one interface to work with many satellites. To give you a few examples of what we did last year, we put a satellite on top of big Russian scientific satellite, which was launched with a Soyuz — and that was just a very small one on top of that satellite. Last November we launched 14 satellites as a cluster on one of the DNEPR launch vehicles, where we had 14 of these very small ones as one cluster on that launch. I am sure that you are aware from the International Space Station, people are now launching these satellites as well and this is a nice image of two of the Planet Labs satellites that were deployed earlier this year. In an upcoming launch we are taking it even one step further: we will 23 of these satellites on one launch vehicle, only as a piggy-back. So, it is not the primary payload — it is just 23 addition payloads that we put on the launch.

So what you do with them? It is nice that you can build them fast, but are they useful? Well, obviously they have their use in education and training and we build together with radio amateurs — the community from the United Kingdom and the Netherlands — a very nice mission called FUNcube-1, which was just one third of the satellite of the satellite that you see here on the table, and it is currently used for education

and outreach and to teach school children how you actually communicate with a satellite. So, they can go out of the classroom and just communicate when the satellite comes over. That's is opening a whole lot of new ideas to these students already at a very young age, obviously.

Capacity-building. Capability-building — many countries use these very small ones as stepping stones to become a spacefaring nation. Over the past couple of years, we've launched a couple of first satellites for nations — like Ecuador, last year — Estonia, last year.

Technology demonstration: If you want to use a new piece of technology on a large satellite that costs 300 million, you want to make very sure that it works, and these type of platforms are extremely suitable to go and test that in space quite fast before you actually use it on a new platform.

Science. We are doing more science with these very small satellites. QB50 is a European driven scientific programme. There, 50 of these satellites will go to a certain region where normally, with a big satellite, you would not go to research the atmosphere.

And then, commercial applications. They are really upcoming and I think that is one of the very interesting aspects of this symposium as well, to look into the future, because commercial applications are coming: on tracking and tracing equipment, doing low data rate communication and looking at the Earth with these very small satellites.

So what can we expect and where are we now? If I look back, when we actively started launching these satellites in 2005, there were only a few. I think many of the people here at the table as well, we've been in touch with them since then and they also know and see that the numbers increased. We had a few in 2005 and in 2010, there was already an outline of: well maybe, there can be many of these. If I look now, if I look at our customer base, if I look at the partners, there are multiple plans of sending tens to even hundreds of these very small satellites. That is also recognized international research, for the market, if you see, there is an exponential growth of companies that step into this and of other entities who would like to use this new type of technology. So, nanosatellites, as they are called, they are coming, and swarms of them are coming, and that's also where the strength of these nanosatellites is: you can use them in larger numbers to make sure that you have many measurements around the world at any given time.

QB50, is one of the items that I already mentioned, is a scientific mission. One of the challenges there is that we have 50 satellites from different universities all over the world that need to be gathered at my office, in the Netherlands, where we put them in a launch adapter and then bring them to a launch vehicle and launch them all at once. That is quicker said than done. There are many challenges there, of which it needs, well, exports, legal and all those aspects are there.

If you look at the commercial constellations, and this is really where we need to pay attention to make sure that this can continue and that it does not stop at some point due to something going wrong — there are many entities, including ourselves, looking at multiple satellites per year that were launched, up to — and you can see it on the slide — there are a couple of commercial entities in Silicon Valley, who have investments of well over 15 million euros. It is just the first step to make sure that they launch 100 of these satellites per year. Planet Labs is one of them. We have launched their first satellites but now they are looking, well, a 100 for next year and maybe even more the year after.

That is just an outline of what is coming in the near future. In the further future, we are working on very small satellites that might be used to do astronomy, but then at the back side of the Moon, looking at very low frequency. I won't go into the scientific details but this is a new challenge where people will use and the […] stronger than that, hundreds of these satellites at the back side of the Moon to receive signals that we cannot receive on Earth.

Even further into the future. Some of you might follow them already. There are some entities looking at deep space exploration and even asteroid mining using very small satellites to explore. That brings me to my introduction — to the rest of the afternoon, I think — there are opportunities and challenges. While I am an entrepreneur, so if there is a challenge, it means there are also opportunities, but if you look at the legislation, every new opportunity also brings its challenges, and that is what we see here, where we see new applications, we see new entities — people who are not used to dealing with space industry or used to dealing with the legislation and the framework that is there — and they want a fast implementation. They cannot wait for five year to make sure they can do it. So, what we are looking at is we have large numbers of satellites that need to be launched, and even the technical challenge alone is already a nice one to take on, but then we have frequency/spectrum allocation, space debris mitigation, registration and all the differences in the different rules that we have. I am happy to leave all those to the experts at the table, just to give you this introduction, to what are very small satellites. So, there you go.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you very Abe. I am going to leave the questions and answers to the end, if you don't mind, because then we have the full picture and can come back to the questions.

Our next speaker is Lulu Makapela. She is from the Council for Scientific and Industrial Research in South Africa, and she is also our only female speaker on the panel today, and she also represents the younger generation of space lawyers, so you have many hats on today. Lulu, we are looking forward to hearing speak about the use of small satellites as a tool for scientific and technical development for certain regions in the world and also as a tool for capacity-building. So, Lulu, you have floor.

**Ms. L. Makapela** (Council for Scientific and Industrial Research) Thank you very much, Tanya. First and foremost, I would like to take this opportunity to add the IISL for inviting me to deliver this presentation on such a topical issue, which is, as you have heard, is very important, is very relevant, because we have a number of small satellites and there is also an increase in this satellite, we need quite attention in terms of regulation.

My name is Lulu Makapela from the Council for Scientific and Industrial Research, known as the CSIR in South Africa. My topic as she said, I will look at the small satellites and how they can be beneficial, especially for scientific-technical development as well as capacity-building in both space law and research.

In my presentation — just to give you an overview — I am going to highlight the significance of small satellites for scientific and technical development and capacity-building, which is going mostly of the areas that have been covered by Abe, and how the scientific and technical knowledge gained from the development of small satellites can be valuable, especially in the development of big satellites, particularly for the emerging spacefaring nations. I will also go further to sort of highlight the achievements in the development of small satellites, especially in the case of South Africa, as an example of how useful the small satellites have been and how they've been beneficial in terms of scientific research and development and also in terms of capacity-building in technical and regulatory matters. Lastly, I will look at the challenges and opportunities, which also Mr. Abe has looked at, especially that have faced with the development of these satellites and how to emphasize on the need, especially for countries to conform and observe the necessary international regulations and national regulations. There is certainly a great value for using small satellites, especially for emerging countries. They are a number of factors, as Mr. Abe has already highlighted, for the emergence spacefaring nations to use small satellites and especially because small satellites before, they had only been used as educational tools, because they have been mainly used by universities, but now we have seen over the years that it is not only for that purpose, now they are growing to be technology demonstrators and also useful in terms of scientific instrumentation.

The use of satellites — most satellites — is also motivated by the use of standard equipment as we are all aware, that — you know — with the small satellites you can easily get the off-the-shelves components, which are very useful for the universities — for the researchers because it gives them an opportunity to produce these satellites and are less costly in terms of — because of their size and because of many other factors. Which brings us to another point, because if the costs are also a validator of many other things and because they also help in terms of the time, as you have had, you can always have these cubeSats within a year, within two years and they can be launched quite quickly.

I believe this really simplifies the development process and it really proves to be beneficial for countries, especially countries with low budgets, countries like Africa and also reduces that barrier to entry in terms of giving an opportunity for participation for both the developed and developing countries — sort of looking into achieving the outer space treaty objectives — of making sure that all countries are in a position to access space. So, these satellites are a key driver for scientific and technical development, especially because in the construction of small satellites, I think, the key thing is that the same engineering principles are used in the development of big satellites. And in most instances, it is easier to use it as a technology demonstrator and a prove of concept for big satellites, for instance, in terms of the development of various components and subsystems, and also looking at new observation instrumentation, which encompasses the overall success features of a mission.

In this instance, I believe that small satellites are useful for both the developed countries as well as the developing countries. Looking at the study that has been done by Jafry, one of the dynamics of small satellites, he confirms that both developing countries and developed countries, they have begun adopting small satellites for diverse reasons: because, as you are aware, for developed countries, they are most useful, especially in terms of being used in terms of sort of complementing the bigger satellites, whereas when you look in terms of the developing countries, they are very useful in terms of looking at specific needs, specific

payloads, so that the countries can be able to achieve, I think, basic needs, whether it is in Earth observation or in navigation.

However, the biggest concern that I would like to highlight in this slide: as much as this increase — and it is useful for both developed and developing countries — and as Abe has indicated that now there is a growing number of countries that are launching satellites — this increase is not only positive, I am sorry to be against you — it is not only positive, but it also poses a potential danger to the safety, for instance, of space activities and also, some times, impacting on the long-term sustainability of outer space, which, in my view, strictly calls for observance of the international standards and measures and also, especially those of the space debris mitigation guidelines, to ensure long-term sustainability of outer of space.

In terms of capacity-building, the small satellites, they play a crucial role in the context of capacity development in space technology and space law, especially for developing countries again, because they present a great opportunity for training of students, great opportunity for participation of engineers, great opportunities for scientific development. Especially because most of the emerging spacefaring nations, you know, they have still a limited number of professional skills in engineering, this is such a great opportunity for them to get the opportunity to work on this small satellite, and also supports — a very good way — in terms of collaborating with other institutions, collaborating also with other countries.

The other important aspects of this is on terms of space law because, you know, with the development of satellites in the increase now, the countries now have an opportunity to be able to evaluate and assess the national regulations, especially those that do not have national regulations — is a great opportunity — I mean, it provides them that opportunity that they can enact new laws because, at the end of day, States, according to the Outer Space Treaty, they are responsible for their national activities in outer space, be it activities of governmental or activities of non-governmental entities, which includes — you know — universities, participation of private companies and of individuals that are conducting outer space activities. So, it makes it a driver, especially in terms of capacity-building in space law, because it makes it, it increases, I mean, I think, the opportunity for them to be able to actually look at the necessary guidelines.

On my next slide, it is to just highlight, how, as an example, how South Africa has developed small satellites and how South Africa has benefitted in the past, which I believe that South Africa is an example as one of the countries that has successfully used small satellites in terms of developing the capability. In 1999, the first microsatellite called SunSat was developed by the students of Stellenbosch University, which have actually created the basis for the technology capability in South Africa. The satellite weighed 64 kg, which falls under the microsatellite category and the costs of the satellite as under a million. This satellite really contributed to the capacity-building, especially because we had involvement of the researches, you have the involvement of the students. It also a programme, a Master's programme that goes with it.

The other satellite is the SumbandilaSat, which was launched in 2009, which weighs 84 kg, about 3.5 million US dollars. This satellite has, I mean was built, actually, from the capability that was done within the first satellite, which is SunSat, because the same students that were involved in the development satellite, they are the same that have contributed to the development of this satellite. This is one of the successful satellites that South Africa has really seen the impact in terms of as a technology demonstrator and also in terms of the being able to receive data fully within this satellite.

The other satellite was just launched last year, this last year, named TshepisoSat. This is a cubeSat, which is about 1.3 in size, which is the small satellites that Abe just presented here. The cubeSat was also developed by the University students, but now from the Cape Peninsula University of Technology, which is the ... this University focuses on a Master's programme and the development of cubeSat is — I mean formal programme — this really helps the country in terms of capacity-building and ensuring that the capability within, I mean, for space developed. The most crucial things about these satellites and that in terms of South African law, all these satellites are licensed within the South African Council for Space Affairs, because within the South African law, all satellites, regardless of their size, regardless of their weight, regardless of their scope, they are licensed — they have to get a licence. And that the Space Affairs Act, because any space — any launching within the country — is regarded as a space activity. So, that is the important, I think, part in terms of making sure that the regulatory needs are met in terms of the space activities in the country and also the satellites they are registered in the national registry. Unfortunately, the test satellite is not yet registered within the national registry, I think, it is still in process, but the South African Council has a register for all the satellites, in terms of the dates they are launched, the scope of their activities and which is accessible also online for everybody who would be interested to look at it.

There are a number of opportunities and challenges in terms of development of small satellites and, you know, I think I will emphasize these opportunities in terms of, I think, the design philosophy of the satellites. It is sort of — it embraces risk management structure that reduces certain levels of oversights in such a way that in the whole development cycle, because this is shorter time, this is low cost, this is just meant for be, I think, for a specific need, for a university, setting this, in my view, it leads to sometimes technical risk and regulator risk. Technical risk in terms of, I think, the under technical aspects, I would say, this affects the quality and the reliability of the satellite and if you look in terms of the regulatory aspects, I think, the time, the shorter time in period to really affects the time to follow the legal procedures because this becomes a challenge in such a way that countries will find out that they have to make quick decisions in terms of issuing the licences and which doesn't ... especially in some instances where these satellites are not accommodated within the regulatory measures, so I think, the risk management ... plans of these satellites ... it really affects in terms of the regulatory aspects of it.

Also, the other challenge is the launching opportunities. In one of the slides I highlighted the satellite which was completed in 2006 and launched in 2009. That is actually the biggest challenge: the launching opportunities for these satellites as Abe has also indicated, most of the time, they are piggy-back satellites on other bigger satellites, and sometimes to get those launching opportunities is a challenge. However, this also, in my view, allows for the opportunity for cooperation between countries because countries can, I mean, developing countries now are in a position to cooperate with other countries for launching opportunities.

The other challenge is in terms of the regulation of these satellites as I have mentioned before, and the small satellites, in my view, even if the outer space treaties are not clear, they are space objects, regardless of their size, regardless of their weight and regardless of their scope and which actually necessitates compliance — there should be compliance — the space treaties and with the guidelines, especially the registration of these space objects and the liability and responsibility of States. Other challenges that the small satellites also share the same scarce resource that is utilized by big satellites, in terms radio frequencies, which also necessitates the compliance with the World Radio Conference Regulations, and it also, I think, the most important thing is that at the end of the day, within the development of these satellites, it is important for countries to observe the national regulations and also international regulations.

In conclusion, the small satellites are, especially for countries like Africa, I think that are important tools for acquiring and developing the space capability for the countries and also they are also an important tool for demonstrating as proof of concept for the development of bigger satellites and also, I think, they are an important tool to achieve, especially the objectives of the Outer Space Treaty, looking at article 1, which also calls for space benefits for all, and will sort of bridge the gaps between the spacefaring nations and the non-fairing nations. I think the most important message is that these satellites need to be regulated because countries are responsible for the activities of their non-governmental organizations, governmental organizations, private participants and it requires that they conform with all the international standards and regulations. Thank you.

**Mr. S. Marchisio** (President, European Centre for Space Law) Thank you very much Lulu for your presentation, which dealt with many interesting issues and any case you underlined that under South African law, all satellites are licensed, including the small satellites, and they are registered under South African law and there are no exceptions for nanosatellites. Then we come to this issue on more general terms with the presentation of the next speaker, with Phillipe Achilleas, he is professor of space and telecommunication law at the University of Paris Sud and he is also director of the Master's in space law and telecommunication and a member of the ECSL board. His presentation is about international space law and the authorization at the national level. You have the floor.

**Mr. P. Achilleas** (University of Paris XI Sud) Thank you Professor Marchisio. Thank you Tanya also for this invitation to participate to this IISL/ECSL symposium. I was asked to make a presentation on international space law and the authorization on the national level and to cover this issue I will first present the question of authorization to operate very small satellites and in second point I will also say that all the authorizations may be requested in relation with space activities dealing with very small satellites.

Concerning the first point, that is to say the authorization to operate a very small satellite, we will see that — and you know, I am sure, this point — that States have the obligation to authorize and supervised activities in outer space and we will ask ourselves if very small satellites operations are included in such activities. If so, there is a procedure for authorizing very small satellites in certain countries and conditions are also associated to these authorizations.

Concerning the first point, you all know about article 6 of the Outer Space Treaty, it establishes a

general obligation for States to authorize and supervise activities in outer space, in particular those that are carried out by non-governmental entities and this is a consequence of the principle of direct international responsibility of States for their activities in outer space. There is also a second issue dealing with liability of launching States for damages caused by space objects and this issue might also be the reason for this authorization for space activities. So, based on these two articles, in particular article 6 of the Outer Space Treaty, States have this general obligation to authorize and supervise activities in outer space.

Some spacefaring nations have already introduced such obligations within their national legislation. So, some national laws have implemented such obligations at the national level. The question is to know if these those take into account vary small satellites. So, very small satellites shall not be excluded from the scope of national space legislations since they are space objects and since the obligation to control and supervise activities cover any space objects. This interpretation is confirmed by some national legislations, in particular the French technical regulations, which give a very broad definition of space object, including any object of human origin functional on Earth during its launch, its stay in outer space or its return. So, this definition is broad enough to cover all categories of satellites, including the very small satellites. Some other national legislations a little bit more clear. I was informed by a lawyer working with some projects in the Netherlands that the Dutch law introduces the concept of guidance of space objects in outer space and that there are some questions to know if such legislation is applicable to very small satellites since those spacecrafts cannot be manoeuvrable once they are in outer space. But my point of view is that all categories of space objects fit within the scope of , or shall fit within the scope of national space legislations. And as a consequence, very small satellites shall be subject to a national authorization. So, for countries that have implemented the principle of national authorization, we have a procedure involving specific authorities and these authorities have to deliver a licence or an authorization for the operation of the space craft, including very small satellites.

Conditions are associated with the authorizations and among the least of conditions, some of them are concerning satellite operators, in particular the obligation to have financial coverage; that is to say, insurance. Here we can note that there is a certain difficulty to meet these obligations with very small satellite projects since the cost of insurance is very high compared to the cost of very small satellites. So, this could represent a restriction — an indirect restriction — to projects involving very small satellites. If we take the example of the French very small satellite Robusta, which was launched and developed by the University of Montpellier when the Ministry of Research had to analyse the file presented to get the authorization, of course there was this question of insurance, and the Ministry of Research considered it, that because the University of Montpellier was a public entity, then the guarantee — the financial guarantee from the State — was sufficient and that there was no need in this particular situation to have an insurance because the entity was a public entity. There are also other obligations to comply with the technical regulations and, in particular, the ability to control the space object or the rules dealing with the limitation of space debris. Here again, which I know that these could cause a difficulty with very small satellites since these satellites, as I said, are not controllable once orbited, so ... maybe it will difficult to meet these technical regulations.

Other obligations now are linked to the authorization, and concerns States in particular, the obligation to register satellites at the national and the United Nations level and that one of the difficulties with dealing with the registration of very small satellites deals with the situation where several very small satellites are launched together; once they are released, it might be difficult to identify them even if they have been registered because it is quite difficult to identify in fact which satellite is now in orbit after the release of a number of very small satellites. States have also the obligation to control such satellites and this also represents a difficulty for States on that they are liable for damages caused by very small satellites, both on Earth and in outer space. The authorization introduces also obligations for the operators in terms of liability for damages caused by the satellites and this is also an issue linked with the financial coverage — the insurance — obligation.

Concerning these national authorizations: the first question is to know if national laws shall cover very small satellite operations. As I said: yes, in order to comply with outer space treaties obligations but if so, national legislations have to be neutral from a technical point of view in order to cover also very small satellites. And if we take the example of the French technical regulations — the regulations are written in very broad terms or they are flexible enough to cover also those very small systems. In particular, in French law does not require satellites to be equipped with propulsion systems. Another example deals with the rules concerning space debris mitigation since the laws — the technical regulations — develop two situations: the first one is the obligation for low Earth orbit systems to proceed to re-entry into the

atmosphere after the operational phase and the second situation is the obligation to proceed to such re-entry before a period of 25 years after the operational phase, which is consistent with the characteristic of vary small satellites since, by this period, they should have re-entered by themselves into the atmosphere.

The second question is to know — to see — if States shall waive the liability and insurance requirement for the in-orbit operations of very small satellites. It could be a solution to promote research and development and to encourage access to outer space since very small satellite operators may find launch insurance costs very prohibitive. It would also be consistent with the actual risks since very small satellites are unlikely to cause very much damage on Earth. However, collisions in orbit are still very important with such systems. So, this is an open question.

And the last question is to see if States may introduce new regulations to cover very small systems, in particular the obligation of in-orbit manoeuvring capability or special liability limit to take into account the actual risks associated with such systems.

My second part will deal with other national authorizations required for very small satellites. We can note here that first of all, some authorizations deal with the provision of spare services if such systems provide such space services and the second authorization — second category of authorization — deals with technology transfer. Concerning the outer space treaty, I just would like to remind that article 3 establishes a link between space law and international general law, where all the branches might be a basis for other authorizations, in particular in the field of communications law or in the field of export control. There is also an outer space treaty, article 9, dealing with harmful interferences, which is an indirect link to the ITU radio regulations.

Concerning the authorization to provide space services, the first authorization is associated with the use of spectrum — on this point my colleague Yvon Henri from ITU — will develop the obligations regarding to the ITU radio regulations. If such systems are equipped with remote sensing capabilities, you have to know that some legislations are introducing an obligation of licence or an obligation of declarations, so maybe such uses of very small satellites will need such licence or declaration. And in case of provision of telecommunication services, international law also encourages States to license such activities.

The issue of export control is more relevant concerning very small systems since very few universities are aware of such regulations and since export control mechanisms are fully applicable to very small satellites, these regulations may represent — here again — a limitation to development of certain programmes. The Wassenar arrangement on export controls, as I said, is applicable to very small satellites and to their components. We have the two lists of controlled items: the dual use goods and technologies list and the munition list. These two lists are implemented within national legislations and participants to the Wassenar arrangement have to authorize the transfer of goods and technologies listed and also the re-transfer of goods and technologies listed, and this represents a major constraint for very small satellites technologies transfer.

So, these are examples of legal texts implementing the principles of export control, in particular the American regulations — the ITAR and EAR. Within the European Union, there is regulation for export control but the principle concerning dual use is free circulation of goods and technologies. And, in other legislations, like in France, there is also this obligation to establish such controls.

So, this summary of my presentation is this table where you can see the licences or declaration procedures for very small satellites. Here you have the three authorizations or declarations that are mandatory: the first one deals with the operation of very small satellites; the second one deals with the assignment of frequencies; and the third licence, or authorization regime, deals with export control. In addition to these authorizations, based on eventual provision of services — via very small satellites — there might be an obligation to make a declaration or to get a licence to provide remote sensing services or an obligation to have declaration to enter the telecommunications market. Thank you very much.

**Mr. S. Marchisio** (President, European Centre for Space Law) Thank you very much Phillippe for your exhaustive presentation with many question marks. I hope that the audience will then raise these questions once again or comment on them. We will now see the same issue from the point of view of another international regulatory institution, namely the ITU — International Telecommunication Union. We have the pleasure to have with us today Yvon Henri, who is the chief of the space service department at the International Telecommunication Union. You have the floor.

**Mr. Y. Henri** (International Telecommunication Union) Thank you very much Sergio and hello to everybody. Firstly I would like to thank you, Tanya and Sergio, for your kind invitations to participate to this symposium. Well, this is an honour for the ITU secretariat and, particularly, for the space service

department, to be there. You notice that I use the term ITU secretariat — as myself, I am part of the ITU secretariat — as oppose some times to ITU just because to clarify that during this presentation, I will refer to ITU and each time that I will refer to ITU in this presentation — well, I will not refer to the few hundreds of people who are in Geneva as part of the ITU secretariat but I will refer to the 193 Member States and more than 700 sector members that are working together to develop a safer environment from the frequency point of view — well, for the user frequencies — and for satellite communication, including we said, cubeSat and small sat. And in a way, beyond those 193 member States, well, I would say that you are the ones in this room, in your own country or organizations, that at some stage, may in fact work indirectly for the development of those regulations or influencing it. So, just to mention that very often, whenever we are talking about these international regulatory frameworks, very often you hear "the ITU" etcetera. and in fact, when people are saying the ITU, they don't realize that they are talking themselves — also part. Because if you want to influence international regulations, please be active and you'll see that there are some means to do it.

One of the things also, and I know that some people might feel — I haven't said you — just some people might feel that sometimes this international regulatory frameworks, or the ITU regulatory layer, which is something which comes in beyond this regulatory framework which has been already presented, and which comes in beyond this national and licensing authorization layer — very often, these international regulatory frameworks — might be seen as a hindrance or impediment to the development of satellite business, well I hope that after this presentation, that you will feel a little more sympathetic with these regulations and that your views would have evolved on it because you will see that, in a way, there is a need for these regulations.

Very quickly and won't go too much into the detail because I think that right now, because of the relationship that exists between Vienna and Geneva, everybody knows the ITU. Maybe I will just stay a few seconds more on this picture just because, you know, that every four years there is a plenipotentiary conference in the ITU, which will decide mainly about our financial future, on our budget, for the 4 years to come and also elect the secretary general as well as some other people within the ITU. So, the plenipotentiary conference will take place this year, in Korea, in October and this team, which is there, will be changed at the end of the year. But just one thing which is quite important in terms of the ITU and when I was talking about the 193 member States and also all of those sector members, associates and academia — I think that those all the people which are in fact are at the heart of the development all of those international regulations. So please be involved.

One of the things also — and I will be keeping repeating myself during this presentation — and firstly just to concentrate about what is the purpose of the ITU, which called Union, and in fact it is regarding frequency lines. We are dealing with virtual things. I've heard a lot of things and even at one of the presentations about how we are there, well, for the ITU, we are talking about frequencies which are quite virtual to a certain extent. Invisible type of resources and the role of the ITU is just to allocate frequency bands to register those frequency bands and at the end of the day, what is the most thing is — why to do all this work — is to avoid interference between the radio stations of the different system and particularly between the radio stations of different countries. And if we translate this ITU missions to the ITU-R mission — ITU-R means the radio telecommunication sector of the ITU. Well, what we have to ensure here within the use of those frequencies: rational, equitable, efficient and economical use. Unfortunately, there is no one single equation to find the solutions in terms of something being rational, equitable, efficient and economical at the same time. So, it is a trade-off and we'll see that this trade-off could sometime be more on the rational side, some times more on the efficient side. Very often, nowhere on the economical side, but the most important thing to be seen at the ITU is that being rational, efficient, economical — the most important thing is that it is equitable. It means that every of the 193 countries could have access to this satellite business and to the satellite services.

One important thing, in fact, everybody has these red books. Don't know why it is red — formally — I remember that the first one more than 100 years ago — well, was not red, but at least right now it is what we call a red book — are the international radio regulations and these international radio regulations are intergovernmental treaties, which are legally binding on all member States. In fact, it governs the use of spectrum/orbit. In those regulations you will find the principle of use of orbit spectrum, the allocation of frequency bands. We will go a little more in detail afterwards, but just about that you cannot choose any frequency for any services, and then also some procedures on how to register those frequencies. Those regulations, in fact, those international regulations through the radio regulations are updated every three to four years. The last conference was in 2012 — in February 2012 — in Geneva, the WRC — and the next one will be next year in September/October in Geneva also. And, in fact, what you will find in this regulation

is the right of administrations and obligations. Many of the rights is the right to an international recognition and to a certain extent, a certain level of protection on the use of your frequencies by, in fact, applying some of the procedures. Very often, many administrations — but many individuals — everybody in a way, do not forget about its rights but sometimes forget a little about the obligations. Two main obligations, in fact, regarding these regulations is to immediately take any necessary actions whenever there is a foreign interference. This is one of the obligations and certainly one regarding these radio regulations and the other one is to discuss together — you will see that one of the big principles beyond the way to share frequencies is to coordinate — we call that coordinations — but it is to discuss together in order to ensure that two systems could share some bands and could share some bands without having adverse effects or interference between themselves. In so, obligations by all administrations there and operators beyond is to discuss between themselves.

So far, I would say that those regulations for which — well, those regulations and particularly regarding space activities for which the first regulations were done at the end of the 60s and in the 70s, well we could say: sure, there is an inefficient use of spectrum — we'll just say that there thousands of systems, there are a lot of GSO — non-GSO systems, a lot of services that we are using on an everyday basis and at the end of the day, very few interference cases. So, it could be, to a certain extent, ensure that these regulations respond to this issue of at the end of the day having something which is efficient. Equitable: well, it is always difficult to categorize what is equitable or not, but my feeling is that, to a certain extent, right now and particularly with these cubeSat and small sat approach, there are more and more countries who are entering into this satellite world and which are launching satellites which are — interesting about satellite services from GSO and also cubeSat small sat, and well, no thing is perfect in this world, but my feeling is that this type of approach, where everybody discuss together, got some regulation that permit to anybody to have the possibility to use those frequencies and at the end of the day, to have access to those space services, may be seen as something which is equitable. One important thing, as I said, about the procedure, which are in the regulations, in this discussion between people before you launch your system. It is true that when you launch a multi-hundreds of millions of dollars project satellite in the air, which is going to the GSO and that because of interference, half satellite cannot be used, well that's half of your investment that one day to another cannot be used and it is a loss. A loss of customers etc. So, it is true that this is something which quite important: these discussions. Beyond some of these issues, if we are looking more carefully to this issue of small sat and cubeSat, it is true that is a debris, there are collision issues, as it was mentioned, but also my feeling is that tomorrow, or quite quickly, there will be this issue of interference between those small cubeSats. And it is not because your system is just working or operating for six months or one year — well, if there is interference you won't be operating at all. So, I am not saying that we need to put something which is as complex or as detailed, maybe, that the big geo-type of discussion, but at least, there has to be a framework by which all people, all universities, developing some of those systems, discuss together, in order to ensure that the end of the day, that system will be operating without interference.

I like this one because this slide is a little techniques, we need to talk about a little techniques and come to the basis. And when I say that, it is just because very often, people forget that unfortunately, regarding those radio waves, and its true for satellites but it is true for terrestrial, as soon we are dealing with radio waves, we are depending on the laws of physics, and some of them, 200 years old, and for which, in fact — well, for the time being — we have not found any other rule that will, in a way, for which we will be able to use more frequencies without those issues of interference. So, we depend on the laws of physics and also, radio waves, they don't stop at national borders. And that's something. There are things that sometimes our political peoples say: "stop at national borders". I won't get into any polemic about it. Being French, I have some story about it, but I won't share it with you. But it's true that here, whatever we can do, this is law of physics and it does not stop at national borders. One of the problems is that because of that there is this interference issue and we must admit that the problem of interference is higher in space radiocommunications. To a certain extent, for your terrestrial frequencies — and trying to simply to the maximum extent possible — the issue of interference could be at your border. So, that's the reason why there are always border coordinations for your terrestrial systems. But it is true that — and some countries might be more lucky than others, and I am thinking of Australia, for example, rather […] for example. But having said that, it is true that as soon as you get into the space radiocommunications services, even Australia for those systems has to coordinate with as many countries as — I would say — Luxembourg, as I take for example. One of the reasons of this regulation is really, at the end of the day, to get an interference free operation of radio communications. Here I was too optimistic by putting interference-free — I should put interference

control because for any that is using frequencies, you know that it is not interference-free, except you are alone. As soon as you are not alone, there is a certain level of control. However, having said that, it means also that you might share and you might add system, so, whoever said: OK, the GSO is congested and tomorrow we will say, well, too much small sat, too much cubeSat, everything is congested. It is not true, there is a solution. There is a technical solution, the only is to discuss between people and at the end of the day, to be able to share a little. That point ... it was just to impress people then. Impress people just to say that: OK, in green and blue, you are the signal that should work, the one that you need and on the dotted line you have all the interference and all the interference possibility. For those which might say: what are those figures: 9.7, 9.14 etc. — those are for the only fuse that treat the […] and know what it means in terms of the coordination between GSO/non-GSO, GSO/terrestrial, non-GSO/terrestrial, etc. Interference and what is important through the RR, is the control of the interference.

A little techniques also regarding in the radio regulations, just to mention what exists, in fact, what kind of solution exists in order to have an equitable access and in order to control the interference. There is one which is the allocations. In a simple way: different frequency band, different service you can share. So, that was one of the things. Another thing is power limit. In fact, you can share between terrestrial and satellite service to the extent that both have some technical characteristic in terms of […] which is transmitted, which is sufficient to ensure that you may have the service, because that is the goal, but that both service could share the bands using those parameters. Unfortunately, we would be grateful through these poor limits and obligations, we would have to find a solution to share, because you have to share with — you know well — you have to share with other service but you have to share also with other satellite systems and one of the main solution there is coordination. When I talk about coordinations, it is a negotiation based on technical parameter, but at least it is negotiations, between the operators and the — well, between the operators and also between the administrations beyond. One of the important things about the control of interference of monitoring. I know that is something which is very sensitive. As soon as you talk monitoring, everybody agrees that, if you want to have a great — if you want to have ... for the frequency management — what you need is to have clear rules, develop frequency allocations, for example, a procedure, you have to have a data base — whatever we call it database or a place where you have all of those informations — and have also to have a monitoring to ensure that the data base represents the reality. So, those are the three pillars of a good frequency management. Those are the three things that we found in the radio regulations and at the end of the day, I will say that the main approach is to record your frequency assignment, to register in your system, including — I would say small sat, cubeSat, very very small satellite, including those that could be launched for a period of a few months, because it is true, this recording that you will get, this international recognitions and certainly also a certain level of protection.

That is part of the radio regulations and just to mention what needs to be notified, what needs to be recorded. And here we are talking about regulations, an international binding regulations that have been signed and agreed by 193 countries. So, as soon as somebody said, OK, I will use some frequencies and here we were talking about using some frequencies for my satellites. Well, you should — you shall — not should, you shall, notify — it is an obligation for the State, to notify and to record those frequency assignments as soon as those frequency assignments are capable of causing harmful interference. And, as I have demonstrated before, as soon as you have a satellite system — well, you will have the possibility of causing harm interference to neighbouring countries. As soon as you […] for international radio communications and also if you are seeking and obtain an international recognitions. So, those are the obligations for you to apply these regulations and to notify your frequency assignments.

I won't go too much into detail. Just to mention that all of those information will be made available to any of you and also through a CD-ROM that you will have at the end of this session or at least after Saturday's session. But it might been seen as complex there and I don't want to get into the details, but it just means that whenever you want to launch a satellite, and I will say here a cubeSat or a small sat, you have to go through a procedure which begins with the advance publication/information and this procedure could be initiative up to seven years before you bring really and to use your system. It is true that talking about cubeSat or small sat, certainly that, this negotiations part — this registration part — could be shorten. Seven years is a maximum, in a way. You can do it in one, two or three years, however, this is an obligation. It is true that for some big, complex GSO system, sometime will find that seven years is even not sufficient in order to secure all of the agreements. However, what is quite important is not, at the end of the day, to secure all agreements, but is most important is to secure the maximum of agreements — definitely — but also to secure operating agreements in order to ensure that when you launch your satellite, it will be operating without

causing harmful interference to others but, particularly, without receiving interference.

One thing is important, and I want to see that step by step, these international radio regulations, step by step, is recognized and more and more recognized and applied. Just recently we received from the International Amateur Radio Union (IARU) informed the bureau of some practice, some approach, to a certain extent, recognizing that even for those cubeSats, cubeSats, using the amateur band, there is a need to have a certain ... well, there is a need to have the recognitions — international recognitions — to those systems, and this recognition would have to be done through the ITU process, with advance publication etc. And that there is a need also to have certain coordinations, at least within the amateur bands, and in fact, that IARU is taking care of that. And I think that it is a good positive way towards, in fact, having more cubeSats more small sats and operating in a safer environments.

One of the things also within this presentation was that there are a lot of documents and documentation regarding this registration of satellite networks. It is true that when we discuss universities or with countries, regarding cubeSat, people very often — which are not familiar with those regulations — are a little lost. And I can understand that they could be lost. That is the reason why you need experts, you know. Sometimes you complexify your little — whatever the regulation — and you have expert to help. No, having said that, it is true as any regulations, there might be some complexity there, but just to say that there is a lot of free online and help and documents that might be, that are, available on the ITU website. And here, there are some of those links where you could find the information. One interesting graphic there was just about whatever we can describe as a Small Sat, although sometimes there is always about what is a nanosat, what is a cubeSat, what is a small sat definitions, but to a certain extend ... just to see here, how within the last years, this number is quite increasing and these numbers are just the numbers for small sat or cubeSat for which the administrations are sending those advance publication information to ITU, which is quite something, which is quite positive for me. As in fact, we thought that the community realized that it is important in a way if we want to have a safer environment, for these cubeSat environment that something has to be done at the international regulations.

I will go quite quickly because I saw Tanya looking at me like that ... saying, please Yvon, reduce, reduce, in order for my colleagues to have some time. Just to say, well ... it is just a little history, it's just happened that the first cubeSat were really amateur ... well, very small satellite or cubeSat, as the name say, in the amateurs band, but more and more, in fact, were moving from those amateur bands to other bands and I think those amateur bands should be reserved for university, the amateur community and as soon as you develop that, then, my feeling is that tomorrow those small sats — cubeSat — that are there in constellation/information would be there to respond to a certain number of space commercial applications. And so, at that time, it is true that you will have to move out of the amateur band in order to follow the regulation concerning the amateur band and some other bands, but I think that just to see that there is an evolution of this, and that is quite interesting. Well, that was just here some other reference to the regulations, but you will have more time between now and the end of the week and then after the end of the week to look in more detail in some of the information that we will provide to you.

Important, as I said at the beginning, in fact, if you want this international regulation to involve, well, it just depends on you — directly and directly. When I say directly, if you are part of the administration, part of whatever group preparing the next conference. If you are part of any organizations, which, within your country could be part of the national preparations and then the original preparation. Just to mention that there is preliminary agenda for WRC 18 on some of the regulatory aspects for nano- and picosatellites and there will be a report at WRC 15 on those issues. And if there is a need, maybe something could come a little in advance at WRC 15, but definitely in WRC in 2018. This issue will be in the agenda and just, in fact, all of those regulatory aspects for nano- and picosatellites. OK. We'll go quickly there ... one thing is also ... and I just because I talked about it, there have been ... we have prepared a small, well, a small satellite DC-ROM. In fact, a CD-ROM on small satellites and not a small CD-ROM on satellites. Whatever the way you put it together ... but just that we'll include all of the presentations that we've done so far about these picosats, small sats satellites, and amateurs band, etc. Some tutorial, also all BR software which can be used in order for any of the universities and through the administration to file those API for those small sats with a filing sample and a complete non-GSO database. And with that, I thank you very much for your attention.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you very much Yvon for your very interesting presentation. I am sorry if I gave you the impression that I hurried you. It is indeed very important and good to see that there is this communication of ITU, also contributing, to the work

of COPUOS. I see a pattern emerging, actually, because all the speakers so far have indicated that there is an opportunity and a challenge and that, indeed, you mentioned also that actually the equitable use, which is a requirement of the ITU rules, can be enhanced by the use of small satellites, but there is a need for coordination and also among to these systems to avoid harmful interference. And also you are doing capacity-building — which is wonderful — with online help and CD-ROM and so on, so that also goes back to Lulu's presentation.

We are going to the engineers now. Actually we have a quite good division between engineers and lawyers at this panel. Better than the male/female distribution, I have to say. We have two remaining speakers who are from the technical angle: Christophe Bonnal is the first. He is from the French space agency but he is here to speak more on the space debris expert to tell us more about the IADC (Inter-Agency Space Debris Coordination Committee) rules, because of course, debris is also a risk that can be posed by small satellites, even if they do not re-enter the atmosphere — they might pose a risk in terms of in-orbit collisions, so I am very happy, Christophe, to welcome you here. You have the floor.

**Mr. C. Bonnal** (Inter-Agency Space Debris Coordination Committee) Thank you very much Tanya, and I am impressed being here, as always. I am not legal guy at all, and so for once in my life, I was so happy because I was invited to a topic which was requirement the debris mitigation for small satellites. I thought, well for the first time of my life, there is nothing to do. There is nothing to say, there are no regulations. Then I thought, no, I cannot just cheat, so what could I give you today. So, I thought you might be interested a little bit in the making of these rules and the kind of chronology of the rules that we have today. I would like to first talk about the IDC chronology and then talk about the first mitigation standards (it is about the IAA position papers, which were […] at that time, and are still), and then the IADC guidelines from 2002 and their follow ups — so, chapter five. And then the chapter about the regulatory needs for very small satellites before our conclusion.

So, IADC started — well, it is really small, but don't worry, I won't read it all — it started, it was not named IADC, it was just an ESA-NASA Orbital Debris Coordination Meeting, which started in October '87 in Rolleboise in France, and the aim was to exchange opinions — present study status, study resources, discuss and so on. By the way, at that time, please keep in mind, at that time, so during this meeting, there were 6,000 catalogued objects at this date, OK. One sentence taken from the minutes of a meeting is quite funny today, which is "Ultimately regulations for the conduct of space operations could become necessary. As being premature, this point was not addressed in the meeting." I like it.

On the ESA side, ESA presented the Space Debris Working Group as SDWG with professor Rex, it was my first job in '87 on space debris in the Working Group on Re-orbiting of Geosatellites. NASA presented its Orbital Debris Programme and so on. Then I skipped to the 7th Coordination Meeting on Space Debris because at that time we had Japan joining in February '92 — the meeting in Noordwijk. In '92 there were 6,800 catalogued objects. Then we had the 9th Coordination Meeting — it was still Coordination Meeting On Space Debris ESA/NASA Japan and Russia in 1993 — inclusion of the Russian Space Agency in this coordination meeting, it was held in Darmstadt. At that time we had 7,130 catalogued objects. And we started seeing the first premises of a draft of a "Orbital Debris Handbook Guidelines" and the first draft of "Orbital Debris Preventative Requirements", which were in PSS-01-40, which later became ESS and ESS 40. I remember very well this PSS-01-40 because there were some unrealistic saying everything which goes up shall go down quickly. And so we laughed at it, saying it is not realistic and not today. And so, there was Japan presenting the Debris Mitigation Consideration for the H2 […] programme. And then we had a second meeting of the IADC, officially, in November in '93, and it's not a typo, it is the second meeting. […] the meeting just following the 9th meeting of the coordination so in reality there was no first meeting of the Inter-Agency Space Debris Coordination Committee. It took me sometime when I prepared the presentation to find out, wow, where has gone the first IADC? OK, so the 2nd was held in Moscow and that is the real serious one because it is the first time we see all the terms of reference of the IADC and the inclusion of the four working groups which exist today. So, working group 1, about measurements, observation; working group 2, environment and database — all the numerical simulations; working groups 3, testing and protection/shielding; and working group 4, about mitigation and proposal of guidelines. At that point there were 7,500 catalogued objects. It was so the 2nd official IADC, but in order to keep track with the 9 previous meetings, the next one was called the 10th IADC. So, there is no number 1 and there is no number 3, 4, 5, 6, 7, but we found nevertheless ... The 13th was held in February of '96 in Darmstadt, including China, CNES/France officially in '96, BNSC and ISRO from India, which led to 9 members, and a steering group was added to the terms of reference on numerous activities and it was really something

serious. It took us a complete week, with plenty of presentations and it was already a dense programme. And at that time that we had the first invitation to present our IADC activities in front of you, to UNCOPUOS, at the 1997 session. There were 8,000 catalogued objects — that is a ton.

The 20th meeting of IADC is probably the most important, I guess, in April of 2002, it was held in Guilford. So is it due to the very good beers that we had or what, but it was very successful because we had the approval by the steering group of the IADC guidelines, prepared by working group 4. I had the rare privilege of chairing this session. And so it was the end of 3 years' convergence process among all the then 11 delegates. We then had Ukraine ... and, OK, you have the list of the delegations ... ASI Italian Space Agency. And we had the unanimous approval of the 11 delegations — and believe me — it was really so impressive to see the effort that every delegation was making. We had, I remember, it took us days, voting word after word after word and remaking, and is everybody OK. So, we were very proud of this document at the end. In parallel we prepared the IADC guidelines support document, which is kind of a justification, and we had the approval of the work plan for the — but wait — at the same session, we had the approval of the work plan for the action devoted to small satellites, the so-called action item 18.4.

So, here were at the 20th meeting ... […] skip a little bit backwards ... some standards were already existing, mainly among the first mitigation standards, were the ones from NASA — NASA Safety Standard 1740.14, established in August '95, following an NMI NASA Management Instruction 1700.8, issued in '93. So, I will not explain what is inside, but this was the very first national guideline, or I should not say national — agency guideline. Very quickly after, the Japanese did their own standards, so they are really second in the kind of preparation — the making of these guidelines in March 1996 — the NASDA STD-18.

In France, it was third with, which came in 1999, with the Exigences de sécurité — Débris spatiaux (Space Debris — Safety Requirements), which was approved by the CNES DG, I quote his name here because you know him, it was Gérard Brachet, and where we had 3 sets of requirements: management requirements, design requirements and operational requirements, which is a structure that we'll find in all the following guidelines after. There was the ESA Space Debris Mitigation Handbook. A very very nice, very thick handbook, not really a standard, but nevertheless with numerous guidelines and techniques for limiting the number of debris and which led to the EDMS: European Space Debris Mitigation Standard, which was prepared by the 5 European agencies: BNSC, ASI, CNES, DLR, ESA, with the first official issue in September 2000, so you, it is still two years before the IADC Guidelines and which were derived from the CNES Standard with basically the same content and this led afterwards to the European Code of Conduct.

Second set of parenthesis: in parallel also, there were what was called the IAA Position Papers, which were prepared by an Ad-Hoc Expert Group in space debris, which now is called the Space Debris Committee. IAA was International Academy of Astronautics and so there a bunch of experts, engineers basically, prepared at first a position paper in '93, which was revised in 2001 and which basically included all the meat of the mitigation insurance, subdivided into 3 categories. Category I: immediate — you should do it immediately; Category II: consider later; Category III: requires significant technology and cost. So, in the immediate thing it was really no deliberate breakups, minimize lifetime in orbit, vent, passivate the LEO orbit, the LEO object and so on and so on. And when you flew across Category I, Category II, Category III — in Category III you found out the long-term proposal which was that everything that goes in shall go out immediately and start removing ... measures for space debris removal and so on. In the same way, in parallel, just after we prepared other position papers — just I will come back just to here, if you look at the second line, what is important is that the logic of these IAA position papers were: first, recognition; second, characterization; third, mitigation; fourth, remediation. So, it was a logic. So, this position paper was recognition, then characterization, then we had the space debris mitigation position paper in 2005, and then we are currently preparing — excuse me, last lines — we are currently preparing the, no we just published this space debris remediation — and we even have one, led by Ray Williamson, on policy, legal, economic considerations, which is […] I think Tanya, that you are a member in […] courses, part of it. So, in parallel — to conclude all this kind of cycle — we are preparing a reference report on space debris, which is just starting now. It's ongoing but it will not issue before two years' time, and which is supposed to be the kind of bible of space debris — everything you wanted to know about space debris — you should find it there.

To come back to my IADC Guidelines. So, in October 2002, approved by consensus by the 11 delegations, and three fundamental principles to prevent orbit break-ups/do not explode. Second remove all the spacecraft which have reached their end of life relatively quickly, so it is what we call the 25 year rule. We defined two main zones in space: lower-Earth orbit

up to 2,000 km — whatever its inclination and then GEO, +/– 200 km altitude, +/– 15 degrees. And what we say is that in these two zones, you are not allowed to remain more than 25 years after the end of your operations. Twenty-five years may seem a bit estrange but this was the consensus that we reached after 3 years negotiations and for which we have a very, very good support from all the simulations that we've done, mainly in the working group 2 of the IADC. Third point, limiting the object's release during the normal operations, so be clean: please behave cleanly and so do not leave mission-related objects. And so the content is quite straight forward. It is a very short document, you know it all, I believe, here. We have the definition and content of the Space Debris Mitigation Plan and any release of debris should be minimized. Potential break-up should be minimized. So, once again, in terms of terms: it should be minimized. We are engineers, we are not legal people. So, it is just a bunch of recommendations written by what we called the polluters'' club — I want to change that to the engineers' club. Those mission disposal, so it is a GEO rule for re-orbitation which we took from the ITU because you wrote it before, and the LEO 25 year life-time reduction rule. So this document was revised in 2007 and we are still trying to finalize the support document.

So, what could we do with these nice guidelines. Once again, we were not asked to write "you shall", so we had three ways of using this document: the first things that we did was to come here to present it to you, and so this led to the UNCOPUOS guidelines for space debris mitigation, where there was a working group started in 2002 following the IADC Guidelines and which led to a final approved document in February 2007. There are seven basic guidelines, which are the same as from the previous page. Personally, I just regret one thing — because it is globally completely coherent with the IADC guidelines, except, unfortunately, there is no mention of the 25 years rule. So, there is just a replacement by no long-term or long lived debris, and it is a bit of a pity because it is the only occurrence in one of the debris codes/law/guidelines/recommendations, it is the only one which does not have the 25 year rule. So, it is a very personal opinion. It would, it would really benefit from a clarification in this point in a further edition.

So, first, the IADC Guidelines follow-up. Suddenly a set of laws/standards/guidelines/code of conducts/ recommendations at national or agency level. For instance, the Russian Orbital Debris Standard was prepared in 2007 with GOST R, with very classical requirements. The advantage of all of these documents which were released after the IADC guidelines were that basically they were all coherent — it was all the same requirements. So, we had the French law space operations, which Phillipe Achilleas already discussed, which was prepared in 2008 and active since the 10th of December, 2010. It is not a space debris law but it has plenty of chapter, plenty of aspects associated to space debris and it basically it takes — it includes — all these space debris guidelines from the IADC text and so on, and with this certification process, at every launch of French spacecraft or launching from French Guiana. There is the ESA standard. ESA/AMIN/IPOL(2008)2, which is the official set of requirements for any ESA programme. Once again, very coherent, very classical requirements. So are the FCC in the United States, the FAA and so on and so on. Sort of a set of siblings — children — from the IADC guidelines, whereas the ISO standardization ... for the ISO standardization — ISO is interesting because, you understand that this a way really where ... when A passes a contract to B, it is easy to say in the contract that you apply the ISO 24113 and the follow ups. So, the highest level of standard is the ISO 24113, which is more or less the same content as the IADC guidelines from 2002. And then we have second level documentation for all the requirements implementation or scientific data. You have means to compute the life-time duration in orbit, you have some standards giving you the atmosphere function of altitude and things like these.

Here, at last, I am talking about small satellites. We had an action, of course, which started in Guilford in 2002, so it is the so-called IADC Action 18.4. Early, it was proposed in June 2000 in Colorado Springs, and the goal was to assess the impact of small satellites and small satellite constellations on long-term evolution. So, we were already quite aware — worried — about what could be the effect of having a massive number of small, very small picosats and things like these. So, the interesting thing for us is to compare the definition of this table here with what Abe presented previously, you see. Here it stops at picosat, which is 1 km. I would say this is ... today we have much lower, much smaller satellites with, what is it called — what is it called? what are they named? I don't remember — but we have some in the range of 100 g or 10 g or even 1 g. I was discussing with Abe at the beginning here, there are some PCB sats, you know, it is the size of a stamp, the weight of a stamp, and you send them ... thousands of them in space at the same time, I don't know what for, but ... so, we had a very nice workplan, with a good survey of all the technology for small sats in order to understand what was behind it. Then, phase 2 was in working […] for all the modelling, of what could come out of it. Then the question about the observation and tracking of these nano and

picosatellites and, of course, producer report on it. And so we had plenty of work. We really worked very nicely during three years. Nine delegations were heavily involved in the detailed questionnaire and all the simulations and all this ... I should note a very important simulation work done by working group 2. One very important thing to note here is the last line, associated to the first line. So, it was proposed in year 2000 ... and last line ... so there were hardly any cubeSats. CubeSat was not even a word which existed. When we talk about small satellites ... wow ... small were 50 kg. So, it is important to understand that we did the job currently, the IADC, but probably too early because in all these surveys that we had plenty of — of 50, we had plenty of 80, 120 — the small satellite for CNES was we called the Myriad family, which was 120 or 125 kg. This was our small satellite. So, clearly, today's things have changed a bit.

What came out of it? So, it came out that — so it's even smaller, it's getting smaller and smaller ... I am sorry — we believe that the launch of a small satellite will not produce operational debris because they do not tend to explode and there is no mission-related object, and thanks to the nice dispenser presented by ISIS here, for instance, these operations are debris-free. There is no explosion or self-destruction events, there are no manoeuvres/fussy manoeuvres at the end of a life time. We can easily see them, up to 1 km, up to, now we say 5 cm, depending of course of the altitude, but in a typical orbit of 600 km, we can see an object which is 5 cm across — see and catalogue.

So, the conclusion was exactly as Lulu Makapela said previously, it was: outer space objects, irrespective of size, weight and scope. And so we just decided there is no need at all to make any dedicated regulation. All the regulations, which are coming from ISO 2002 and ... IADC 2002 and follow up are directly applicable. A small satellite, whatever its size, is a satellite and shall comply with the complete sets of regulations. It means that since satellites ... since cubeSats, for instance, generally do not have propulsion, they must be left in an orbit which is low enough to re-inter within 25 years. So, typically in the range of 600 or 650 kg. So, that was the end of action 18.4. It is a very nice report with 226 pages. And that time we had 8,391 catalogued objects. And so, my conclusion is — oh, last line, today we have 16,000, so it is double as much as the previous stage.

We have plenty of regulatory documentations, […] that we don't really apply it, but we have plenty of national standards, codes of conduct, law, guidelines, international guidelines, international standards, ISO and so on and so on. In none of them there are a any kind of dedicated rule for small, micro-, nano-, picosatellites. Nonetheless, we see clearly that these two charts are coming from a study done by CNES, which was presented recently in CNES, showing the evolution of the compliance with respect to the 25 year rule these last 10 years. So […], it has one of red curve and blue curve, but that's not the point, it is just two different ways of counting it. What you see is basically is flat, we are not improving anything, and it's flat — it's a relatively good level — 50 or 60 per cent — but it's cheating its own because we have 50 or 60 per cent of satellites which naturally are in a zone which comes up in less than 25 years. These two curves just show that we do absolutely no effort and that we are just […] with the natural life.

Ok, just as conclusion, we need to be more rigorous at the international level on the application of our mitigating rules and I wish all the best to small satellites because they are really terrific but maybe we need to come back to them because things have changed with respect to action 18.4. Thank you for the floor.

**Mr. S. Marchisio** (President, European Centre for Space Law) Thank you very much Christophe for your presentation and for having reminded us with all the story and the process concerning the adoption of the rules on space debris mitigation and for your conclusions concerning small satellites. Now we have the last speaker, our list and this is Otto Koudelka, who is the head of the Institute of Communication Networks and Satellite Communications at the Technological University of Graz, will present a best practice case study. Please, you have the floor.

**Otto Koudelka** (Technological University of Graz) Thank you Mr. Chairman. Distinguished delegates. Thank you for the invitation, having the opportunity to present the BRITE mission as an example. A month ago I had at the technical subcommittee meeting the opportunity to present some initial results of the mission and today I will more go into the details of the legal and regulatory aspect. But before doing so, I will briefly introduce the mission. BRITE stands for BRIght Target Explorer and it is a constellation of nanosatellites currently consisting of 6 spacecraft. Three are already in orbit, the 2 Austrians and the first Polish satellite, and this year in May and June, the two Canadian BRITES and the second Polish BRITES will join the constellation. BRITE is based on the generic nanosatellite Bus of the space flight lab of the University of Toronto with whom we have very good collaboration, and BRITE is dedicated to a astroseismological mission. The scientific goal is to measure the brightness variation of the massive luminous stars who are mainly in the Milky Way by

photometry. So are measuring two spectral ranges: blue and red. One spacecraft has a blue filter, the other one has a red filter, so we have not only temporal but also spectral resolution and we collect time series per target of typically 100 days. The mission duration is at least 2 years from the design, but we hope that the spacecraft will last longer and the prospects are pretty good. The Canadian MOS satellite, which is using similar technology was launched in 2003 and in 2014 it is still working very well. So, the operation life time will helpfully be a bit longer.

The two Austrian spacecraft TUGSAT-1, which was built in my institute, and UniBRITE, which was built at the space flight lab on contract by the University of Vienna. They were launched last year. The first Polish satellite LEM was launched in November of last year with a Dnepr and the two Canadian spacecraft — Toronto and Montreal — will come in June, as far as I know, and I heard from my Polish colleagues, the Heweliusz will be launched, hopefully in May.

So, this is how it looks like. It is a cube of 20 cm, has a mass of about 7 kg. All the outer surface is covered by solar cells. We have no deployables. It was all launched in the so called […] and we are operating in the S and UHF band, originally also VHF band as foreseen but this was later skipped. The launch took place on the 25th of February 2013 on the PSLV-C20. This was a flawless launch and it brought the TUGSAT-1 and the UniBRITE into a Sun-synchronous dusk/dawn orbit and this way, and this makes us quite proud, made Austria a launching State — it put us in the club of the spacefaring nations. Although I have to say the very first Austrian space object was launched in 1969. This was a scientific instrument on a Scandinavian rocket. It was a ionaspheric probe, but this was a short mission only, a ballistic flight. This is not an orbital flight.

We have the mission control centre in Graz. This one is tracking UniBRITE by Austria everyday on S-band and UHF. We have about 3 passes in the morning and 3 in the evening, which we can track out of the 14 passes. UniBRITE, the sister satellite, is tracked from Toronto and LEM is tracked from Warsaw. So there are 3 compatible ground stations using exactly the same software and we can also cooperate and do some telemetry from other stations if so needed.

Automatic operations are supported but in the early phases it was quite intensive from the operational point of view is, well, particularly during the commissioning, we have just completed the observation of Orion. First we had to get the spacecraft into fine pointing and we are quite happy. The specifications exceeded. The specs said that 1.5 arc minute of pointing accuracy and we have gone below 1 arc minutes, so the arrow is less than 1.5 pixels on the CCD, so you won't see it very well, but this is Orion, the 3 stars in the belt and the other ones here — this is a full image, but normally, we just take […] around 15 target stars and this represents an enormous data reduction. And this is quite an important figure for the astronomers. The red dots are averaged brightness measurements in successive orbits and this curve here — this variation — is due to the pulsations of the star. This was verified that it is not artefact. We measured with 3 spacecraft, with MOS, with UniBRITE and BRITE Austria, looking at the same star, that Orionis, and that they show all the same variations. We have now moved, as a new target, to Centaurus, which will now be observed for the next 100 days. But this was the technical part. Now, coming more to the legal and regulatory part.

Frequency coordination as it was pointed out by the ITU delegates, is a very important activity and we are a radio telecommunications department being active in this sort of thing since the 1970s and the registration of ground stations and frequency coordination, was something we are very well aware of. We started the registration process nearly immediately after the contract by the Austrian Aeronautics and Space Agency was awarded and we got in contact with the Austrian Radiocommunications Bureau and informed them about the plan, what frequencies will be used (VHF/UHF and the science S-band) and in this particular case, we had to notify both IARU but also a full notification process with ITU with respect to the use of the Science S-band had to be done. Due to the very good contacts with ITU, we are carrying out every year a United Nations ESA-Austria symposium. There are quite often ITU representatives, while there, where we early got familiar with the procedures that helped my co-workers very well in doing the paper work. So, we used the ITU software tool to generate the advanced publication information data package, which was submitted to the Austrian administration, filing a BRITE constellation. So we filed BRITE Austria and UniBRITE as a constellation and in parallel we submitted to IARU for amateur radio subsystem of the spacecraft, VHF and UHF. In addition, the ground station authorization was requested to the Radiocommunications Office for Styria and Carinthia, which is based in Graz, and then, after filling out the forms, we got the permission for the VHF/UHF S-band ground station.

Then, in the process of following the API, we got some clarification requests by administrations in Europe, Asia-Pacific, North America. They were collected by the Austrian administration and ITU, asking clarification to avoid potential interference to

other space services. Many of them were answered very easily because our space craft is only switched on from the transmitter when is in reach of our ground station. So, it is never switched on when it is in the Asia-Pacific region, so all the clarification requests which came from Asia-Pacific, they could be answered very easily, so there is interference risk there because it is never switched on. And also it helped that since the same frequencies as the Canadian […] satellites have been used. The frequencies were already coordinated for Canada and North America, which also was quite helpful. Again, there were some requests from the United States and Canada but that could be easily clarified because again, it was answered that the service area is Austria. So we provided the answers to the Austrian administration, which made the formal communication to ITU. Everything was published in the API/B and the final notification was done approximately 1 year before launch and after launch we submitted the "Bring into use" notification, which contained the actual orbital parameters because the earlier papers had only the target parameters but then we had the final parameters given.

So, it is quite important and with the university cubeSats, this is sometimes not realized, the satellite owner and operator has to notify both IARU and ITU, even if only amateur satellite service frequencies are used. I mean, this is not a bureaucratic obstacle. I mean this is a necessity, particularly bearing in mind that the number of such small space craft is rising. For instance, when the 50 — cubic 50 — satellites, will be launched, if they are given a unique frequency, then you use up the complete spectrum allocated to amateur radio satellites in the UHF band. So, there will be some double frequency assignment necessary and then you have to obey some rules of when you turn your space craft on and when it is not operating, otherwise it is not going to work. So, it is not an obstacle. It is something that helps for the operations of our own space craft. Because, if you have interference, then your whole investment may be rendered useless — you have invested a few hundred thousand euros, perhaps, even for the cubeSat, but then, if there is interference, then your service will not run and also, in reverse, you can harmfully interfere with some other terrestrial services. So, of course the frequency coordination process is a bit easier if only the amateur radio bands are used. Also, I have to say, also the full registration and coordination process is not rocket science. I mean, this is quite easily done. However, and it was said before, in November, within two weeks, more than 50 cubeSats were launched only in April and subsequently on the […] and not all of them properly frequency coordinated. So, there is an interference risk.

Also, it has to be borne in mind that if amateur satellite service frequencies are used, all the operations personnel have to possess a valid amateur radio licence. This is article 1 and 25 of the ITU radio regulations and also the space craft needs a call-sign, in our case is OE 0 GUT Graz University of Technology — very appropriate. And also the ground station needs a call-sign, in our case it OE 6 XUG, so we have our own radio […] operating the ground station.

Coming to insurance ... we investigated insurance possibilities. However, this is not so easy for a small space craft and it turned out the premium would have been between 30 to 50 per cent of the cost of the whole project, and it was decided it would not be insured for launch, but also — I mean — ESA space craft are not ensured, so we are in good company there. However, the transport of the space craft to external environmental tests, and also to the launch site, this was ensured, so this cost for every event, about 5,000 euros. So, if there would have been a damage, the cost of the space craft would have been recoverable. And also, on the launch site, our personnel, which did the launch integration, were covered by an insurance of the university plus some small add on premium, because this is a special event, so the personnel were covered in Sriharikota, so if they would have done some damage, which it didn't, then it would have been covered by the university's insurance.

The launch contracts, UTIAS acted as the launch service provider and, before hand, the science team had made some recommendations on suitable orbits and in the beginning we looked at different options — at the time when we started the project, there were not so many suitable possibilities — and then, ISRO offered a very good launch opportunity and then a contract was set up between our university and UTIAS in 2011. Here is our rector at the event of the signing of the contract — to keep that in history. And then, UTIAS negotiated and set up the launch services contract with ISRO/ANTRIX.

Our satellite was a stimulus for the implementation of the Austrian Space Law. This was set in force in December 2011. Since the BRITE Austria project was initiated before one clause of this space law says, that in this case, only a notification process is needed. So, we had to notify the Ministry of Transport, Innovation and Technology, but now, for any subsequent space projects, the full authorization and permission process is necessary. So, you have to comply with the space law — I mean also for BRITE Austria, we had to comply, but there is just a notification process and not an authorization process — and by the way, since the whole mission was paid for by the Ministry, it is in the public interest and there

is also a special clause governing that. So, what we had to deliver to the Ministry was to give evidence of the know-how, of the capability and the reliability of the applicant. So we had to tell in which previous space projects we had been involved, what background experience exists. Also we provided the CVs of the personnel involved in the project, then we had to give evidence that there is no danger for public safety, persons and goods. There are also no infringements of national or international law. Also that we take care of the space debris issues — there was an external study contract given to the University of Stuttgart by the Austrian Aeronautics and Space Agency just to look into the mission. So, we are not using any harmful materials. There is no danger of break-ups. There are no explosives used. And also, the space craft will be de-activated after service. Also, transmitters will be permanently switched off after the useful life time. And also we gave evidence of the frequency coordination with ITU. There is a clause which says that an applicant has to provide a liability insurance. However, this can be waived if it is in the public interest. And if it is for science and research, which in this case, is given. Then, we provided all data about the space craft and the final orbital parameters to Ministry of Transport , Innovation and Technology, which then delivered this information further to the Austrian Ministry of European and International Affairs and they sent the registration to United Nations OOSA, and now BRITE Austria and UniBRITE are in the United Nations database and also, of course, in the NORAD/Spacetrack database. BRITE Austria is object 39091 and UniBRITE is 39092. Also, thanks to the American authorities, from time to time, we get the conjunction analysis and this gives us notification when some other object comes closer to our space craft. But luckily nothing has happened so far. Since we have no propulsion, the only countermeasure we can take in such a case is pray. But, OK, so far nothing has happened and keep the fingers crossed for the further continuation of the mission.

So, in summary, BRITE Constellation is the world's first nanosatellite constellation dedicated to a challenging astronomy mission. So the first 3 members of the constellation are already in orbit. So, the constellation will be completed this year, and we are happy to say that the scientific and mission requirements are fully met and this demonstrates that a demanding scientific and technological mission can be carried out with a very small space craft. So we are in a transition period where the small space craft are leaving the typical educational field and, well, some years ago, many people thought: these are nice toys for universities — for education — but now space agencies: NASA, ESA, JAXA, they are using these small space crafts for in-orbit demonstration and validation of new technology and procedures before they get on larger mission. So, and also, the BRITE mission was an important stimulus for implementation of the Austrian Space Law. But since the number of small satellite missions is sharply rising, following the procedures is very important to ensure safe and interference-free operations. And, so to say, I hope I was able to give you an example that BRITE could bring the space craft smoothly into use and we are looking forward for the scientific results in Toronto, at the AIC. We hope to be able to deliver already the first scientific results of observations and with this — and that goes from all institutions involved in the BRITE mission — I would like to thank you for your attention.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you very much Otto for completing the picture. I hope that you have all enjoyed the excellent presentations and I want to thank them on behalf of ECSL and IISL, also for keeping to their time indications, because finishing at 5:30 means that we will have some time for discussions. So I would like to invite questions from the floor to any of the panellists and I see Professor Gabrynowicz in the back.

**Other** (IAASS) Thank you. It was a very enjoyable panel. Thank you. I have a question for Monsieur Bonnal. You mentioned the 25 year rule. I was wondering if you have a sense of how often that rule is actually applied to a space craft because even under United States law, the only entity upon whom the 25 rule is binding is NASA. Is not binding on any other agency. It is only voluntary and even then, there are waivers to the application of that. So, I am trying to get a sense of how often they choose, or is it more often not used.

**Mr. C. Bonnal** (Inter-Agency Space Debris Coordination Committee) You are completely right about the binding effect. There is no binding effect except for NASA and we have been discussing this with the FAA and with FCC and so, so it is a best practices and they try to apply it as often as possible. Unfortunately that is not very often that is applied. Meaning that typically for a missions which are below 650 km circular altitude, it is naturally respected. It is naturally fulfilled. For other ones, usually it is just left and with the exception of NASA, which does it its best effort every time to comply with the 25 year. I am not capable right now just to make a kind of exhaustive review, but for instance, I was told that even space X, the famous space X, will be using the excess propellant to try to comply with the 25 year rule. So, I am an optimistic guy, I think that everyone has a 25 year rule in mind. They know that it is not binding, so they will

try to apply it as often as possible but today it is improvable.

**Other** (IAASS) Thank you.

**Other** (Belgium) Thank you very much Tanya. Thank you very much for this very interesting dose ... very interesting presentations. I would like to come back to Phillipe Achilles said on the non-manoeuvrable space objects, which is, I would say a very familiar characteristic of cubeSat and small satellites. I was not aware that colleagues from the Netherlands were facing the same issue, but actually the question of non-manoeuvrable satellites, once positioned into orbit, was at the origin of the revision of the Belgian space law which took its effect in January this year. I just wanted to make sure that we understand the same thing ... that this argument was not say that small sats, let's say what we call passive satellites, which cannot be manoeuvred once in orbit, should not be subject to space law. It was just to say that according to article 6 of the Outer Space Treaty, there is actually no activities once they have been positioned and if there is no activity then there is nothing to supervise. Of course there is one activity at the origin, which is the position by the launcher — once the launcher positions it right — this is a human activity and that is what we try to avoid with the revision of the Belgian space law is that, given the fact that it is the long service provider who in charge of the positioning, we have a situation where the launcher's provider is actually becoming the operator of the satellite because he is at the origin of the only manoeuvre that you can perform with that satellite — after that, it will be the law of nature revolving around the Earth. And what we said with the new Belgian space law was to say that we consider, as a legal abstraction, as a presumption that it is actually he who orders the launch and the positioning that becomes the operator of the satellite. I don't know if it is clear enough, but it is just to avoid that the launcher's provider the operator, just because he is performing — technically performing — the positioning of the satellite. It should be actually he who procures the launch, according the Liability Convention, he who procures the launch that becomes the operator of the satellite and then becomes subject to article 6 of the Outer Space Treaty. But, it was exactly to avoid a situation where non-manoeuvrable satellite would be launched without anybody caring for what happened once they are in orbit.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Clarification. I believe Christophe.

**Mr. C. Bonnal** (Inter-Agency Space Debris Coordination Committee) Just one minute to say that I am changing my hat. Now I am the launcher guy and when we launch a cubeSat with a very nice peapod. The peapod here is part of the payload and the peapod or whatever adapter, that you have the springs and so on, […] made in terms of the last metre per second is done by the payload not by the launch operator. So, as launch operator, in no case is the one who has placed finally the cubeSat in its at morph situation, if you want. It is the satellite, which has tuned, […] own strings could be operable. Thanks.

**Mr. P. Achilleas** (University of Paris XI Sud) Thank you for your clarification, Jean François, so as you confirmed it, more and more now space legislations try to be clear on the point that there must be an authorization for cubeSat, even by amending the first […] of some legislations.

**Other** (Luxembourg) Thank you very much for this extremely interesting workshop. I have a question to Yvon Henri. You have convinced me about the necessity to register the cubeSats by the ITU. I have a provocative question. According to the radio regulation, the satellite has to be registered at least two years before being deployed. But to my mind, the cubeSats are very frequently developed much more faster and they can be deployed in several months. So, are you thinking about changing or modifying the radio regulation rules specifically for the cubeSats? Thank you.

**Mr. Y. Henri** (International Telecommunication Union) Thank you for the question and thank you Mahulena. Well, at least one person is convinced but I was sure that there are more persons because the most convincing presentation was done by Otto, I think., which in fact showed at the end of the day I wouldn't have had the need to make any presentations to a certain extent. Regarding ... it is true that at some stage the regulations have been thought in terms of big GSO systems or big non-GSO systems, something that ... and it is true for which there was a need for a little more time. What is sure is that in fact the regulations said whenever you want to use some frequencies, and it could be a cubeSat, you have to API ... you have to send some information, which is Advanced Publication Informations, the thing is that this could be done up to 7 years in advance. However, the 7 years is a maximum. It is true also that the regulations said that for such system, like cubeSat, for which there is no formal coordinations, and I won't go into the details, in a way you may notify and record your system 6 months after the publication of the API. So, to a certain extent, it means that roughly it takes roughly 2 to 3 months maximum for us to publish the information, so 6 months, plus 2 or 3, which means that 9 months, in a way, the minimum time, could be up to 9 months to 1 year before you bring in to use your system. So, I

would say that the regulation takes account of these types of issues, but having said that, I think that that is the reason why there were these agenda items for WRC 18 and there is also some questions in some […] groups dealing with those issues where in fact the question is: OK, there is a regulation that exists today for satellites. This regulation is mainly for bigger satellites. If you that at some stage this regulation or the trust of this regulation is OK, however does not match really to the real necessity of cubeSat, and I think that certainly some experience by Otto regarding all of those rules, could come to say it is maybe too cumbersome to go into that direction or no. Then, please come to those group, discuss it and maybe that the regulation will need to be modified for small sat or cubeSat in order to better respond to those type of satellites. As was said by Christophe at some stage, well, ages ago ... 8 or 10 years ago, well ... small sat ... well, cubeSat was not existing in search as a terminology and a small sat was roughly 50 kg or more. So, it is true that now, with those cubeSat and the stump sat — I will call it stump sat, maybe — but it is true that maybe the regulation doesn't need to be chanced at the trust of the regulation but certainly, whatever has to apply, or whatever information has to be provided, need to be simplified to a certain extent. And, I would say, all of you would be more than welcome to work on this evolution of the regulations.

Directly to respond to Mahuela in the good order, just to say, that in a way, my feeling is that even if it's a cubeSat it means that, my feeling is that whatever project will certainly last a little more than one year. And so the regulations, in a way — even if it's ... when I say a one year project — if you decide on the project and you decide to bring into use your cubeSat within one year, the regulations as at the ITU could respond to this timing. Thank you.

**Other** (Mexico, interpretation from Spanish) I would like to thank all the panellists for the excellent symposium. I have a question. I have quite a few doubts more than I can imagine and quite a bit in a way of additional concern. I always thought that lawyers are quite creative and ingenious and nobody was going to get ahead of us, but today, at least in my country, I am realizing that an engineer takes a can of Coca cola, put something in it and launch it. So where is the regulation here? My question is: is there any aeronautics permit but the answer might be that it won't go beyond the 19 km because then it would be aviation. It is an object that is launched into space and as such is subject to registration and as such, as Mr. Yvon Henri said, also has to be subjected to the radio communications (ITU) regulations. Is quite a reason for concern here, probably in the radio communications conference in 2018 there will be some form of regulation because there will be interference, there could be cause of more space debris — that too is reality — so, if it is to be regulated, that might be nationally, but there still is that obligation to register in accordance with the registration of objects launched into space and with the radio communications regulation now, I would see them getting around that and just go through registration as any other satellite. We are not talking about a geostationary satellite where it is more complicated, I am not talking about a medium satellite, I am talking about low-orbit satellites that generate space debris that are not subject to any regulation, practically. There might be a national regulation that requires a permit but with the international community, it is the same the State that has obligation. So I am feeling too concerned because there is an excess of space debris. We don't have ideas out as to reduce it but this proliferation […] is just incredible how engineers have that tremendous capability of feeling space with satellites and I think we have quite a bit of work ahead. I don't know what we can do in the ITU 2018 conference on radio communications. We weren't successful last time. But if I were asked today if they are subject to the regulations of the five treaties and the ITU, that would be my question.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Who would like to take the question?

**Mr. Y. Henri** (International Telecommunication Union) I might try. Thanks. Well, I think in a way, if we listen whatever has been said today, you should not have so much concern to a certain extend regarding the developments of small sats and cubeSats. It is true that today, engineers can do a lot and — fortunately they can do a lot — and develop a lot of those techniques and capabilities for the development of the services are still to be invented and many of those — and many of those — services will be offered through those small sats. I like you comparison with Coca cola ... well, I have to be ... I could say Coca cola, Pepsi cola or Breizh cola ... what I am coming Brittany and in my region there is Breizh cola — whatever, hopefully, those cans will be emptied from the original liquid and full with […] and scientific equipment, but I think what I have been demonstrated today is that firstly: on the technical, for the technical part, there are things that are going on and fortunately a lot of things, then regarding the regulatory part and the space law part, there are people looking at that very carefully. And what I have heard today is that everything exists in order to respond to this challenge of the small sat and cubeSat, on the debris part, also on the frequency use and on interference risk. So, everything exists. What is said is that everything exists but might be looked again to

better fit to those new types of satellites — to cubeSats which in fact, we had not foreseen 10 or 15 years, when the […] regulations or even 20 or 30 years ago […] space law we are following now, were invented. And so, I think I won't be so pessimistic. However, on the other hand I will say, well, it is time to talk about it, to work on it and on one which are the frequencies and protection of frequencies, and I will just talk of this one as ITU responsibility, it is true that there WCR 15 and WCR 18, those conference that could make the regulation evolve, then one more time, I will invite all of you, Mexico included, to work on that in order to ensure that those regulations really fit those new developments in pico- and nanosatellites.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you Yvon. I have three more questions on my list. Professor Monserrat, representative from Slovakia and Professor Marboe. And I will give the floor to Abe Bonnema to give a quick reaction to this question. I would like to ask everyone to please be very brief in your questions as well as in your answers because afterwards we have to conclude the symposium, so Abe, you first.

**Mr. Abe Bonnema** (Innovative Solutions In Space) I will be brief. I want to take the opportunity and thank you for the question but also give a note that we need to be aware of the fact that the people who are developing these new satellites are not the traditional players and that one of the big issues is that people in countries that have never launched a satellite before are not aware of all these regulations and do not know where to attend to. In other words, your colleagues in those countries may not be known to the people who actually need to get to a licence or to go to a registration office. We often experience from dealing with newcomers to the field that we need to guide them to the actual ministry that they need to go or the actual agency. And I see it as big challenge for you as well and for all of us to try and find a way that we can create that awareness because most of it is not unwillingness of people to comply with the regulations, but they are simply not aware of them and do not know where to attend to actually file for the application. So, that's — I think — one of the big challenges that we need to try and overcome.

**Other** (Brazil, interpretation from Spanish) I would like to congratulate all participants at this seminar. It has been very rich and very topical and it is very stimulating to further studying this area, which is very much a topical one. After hearing various presentations, I would say that we need an international document. One with explanations and clarifications. The movement towards the production of smaller and smaller satellites is a fact ... it's a growing situation. There are countries that now have an opportunity to get into the space them and these are countries that are more interested in small, cheaper satellites, which create jobs and open up prospects for space activities for countries that normally wouldn't be approaching these activities. So, one form of international cooperation today should be a document to be created to clarify and to stimulate rational participation — rational participation — in these activities, so that it isn't disorganized and chaotic as it could be seen as today.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Thank you. I believe we will take that as a remark. It is not a specific question to anyone. I assume this is more like a suggestion for future work.

**Other** (Brazil, interpretation from Spanish) I would like hear your impression on the idea of an international document, one that could be outreach to our country.

**Mr. P. Achilleas** (University of Paris XI Sud) Just in a few words, maybe a document or a policy paper, could serve as guideline for — I mean, when I say a non-binding documents — just a few guidelines, for universities and companies that are developing such projects.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) Perhaps this is topic this committee could take up in the future some time. I would like to go to the representative of Slovakia. I believe you had a question.

**Other** (Slovakia) Thank you very much Mrs. Chairperson for the opportunity to giving the floor. Thank you also very much for our presenters for excellent information provided to delegations. I would like to follow one of the remarks of Professor Koudelka, which mention that the small satellite activities are very important stimulus for creation of the national policies framework. I would like to ask, maybe Professor Achilleas if the practice shows that many countries are using small satellite activity as the first national space programmes. Is there ... can be then a clear question or answer on the question that the national space legislation or internal regulation should be or shall be done in hand-to-hand during the preparation of sort of final launch of the first national satellites in terms of, for example, many States have ratified the space treaties but they still did not implement the most important part of the space treaties into their national law, so they don't know, for example, they don't know, in the international law, what does it mean space object. What does it mean liability for space activities. So, if there can be a clear

question for the new spacefaring States, they should or shall hand-to-hand with these activities, creates — starts to create the national legislation. Thank you very much.

**Mr. P. Achilleas** (University of Paris XI Sud) Thank you for your question. I believe that as soon as such projects are developed by private entities, then the issue of authorization is a real obligation for States and therefore there might be a certain procedure to authorize and supervise such activities. In the case of development by public entities, you might consider that the State, in fact, is authorizing itself, so the issue of space law with the complete procedural licensing is not that important. However, there must be a procedure for registration, at least, of space objects, both at the national level and at the United Nations level.

**Ms. T. Masson-Zwaan** (President, International Institute of Space Law) I am told by the Chairman of the committee that we urgently have to end, so Professor Marboe, I hope that you will accept that you will ask your question at the symposium next Saturday or during the drinks and that I have to, unfortunately, cut off the questions. Professor Marchisio.

**Mr. S. Marchisio** (President, European Centre for Space Law) Yes, before giving the floor to the chair of the Legal Subcommittee, Kai-Uwe Schrogl, for his concluding remarks, I would like to thank very much all the speakers and the audience, the two institutions that organized that together with COPUOS these meeting: the International Institute for Space Law and the European Centre for Space Law and I would also extend our gratitude to Corinne Jorgenson, executive secretary of the IISL, to P.J. Blount, assistant executive secretary of IISL, to Edmond Boulle, executive secretary of the ECSL and to Joanne Gabrynowicz, board of directors of IISL. You have the floor, chair.

**Mr. K. Schrogl** (Chairman) Thank you very and I think, on behalf of all of the delegations and observers, I can congratulate IISL and ECSL for organizing this seminar — this workshop. Also for selecting this topic, which is extremely timely and indeed topical and for putting together a panel which has been covering, in such a broad way, all the relevant issues which are related to the issue at hand: the very small satellites. Now, I think there two main messages from this symposium: the first one is that small satellites, very small satellites are more and more important for taking up issues and tasks of space activities. They are also more and more important for a growing number of States and this is something which is also very much welcome — that more and more States can participate in space activities, including developing country — and this is, I think — a very important message. The second message related to the activities of this subcommittee is that there are regulations in place. We have to apply them and comply with them. And you have heard the thematic presentations on authorization and registration, on frequency management and on space debris mitigation and this is the second message: they are in place and they have to be considered and they have to be complied with. And I think one of the important elements in addition to that is that they do not simply have to be applied and complied with because they are there but because it is for the benefit for the benefit all space actors. Those who are conducting their respective activity because they are also then safeguarded through this and for the other actors. And this is, I think, also a very important message which has been brought about during this symposium. So, thank you very much again. The two organizations having organized the symposium and all the speakers and I think we could join in a round of applause for all involved. Thank you very much. And now I think we can turn to the pleasant part of it ... maybe you announce? ... I can announce the reception, which is done by ... given by IISL and ECSL — will take place right outside the conference room in the cafeteria section.

*The meeting is closed.*