

**CENTER FOR  
STRATEGIC AND INTERNATIONAL STUDIES (CSIS)**

**TRANSFORMING INDIA'S SPACE PROGRAM**

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**MONDAY, JANUARY 28, 2008**

*Transcript by  
Federal News Service  
Washington, D.C.*

VINCENT G. SABATHIER: Okay, well, welcome to CSIS and welcome to this Global Space Agent event. It is a pleasure today to welcome this Indian delegation, led by Chairman Nair. And before I start I would like to thank Lorinda Cuomo (sp), space attaché of the embassy of India and a personal friend and a friend of many of us, yes, in D.C., for making this event possible. I would also like to take this opportunity to remind everyone that Rajib Lochen (sp), the former space attaché here in D.C. for India, passed away last year, last fall. And Rajib was also a very good friend of many of here and I would like to take this opportunity to pass my condolences to Hisru (ph) and his family.

I am glad to report that this is our biggest event so far, and clearly the transformation of the Indian space program is fascinating and we are all waiting to hear more about it. But also, I'm noticing more and more interest in the D.C. policy circles about the globalization of space and what it means for the U.S. I notice as well more and more focus and interest on international cooperation, and the results for that are many. First, there is a need to increase the political sustainability of our space program, civilian space program, especially when there is a need to share some of the burden in a constrained, rigid environment. And finally, last but not least, there is a need to exercise smart power for civil space. With that in mind, the bilateral relationship with India is going stronger everyday and there is no doubt in my mind that cooperation in space will play a very, very important role in this relationship.

It is for my pleasure to introduce as our first speaker Ambassador Schaffer, who will introduce Chairman Nair. Ambassador Schaffer is a director for the South Asia Program here at CSIS and she's an expert on India. She's currently working on a book on the U.S.-India relationship and I believe space will be part of this book. So without further ado, Ambassador Schaffer, the floor is yours.

TERESITA SCHAFFER: Thank you very much, Vincent, and it is a great pleasure to be here. Vincent started off by recognizing the passing of one of the space attachés at the Indian Embassy here and I would like to start out on a somewhat similar note. Those of you who follow U.S.-India relations, I think, know that Ambassador Bill Clark, who was U.S. ambassador in Delhi in the early 1990s and was very much of a personality on the U.S.-India scene thereafter, died suddenly last week and I wanted to acknowledge his great contribution and pass on condolences to his family.

As Vincent said, I am the India person at CSIS and I'm happy to be playing a modest role in this fantastic event put together by the space program here. But as I was saying to the chairman earlier, the fact that we are even having this event is really an excellent illustration of the revolution that's taken place in U.S.-India relations in the past 15 years.

When I was in the government, when I was in charge of South Asia policy in the State Department, space was basically taboo, as were a number of areas of advance technology cooperation. India had at that time as well a vibrant space program, but there were severe

restrictions on what the U.S. could do with it and basically anything involving getting stuff from Earth up was off-limits.

The fact that we are now talking about collaborating on scientific missions to the moon is one of the clearest indications of what has changed. And what I thought I would do, to provide kind of backdrop for what the chairman is going to talk about, is spend just a few minutes talking about where U.S.-India relations are now, where they've come from, and where they might be going.

In a nutshell, in the past 10, 15 years we have, as I said, undergone a revolution caused, I would say, by three things: One was the end of the Cold War, which it took both the Indian and the U.S. governments some time to adjust to. The second big impact was India's accelerated economic growth, which made India more interested in the economic dimension of its relations with the world and which made India also a much more attractive economic partner for other countries. And the third big factor was the growth, prosperity, and prominence of the Indian-American community.

Fifteen years after the Cold War officially ended, we have arrived at a point where the Indian and U.S. governments, I think, have put in place much of the bilateral infrastructure we need for a more serious partnership in today's world. Part of this bilateral infrastructure is in fact governmental and I'm talking about the emerging security relationship, this network of government-to-government committees and groups. If I were to recite all of the groups you would find it hideously bureaucratic and boring, but the important reality behind all of that is that you now have most of the senior bureaucrats, senior officials in Delhi and Washington either know each other or can navigate to find each other with relatively little trouble. That is a big change.

The other part of this bilateral infrastructure, of course, is the part that has very little to do with the government and that is the economic relationship, which is overwhelmingly private. Trade is up; investment is up. Trade, investment, and energy have become a major driver of India's foreign policy and have become important areas where India and the United States interact. When the two governments talk they're usually talking about policy, but they're talking against a background of interactions that happen with the government having very little to do with them.

What has not yet happened, and this is one of the things that I'm going to be writing about, is that I think India and the U.S. have not yet really looked seriously at the question of to what extent do we have a common view of the world? Now, this is a big subject and I won't take your time with it now, but I see that as one of the major tasks before both countries in the coming years. I think it will be a rather complicated enterprise. India, as you all know, is a country that is passionately attached to the idea of strategic autonomy in its foreign policy. The U.S. doesn't have any problem with that in principle, but in practice has had relatively few close relationships in which this strategic autonomy question was as important as it is for India. So, we are in a phase of getting used to one another and we are in a phase of starting to talk about a whole range of subjects that weren't really part of the dialogue before. The easiest example of a

subject that embodies a lot of common interests is Asian security and, more broadly, our perspective on East Asia.

These common interests I see as the real drivers of the India-U.S. partnership, but there are also areas where our interests diverge or where you have both common and conflicting interests. And the easiest example there, of course, is the Middle East and Iran, where you have a strong common interest in the security of the oil markets and a common interest in Iran's not developing nuclear weapons, but very different ideas of what to do about it and very different ideas of what Iran is likely to represent as a regional power in the coming years.

So I see that as the big task before India and the United States. But let me come back a bit to the subject of this morning, which is space. I mentioned already that the fact that cooperation is what we're talking about is a remarkable change. I think that space has the chance to be sort of the big engine of further transformation of the bilateral part of our relationship. And that's what I look forward to hearing from, from Chairman Nair. Now, I'm not going to give you a long biographical introduction of Chairman Nair; people usually take the occasion to sleep during those and I think you don't need a nap. What you need to do is hear from the chairman.

But let me say that he actually holds three positions: the chairman of the Indian Space Research Organization, the chairman of the space commission, and the secretary of the Department of Space. So this is Mr. Space – Dr. Space, I should say, on the Indian scene, a man who has spent a lot of time looking at both the present and the future of space exploration and what it could mean for India and the world. I had the great pleasure of working with a classmate of one of his predecessors during my posting in Delhi 30 years ago. My boss was a guy named Tom Vrebalovich (sp) and he had been in graduate school, I believe in Southern California, with Mr. Saddich Hoven (sp). So for me, this is in its own strange way, a home coming and I take great pleasure in presenting Dr. Madhavan Nair.

(Applause.)

G. MADHAVAN NAIR: Thank you, Ambassador Schaffer, for the nice words of introduction and I think that correlation with the second chairman, Prosa – (unintelligible) – and myself. Only one year – (unintelligible) – director in my name. We have some commonality in that but otherwise I think we are two different personalities altogether. He was – (inaudible) – but today he's not with us. But he was the person who really laid the foundation stone for the institution of space technology in the country. Of course – (unintelligible) – he was the originator – the father founder of the space or such in India. And then – (unintelligible) – was there, then later – (unintelligible) – and later Dr. Katsulagan (sp). And I'm happy that I'm able to carry on the flag from them and then carry on the mission.

Well, I think before that I get into formal discussion, I must acknowledge the sentiments expressed about my friend and colleague, Mr. Rajib. He has been a strong personality, not only as assigned secretary to me, but also he was a person instrumental for strengthened the India-U.S. relationship what it is today compared to the last five years. I think he was the main person behind it so it's good that all of you remember him. Thank you very much and I will convey your feelings to his family members.

Well, I think talking about space in this country is like carrying coal to the new castle and I don't know, really, what you're doing that. You know, when you have landed on the moon, we were just making pencil rockets. I was in the Thumba Equatorial Rocket Launching Station near – (unintelligible) – preparing one of those tiny rockets for launch and in the middle of night through Voice of America radio as only being so – (unintelligible) – in those days, the crackling sounds of Neil Armstrong and that's it. There's a gap between the U.S. space program and ours.

But yes, over the last 40 years, we have been working on the space program with a sort of focus and I'm happy to say that perhaps we have evolve the space program in such a way its highly need base, while harnessing the high technology of space, whether it is rockets or the satellites or the communication goes to that. But how to use this high technology impulse to benefit the common man and improve the quality of life of the people of the country? So that has been our driving force and perhaps I can confidently say that we shall not – (unintelligible) – which was coordinated the '60s. We have fulfilled.

Today, we are at a turning point; we are looking at what next. And perhaps that's – (unintelligible) – in the second regional space in India is just emerging and we believe that international cooperation, rather than the competition, is going to be the norm for the future. And I have been trying to take this idea with my colleagues in other space agencies. Mike Griffin is a great friend of mine and we have exchanged a lot of failures on this topic and then – (unintelligible) – from France and also Mr. Promono (sp) from Russia. We've all have exchanged notes on this subject. And finally I could see that there's a lot of commonality in thought process emerging and perhaps the space of such being such a very – (unintelligible) – and where, you know, there's a lot of opportunities.

At the same time, looking at the technical complexities, the challenges associated with that is going to be pretty expensive and demanding very highly on the human resource. So, with these factors under consideration, the cooperation emerging in the global scenario is going to be the norm for the future and I'm sure that's really going to succeed.

Well, let me quickly give you an overview of what we have been doing in the past in the space program in India. I'm happy to say that the U.S. has played a very major role in the interface of the Indian space program. The first rocket launch from India rocket launching station, it was a Nike-Apache rocket of the U.S. with the payload and instruments coming from Europe. And Indian and the European, as well as the U.S. scientists, working together on that mission. So that is a very unique example of international cooperation, the same as the way back in the '60s to be excited in '63.

Since then, we have been working with the U.S. in many ways. One of the societal experiments, which we have successfully implemented in the mid-'70s, this is called a sight-satellite instruction television experiment. A huge satellite India accept from the U.S. was brought over in the continent and over one year we have used this satellite for relaying the television instruction program to something like 2,000 religious in the central part of India.

As you know, India, even today, that electricity is very high. Those days, those very, very difficult situation, more than 50 percent of the people really know how to even read and write. But we will use this satellite in India for communicating to the – (unintelligible) – leaders, generating all the audio-visual programs, and leaving to – (unintelligible) – in a very effective manner, so they could be educated on better hygiene, healthcare, agricultural practices, the societal behavior and so on. And it turned out we are one of the best examples even today, in term so of societal application of space technology. This happened in the mid-'70s.

Then we had the first series of Indian satellite we cleared for communication inside one series, which were built here by – (unintelligible) – space and large use in the delta rockets. And even we were considering using the space shuttle for another – (unintelligible) – but unfortunately, there was a mishap and then we couldn't do that. So that was the beginning of our relationship and a very, very strong and a lot the technology, as were less the scientist exchange program, happened in those days.

But unfortunately, as ambassador – (unintelligible) – there was a phase in which when we have built up the competence to launch the satellites into orbit. There is absolutely was launched in 1980. For the first time, we entered the launched club. Then onwards, I think, there were maybe not the space community, but you know, because of the cutthroat regimes and the administrative procedures and legalities and so on, virtually many of the space institutions in the country came – (unintelligible) – so there was a very lull period, so to say.

But not withstanding that, we have been trying to see how we can establish contact at the scientist level and perhaps the last five years, the – (unintelligible) – have seen the – (unintelligible). And they're so pleased that we're going to create the Chandrayaan-1, the first mission to the moon. Two instruments from the U.S. that NASA has sponsored that and we are going to have a stand years instrument flying in the new satellite for a lunar observation mission so this I consider as landmark event.

Again, go back to India's program; we have – (unintelligible) – initially in developing the satellite technology for Earth observation as well as communication. Seeing that that can benefit the people. Earth observation satellites were built in the country and initially launched with Russian rockets and later our own rockets – (unintelligible) – and the India's most – (unintelligible) – satellites. The India most – (unintelligible) – satellites have started off with the resolution of initially very cold, so to say, about one kilometer. And today, we've got one meter resolution imaging capability interface and not only that, it has got a multi-spectral imaging capability. So with that, it has become a very powerful resource for the arrangement of the natural resources and it has become a day-to-day tool for the Indian planning commission, the villagers, and the agriculturists and the forest and so on.

So you can say to cite another examples, we have implemented what is a called a drinking water mission in India. As you know, about 30 to 40 percent of the country, the rain is there for hardly a week or so. After that, it completely dries up. So to target water in those regions is a tough job. Using the space images, we can get a global picture as to what's a kind of terrain is there and what's a kind of vegetation, which comes up in the region. And also, try to have some local samples of the topography and so on.

(Unintelligible) – synthesize in this data, we were able to credit the zone where, if you dig a while, you are 90 percent certain that water will be available. This experiment we started about 10 years back, but the last years, more than 200,000 wells were dug. The success rate in this is cutting very close to 90 percent. If you have not used the space technology, you could have hardly 30 percent. The sheer saving out of these number of wells itself, pays for the satellite and a profit was created from that. That's one example of how the space technology has been – (unintelligible).

Second, of course, you know that disaster management is really relief at war and in India, it's almost an annual feature. We have the heavy floods, which is taking place in the Brahmaputra Region or the cyclones, which hit the eastern coast, and of course, the earthquake cutoff on it in some regions. So in these such cases, of course, previously we have been using to assess the damage and how the mitigation measures can be initiated.

But now we have put into place a comprehensive system. (Unintelligible) – countries mapped and the disaster preparedness maps are generated and it is available to the administrators. And then, of course, this labor base is linked to the district authorities who implement that to program and in case of an event, he can access the database and use it for immediate action. And also, the space communication has come handy because almost now their developing into a subject using the space communication. Immediate information about impending events by which, you know, one can plan for the evacuation and so on so such they have happened.

On the communication side, I mentioned the – (unintelligible) – experiments but other than that, of course, on the commercial basis also, Indian skies are revolutionized by the satellites. Today, we have a fleet of satellites, which provide over 200 corresponders with various bands starting on the S-band to C-band – (unintelligible) – band, et cetera. And to have something the entire country needs for telephone connectivity, television broadcasting, and in the recent past, to – (unintelligible) – home transmission of television signals.

We were really surprised to see that even before the satellite is built, the entire capacity sold out for the media's application. Of course, this is on one side. The other side, we'll try to see again how the community development program can be accelerated using the satellite technology. The digital connectivity provides a very fine means of reaching out to the regions where the wire connectivity is not there. The rural (?) connectivity is not there. And this has been produced first for the education. We can carry the other literacy programs and the programs, which is prepared for schoolchildren use through the satellite link.

But we have eliminated on that by going for an interactive classroom use to a satellite link. Expert professors lecture in the metros (?) or any of the university can be relayed to the farthest place and the students there can interact with the professor. And we found that this program could be extend upwards to something like a hundred classrooms and each one of them, even if you assume about 30 students, about 3,000 students at a time, we are able to reach out using this program.

Today, something like 30,000 classrooms are connected in the country starting from family education, secondary education, engineering, medical, management and so on. (Unintelligible) – and these interactive classrooms are becoming very, very effective, not only for the student community, but for providing teachers training and accreditation, knowledge. And of course, we want to expand it to – (unintelligible) – so that, you know, if their offline, people can access to the expert classrooms or to the satellite link itself. So that's some application where we have made an impact and it's been successful.

Thirdly, we are in which communication is found to be very useful is with respect to the telemedicine. Off course there are means by which we can consult a doctor over telephone or things like that but this is going one step further. Using the satellite link, from every remote village, the patient data can be transferred to the expert doctor who is sitting in the – (unintelligible) – city and the doctor studies this patient detail and later interacts with the patient in a teleconference mode. So this is providing an opportunity for a consultation of a patient with a few thousand kilometers away without traveling to the specialty hospital to have a first-level consultation. Quite often, about 60 to 70 percent of the cases, simple medication advice is more than sufficient. But for the follow-up care, those patients are advised to go to the nearest hospital, which has better facilities and so on.

This has been penetrated in areas like Ansolkhare (ph) in the state of Kavala-al-Maharashtra (ph). The leading cancer institutes are connected to almost all the district levels. The patient doesn't have to travel more than 50 kilometers before he can reach the medical center. From there, the leading oncologist can be consulted and that will become a very effective way of managing that. Of course, not only that – whether for the – (unintelligible) – so this system is more operational. We help out something like 250 hospitals connected in this network, and we are trying to see that this method is afforded to every village. Of course, it is not a visible problem. India has something like 600,000 villages, and to reach the 600,000 villages is humanly possible, but they're trying to reach at least 10 percent of that to be covered in the course of the next few years.

But today, what we have done is demonstrating the efficacy of the system, and also providing services that are really badly needed. But there's a big opportunity, you know, once you want a progressive model of that and deploy it at a national level, huge level of business in terms of how the prospector as soon as the extra services, all those things are in one, and one can exploit that.

Looking at all this, you know that remote sensing application, the telemedicine telecommunication, we have now come out with a concept called a villager source center, where the village – (unintelligible) – can connect with – (inaudible) – the villages can look at the local maps – (unintelligible) – surrounding them – the forest cover – (unintelligible) – conserve fields, the infrastructure which is there, and so on. And they themselves can decide as to what type of improvements one has to achieve, and also they can consult the agriculture universities or the forest department or the fisheries department to see how practically they can implement the programs. So this is one aspect of the remote sensing application and of course, telemedicine, tele-education. All of this at the same terminal – (unintelligible) – and again, close to over 300 pilot projects are running in the country to it.

So these are some of the practical applications of space, which we found is very effective today, and we are able to really justify space programs by that what is spent on the country. Talking a bit about – (unintelligible) – I think perhaps globally, if you look at it, we are spending very little on the space program compared to many other leading nations. Even today, it does cross the \$1 billion mark yet. Cumulative expenditure, I think I have a – (unintelligible) – 2003 – (unintelligible) – that is a little dated, that was close to \$2 million, what we spent on the space program; that's over 30 years.

And you can see that we have five laboratories which can do rockets, which can do satellites, which can do the competition payloads, observation cameras, scientific instruments, and all these things. In addition, we have got the scientific community which is about 6,000 strong, qualified of engineers and scientists, and we've almost double that number of supportive staff in world-class facilities, which have come into operation there; again, these application programs and all these things.

So we have energized one other leading specialist, Madras School of Economics, to make a study as to the efficacy of this program in terms of the social delivery. Their answer was really invigorating. In fact, they came out and told us, look, here I think we can pop in much more money and pay much more from the government, for the simple reason they give us \$2 billion we have up until that time, just add the space research, which is pro-rated. That is how it goes more than \$3 billion, so you can imagine it an another 20 which is coming – (unintelligible).

So those – (unintelligible) – investment in the high-tech area, that had benefit associated with itself justifies the space program for the simple reason our programs are well-focused. We have a – (unintelligible) – from which we pick up what needs to be done for the five years and the current year and so on, and with that, you know, that every rupee which is spent on the program is very, very effectively being utilized, and again the returns are maximized. Of course, there's some advantage. Though you will talk about the conversion rate of dollar to rupees or 40 (?), but if you take into account actual purchasing power in terms of the – (unintelligible) – research, it may be a factor of high only, so that also accounts for how we are able to manage the technical cost of this whole program.

So that way, we have seen that we were able to go beyond this distance effectively, and show that it's first for the country, and the country's happy that they are prepared to further fund the programs for the future. So in that process of we are looking out for what's next, but I think there has been a brainstorming session from the Indian scientific community. And they all came to the unanimous conclusion that space is going to be the next frontier for humankind, and it is just not only looking at the planet Earth and then trying to understand a new place for the sources in a very effective manner for improving the life of other people, but the space exploration also will pay a very major role for the future. In fact, that is the theme which where are evolving, not forgetting what we have to deliver to the society; that will become our main driving force. In fact, last year we wrote down about 26 missions which meets the social obligation; in the next five years we may be doing our 80 missions. So that shows how much importance we are going to give on the actual application of the space program for the – (unintelligible).

But in addition, there are new themes which are evolving. The exploration of the moon, it has already taken off; last three years, we have been working on the Chandryaan-1 project. It is an instrument at payload which will be going around the moon for two years, trying to map the interlunar surface using laser terrain map out, mineralogical map out, and number of other instruments which goes on board. So this is going to provide inter-atlas of the lunar surface, on a mission of over two years.

I'm really happy to say that, against the international offer for cooperation, we're taking off with this addition scheme. Out of that, we could pick up around six of them to go on board, two of them from U.S., four of them from Europe, and another six from the Indian scientists. So this was a truly demonstrated not only of the feasibility of international cooperation, such very vital area, but also a note of interest in the providing the linkages between the scientific community in a big way. If everything goes all right before the middle of this year, the mission will take off, and next to two years it will be in orbit.

But then, we are trying to look at what next, perhaps not only orbiting around the moon but landing on the moon and then trying to put some rovers, picking up samples, analyzing and relaying back, that sends an opportunity. And we have signed an agreement with Russian space agency for cooperating such a venture, and perhaps in the month of March we will try to look for possible international cooperation. There are a lot of interests from both the Russian and the Indian scientific community itself but there is a possibility that, depending on the payload mass and the money available, one could consider international cooperation as well, and other countries' cooperation as well. So we have been working on that and of course, if there is an overwhelming interest in such missions, we won't mind having another launch of another Chandryaan, maybe Chandryaan-3.

So in fact, my discussion with most of the space agencies indicate that there's a strong interest in going closer to the moon and studying it in great detail on the surface features and so on, and I'm sure there's another avenue where the U.S. and India could really join hands and work together. Of course, Mars, you have rovers and pictures all coming through and so on, so that we said we were taking a very big lead, a gap-filling role. We don't mind doing it; perhaps we'd like to think of how we can get it out. And as I mentioned earlier, you know that cooperation in the international arena is and must, and for reasons we have opened up areas of cooperation. It can further grow.

But one of the aspects of the opposite in my earlier portion of the speech also, it has come out, is with respect to the regulations and the controls and systems like that. Yes, I think there is a need for perfecting the intellectual property; there is a need for safeguarding the sovereignty of the countries. But in taking care of all of those aspects, I believe there are enough opportunities for coming together, putting together the scientists and working for a common good.

Let's look at the parameters itself. We have understood many things about the planet Earth; we don't understand many of the similar phenomena which has taken place with respect to the weather or the climate or the earthquake and other damaging events. Again, we talk about the global warming and the contributing factors, whether it is a cause or the effect and so on. So much observation to be done, so much scientific data to be collected, and various models have to

be made, simulations have to be made. Again, in actuality to a full class with – actually, once, which is taking place, and so on.

So if we look at it, the planet Earth itself provides a lot of opportunities for other studies, investigation, and working together. Any of these phenomena, it has quite a global impact and it's just not selfishness, some local models are made and we try to evaluate it. We have the world global models and also global systems for data collection, and how this data can be assimilated into such models; again, how to make the forecast nearly on time and how to make the government observations and field into this state. So it's a very big field by itself, and I'm sure it's going to be the big challenge for the global community.

Of course, we are also trying to see who can help us conduct work in this area. We are going to have what is called an Ocean SAT, which will be looking at the color of the ocean, the sea surface temperature and also the ripples on the ocean region (?). Then, there is a giant experiment between France and India, which is looking at the cloud pattern and the tropical phenomena which is taking place with respect to weather that's forming in the tropics. The scientific payloads are from both countries, and India will be building the satellite and launching it. And again, the global community is showing interest in sharing this data.

We have built another satellite called the ASTROSAT, which is going to be perhaps the first satellite which will have the capability to look right on the visible, all the way up to the gamma ray radian simultaneously, so it becomes a really useful tool for looking at the galaxies and beyond. Again, I think the opportunities are there for the international community. So the science program with respect to planet Earth are due to the galaxies and the stellar systems, and of course when you talk about the solar system, the solar system and sun-earth coupling becomes a very important element for study. So we are trying to see how best we can bring out meaningful experiments in that.

So in this process, what we are trying to do is while spending, let's say, over 80, 90 percent of our resources for meeting the needs of the Indian national systems, we are trying to set our sights on the manning for scientific exploration, which is going to be of use for the global community. Of course, there are a large number of Indian scientists in the country who are interested in such studies, but a number of universities who are working on that, a number of laboratories in the country. At the same time, of course, we have a drawback also. We produce a lot of highly talented scientific community, scientists in this area; they yank scientists even before they have submitted their theses. There is an offer either from U.S. university or the Canadian university for employment here, so it is virtually we become a resource or a supplier in this area. But we are not against it, but at the same time we look forward to some of these resources coming back and serving in our place as well.

Well, talking about the human resource, we felt the need for bringing up a strong team for the space technology and the space science research. We have a university that's called the Indian Institute of Space, Science and Technology in India. It's sponsored by the space department and it's fully funded by the space department, and it is going to be a world-class institute to be looking for professionals in the field of space technology and the space sciences. And of course, we are asking them to work with us after graduation for five years or so, so it is

the kind of offer we are making. But this institute, we will be looking forward to cooperation with the sister institutes in the U.S. in various fields; family exchange program, the student-exchange program, and there can be joined experiments and joint projects and so on. So we are looking forward to that area.

When we come to the space commerce, at one time U.S. was one of the strong partners; in fact, the U.S. was the largest suppliers of components and sub-systems as far as the Indian space program was concerned. But after these embargoes and other kind of – (inaudible) – came to a very low value and really, I'm not really happy to say that we are hardly doing about \$50 million a year of business, compared to the potential of almost \$100 million we have an open exchange on for science and research. Perhaps, I'm sure, the arrangements is coming and we are talking to various levels of the government, and the next step towards cooperation will lead to much further growth in the space commerce as well.

In the space commerce, one can talk about the various technology research going on for the ground systems, and there are software applications which is going on. Then, of course, in the communications satellite area we are more or less self-reliant today. But again, there are certain technologies which can be transfused for the major benefit. Our software industry is well-known here in U.S.; a lot of outsourcing taking place in terms of the software development. Again, the higher software development has demonstrated what we are capable of doing, and we can make even the most sophisticated mission software or the finest element for the – (unintelligible) – which have paid for this in a very short period and really effectively. Again, the panel computing and clustering technologies we have developed and were demonstrated. So there are many areas in which the Indian technologies are good at it.

Again, some other manufacturing systems, the cost compared to many other parts of the globe, is low, and one can take advantage of that. If there are willing partners who can invest in high-tech manufacturing in India, in industries that are also coming up to take on these responsibilities. In the space program itself they are shouldering the work of nearly 60 percent of the manufacturing and supply within the country. Our 60 percent – (unintelligible) – space program auto industry. Well, if there are aerospace industries in the U.S. who are willing or who need such cooperation with Indian industries, they are mature; they can make a product which can be flown to moon. They can do anything else as well, equally effectively. I'm sure that also will provide a great opportunity for the cooperation between the two countries.

So you must be aware how the economy is growing. Today it's close to 9 to 10 percent, which is the annual growth, and we are happy about it and, yes, we have on one side wealth is being created, but at the same time we have other practical problems of how this wealth has to be shared with the people in the country. It's not like your country; we have got over one billion people. And out of that I will say, I'm really sorry to say that close to 30 percent of people, they are below the poverty line, so we have to improve their plight. So while developing high technology, while developing the industries and developing the wealth, we have a social commitment also.

In fact, this is one other point which I will also mention. In the space program, always have been giving importance how the space technology can be used as a tool for the development

of the villages and the villagers. To give an example recently, an experiment conducted in the state of Karnataka, where we went in for a watershed place development program for the villagers. You take where the water can be accumulated and surrounding regions, and you – (unintelligible) – these villages as to what the purpose of the agriculture they are doing, are not good at farming either poultry or other – (unintelligible). So with that research, we found that in over three years itself the income level could be brought up to more than 40 percent. So it is highly focusing on the local development based on the knowledge, global knowledge, of the surroundings and so on. So that's a social application also, an element there.

So we do give trust to not only creating the wealth within the country, knowledge within the country, but how it can be applied to the needy in the country. So this has been one of the main strong points, and perhaps when we talk to various others, like lunar technicians and so on, we believe that perhaps India is the only country who have the space effectively for the common mass benefit (?).

So to conclude, I would like to say that we have a very strong space program. We have confidence to build a satellite, whether it is for the communication, data observation, other scientific observations. And also, we have the rocket systems which can take these spacecrafts into these orbits. Meanwhile, we have internal hands in the societal application of the space technology and we have succeeded. As a next phase of evolution, we are looking for the planetary exploration and international scientific cooperation for observation and other factors.

So thank you.

(Applause.)

MR. SABATHIER: Thank you very much, Chairman Nair. We have some time for some questions, so who wants to – yes?

Q: (Off mike) – just to say wearing another hat as chairman of the awards committee for the Society of Satellite Professionals, on February 26<sup>th</sup> we are giving an award to Israel and the Indian government for their tele-education program, and I'll talk to you later about that. But it's a very impressive program, with millions of students involved.

My question is there have been reports of a two-stage-to-orbit cryogenic or semi-cryogenic engine for a reusable launch vehicle that you're developing. Could you tell us a little bit about that and whether 2012 is actually still the objective for such a hundred kilometer or so capability?

DR. NAIR: Thank you very much for the appreciation of our tele-education program and in fact, I have the key person behind that tele-education program here, Maska Naren (ph). He is actually, I will say, the father of this program and he has really worked with perseverance to demonstrate it at a national level. Thank you very much.

Well, talking about the launch systems, we believe that low-cost access to space is going to be a procurement for the future. And if we can get into systems which can be recovered and

reused, it can substantially bring down the cost of launch. Towards this, we have done some critical studies and the center that is satellite that's two-stage-to-orbit could be a choice for the next generation of systems. Here, yes, the whole concept is unfolding but there are a host of technologies to be developed for the hypersonic reentry and controls and so on. In fact, the whole concept is firstly, we will take the system to a 100 kilometer altitude and then the second stage will take the system to orbit and so on. So from 100 kilometers, reentering with a speed of Mach – (unintelligible) – 12 to 20, that's going to be a real challenge.

So what we have conceived now is a demonstrative program, by which we will make a sub-scale version of that, and we will launch it with a rocket to a Mach number of six. And six to nine, perhaps we are toying with the idea that we can use a conversion of chemical propulsion or maybe using – (unintelligible). So this is purely a technology demonstration. That demonstrative part of it, yes, by 2012 we will be doing that. And in course what we'll derive from this demonstration will go towards deciding the final system, which is required to be made. Perhaps the timetable would be something like 2020 to 2025 before such a system can be operational.

Q: (Off mike) – India Global Nation Today. Dr. Nair, this was a great presentation you have given. My question is that you already said that India is producing doctors, scientists, engineers and IT, and they are giving everything to the world but not to India, Indians in India. What is the drawback? Is it politics or corruption or bureaucracy in India that Indian scientists are not producing in India but they're doing better outside India? And when do you think we'll take the first Indian traveler in the space program?

DR. NAIR: Well, I am neither a politician or involved in the bureaucracy, so I can't answer any of the questions which are asked, especially regarding the corruption and other things, and partly alluding to that. Well, but I don't believe that is any reason for the scientists or – (unintelligible). Yes, there is a financial advantage which is very much there, and also I understand from what I know about this country what a great freedom for people to work. You know, the audience is always ready for an idea; you can really sell it for millions. But in India, I think in our research it states even if you have an idea you are to work through the establishment.

But one thing I can say that, in spite of a large number of our highly qualified personnel migrating to countries like U.S., we are still left with a large fraction of people who are equally good, and they are running our programs. We find that in all we are able to make, the satellites, rockets, et cetera, is a touchstone for the high end of technology that shows what we are able to do. Again, we are able to create a better ambience for the scientists to work in the country. They have given respectable salary for living and things like that. And also we provide a lot of infrastructure at a government cost so that you know they can make use of that for doing their research and so on.

Of course, there are isolated places where, you know, the personalities come into play, the egos and other factors effect and – everywhere's the same. So perhaps in the Indian context some of the people will see more, but in the recent past with the globalization and opening up of our boundaries, et cetera, the culture is improving and we have a very good ambience for working, and we have world-class scientists working in the country as well. The fact that so

much a volume of IT business, hi-tech business, is being done in India and also, many of the multinationals are opening up their research laboratories in India, is proof of this.

Now, coming to the manned mission, so far we have not addressed this issue. Right now, we are in the conceptual study phase. Of course, we recognize that capability to have a man – (unintelligible) – into space is very important for the future explorations, and from that angle we have completed a design phase and we are approaching the government for funding. If the funding comes, maybe in seven to eight years we will have our own system which will carry the crew to the orbit and back.

Q: Thank you for your presentation. It was very interesting. On to Mr. Hitchens with the Center for Defense Information here in Washington.

I had a question that's kind of sideways but perhaps you can adjust it. There's been more interest in India in the last several years in the military space program; quite a lot of discussion, articles, et cetera, and it seems like the government is more interested in that than it has been in the past. And I wonder how that might affect ISRO and is there any concern that a military program might siphon funds from the civil program?

DR. NAIR: Well as you know, ISRO right from its inception has been to promote peaceful applications of outer space, and that has been the main theme in the context and we are totally living up to that spirit.

As far as the military programs are concerned we have a different organization, defense, research and development organization in India, who lives with the government decides and so on. So they are – (inaudible) – center; it's not a commonality.

Q: Brian Berger (sp) with Space News.

How much annually is India spending right now in pursuit of human spaceflight capability?

DR. NAIR: Oh, at the moment it is very little. It is less than about \$10 million. That's only for the pre-project studies there has been some money, and perhaps when the whole program comes in it will be 10,000 – (unintelligible) – and rupees, I don't know, it will be well over \$40 million.

Q: (Off mike.)

DR. NAIR: Twenty five billion – or \$2.5 billion, sorry; \$2.5 billion with the – (off mike).

Q: That's an annual –

DR. NAIR: No, no, that will – (inaudible).

Q: (Off mike.)

Q: Sir, Truman Eyre (sp). Really enjoyed your speech today.

My question goes to the launch of an ASAT by the Chinese, about a year ago now, and how that is viewed in India, particularly how that is viewed within the space arena within India, and any thoughts that you would have in India's response to something like that?

DR. NAIR: Well, I think we are aware of what the Chinese have done in this context. But at the same time, you know, we are not trying to compete or establish ourselves in part with any other space agency. We have our own priorities and in fact, we have come to the opinion on the international forum; the outer space should be used only for peaceful applications. Any indication of an organization, it should not be happening, and that has been our stand on this.

Q: Chairman, I have a question on this line. Do you have any ongoing or planned cooperation with China?

DR. NAIR: Well, on the commercial basis the Chinese space agency is using our satellite data, remote sensing – (inaudible) – and other satellite application. But otherwise, we do not have any formal cooperation with the Chinese space agency at this moment.

Q: Chairman Nair, this is –

Q: I was wondering whether India has any plans for a mission to Mars, and number two is do you have any plans for cooperation with NASA on the conservation program, which is the lunar base on the moon, a vision for space exploration?

DR. NAIR: Well, Mars I think a number of U.S. probes have already gone round, landed and so on, and a recent picture of what I have clearly sitting there except – (unintelligible). But we are trying to see our scientific community and I would like to see what new things we can find, just not for the sake of sending a probe to Mars. Yes, we have that on the agenda; before 2012 we should have a Mars mission. But what instruments we should carry and whatever things we are looking for is yet to be discerned.

Now, NASA I think we are working very closely. My good friend – (unintelligible) – is here, and he has gone around with us and I am also, we are exchanging notes and we hope that we will hold a good cooperation for the future.

Q: Mike Gold, Bigelow Aerospace.

Mr. Chairman, many of us in America are highly critical of the current export-control regime in America and I'm wondering from an Indian perspective, has the obsolete and broken ITAR created barriers for the Indians in collaborating with the U.S., and have you seen export control as a significant challenge in working with U.S. companies or the government?

DR. NAIR: (Chuckles.) Well, I think this is a difficult question to answer. At the political level there is a good understanding, and in 2005 our – (unintelligible) – and then with President Bush lately, that we will try to strengthen relation especially in the space cooperation, space commerce and so on. We are trying to look forward to this. There are positive signs and negative signs. I can say that one of good example is with Raytheon we were able to work for again, that is an augmentation system which is for the GPS or aviation purposes. That system is fully established in the country.

On the other side, with another company we have almost come to the final stage of our signing a contract for a semiconductor plant to be established in India. The same control has put a block on that thing. So there are plus and minuses, but one has to be patient because each country has its own legislative requirements and things like that. So we have to convince the government level.

The process is rather slow; I wish it would be faster.

Q: (Off mike) – Corporation.

India has built up a very vibrant IT industry. What steps is the Indian government taking to build up a similarly vibrant space industry, much like we see in the United States and Europe, where multiple companies compete for contracts and government commercial customers for satellites, launch vehicles, or other space services?

DR. NAIR: Well, I think we have been trying to offer this satellite launch on a commercial basis and we have succeeded. About half a dozen small satellites to go on the PSAV (?), and two full-flight satellites have been launched in the recent past, one for the Italian space agency and another one for the Israeli space agency. Both of these are completed.

In the recent past we had an order for building two satellites for the European community. Some of those orders are coming from Europe, the main satellite – (unintelligible) – control system, and individual satellite is taking place in India. There is a few here on a commercial basis and we are feeling that business is going to increase in the time to come.

Q: Kipi Nare (ph) from the Telegraph.

You mentioned in passing, in your speech, about the plan to land on the moon and the agreement with the Russian space agency in connection with that. Can you expand on that a little and tell us something more?

DR. NAIR: Well, this is going to be again an integrated system. As you know, that after identifying the type of universe and the sort of features, et cetera, we would like to have a very close look at areas which are not explored in the past. So from that context, I think we believe that the second mission to the moon will contain an orbiter along with an instrument or system which can land on the lunar surface, and then try to make a very close observation of some other members or elements which are there.

So this is going to be joint experiment between Russian space agency and ISRO. And we have a venture there – (unintelligible) – you on that. A detailed definition of the spacecraft is in progress and we hope to launch it by 2011 to 2012 timeframe.

MR. SABATHIER: Okay, we have for one more question, I'm sorry. Yeah.

Q: Tracy Watson, U.S. Today newspaper.

I'm wondering if you can tell me how confident or optimistic you are that you will get the funding you need for your human spaceflight program, and what you can tell us about what your design study showed. Thank you.

DR. NAIR: Well, I think we have been judicious in apportioning the funding which comes to the space department for various programs. And so far, our priority has been to build up the technical competence for launching – (unintelligible) – to build satellites; that we have achieved already, and truly we can cost-effective solution we can provide.

But the human space program is concerned, we have already sensitized the government and they have asked us to submit a detailed project report. And this report will be submitted soon; once the report is analyzed by the government, I don't expect a major hurdle, but we have to go through the process of approvals – (off mike).

MR. SABATHIER: Well, now thank you very much. Everybody, I think we need to close because we need the room at 1:00 so if you have some time to eat lunch, we need to stop.

Thank you very much, Chairman Nair. It was a very, very good speech –

(END)