NATIONAL PRESS CLUB NEWSMAKER BREAKFAST WITH MARK KELLY AND TERRY VIRTS

SUBJECT: THE INTERNATIONAL SPACE STATION

MODERATOR: JOHN HUGHES, PRESIDENT OF THE NATIONAL PRESS CLUB

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JOHN HUGHES: Well, good morning, everybody. Welcome to the National Press Club. My name is John Hughes. I'm an editor at Bloomberg First Word, that's Bloomberg's breaking news desk here in Washington. And I am the President of the National Press Club. We have a historic day here at the National Press Club. Our guest live via video link from the international space station is astronaut Scott Kelly. Here in the ballroom next to me, we welcome astronauts Mark Kelly and Terry Virts.

But first, I want to introduce our distinguished head table. This table includes club members and guests of our speakers. From the audience's right, David Shepardson, Washington bureau chief for the *Detroit News*; Robert Kuntz, deputy news editor for physical sciences at the journal *Science*; Colonel Cady Coleman, a NASA astronaut; Frank Morring, Jr., senior editor for *Aviation Week and Space Technology*; Jerry Zremski, Washington bureau chief for the *Buffalo News*, past president of the National Press Club, and current chairman of the Speakers Committee; Danny Selnick, senior vice president for Business Wire's Public Policy Wire, and the Press Club member who organized this morning's breakfast. Thank you, Danny.

Captain Samantha Cristoforetti, a European Space Agency astronaut; Andrei Sitov, bureau chief for *Tass*, the news agency of Russia; Ferdous Al-Faruque, reporter for *The Gray Sheet*; Tom McMahon, vice president of advocacy and public affairs for the Association of Unmanned Vehicle Systems, International, and a National Press Club board member. Welcome to you all. (Applause)

I also want to welcome our C-SPAN and public radio audiences and our live audiences watching around the world on the internet. You can follow the action on Twitter. Use the hashtag NPClive. That's hashtag NPClive on Twitter.

So 100 years ago, one of the first transcontinental telephone calls was made from the National Press Club. A photo on the wall upstairs documents that historic moment. It also marked the first time that a high ranking U.S. official was photographed at the National Press Club because it was then Secretary of State William Jennings Bryan who made that historic call to San Francisco. Earlier this year, Vint Cerf, who gave a speech here and has been doing some work for NASA, asked the question: what would be the 2015 equivalent of that 1915 phone call?

Well, some conversations that resulted from that question, and some cooperation from NASA, led us here today for another first for the National Press Club; a live press conference, live messaging going up to space. And it's a historic day. It raises the question for the National Press Club president of 2115. That is, who are you going to call and how far away are you going to reach? So it's very fascinating that we're here today.

And I want to remind you all that our astronaut in space is Scott Kelly. Kelly went to the space station in May to begin a 342-day stint there. And that will be-- I'm sorry--

MARK KELLY: March.

MR. HUGHES: It was March, not May. This is his brother who just corrected me. This will be the longest ever stint by a U.S. astronaut. And as of today, he is just under the halfway point to making history. And here on the ground we have Scott's twin brother, a retired NASA astronaut, Captain Mark Kelly. And he is undergoing a study with his brother to determine the effects of long duration space flights on the human body.

We also have here on Earth, Air Force Colonel Terry Virts, who in June was the most recent NASA astronaut to return from the international space station. So we welcome our astronauts here on the ground. And I expect that in about a minute, we will be hearing from the international space station. What are you going to say to your brother if you're able to send a message to him this morning?

MARK KELLY: So you want me to say it twice? (Laughter)

TERRY VIRTS: No, should wait until we have him on the screen.

MR. HUGHES: We'll be surprised.

MARK KELLY: No, I talked to him yesterday, so we've kind of caught up a little bit on what's been going on. I had the opportunity to-- there's a phone on the space station, for folks that don't know that. It's kind of like an internet call and there he is.

MR. HUGHES: There's Scott.

MARK KELLY: In space. Scott, can you hear us?

__: This is Houston. Are you ready for the event?

SCOTT KELLY: I'm ready for the event.

__: National Press Club, this is Mission Control Houston. Please call station for a voice check.

MR. HUGHES: Station, this is National Press Club. How do you hear me?

SCOTT KELLY: I have you loud and clear, welcome aboard the space station.

MR. HUGHES: Welcome. Thanks for joining us, Scott. We have a full room here. I know it's around lunch time up there. We just had breakfast. Could you tell us what you're doing today?

SCOTT KELLY: Yeah. Well, first of all, it's great to be here with you guys today. Yeah, I know you're having breakfast because both my brother and Terry Virts there sent me pictures of their food. I guess they're trying to make me feel bad about what we have to eat up here. But today's actually a day off for us because we had some crew members departing late last week, so today is actually a free day.

MR. HUGHES: And what do you do on your day off on the international space station?

SCOTT KELLY: You know, we have a lot of work up here with over 400 different science experiments going on throughout the year I'm here. We do a lot of work on the different systems that keep us alive. So mostly, on the day off it's a time to rest and recover from a very hectic schedule. I generally take a lot of pictures of the Earth, do email, maybe watch something on TV. Yesterday, we were watching the Texans game and the Broncos game later so that was nice.

MR. HUGHES: So, you're about half way to your year-long goal. How do you feel? What effects have micro gravity had on you so far in this almost six month period?

SCOTT KELLY: Yeah, so I feel pretty good overall. I definitely recognize that I've been up here a long time and have just as long ahead of me. But I feel positive about it. I think if I manage my work, pace of work and energy right, I'll have enough in the tank to get to the end. I'm pretty sure I will.

As far as physically, I feel good. We have some pretty good exercise equipment up here. But there are a lot of effects of this environment that we can't see or feel, like bone loss, effects on our vision, effects on our genetics, our DNA, RNA and proteins,

things like that. And that's why we're studying this, myself and Misha, on this one-year flight. And I think right now, the jury's out on that. We're going to have to get all the data and have the scientists analyze it and submit the results for peer review, the stuff the scientists do. So hopefully, we'll find out some great things about me and my colleagues spending a year in space.

MR. HUGHES: So there's a lot of attention, a lot of interest, in getting to Mars. How will your effort up there help us get to Mars?

SCOTT KELLY: So, a lot of the studies we're doing focuses on, particularly me and my Russian colleague, Mikhail Kornienko, longer duration space flight than we'd done before. This is an incredible facility we have, the international space station. Has a lot of capability to collect data on us. You know, we have an ultrasound, we have these devices that measure our vision. Next week, we're going to do a lot of this imaging and data collection in a Russian device that actually pulls the blood down towards our feet, this lower body negative pressure device.

And from these experiments, we'll hopefully find out if there are any cliffs out there. You know, if our vision gets significantly worse, maybe after nine months or a year. And even though the Russians have flown on board the Mir space station for a year or longer in a couple of cases, they didn't have the technology we have today to figure this out.

You know, the space station's also a great experiment in sustainable energy and life support equipment and understanding how that works and how we can maintain ourselves with these systems for longer periods of time. Both of those things are going to help us go to Mars some day, and hopefully in the not too distant future.

MR. HUGHES: As part of what's happening, you're undergoing a twin study along with your brother here on the ground. Explain how that is working. Do you have any results on the twin study so far, anything you can share, or won't any of this be known until after your experience is done and you analyze all the data afterward?

SCOTT KELLY: You know, I think most of it will be stuff that we learn afterwards. I have had some interaction with some of the investigators. You know, one thing that was, I found, somewhat interesting, maybe not too unexpected, is our microbiome, you know, the stuff that's inside of us that's not us, we have more cells of bacteria that we carry around with us that the microbiome, the stuff that's inside of us that's not us, you know, we have more cells of bacteria that we carry around with us that aren't-- isn't part of our body, but they just live inside of us.

And one of the principal investigators told me that while I was up here that she found it interesting that my brother's and I microbiome are completely different. I guess that's not really that unexpected because we do live separate lives. But it was kind of an interesting factoid, I guess.

MR. HUGHES: The goal, however, is that at the end of this, you'll be able to document, or NASA will be able to document as never before, the effects of micro gravity on a human using a twin human to really get in at a detailed level.

SCOTT KELLY: Yeah. You know, really, it's kind of a serendipitous thing, I think, that my brother and I are both identical twins and astronauts. And the fact that he's an astronaut and has a lot of experience with NASA means not only is he comfortable doing all these types of experiments as the control person, but also NASA has a lot of data on him going back to when we interviewed in 1995. So they can look at that data and look at the data they collect with him over this year and see what kind of deviations we have on a genetic level which, you know, could be a result of this environment; the weightlessness of the environment, the radiation that we see. And from that, figure out other areas we need to investigate so we can eventually complete our journey to Mars and elsewhere.

MR. HUGHES: NASA estimates that the recently discovered Earth-like planet in the Kepler 452 star system has double the Earth's gravity. Those scientists mentioned your heroic experiment and the effects on gravity when talking about this. So as you anticipate the physical recovery needed to return to Earth's gravity from the weightlessness of the space station, how do you think humans could one day adapt to gravity stronger than Earth's?

SCOTT KELLY: You know, I guess Charles Darwin proved that the species, different species in general, are very adaptable to their environment. And so I think over the long term, it wouldn't be an issue. Just like we've learned to live and work in a micro gravity environment, I'm sure people would be able to live and work in an environment that's twice the amount of gravity, although I think to be comfortable with that, in that situation, it would probably take a little bit longer than to get comfortable up here weighing twice as much.

But, you know, when we come back from the space station, we do feel like you weigh 500 pounds more than double your real weight. But it's something you adjust to very quickly and I think we as a species throughout evolution have shown that we're very adaptable.

MR. HUGHES: So how long has it taken you to get used to this environment of micro gravity? And is it a constant process of adjustment, or is it something that you figure out and then it's just there?

SCOTT KELLY: You know, that's a really good question and one I've never been asked before. You know, what is the process of adjusting? And so far, I found that it is a continuous thing. It gets less significant over time, but I do notice I can do things now that I couldn't do right when I first got up here, even though I'd flown 180 days in space before. My ability to move around has really improved over time and continues to improve. And you just get more comfortable. Your clarity of thought is greater, your ability to focus, things like that.

So, I found that the adaptation has not stopped. And it'll be interesting to see where I'm at six months from now.

MR. HUGHES: I know that on Earth when they do experiments-- there you go-- that's good, that's good. On Earth, when they do experiments, they often put people down in a close environment and leave them there for months at a time to see how they interact with one another. Now, you're up there for a long time with your colleague. How about the human component of this, the human interaction? Are there subjects that you need to avoid in talking about or how do you learn to live with one person for such a long time, or people so long, up on the space station?

SCOTT KELLY: You know, I think people find it hard to believe, but so far in my over 300 days, actually approaching a year in space, I've noticed very few conflicts. I think not only does NASA, but our international partners, do a very good job at selecting people that are easy to get along with in this type of a harsh environment. So, you know, especially on this flight, I haven't had any issues, nor do I expect to have any, or people to have issues with me, hopefully not.

You know, we get along great and we're all one big team up here. We recognize how we rely on each other on a psychological level, but also for our own personal safety and that goes-- it's just as important with my fellow astronaut up here as it is with my other international colleagues, including the Russian cosmonauts on board.

MR. HUGHES: All right, I'm going to bring in your brother here in a minute. But do you think that you or Mark got the better end of the deal on the twin study?

MARK KELLY: We've got better food.

SCOTT KELLY: Well, I think it depends. You know, it's a privilege to fly on this flight, but sometimes when he sends me pictures of his breakfast, I'm a little envious. (Laughter)

MR. HUGHES: And Mark, what would you say to your brother?

MARK KELLY: What, about breakfast?

MR. HUGHES: Sure?

MARK KELLY: I talked to him yesterday and we caught up on a few things. You know, there's a phone on the space station, so we can communicate other than this kind of setting. I was interested in what you thought about the Houston Texans' first performance yesterday?

SCOTT KELLY: Well, fortunately it's a long season. So I'm very optimistic they'll improve. I think there's areas where they need to. But regardless of how they do,

I'm a huge fan and feel fortunate to have football season here and have something to look forward to on the weekends.

MARK KELLY: You know, I had another question for Scott I think people may find interesting. So in space, as you can see, he's got his legs down, right? But he's not standing. So his feet are actually under a handrail. And I always think it's interesting, actually, what happens to your feet in space. So maybe you can share, if you're comfortable, sharing that with folks?

SCOTT KELLY: Yeah, you know, so we don't really use the bottom of our feet much. And so over time, any calluses you have on your feet kind of fall off. And after about five months up here, you have baby feet. But then you had a big callus on the top of your toe, the big toe because you use that to move around. When I got back from my last flight, a few days after the flight I was getting a massage at one of those massage chain places because I was pretty sore in certain areas. And the masseuse says, she goes, "You have the softest feet I've ever felt in my whole life." And my response was, "Thank you. I'm very proud of them." (Laughter)

MR. HUGHES: Scott, this is obviously-- probably the start of what will be a long experience of long human space flight missions as we contemplate Mars and beyond in our future. You have been up there about half way now of your full year stint, but do you have any advice that you'd give to future astronauts who are going to be spending a long duration in space? Anything you've learned so far that you'd pass on to them?

SCOTT KELLY: You know, I was fortunate that I'd had flown almost six months my previous flight, so I sort of knew what I was getting into. But, you know, despite that, I did have certain apprehensions having to go into something that was going to be more than twice as long. So I intentionally thought about ways for me to get to the end of this with as much energy as I had in the beginning.

And part of that is having a good balance between work and rest and I intentionally don't work at the same pace I did last time I was up here where I felt like I could go at 100 percent speed for the full six months. I can't do that. So I consciously try to throttle myself back a little bit at certain times and have a really good balance between work and rest and that's what I would encourage anyone who attempts to spend this amount of time in this type of environment, is you just have to pace yourself.

MR. HUGHES: So in the remaining time you have up there, as I said, you're about half way, what are you most looking forward to in the next six months or so up there?

SCOTT KELLY: You know, we have a couple of space walks coming up. And I look forward to that. I've never done a space walk. I'll be doing one with the guy that just got something out of the refrigerator. (Laughter) So we both look forward to that, and that'll be a challenge for the two of us.

But what I'm looking most forward to is just getting to the end of this with as much energy and enthusiasm as I had in the beginning, and doing it safely and completing all of our mission objectives and getting all the science done.

MR. HUGHES: Okay. Last question: what is the thing, of all the things that you miss in your time away from Earth, and now after such a long time, what's at the top of your list of things you miss from being down on the planet?

SCOTT KELLY: So, after being with other people, people you care about, your family, your friends, just going outside. I mean, this is a very closed environment. We can never leave. The lighting's always pretty much the same, the smells, the sounds, everything's the same. So, you know, even I think most prisoners can get outside occasionally in a week. But we can't. And that's what I miss after people.

MR. HUGHES: Well, Scott Kelly, I want to thank you for joining us today on this historic day at the National Press Club. And the audience wants to show its appreciation by giving you some applause. Thank you. (Applause)

SCOTT KELLY: My pleasure.

MR. HUGHES: All right, see you later. Somebody passed up a question, and maybe it was one of our news photographers in the room. But there were some large cameras in the picture, telephoto lens-type cameras. Are those to take pictures of Earth or what are those used for?

TERRY VIRTS: Yeah, those are for Earth lab, where Scott was, has a very large window. It's very high quality. Sometimes, we have experiments in there that take pictures of farm fields, how those are used, or different experiments. But when we don't have the experiment blocking the window, we can grab the camera and take pictures. And Scott's been really good.

I had a tendency to take like big picture views where you could see the Earth and the limb and space and stars and Scott was a big fan of getting that big, gigantic 800 millimeter telescope and zooming in on stuff on the Earth. So, it's one of the favorite things we do in space, is take pictures of Earth.

MR. HUGHES: What was the room that he was coming to us from? What was the purpose of that space?

TERRY VIRTS: So, we were in the lab and we were looking backwards towards the Russian segment. And where 00:14:05 came from is some exercise equipment off to the side. So I think he was in there either running on a treadmill or we have an exercise machine that allows you to do bench press and squats and dead lifts and that kind of thing.

MARK KELLY: The U.S. laboratory.

TERRY VIRTS: Yeah.

MR. HUGHES: Okay, the U.S. laboratory. And how would you avoid-- he mentioned missing going outside. What would you do to avoid being stir crazy up there?

TERRY VIRTS: It was funny. I think it was right after Scott got there, when Samantha and I were there, I missed Earth and the Russians actually were sending up audio clips of rain and wind and birds and stuff. So there was one weekend where every laptop-- the station has 100 laptops-- and we put this rain sound. So it was like raining in the station for the whole weekend. It was pretty cool. Everywhere you went, it just sounded like rain. That was good. So that's one way to cope with it.

MR. HUGHES: Right. Mark, I talked with your brother about the twin study. What is your role in the twin study here on the ground and how much time does it take? How often are you being tested, and the like?

MARK KELLY: So far, my role has been to provide samples; blood, saliva, other things I'm not going to go into. And be there for MRIs and ultrasounds and even some experiments. Sometimes, I'll be laying in some kind of contraption, I didn't even know what they're trying to figure out. I'm just like do whatever you need to do.

So it's providing data over extended period of time. So sometimes I'll visit Houston and meet with the researchers and spend a whole day giving data. Sometimes, they will send somebody to Tucson, or even once to New York City to collect data from me. And we'll do this while my brother's in space, but I think also after he gets back for a period of time.

From what we understand from some of these researchers, one of them recently said that they're going to have more information on Scott and I on our molecular and genetic information than any other human ever. You know, that was not an official position, but this is what one of the researchers, their comment, on this study. And there's probably 10 to 12 different experiments, or at least different universities, doing experiments from all the way from the University of Frankfurt to Stanford, Harvard Medical School, Johns Hopkins, I think the University of Pennsylvania, Purdue. So really, pretty substantial research universities.

And it'll be interesting to see what the data shows on the genetic and molecular, mostly, effects from this long duration space flight. You know, my brother mentioned that there might be a cliff. And I don't think he-- I think that needs a little bit of further explanation, right?

So we have data on a lot of people after six months from being in space. So we have a pretty good idea of what happens in that six month period. We have no data beyond six months. So, maybe there becomes a bend in the curve. And what I mean by

that is we know people's vision gets worse over the six month period. But maybe at nine months or ten months, maybe it gets really, really bad.

And imagine you're trying to send a crew to go work and live on Mars for an extended period of time, but by the time they get there, we find out they're going to be nearly blind from the environment. That's a big problem. So that's part of the idea of doing this research over a one year period, just to figure out if there's any of these bends in the curve.

MR. HUGHES: Right. What are the thoughts of both of you on how soon we can get to Mars?

TERRY VIRTS: You know, I think our ability to go to Mars is not so much based on the technology to do that. I think that part we can figure out. We can figure out the engineering and the propulsion system. Ultimately, I think we can figure out what it's going to take to mitigate some of these physiological effects from being in space.

I think the limiting factor and the thing that really controls when we actually do this is the public desire to do it. You know, we will need a lot of public support if we're going to take on that kind of endeavor to put a person on Mars. And that public support then means that we get congressional support and administration, support of the administration in the White House. That's the most important thing because a challenge like sending someone to-- sending people to Mars, it's going to be expensive and it's going to take a long time. So without that public support, I would say it won't happen.

MR. HUGHES: Now, the both of you have spent time in the station and had that experiment of adjusting back to Earth gravity and Scott will have that in a more significant way, one imagines, because of the length of time that he'll be up there. But what are the three or so most unique things that your body experiences that you go through when you transition back to Earth from a period of time up on the space station?

TERRY VIRTS: That's interesting. After my shuttle flight, which was relatively short duration, it was only two weeks, I really felt heavy, more than anything I felt the sense of gravity was pretty significant. And after my station flight of 200 days, it was-- I felt heavy, but the main sensation I had was one of being dizzy where I could still walk and stuff, but I really-- it took a few days before that dizziness abated.

But the thing that really surprised me about the station flight, 200 days, was how quickly I adapted back to Earth. I was prepared for much worse and have months of lingering effects, but I adapted a lot quicker than I thought.

MR. HUGHES: Right. Was that also your experience in the transition?

MARK KELLY: Well, I flew four flights, but they were all around two weeks, or a little bit more, a little bit less. So I don't have that experience of being in space for a long period of time. But my observation has been that when you're flying a space shuttle

mission, it is like a two-week train wreck of trying to operate and get everything you need to complete in this very short period of time.

So you have a lot of crew members working very fast. You don't have a lot of time to exercise. It's important to exercise in space. So on a space shuttle mission, I'll exercise like two or three times. Where you have space station crew members, even though they're in space for six months, they're doing a significant amount of exercise almost every single day. So I think that's what really helps. I think that's probably why you acclimated pretty well after 200 days in space. And it probably didn't feel a lot different than being in space for just a couple of weeks, probably because of the amount of exercise and the amount of work you're doing during that time in space.

MR. HUGHES: I think both of you would agree the technology is imaginable on getting to Mars. What happens with our astronauts once they get there? How do we handle making it so astronauts can live there? How difficult will that be? And do we have any idea how long they'd be able to stay before coming back, or would they just not come back?

MARK KELLY: Aren't we going to see that in a movie here in about like a week or so?

TERRY VIRTS: Yeah. Wait to see the movie. You can read the book, also. I think there's two ways to go to Mars, and this is a big question that needs to be answered. You can go the slow boat way, which is using a traditional chemical rocket, the kind of rockets we have now. And if you do that, it takes six to nine months to get there. And then you have to wait for Earth and Mars to go all the way around the sun to catch up again before you can come home. So you spend about a year and a half on the surface, another six months to come home. It's a three-year mission, which is a long time for you water systems to work and for your carbon dioxide removal to work. It's a lot of food to pack. It's a big thing.

The fast boat to Mars is to do what we call electric propulsion. It's using electricity, you pump out the propellant really fast out the back end and the spaceship goes a lot faster. And you can get to Mars in a couple months, spend a few weeks or a month on the surface and come back. The problem to do that is you need a nuclear reactor in space to put enough electricity.

If you go the fast way, the problems of the human body in space are mitigated. Problems of packing a lot less water and food is mitigated. And your systems don't have to last for as long. So that's a decision that we're going to have to make, how to get there, either the fast way or the slow way.

MR. HUGHES: If we made the decision and if Congress got behind it, how far away are we from realistically achieving this, do you think?

TERRY VIRTS: Well, the first human in space happened in 1961 and we were on the moon in 1969. So there's a historical context. Actually getting to Mars takes longer than getting to the moon, but it could be done in a decade or two, maybe. But I think Mark said it, his answer was very well, but it's more a question of political science than it is rocket science.

MR. HUGHES: Right. Let me ask you about NASA in general as someone who grew up with Apollo, right? And for me, Apollo XV was the end all because I was seven years old. I didn't remember Apollo XI, but I had the astronaut dolls, or whatever you want to call them, the little guys that I'd play with. NASA was a huge deal, right? And then in more recent years, there was some thought that NASA had come on harder times. We were relying on the Russians more and NASA's glory days were over. But then we had the Pluto fly by, there was so much excitement created, and NASA seemed to be hip again.

What is your view of where we are with our space agency here in the United States? And what do we need to do, if anything, to put it on the right future course?

TERRY VIRTS: I can talk about what we're doing now, and I'll let Mark finish. But there's a lot going on at NASA. I mean, the Pluto mission, obviously, Mars rovers, we have three rovers active on Mars right now and the Mars program is very robust. Of course, the human space flight program is very robust. Samantha and I just got back from a long flight and Scott's up there now and Shel. So NASA is very involved in space exploration, all aspects of it robotically and human. It has not gone away at all. We are flying with the Russians right now and that was one of the highlights of my mission, was actually getting the chance to go work with Russian colleagues and launch on the Soyuz. That was a great experience.

Soon we'll be flying on American vehicles again, so NASA's very busy. It hasn't ended in any way, shape or form and there's, I think, a very bright future.

MARK KELLY: I think here in the United States, we have the best scientists and engineers in the world. And I think we can do anything we set our minds to. I mean, really, anything we want-- especially in space flight. It's challenging, but we have the resources to do these things.

I think what we need to do is pick exciting missions that the public will be interested in like the Pluto mission. I mean, you know, some of-- being somebody who used to work at NASA and fly in space, even I thought that was pretty neat, to see Pluto up close for the first time, to see those images come back and start to learn more about something that is, or isn't, a planet. I don't know what it is today.

So we've got to pick these exciting missions. And then we've got to allow NASA to do this. You know, what often happens is you'll see-- we'll be asked to do something and then either sometimes NASA'll cancel a program or Congress will cancel it or the White House will cancel it. And, you know, we've got to understand that these things,

despite the ability of our scientists and engineers to do these things, they do take a long period of time, often from one administration in the White House to the next.

So I think people just need to be patient. We need to give NASA the resources to do these hard things. But we have the people and the ability to accomplish exciting things in space.

MR. HUGHES: Terry, we heard Scott earlier say he was really looking forward to his space walk. And you completed three space walks during your mission and this helped prepare the space station for the new Boeing and SpaceX commercial crew vehicles. And you also gave us some amazing go pro imagery and it made us feel like we were there, too. But can you tell us what it was like to be out on these space walks and doing this sort of work?

TERRY VIRTS: Yeah, it was definitely a unique-- I've had a chance to do a lot of stuff in life. That was definitely unique, going outside for the first time. In the pool, we practice doing space walks in this weightless pool. And you go out of the airlock and there's a module and you can kind of-- it's about from there to there. I reach over and grab and then move on to where I'm doing my work. And on my very first space walk, I went to do that. I went, "Nope, I'm not going to do that." And so I kind of stayed on the side of the space station and didn't take the short cut.

But it is an amazing experience to look back and see the Earth. I'd felt like maybe a minute or two to do that, and during all my three space walks, because they were so busy, there's many tasks that had to happen. So I never really felt like I had any free time while I was out there. It was more work, work. It was more like a shuttle flight than it was a station flight.

MR. HUGHES: All right. Mark, with the international space station, it's almost like we're so used to it we're almost taking it for granted. But what could be done to improve the scientific output of the space station and the impact it has?

MARK KELLY: Well, my brother mentioned that they've got, over the period of time that he's going to be there, there's 400 different experiments going on in a bunch of different laboratories. There's the U.S. laboratory, there's a Japanese laboratory, there's a European laboratory on board, the Russians do science in the Russian segment. So it's an incredible facility. There's a lot going on.

To expand the output of the space station, you just need more people. Space station was first launched in 1998, so 17 years now. Starting to get kind of old, things break. People have to fix things when they break. That takes time away from doing the science. You know, you don't have an electrician or a plumber. You don't have somebody to clean the place up. So the crewmembers are the-- you know, they're the mechanic, they're the scientist, they're the secretary, the guy who's fixing the toilet when that breaks. You're the maid, you're cleaning up on the weekend, or during the week.

So it really comes down to crew time. But to add crewmembers is complicated. You know, you have more crewmembers on board. Now you need another return vehicle on board that acts as a lifeboat if something happens. It also needs-- then those extra people, you need to be able to support them not only with food and water, but oxygen, air to breathe and carbon dioxide out of the atmosphere. So it gets really complicated and it's hard to do. But just to answer your question, we would need more people to get more out of it.

MR. HUGHES: Right. Of course, the international space station living up to its name has been such an international effort. Do you foresee when we look at Mars and long space flight missions in the future, do you envision that these will be international collaborations or will they be more of U.S. efforts?

TERRY VIRTS: My own personal view is that it will definitely be international. The reason that the international space station survived, if you look at the history of it back in the '90s, is I think the international program aspect of it allowed it to make it through Congress. And going back to the political science first as rocket science aspect of it, the international program makes it something that can survive over a longer period of time. And plus, it's great to have the ingenuity and you can gain some efficiencies by having different countries build different modules and so one country doesn't have to build the entire program themselves.

MR. HUGHES: Somebody passed up a question about Elon Musk, who recently talked about Mars and using a thermonuclear device as an option to make Mars more habitable. Any thought or comment on that?

MARK KELLY: You know, I saw that in the newspaper. I don't know the science behind nuking a planet, but I will tell you Elon's a very smart guy and he does think outside the box. And when you look at what he's been able to accomplish not only with SpaceX launching cargo to the international space station, hopefully people here pretty soon, an incredible car company, a big solar company. I mean, he tends to know what he's talking about. But I don't know the science behind nuking the planet.

MR. HUGHES: Another person in the audience here writes U.S./Russia relations are tense on Earth but seem very productive in space. What can leaders on Earth learn from your cooperation aboard the international space station?

TERRY VIRTS: I can definitely second that motion. Relationships in space, and on Earth, training, or preparing to launch into space are great. Our colleagues there are very capable, they're very friendly. I had a great time in space with Anton and Sasha and Misha who's up there right now with Scott. So we had a great experience with them.

And frankly, I think the station has accomplished a lot of things. And the most important thing is the international relation aspect of it. It's been, of all the ups and downs of relationships on Earth, the space station has been a very positive beacon of light.

MR. HUGHES: So Terry, you were on the space station during experiments with 3D printing. Please describe the benefits of this technology for deep space missions in the future and for the space station now if there are any? Were there any parts produced during the test run that were actually used and any lessons learned that can improve on the technology in the near term?

TERRY VIRTS: Actually, I'll let Samantha answer. This was her baby in space. But yes, the 3D printing I as great concept in that you can imagine going to Mars. Your closet is going to be full and you're limited to one bag only. So you can't bring all the tools you need. And if you could potentially print out parts or tools, for example, that could really save on the amount of mass that you have to launch.

We did make a little wrench and it was made out of the plastic. It wasn't like a hard metal wrench, and it was the first time it's ever been done in space. So it was more of a technology demonstrator. But it was pretty cool to see a tool printed out in space. We sent it back down to Earth for analysis, so we didn't keep it up there to use it. But that's a technology that has a lot of promise, I think.

MR. HUGHES: Okay. Mark, what's the lasting impression that space has given you? When you think of your time up there, what is the thing that strikes you the most later on?

MARK KELLY: Well, I think what became very obvious to me in 2001 during my first space mission was that we live on an island in a really unforgiving environment. You know, you look back at the Earth from a distance and you have very few people on board the space shuttle and space station. We've got 7 ½ billion of people on this round ball just floating there in the blackness of space. We really have no place else to go. And that becomes a very-- I mean, that was pretty striking and pretty quick observation by my part, and I imagine by other astronauts that fly in space.

So, it gives you, I think, a little bit more of an appreciation for our planet and what it does for all of us and the need for us to consider that and take care of it.

MR. HUGHES: Right. Terry, as we've talked about, the space station crew has conducted hundreds of experiments including many that have been developed by science students and transmitted up there. Do you consult with these same students when questions arise? And if so, how? And which science student experiments were the most interesting or challenging?

TERRY VIRTS: It depends on the experiment. Sometimes, they will-- we just talk to Houston or Huntsville as the NASA control center we're doing experiments. And then sometimes if it's complicated, they'll tie us in directly with the scientists who made it. So it depends on the experiment.

And I'm trying to think of what student only experiments we had. And most of the experiments we did, you kind of don't-- you just do the experiment and you don't really know who came up with it. But as far as student experiments, the student things I do remember is they built some equipment, like some storage bags or storage locations and stuff. Yeah, actually, so I was not involved in this, but there was a thing called spheres, that they're little satellites with little cartridges of air jets that fly them around and that was a big student led experiment with MIT that my crewmates were talking to the ground. And that was very interactive. The students could make software and fly them around, kind of like these robotic competitions that a lot of kids do nowadays, only this was a satellite in space competition that they were flying around.

MR. HUGHES: Right. Mark, I mentioned earlier relying on others for transport up to the space station. Do you think ending the space shuttle program before there was a replacement slowed the U.S. space program? In other words, was it a good transition or could we have done better?

MARK KELLY: So, we have the Columbia accident happen in 2003 and after Columbia, there was a joint decision made to retire the space shuttle because we realized if we continue to fly it over another decade, we'd probably lose another spacecraft and a crew, and we didn't want to do that. So this is a decision that was made by the White House, by Congress and by NASA including the astronaut office. This was the right thing to do, to retire the space shuttle.

What it allowed us to do is speed up the development of what the next spacecraft was going to be. When you get into testing and developing and building the hardware for a new system, a new launch system, a new rocket, a new spacecraft, it gets really expensive really quickly, like upwards of two to three billion dollars a year to do this.

Well, it just happens to be that the space shuttle operating budget was about two to three billions dollars a year. So there's two things we could have done. We could have retired the space shuttle and used that money to develop a new spacecraft. Or, we could have gotten two to three billion dollars more out of Congress and the White House to develop a new spacecraft at the same time.

Well, NASA's budget is only about $19 billion. So, you're talking about a 15 percent increase in NASA's budget to build a new spacecraft. In this fiscal environment over the last decade, I mean how hard do you think it would be for an agency to get an increase of about 15 percent in its yearly budget? Be really, really hard to do.

So, you know, I absolutely believe we made the right decision. I mean, we wanted to-- now, I personally would have flown the space shuttle every year for the rest of my life if I could. It is the best spaceship ever. I loved it. You know, part of me still wishes it was still around. But at the same time, we did make the right decision because the space shuttle was designed-- they were each designed to fly about a hundred flights. And Endeavor, which I flew on its last flight, that was flight #25. So they were designed to fly

about a hundred flights, but they were not designed to fly for 30 or 40 years. And that's the issue we were dealing with.

So, it put us in a position where we have to rely on our Russian partners to get crewmembers to and from the space station right now and over the next couple of years, still. But we'll be back flying U.S. crew members on U.S. rockets from U.S. soil here in no time and I think it puts us on a good path going forward.

MR. HUGHES: So either one of you, if you were Congress or the President, where would you focus our resources for NASA? Would it be a Mars mission? Would it be missions like the Pluto fly by, going back to the moon, the space station? Where do we need to put our focus?

MARK KELLY: We do everything.

MR. HUGHES: Do it all?

MARK KELLY: Yeah, if it was up to me.

MR. HUGHES: Yeah? But what if you didn't have unlimited resources, what would you prioritize?

MARK KELLY: That's harder. I'll let Terry answer that one. (Laughter)

TERRY VIRTS: Let the active astronaut, active duty-- no, I think NASA does not have just one-- I would not focus on just one thing. NASA has a broad mission to do both aircraft research and also robotic space exploration and human space exploration so I would divide it up.

MR. HUGHES: Okay. Terry, you stayed connected to Earth through your favorite pastime of baseball when you were up there. So as I understand, you set out to photograph every major league ball park from orbit and you posted many of these images on social media. Did you get them all? Where did that end up?

TERRY VIRTS: I got almost all, and the coast stadiums are pretty easy to get. Like Baltimore is easy to get, D.C.'s easy to get, the New York stadiums, Boston's very easy, San Diego. It's when you get to the middle of the country, it gets tough because there's nothing obvious around Kansas City. It's hundreds of miles of flat-- or St. Louis or Cincinnati. So, the ones on the corners were very easy to get and the ones in the middle were a little bit tougher to get. But I think I did get them all. I still need to go through some files and double check some of the ones in the center of the country because I didn't have time. Pittsburgh was always tough to get with all those hills and stuff in western Pennsylvania.

MARK KELLY: I think my brother's working on getting all the football stadiums now maybe because of what you did. Maybe that's where he got that idea.

MR. HUGHES: Okay. Before I ask the final question, I have some housekeeping. I want to remind people in the room that our astronauts will be available down the hall for stand up interviews immediately after this program concludes. I also want to remind you that the National Press Club is the world's leading professional organization for journalists. We fight for a free press worldwide and for more information about the club, visit our website, press.org. And to donate to our nonprofit Journalism Institute, visit press.org/institute.

I'd also like to remind you about some upcoming programs. This Wednesday, September 16th, at 1:30 p.m. Archbishop Thomas Wenski of Miami, Bishop Oscar Cantu of Las Cruces, New Mexico, and Dr. Carolyn Woo, CEO of Catholic Relief Services, will discuss Pope Francis's upcoming visit to Washington, D. C.

On Monday, September 21st, Big 12 Commissioner Bob Bowlsby will discuss college athletics. And Jane Chu, chair of the National Endowment for the Arts, will discuss new initiatives at a breakfast on September 28th. I'd now like to present our in-room guests with the National Press Club mug, much cherished. You can't easily find it on the space station, either, it's very valuable and we'll have to figure out a way to get it to your brother, right? Give him an extra one.

TERRY VIRTS: I can take care of that.

MARK KELLY: It's not very useful in space, though. (Laughter)

MR. HUGHES: So we mentioned the Mars movie that'll be coming out. So much fascination in literature, movies, television with space. I myself, of course, "Star Trek" junkie. Grew up that way. How about you guys? Could each of you tell me what kind of science fiction you enjoy, if any, and what you think about the movies and the science fiction that you see out there either in books or on TV or in the movie, starting with you, Terry?

TERRY VIRTS: Yeah, I've always enjoyed it. When I was a kid, of course "Stars Wars" was the big thing and I loved that. And I remember reading Arthur Clarke as a teenager, and that was-- he wrote some great stuff, really cool. Watching "2001," there's a space station in north orbit and I watched that when I was in space and I thought a lot of the stuff came true 50 years later. Just watched "Interstellar," too, while I was in space and a lot of that stuff is not what's going on board the space station. There's no worm holes or anything like that. But that's a movie you got to watch a couple times to figure out what's happening.

MR. HUGHES: So does Hollywood get it wrong most of the time?

TERRY VIRTS: Hollywood, of course they have to make it exciting. Actually, Scott brought up this big projector with him and so we watched "Gravity" one night. We put a projector up right where you guys were watching and watched the disaster movie,

"Gravity," it was fun. And the graph-- the mechanics of where everything was and what it looked like and it was very real. They got that done. And, of course, we don't have giant explosions and fire balls and the Soyuz exploding for us. So they have to make that to make a movie interesting. But if it was just astronauts doing science experiments, you probably wouldn't gross very much at the box office. (Laughter)

MR. HUGHES: Mark, how about you?

MARK KELLY: I just started reading this book called, science fiction book, called *Seven Eaves* about using the space station like save humanity after something really bad happens on Earth. So it's pretty interesting to see how either an author or Hollywood uses existing space technology in their movies. When I was younger, like these guys aged down here, these four-- well, the brothers and sisters down here-- I used to read a lot of Robert Heinlein, Isaac Asimov, those kind of books. It made me think about what it would be like to be in space one day, and I think that's an important-- it gives people ambition and they can picture themselves in a different place in a different time.

TERRY VIRTS: You know, the good thing, Mark, with all the genetic data they have on you and your brother, if that apocalypse comes, we'll be able to clone you guys. There'll be like millions of Kelly brothers. (Laughter)

MR. HUGHES: What about the young people? I mentioned as a youngster and you as a youngster, we were so fascinated with the space program. And I'm sure that continues. Young people who want to go to space some day get on that career track. What would you two suggest that they do?

TERRY VIRTS: I know Mark-- we get asked this question all the time. "What do I need to do to be an astronaut?" And I think the real answer is do what you're passionate about. Everybody has gifts, everybody's been blessed with different abilities and skills. What you are made, created, to do, go do that and do it well. There's not one path to being an astronaut. There's lots of different engineers and scientists and Mark and I are both previous pilots in our former lives. And there's medical doctors, Shel in space right now, Scott is a medical doctor. So there's lots of different ways to be an astronaut, and we need people with lots of different skills. I think the key is to do what you're passionate about and, like I said, where your gifts are.

MARK KELLY: But, you know, we're also on the cusp of this big sea change with access to space for people. I think there's a very high probability that the young people in here today some time in their lives, even if they're not a professional astronaut, will have the opportunity to go into space. You see companies like Virgin Galactic and others that are starting on this road to space tourism. And it's exciting and we're going to see a lot more. I mean, right now, there's probably about 550 people that have ever been in space and I think that number is going to grow substantially over the next decades.

MR. HUGHES: You think there's more excitement now about prospects in space than there were at any time in the past?

MARK KELLY: Well, I think one of the reasons is is that people are starting to think that, hey, this could directly affect them. Like, maybe they're going to be the person in space. So I think that's true. You know, maybe in some of our lifetimes instead of taking a flight from New York to London, that typically takes about 6 ½, 7 hours, maybe some of us will some day be taking that flight and how fast we could do it in the space shuttle, which is about 40 minutes. You know, that is-- there is no reason why that is not possible in the next-- in the coming decades. So I think people are starting to think about this differently.

MR. HUGHES: How about a round of applause for our guests? (Applause) I want to thank our National Press Club stuff including the Journalism Institute for their work on today's program. If you would like a copy of this program, go to our website, press.org, and that's where you can also learn more about the National Press Club. Thank you so much for attending today, we are adjourned. (Applause)

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