ПЕТЕРБУРГСКИЙ МЕЖДУНАРОДНЫЙ ЭКОНОМИЧЕСКИЙ ФОРУМ

22—24 мая 2014

Панельная сессия

«КОСМИЧЕСКАЯ ГОНКА»: НОВЫЕ ГЛОБАЛЬНЫЕ ИГРОКИ

22 мая 2014 — 16:00—17:15, Павильон 5, Конференц-зал 53

Санкт-Петербург, Россия

2014

Модератор:

Джо Паппалардо, Старший редактор новостей, Popular Mechanics

Выступающие:

Жан Лоик Галл, Президент и главный исполнительный директор, Thales Alenia Space

Игорь Комаров, Генеральный директор, Объединенная ракетно-космическая корпорация

Виталий Лопота, Президент, Ракетно-космическая корпорация «Энергия» им. С.П. Королёва

Д-р Сусмита Моханти, Сооснователь, главный исполнительный директор, Earth2Orbit

Сергей Недорослев, Сопредседатель, Общероссийская общественная организация «Деловая Россия»; председатель совета директоров, КАСКОЛ

Франсуа Ок, Исполнительный вице-президент подразделения обороны и космоса, Airbus Group

Олег Остапенко, Руководитель, Федеральное космическое агентство

Участник дискуссии:

Алексей Беляков, Вице-президент, исполнительный директор кластера космических технологий и телекоммуникаций, Фонд «Сколково»

J. Pappalardo:

Thank you all very much for coming to our panel on competition in spaceflight. We have a very distinguished panel and I would like to give them as much time as possible to answer our questions. I was going to start the session by asking each of the panellists to introduce themselves, talk a little about their company and their role in the company. Then we will begin our conversation about what has been called 'the new space race' by some – the competition in the spaceflight industry to launch both satellites and human beings into space, lower earth orbit, and orbit, and possibly even beyond.

I myself am an editor at Popular Mechanics magazine in the United States. I have being covering spaceflight for a little over 15 years now. It is a fascinating topic. Enemies become friends and allies become competitors, and sometimes that changes week to week.

We will hear a little bit today about the trends that are changing spaceflight and how the people on stage here today are dealing with those changes. They are the brave souls who are getting human beings, and hardware, off the planet, as space technology and space hardware become increasingly important in our lives. So it is a very pressing topic.

We will go from right to the left. Sergey, if you could introduce yourself, we will get started.

С. Савельев:

Добрый день, уважаемые дамы и господа! Меня зовут Сергей Савельев, я являюсь заместителем руководителя Федерального космического агентства, отвечаю за международную деятельность.

Как известно, агентство — это федеральный орган исполнительной власти, который отвечает за разработку, подготовку и обеспечение реализации государственной космической политики в России, являясь при этом госзаказчиком, а также координирует международную деятельность

ракетно-космической отрасли нашей страны. Именно государство, в соответствии с международным законодательством по космическому праву, несет всю полноту ответственности за результаты национальной космической деятельности. Спасибо.

F. Auque:

I am Francois Auque, Executive Vice-President of the Defence and Space Division, Airbus Group. We were formerly called Astria, for the space part. The Airbus space programme has a turnover of EUR 6 billion. We are the second largest global space company, and by far the largest in Europe. We are French, German, British, Spanish, and Dutch. We are involved in space transportation, such as the Ariane launcher. We run joint ventures with Soyuz. We are in charge of the French ballistic missile systems, and we are in charge of a big part of the European contribution to the space station.

We are a global leader in all types of satellites. We are also a global leader in space services. We own and operate military communication satellites, and we also own and operate earth observation satellites. So altogether, we have quite a consistent business. I am pleased to be here with you today.

Dr. S. Mohanty:

Good afternoon, everyone. My name is Susmita Mohanty. I have been in the aerospace industry for over 16 years now. I started my career with NASA Johnson in Houston. I worked for Boeing in Southern California for the International Space Station programme for about two and a half years. In 2000, I decided to become an aerospace entrepreneur.

I started my first company in San Francisco, which was a small consulting firm called MoonFront. We ran it for seven years. I then started my second company in Vienna in Austria. It is called Liquifer and it will be ten years old this year. The Vienna company primarily works on designing exploration systems, both for

human exploration and robotic exploration. This company bids for contracts, and works on contracts funded by the European Space Agency and the European Union.

I moved back to India in 2008, where I launched my third venture, which is called Earth2Orbit. India, as some of you in the room might know, has a very accomplished space programme. It started in the late 1960s, and now India finds itself on the crossroads. We build our own satellites and we launch some of them. What next for a nation of 1.25 billion? Planetary exploration is the obvious answer.

In some ways, among the panellists here, I belong to what I would call the new space generation. Each of my companies was co-founded with people roughly my age, and all of these companies were bootstrapped by founder capital; we slowly improvised and grew.

For Earth2Orbit, our primary focus is to try and commercialize some of India's space assets, including trying to bring new international customers to launch on the PSLV rocket. We are trying to commercialize some of the imagery from India's fleet of remote sensing satellites, since we have a pretty good fleet of such satellites. We are targeting the Japanese market and the US market.

Earth2Orbit is putting together a consortium of new space companies in India, to try and build our first private constellation of LEO [low earth orbit] satellites.

I will now hand over the floor to the next panellist. Thank you.

И. Комаров:

Добрый день! Меня зовут Игорь Комаров, я генеральный директор Объединенной ракетно-космической корпорации.

Корпорация создана указом Президента Российской Федерации 2 декабря и должна объединить около 70 предприятий ракетно-космической промышленности, производителей космической техники. В марте компания была зарегистрирована, сформированы ее исполнительные органы. К

сентябрю следует оценить акции акционерных обществ, которые войдут в структуру Объединенной ракетно-космической корпорации, и ко второй половине 2015 года должны быть акционированы и войти в корпорацию федеральные государственные унитарные предприятия.

Главная задача корпорации — реформирование нашей ракетно-космической промышленности. Необходимость реформ выражается в новых тенденциях, развивающихся в производстве космической техники. Все задачи в совокупности, на мой взгляд, делятся на два типа: срочные, которые касаются финансового оздоровления и создания систем качества в соответствии с лучшими мировыми образцами, и долгосрочные, требующие системных преобразований. Это касается реформирования производственных мощностей, унификации продуктов, технологий, улучшения работы с проектами структуры, подготовки специалистов в отрасли. Задачи серьезные, масштабные, но вместе с предприятиями отрасли, я уверен, мы их решим. Спасибо.

J.L. Galle:

Hello, everyone. I am Jean-Loïc Galle, and the Chair and CEO of Thales Alenia Space, a joint venture between two large defence and aerospace companies, Thales and Finmeccanica.

We have a turnover of EUR 2.2 billion and are the European leader in satellite manufacturing. We deal with all kinds of satellites – telecommunication but also observation, meteorology and scientific satellites. Currently we also produce more than 50% of the infrastructure of the International Space Station.

I am very happy to be here today in St. Petersburg at this economic forum, because cooperation between Thales Aerospace and Russia has always been at the heart of the strategy of my company. In fact, this partnership began more than 30 years ago. We built a satellite called C-Sat in the 1990s with ISS of Russia for a Thales customer. Since then, we have participated with the Russian

space industry, the ISS, and also with other companies such as Lavochkin, Gazprom, and Energia. We have participated in the production of 35 Russian satellites. The bulk of them for Russian needs, for RSCC and for Gazprom, but also some for export. We are very happy to have exported some satellites jointly with the Russian industry, to Kazakhstan, Indonesia, Israel, and many other countries.

This partnership, with the Russian industry expanded, last year with the creation of a joint company on Russian soil, in Krasnoyarsk in February 2013. It had the blessings of the Presidents of Russia and France, Mr. Putin and Mr. Hollande, respectively. I can tell you, whatever the current situation is, cooperation with Russia will remain extremely strategic for my company, and we will strive to expand it in the coming years.

С. Недорослев:

Добрый день. Меня зовут Сергей Недорослев, я основатель и президент компании КАСКОЛ. Более 15 лет мы инвестировали в космические отрасли России и были акционерами крупных предприятий авиакосмического комплекса: РКК «Энергия» и двух моторостроительных предприятий — «Кузнецова» (бывшего «Моторостроителя») и «НПО Энергомаш». Работая в советах директоров этих предприятий, я получил определенный опыт и в последние два года работал в качестве эксперта в Экспертном совете при Правительстве Российской Федерации, возглавлял группу по реформе системы управления космической деятельностью.

Двенадцать лет назад в соответствии с договоренностями, достигнутыми на встрече президентов Путина и Миттерана, мы совместно с компанией Airbus создали инженерный центр, который работает и сегодня, и президент Франции господин Олланд посещал его в прошлом году. Сегодня это уже не стартап, а достаточно развитая структура. Мы также инвестируем в небольшие стартапы, связанные с космической промышленностью.

В. Лопота:

Добрый день. Виталий Лопота, президент Ракетно-космической корпорации «Энергия» имени Сергея Павловича Королева, генеральный конструктор пилотируемых программ нашей страны. О корпорации, наверное, не нужно много говорить. Это и первый спутник, и первый человек в космосе, и, по сути, вся практическая космонавтика.

РКК «Энергия» — один из крупнейших интеграторов космических проектов. Международная космическая станция в основном построена на идеологии российской космонавтики, это идеология одной из крупнейших кооперации по дальнему космосу. Вся кооперация по обсуждаемым в последние пять лет проектам освоения дальнего космоса пилотируемыми программами — с Lockheed, Astrium, Airbus Defence and Space, Boeing, Mitsubishi — основана на идеологии «Энергии». Идеология, которую мы обсуждали три года назад здесь же, на панельной дискуссии, вместе с Джо, постоянно развивается, но особых изменений не претерпела. По сути, это всё амбиции человечества, какие оно может проявить в дальнем космосе. Спасибо.

J. Pappalardo:

Thank you all very much. You can see that I could probably spend an hour and 15 minutes talking to each individual person, so I will try to get everyone involved in the conversation. As you notice on the panel, there has been a lot of international cooperation in space. It is such a daunting task, such an enormous endeavour that it lends itself to that. However, there are pressures that are put on it, both economic and political. Right now is one of those times that international tensions are such that this cooperation is at risk.

I could pretty much ask anyone here on the panel, but I think I will start with Jean-Loïc. You have been involved in a lot of international cooperative endeavours. Is there any advice that you can give in terms of what might be lost

if that international cooperation is lost, if there is a retreat within Europe and in the United States? And what are some of the clear advantages of sticking together, and keeping this as an endeavour that many nations can cooperate on, given the current economic and political environment?

J.L. Galle:

In answer to your question, obviously I am not a politician. I work in industry, and I do not want to give a political answer to this. I am sure that space activities, the space business, and space cooperation are above short-term political crises that can arise around the world. If we can go back to the past then you may remember that even during the Cold War, the US and Russia continued to cooperate, and I think that this was a very good decision at that time.

I am completely convinced that, because space is related to mankind's activities and is above local interests, in a lot of fields, including space exploration, obviously, we have to overcome those short-term political difficulties, and different nations should maintain space cooperation.

I am convinced that the big space nations – the US, Europe, China, Russia and also Japan and India – should continue to cooperate. As an industrial leader I will encourage European and French politicians to continue cooperating with other nations, including Russia.

J. Pappalardo:

There is a lesson in an engine called the RD-180, which is a fantastic engine made in Russia. It powers the United States' rockets and has become a political football on both sides. The Americans say they were providing lots of money to Russia to launch their military satellites, while the Russians say the Americans are using the engines to launch military satellites that are perhaps used for watching Russia or its allies.

Sergey, I wanted to ask you a question. It is an uncomfortable topic, but how can you make a business plan, and how can you partner with someone, when all of a sudden the political situation can change so much that what was once regarded as a fantastic partnership becomes a political liability almost in a couple of months?

Is there anything you can do to speak to that, as an operating environment, as a condition of your business?

С. Недорослев:

Мой коллега сказал замечательные слова: мы меньше политики и больше связаны с производством. А я вообще был акционером этой компании, единственным частным акционером. Я помню, как начиналось сотрудничество — еще до того, как я стал акционером, в 90-е годы. Тогда был реализован ряд очень интересных технических проектов. Например, «Морской старт», задуманный академиком Семеновым и реализованный четырьмя странами: Украиной, Россией, Америкой и Норвегией. Проект делался в РКК «Энергия» совместно с Boeing.

Такие проекты принадлежат не политикам, а человечеству. Технический проект, будь то «Морской старт» или замечательный двигатель, это произведение искусства, красота и мощь. Я видел восхищение американских и российских специалистов и не думаю, что в тот момент, объединенные прежде всего техническим мышлением, они разбирались, кто из какой страны. Я, например, закончил физико-математическую школу, а потом физический факультет, аспирантуру и так далее, работал с совершенно разными людьми. Последнее, что нас интересовало, — кто откуда.

Проекты такого уровня я бы даже не назвал коммерческими, и мы сейчас не будем подсчитывать, кто понесет больший коммерческий урон от остановки

сотрудничества. Я убежден, что он будет настолько мультиплицирован, что прекращать сотрудничество — преступление перед человечеством.

Знаете, иногда проще посмотреть не на пять лет вперед, а на пятьдесят. Неужели вы думаете, что через пятьдесят или сто лет этот политический ландшафт сохранится: эти страны, их границы? Кто мог представить современное состояние Европы еще при великом Монне? Поэтому не надо слишком резко реагировать на сиюминутные политические вызовы. Как сказал другой великий, все проходит. А сотрудничество должно сохраняться: таково мое мнение как инвестора и как гражданина. Спасибо.

В. Лопота:

Спасибо. В период холодной войны именно мы придумывали уникальные проекты: «Союз — Аполлон», «Мир — Шаттл», Международная космическая станция, «Морской старт». Все проекты блестящие, великолепно реализованы. Я не знаю ни в одной стране мира инженеров космической отрасли, которые бы друг друга не понимали. Мы все в одной лодке. Освоение космоса — особенно дальнего космоса — международное дело. Здесь, мне кажется, политики могут у нас поучиться.

Это действительно уникальное состояние. Мы не спорим, кто главный, когда у нас возникают внештатные ситуации. Мы делаем общее дело. Мы создаем дружественные интерфейсы. Например, за последние несколько лет мы сделали великолепный проект посещаемой орбитальной базы вокруг точки Лагранжа L-2 за Луной для освоения Луны через эту орбиту. Ракеты с грузоподъемностью более 75 тонн в ближайшие десять лет у нас не будет, а с ракетой меньшей грузоподъемности мы можем освоить только орбиты вокруг точки Лагранжа и с них работать автоматами по любым орбитам Луны.

После челябинской катастрофы мы начали обсуждать интереснейшие проекты, связанные с метеоритно-астероидной опасностью. Чтобы отразить

опасность, у наших ракет, у наших, так сказать, полезных нагрузок должны быть такие дружественные интерфейсы, чтобы мы в кратчайшие сроки сделали единую ракетно-космическую систему и обеспечили безопасность в космосе и из космоса. В этом плане космос и космическая деятельность — межнациональная идея, являющаяся драйвером всех технологий, которые потом будут широко использоваться на Земле.

J. Pappalardo:

There is a lot of room for cooperation, not just in asteroid defence but in space junk mitigation and tracking. There are certainly a lot of opportunities if people are willing to collaborate on them.

I wanted to ask Francois the following. In your view, what are some of the new trends that are emerging in satellites, and human spaceflight, that you have to consider while you are moving forward in planning? From your perspective, what are some of the biggest and most disruptive things that are happening and how are you preparing for them, in terms of hardware and the development of technology?

F. Auque:

That is a very big question, of course. First, I think that the paradigms in economics are changing a little bit. As we said previously, space was initially a completely government-funded and government-led activity, with a very strong political content. I believe this political content will remain.

I do not want to repeat what has been said already, about the strength of space as a cooperation tool. If you look, for instance, at what has been happening in Europe. In some ways, one of the key drivers of the unification of Europe has been space and aeronautics. This is something which is very important.

Progressively, the paradigm is moving towards space being taken over by industry, and by private corporations. We should not be misled by this.

Government funding is still dominant, but if we look at what has been happening, governments are giving increasing responsibility to industry.

I will give you one example. For me, a good example is SpaceX. Basically, the money is coming from NASA, but the responsibility to design the launcher and organize the industrial setup is being led by a private company; this is definitely a trend. You can imagine how my company and I are pushing for this trend in Europe. Giving more responsibility to industry is a clear trend.

The second trend is to capture more and more money from private investors. This is probably easier for the use of space assets, such as images and all the services derived from space assets, than the financing of those space assets.

Third, of course, is the trend towards the evolution of technology. We could spend a week on that. This includes miniaturization, blending of software, the introduction of biotechnologies. There clearly is a trend in technology.

J. Pappalardo:

So much is changing in the landscape, technology-wise, for example in small satellites: nanosats and CubeSats. Igor, in the consolidation, is this an opportunity for you to prepare the new company for this changing landscape? Is that part of the reforms? How are you dealing with that aspect of it, in the changing landscape? Are you involving smaller companies?

И. Комаров:

Чтобы успешно провести реформу и успешно развивать отрасль, необходимо учитывать те тренды, о которых говорили Вы и господин Ок. Действительно, появляются новые частные инвесторы. Серьезный акцент делается на повышении конкурентоспособности и эффективности работы отраслей, на стоимости предоставления услуг космической промышленности. Важный вклад внес SpaceX, который привлек всеобщее внимание к изменениям в космической промышленности с точки зрения

эффективности вложений капитала. По-другому стала восприниматься возможность участия частных инвесторов в развитии космической промышленности — очень технологоемкой и инвестиционноемкой промышленности с длительным циклом разработки.

На мой взгляд, гораздо больше перспектив в области малых спутников. Я не думаю, что этот тренд главный, но он очень серьезно повлияет на ландшафт отрасли. Компании, которые сейчас создаются в области малых спутников, станут серьезными конкурентами и мотивируют нас на повышение эффективности предоставления космических услуг. Есть хорошие, успешные примеры, в частности компания «Даурия», и я надеюсь, что они будут множиться. Безусловно, мы станем сотрудничать. Для нас важно не пропустить изменения, происходящие в отрасли, чтобы справиться с задачами, которые перед нами встают.

J. Pappalardo:

One of things that Earth2Orbit wants to do is take the Indian space industry – and I quote from your website – “out of isolation”. Please tell us a little bit about what that means. Given what we have been talking about here on the stage, how does that fit into the trends? You are almost like a sunflower seed falling onto disrupted soil. Maybe this is a good opportunity for a young company such as yours to emerge and thrive. How does the landscape look from where you are seated?

Dr. S. Mohanty:

When I said that the idea is to take the Indian space programme out of isolation, let me explain what I meant by that. The Indian space programme, which is hugely accomplished, began in the late sixties. After India became a republic, the space policy pivoted around the idea of technological independence. The idea

was for India to develop its own technologies, so that it could be self-reliant when it came to satellite manufacturing, rockets, and the like.

Now we have reached a stage where, if you look at the space-faring nations in the world, India is in the top six in terms of annual budget allocation, and also in terms of technological capabilities.

The questions facing India, moving forward, are: how do we create the right kind of business environment? How do we give the right kind of incentives to small and medium-sized enterprises, and big companies, building parts and subsystems for our rockets and our satellites? How to go out and compete internationally?

The international civilian space market has an annual worth of about USD 300 billion. India, as of today, has a small marketing arm called Antrix, which, in a good year, makes about USD 200 million.

If you look at USD 200 million versus a 300-billion-dollar industry, there is a huge gap. What I am trying to say here is that we, as a space startup, want to push for an overhaul of our economic policy, with which Indian industry can go out and compete and get a share of this international market. That is what I meant when I said that we would like to take India ‘out of isolation’ and become part of this international marketplace. Over to you, Joe.

J. Pappalardo:

Thanks. I think all the panellists agree that there is no nation or company that is going it alone, without partnerships. Where do you see the most fertile partnerships forming in the future, and how do you position yourself to keep up with shifting landscapes, be they political, economic or otherwise?

С. Савельев:

Прежде всего я бы хотел отметить, что еще Советский Союз начал сотрудничество с десятками зарубежных стран в области космической

деятельности, и Россия продолжает эту работу. У нас серьезные партнерские отношения с европейскими странами, с Европейским космическим агентством, с американскими партнерами. Сегодня уже упоминалось о Международной космической станции: это, наверное, самый масштабный международный проект в области космической деятельности. Россия ведет активный диалог с Китаем. Мы планируем активизировать сотрудничество с индийскими партнерами. Очень важным остается для нас взаимодействие со странами СНГ: Белоруссией, Казахстаном. Космодром Байконур принадлежит Казахстану, Россия арендует этот уникальный объект, и сотрудничество с Казахстаном — очень важный для нас аспект.

Здесь говорилось о том, что космос должен быть вне политики. Отчасти это так. Но надо признать, что у каждой страны есть свои национальные интересы, в том числе и в области использования космического пространства. У каждой страны есть своя стратегия, своя национальная программа. В одних странах эта отрасль более продвинута в технологическом плане, в других менее, но игроков становится все больше, это уже десятки стран.

Есть вопросы, общие для всех: сохранение безопасности космической среды, прекращение гонки вооружений в космосе. От решения этих вопросов зависит не только мирное сотрудничество в космическом пространстве, но и реализация национальных космических программ.

Россия открыта для партнерства со всеми странами. Известные санкционные мероприятия последних месяцев показывают, как мы взаимозависимы. Если из-за санкций финансовые показатели российских предприятий ухудшатся, они могут стать неспособными, например, выполнять международные обязательства по МКС. Но повторюсь: Роскосмос с оптимизмом смотрит в будущее и настроен сотрудничать со всеми потенциальными партнерами. Спасибо.

J. Pappalardo:

Thank you. One of the interesting things about even the name of this session is the term ‘the new space race’. What drives nations and companies to undertake something so audacious as to load up a rocket filled with explosive fuel and send it into space? It is inherently an act of hubris. It is an amazing miracle every time it happens.

I would like to put this question to the entire panel and ask, whether there is a new space race, and if so, what is it? Is it a quest for profits, in terms of launching satellites? Because people are now more bound to that technology, their cars have GPS, and then there is the military. That is only going to increase as the technology becomes more ubiquitous.

Or is it in human spaceflight? Is it national prestige? What is the race? Is there one? I would love for someone to volunteer, but if not I will volunteer you.

F. Auque:

Just to launch the debate, if I may. In my view there are two races. There is still clearly a race between nations, which can be cooperative, but it is still a race in critical technologies, technologies of sovereignty, or technologies which allow other industries to develop. It is a fact, that an increasing number of nations want to develop space activities on their soil. So, we must face it.

For a company such as mine, there can only be one conclusion: to develop links with those nations in order to do business with them.

There still is, and I hope there always will be, a good, legitimate race between nations, because space is strategic.

Secondly, there is a business race between companies. In my view, the business race today is a race to use space and to transform space assets into a business. Look at what is happening, for instance, with Google. It is absolutely fascinating how an exploration of all space tools is underway in terms of developing business.

That is why I am very positive about the space business. Space is going to enter even more into our daily lives through applications.

Dr. S. Mohanty:

I shall respond to this question in two ways. I often travel, and people ask me if I think there is a race between India and China. Here is the difference between the race that we saw in the sixties and the imaginary race, in some ways, that we see now.

This new race between nation states is not linear any more. It is not as if both are relaying and landing on the moon one after the other. India, right now, is headed to Mars, and China has just landed a rover on the moon. So the race between nation states is not linear anymore. It is a race, but of a different kind, a more complicated race, which is open to interpretation.

I spent 12 years in California working in the private sector, and I can tell you that there is a race on between venture capitalists (VC) as to who is going to put the money into the next small-sized company. A company in California, called Skybox Imaging, raised almost USD 100 million in three rounds of fundraising. There was a competition between well-known VC funds to put money into this company. What are they going to do? They are going to launch a commercial constellation of earth observation satellites, and there are rumours now that Google might even buy them out. So ‘the new space race’ has, in the private sector, seen a convergence of information technology, industry, data analytics, and space.

We are looking at the emergence of a hybrid industry that is following some of the trends Silicon Valley has seen over the years in its IT industry. There are two kinds of races here, and I think Francois also referred to both of those races.

J. Pappalardo:

It is good to be hybrid. There is something called ‘hybrid vigour’, where hybrids tend to survive, especially in destructive environments.

J.L. Galle:

I would like to complement the two previous answers. I think there also will be another kind of race, created from the technology and from the technological evolutions in the different fields of space research.

If we look at the situation today, with telecommunication satellites, for example, the picture is very monolithic. Probably 98% of satellite telecommunication today is provided by geostationary satellites.

With the evolution of technologies we will probably have different kinds of satellites competing for the same services. There will be constellations of satellites at lower altitude orbits in the telecommunications segment. My company is working on a concept which is a kind of hybrid between a balloon and a satellite that will fly at an altitude of 20 kilometres. There will be the emergence of very small satellites that will also operate as telecommunication satellites.

There will be a race between different technological solutions put on the market by different companies – big companies, startups and new companies – to provide the same service to the customer. Obviously, the competitiveness of the different technologies will be key.

I have used telecommunication satellites to illustrate, yet I could do the same analysis for ‘observation’ and for other segments of the satellite business.

We should also not forget that there is, and will continue to be, a race between space technologies and other technologies. Here I am thinking about optical fibres. We should not forget this, because if space technologies are not competitive, we could be facing a serious problem very quickly.

J. Pappalardo:

I would love to hear from our Russian panellists on their view on how the ‘space race’ will proceed.

И. Комаров:

Я согласен с тем, что космическую гонку можно рассматривать с двух сторон. Это соревнование с самими собой в освоении космического пространства, новых технологий, услуг и возможностей. Здесь главное — работать вместе, потому что задачи это наднациональные и стоят выше, чем бизнес или политические интересы отдельных государств.

Второй момент — это реальное соперничество, но, на мой взгляд, в ближайшее время, учитывая глобализацию технологий, знаний, исследований и экономик, оно также станет отчасти наднациональным.

С одной стороны, надо соответствовать ожиданиям своих государств, а с другой — не пропустить те тренды, которые наблюдаются в мире и связаны с появлением новых игроков и новых подходов к организации космической отрасли, новых бизнесов в области малых спутников, приборостроения и так далее.

Для России очень важно понимать, что одновременно должна происходить смена технологического уклада, поскольку именно в этом мы отстаем от наших партнеров. Такой мы видим одну из главных задач и всей отрасли, и Объединенной ракетно-космической корпорации. Спасибо.

J. Pappalardo:

I want to talk about human spaceflight now, because it is so inherently interesting. Right now, worldwide, there is more human-rated spacecraft being built, designed and tested than in any other time in human history. I wanted to ask the panel if they thought, in their inestimable wisdom, that spaceflight could ever become as routine as air travel. Is that at all possible?

Dr. S. Mohanty:

I think it is inevitable, Joe. It is only a matter of time. There are two things that are necessary.

First, the aviation authorities and the companies that are going to be offering commercial spaceflights to paying customers – BlueOrigin, Virgin, Sierra Nevada, Airbus, among others – and the space boards – the people who will be running the space boards – have to put their heads together and figure out what the rules of the game are, from a regulatory standpoint and from a safety standpoint.

The second aspect necessary for a move towards an opening up of the space frontiers for all of us, is that we as a species, all of us, need to invest more resources into developing reusable rockets, greener, cleaner propulsion technologies, and more advanced modes of transportation.

So, yes, I think it is inevitable, and it is just a matter of taking steps in the right direction.

F. Auque:

I am always a bit shy when it comes to speaking about humans in space in Russia, because honestly, if there is a place in the world where everything has been invented, in terms of humans in space, it is here, and I really want to pay tribute to this tremendous industry, these tremendous people.

In terms of humans in space, our company currently has several projects, and I want to mention them because I think they are meaningful.

We have a project called SpacePlane. It is a sub-orbital plane, set to go to the edge of the atmosphere. We have been working on this and have reached quite an advanced stage. The technologies are there, and I completely agree with what was said just now.

There is a lot of work to do regarding regulation, such as defining the authority in charge of those regulations, if we want to transform that into a business model.

There is also a lot to do in terms of operating costs. You might remember, when the shuttle was designed, the operating costs were supposed to be low, but in the end they were tremendously high. There is the huge challenge of cost.

At my company, we have a lot of space technologies and a lot of aeronautic technologies; we also have another project, which uses some of the space technologies to develop a new type of commercial plane.

How will we evolve? Will it be in terms of sub-orbital flights? Or new, hypersonic commercial flights? I do not know. What I do know is that we have to explore both of these options.

В. Лопота:

Дорогие друзья! О перспективах пилотируемых космических полетов можно рассуждать очень много. Я скажу вот о чем. На сегодняшний день имеется 925 заказов на суборбитальные полеты. Эти заказы делят четыре американские компании. Это полеты не более чем на 100 километров, по баллистике, которая, по крайней мере, замыкается на поверхность Земли.

Если говорить о полетах в глубокий космос или даже на орбиту, то было несколько туристов, мы начали этот бизнес. Но желающих немного. Слетать на орбиту на неделю (к Международной космической станции — примерно на две недели) стоит порядка 45-50 миллионов долларов. Полеты длительностью более одного месяца — для профессионалов, не у каждого человека хватит здоровья. В невесомости наша голова заставляет сердце обслуживать только верхнюю часть туловища, это большая проблема.

Перспективы есть, но давайте определимся с целями. В первую очередь это, наверное, колонизация. Есть опасность: Солнце превращается — отчасти уже превратилось — в желтого карлика. Астрофизики считают, что наше светило начнет расширяться в ближайшие миллионы лет. Расширение остановится где-то между Землей и Венерой, и человечество сможет продлить свою жизнь, только переместившись на Марс. Это один из

наиболее реалистичных прогнозов на сотни миллионов — миллиард лет. Но начинать-то надо сегодня.

Дальше Марса мы не улетим. Чтобы улететь дальше Марса и исследовать остальные звезды нашей галактики, нужны новые принципы движения. Реактивное движение, которое мы с вами используем, не годится. Мы сегодня даже не можем разобраться, как наше Солнце, наша планетная система двигается вокруг черной дыры в галактике Млечный Путь. Вы знаете, что мы летим со скоростью 240 километров в секунду? А один оборот, один галактический год, равен 250 миллионам лет.

Нам надо научиться летать на новых принципах движения. Джо очень правильно делает, когда задает в своем журнале самые фантастические вопросы, которые заставляют думать. Тематика пилотируемой космонавтики будет жить. Это платформа развития технологий, которые человечество будет использовать с целью обеспечения безопасности в космосе и из космоса; это поиск ресурсов, поиск направления в освоении космоса. Мы не можем создать роботов, которые заменят человека. Спасибо.

J. Pappalardo:

I am content to go to Mars, but we are discovering exoplanets that are very similar to Earth. So why stop there? If we are going to go, let’s go as a species. We almost have a biological mandate to follow: to spread and go to other places. I entirely agree that, if we stay on Earth, we are done for. That is a fact, so I am very appreciative of those comments.

People do not like to hear it but, although you can build a very big pyramid, it is not going to be there when the planet is gone. The only thing that will be left will be those things we put into space that are going really far, like Voyager and other deep space probes. That will be our only legacy, unless we can pull together to invent new technologies which will get us out.

Having said this, the first step would be to make spaceflight cheaper. Open it up to more people, open up the technologies to more people. Make the benefits of spaceflight so ingrained in our daily lives that it is worth the cost and effort, because none of this is easy. Everyone on this stage, including myself, who is not actually involved and only watches them do it, knows that it is exceptionally difficult. Anyone who is brave enough to jump into this as a field, as a business person or as an engineer, should be applauded.

You can tell by the way the panel is talking that these discussion are larger than just business, and larger than just politics. We tend to think in long-term trends.

There are panellists here who need to get on planes immediately. I would love to leave things on such a cosmic note; it seems unfair to talk about consolidations or budgets or anything like that now. However, in the short term, getting more people to access space, what is the best way of doing that? Is it through space tourism, which seems very narrow? Or is there another way to get people to engage in it? Because without the support of various populations around the world, none of these programmes, none of these thoughts will, literally, get off the ground.

I open that up to the panel, as a parting shot.

F. Auque:

Let me try and start. I believe the attraction of space is a mixture of a lot of things. Of course, there is the debate about exploration, about how to push the limits. There is the attraction of discovering more about our origins; we should not forget that, because that is, I think, very appealing to human beings.

But there is also a very important aspect of space, and that is: space is useful. It is dramatically useful. It is so useful that we forget that we use space tools in our daily lives.

I very much liked the proposal by Jean-Jacques Dordain, Director General of the European Space Agency, who said that, “the only way to measure the usefulness

of space would be to shut down all the satellites for 24 hours, and see what the results would be".

I believe that we need to properly measure how tremendously useful space tools are. The economic revolution which is ongoing, in my view, will dramatically increase the practical use of space tools.

J.L. Galle:

Another aspect that will probably increase interest in space is the fact that the planet's environmental issues, and the problem of pollution, will become increasingly crucial to us living on our planet, and to all nations.

We know that satellites, such as meteorological satellites monitoring the oceans and the land, will play a key role in helping key decision makers take the right decisions on environmental conditions and global pollution.

I am convinced that, in this regard, space will naturally play an increasingly important role.

Dr. S. Mohanty:

I come from a country where almost half of the population is under the age of 25. One of the challenges the Indian Space Agency was facing for many years, was how to attract talent to come and work on space projects; in competition with lucrative jobs in IT and banking.

The one thing that has captured the imagination of young people, in high schools and universities, is the new revolution being ushered in by CubeSats. On the one hand, you can think of a 10 centimetre square CubeSat as a toy. On the other hand, you can put together a small satellite in your lab, or in your garage, and it gives you this tremendous sense of empowerment and excitement.

I personally think that what the desktop did for computing many years ago, nanosatellites and small satellites are doing for the space industry. They are going to disrupt the space industry in ways that we could never have imagined.

Building little shoebox-sized satellites and pushing them off the space station and creating a constellation. A company, called Planet Labs, which operates out of San Francisco, has an office the size of a family home. The number of employees is probably, at this point, less than the number of satellites in orbit – the economics of building small satellites and applying them viably is changing rapidly. To me, the future of space, and engaging young people in space, has a lot to do with hands-on things such as nanosatellites.

J. Pappalardo:

It is a really good point that the more people interact with space in their daily lives, the greater the understanding will be of how important it is as an aspect of their reality. It will make it more tangible, even if they are not launching them. It may be, as GPS has done for driving, that you expand that to your own personal satellite constellation, or to wearable electronics. If it starts intersecting with other technological trends it really brings space to the fore.

I would like to extend my thanks to the panel. We are out of time. I am deeply appreciative of the time and the opportunity to speak with you all.

In closing, I would like to remind you that Earth is the cradle of life, but it is time that we grow up and get out of the cradle. I think that a wiser person than myself said that much better.

A round of applause, please. Thank you all so much for coming. It is greatly appreciated.