

**Thanks for inviting me** to your fall kickoff luncheon.

I know **you've heard a lot about our journey to Mars**. If you've been to a NASA social media page, you've seen the hashtag. We made a lot of news last week about the finding from Mars Reconnaissance Orbiter that the Red Planet has flowing water beneath the surface. That journey informs everything we do.

Many of you may also have seen the movie **The Martian**, or at least heard about it with all our social media and special events talking about science fiction and science fact moving closer and how a lot of the things that will make that journey a reality are actually in progress right now. While a possible and exciting vision of what we CAN do, thanks to Hollywood several elements were already there at the start of the movie – a hab on Mars, a MAV, and the HERMES to take the crew on the journey to and from Mars – all items we know we eventually need and are in our long term plans.

What I want to talk to you about today is our **overall plan for actually getting to Mars**. How are we strategically aligning our resources and our work to actually make this possible?

We've gotten a lot of **flack in recent years for not having a plan**, which is hard for us to understand sometimes when we see the smoke and fire of real engines for the Space Launch System, and Orion performing flawlessly on its first test flight in space, or even the progress with commercial crew and the one-year mission aboard the International Space Station.

But, often I think the flack is not necessarily for lack of a plan, but more around “they aren’t **doing MY plan**”. You see we as a space community have turned this debate into a “**right or wrong**” or “**good or bad**” instead of simply recognizing there are different ways to do this! All of which have merits and, frankly, all of which have challenges.

In the **simplest of analogies**, think about how you got here today. **Some walked** and many factors played into that decision: beautiful day, had the extra few minutes that might option might need, didn’t have the money for a cab or metro. **Some took the taxi** for the opposite of the other reasons, And I am sure there were other ways as well. Interestingly, I bet those that walked took different paths and, God forbid, some of you might have even walked in the grass! Those that took a taxi....I am sure they were different routes! Plus, each of us had to have plans resilient enough to the fact that Rich could lose the room and we might be on the other side of the Capitol. And, in all cases, no way was “right” or “wrong” – just different, we all assessed our own constraints and environment and made the decision and pressed. In all cases, we all got here!

**We do have a roadmap and a set of deliverables**, and a plan for our journey to Mars that make it much more than a slogan or a hashtag or something connected to a particular media event or pop culture phenomenon of the moment.

So, **today**, I have the podium and you all got to **hear MY (OUR)** plan and what we are thinking. Do we have the EXACT missions laid out for the next two decades? NO but we are making sure they build off things we are

doing today AND will let technology demonstration needs and readiness drive the content when ready.

We are **already on this journey**. Let me give you the overall picture of where what we're doing today fits along the trajectory that ends at Mars.

You know, when we received the **charge from President Kennedy to go to the moon**, we didn't just start building a rocket aimed at our neighbor and say, "here are the keys Neil, Buzz and Michael, good luck and give us a call."

**We had to get there in stages**. We had to prove technologies that built on each other so that each mission helped us retire risk, learn new things and advanced our capabilities. We had to work on both the human and robotic angles.

Even before President Kennedy's challenge, **we started with Mercury**, testing the systems **just to get humans to space**, first for short periods of time, and then for longer periods. In response to the Kennedy challenge, we began a robotic period with the Ranger satellite to help us identify landing spots and scout the terrain.

**We also moved to Gemini**, where we did **more complex things** like a rendezvous in space and walking for the first time outside the safety of the space capsule.

**Finally, we advanced to Apollo**, where we started working with the power of the Saturn V rockets and sent people on missions to orbit, but not land on the moon, **until finally we were ready** with a lander and a system we were confident could break free of Earth, safely reach the moon and deposit a crew on its surface, return them to their orbiting craft and bring them home.

It's a **similar model today**, with a few important exceptions – this journey will be an **international** one, this will take **longer** and be done for roughly **1/10 of the total federal budget** we had during Apollo, and it will be to establish a **permanent presence** at Mars

If you will, **we're in the Gemini (Mercury) stage right now.**

Think about today. We are **operating on the Space Station** and using **commercial partners** to send supplies and ultimately crew. We are **building SLS, Orion, and Mars 2020**. Some of the **technologies** in our Space Technology Budget and HEO's Advanced Exploration Systems. They are all key pieces we need if we are ever going to get to Mars. Further, this is "**AND**" **not** "**OR**". We need all of this and we need to be flexible to **inevitable change and challenges** so how can we build a plan **resilient** to things that could happen?

In just a few weeks, we'll have had human beings in continuous occupancy aboard the International Space **Station for 15 consecutive years**. Not only is that an unprecedented achievement in human history, it's given us an incredible **baseline of knowledge about living and working in space**,

and it's helped us develop a lot of technologies that will take us to the next stage. Technology drives exploration, and it's certainly driving this journey.

**On the station, we're a matter of hours from home.** We're still in the harsh environment of space, but we're learning a lot about human health in microgravity for long periods, not only with regular duration expeditions but also with more extended stays like the one-year mission currently underway.

We're also **testing new technologies**, learning things like how to grow food in space, perfecting life support systems, mitigating the effects of microgravity on the human body, and perfecting the **human robotic interface** as our astronauts work with DEXTRE and Robonaut and the station's other robotic systems. And we're learning to manage a complex system without the immediate support of Earth's resources, even though we're close.

As an additional outgrowth of this phase, we've been developing the **industrial base** that supports our more ambitious missions. American industry is now capable of sending cargo to low Earth orbit and soon will be sending crews to the station. A wide range of companies are developing their own systems and innovations that will support a space economy based on activities in low Earth orbit and poised to support the farther legs of our journey to Mars.

So, to summarize, **in this stage, we continue to learn about how to live in space and the impacts on humans** but we are also **testing some of**

**the technology and robotics** we will need – while enhancing the country's industrial base of providers for LEO access.

Now, **fast forward to the decade of the 2020's. What do we need to be doing** there that enables us to get humans to Mars in the 2030's?

So let's talk about **that decade and how it works to ultimately enable a Human Mars mission.** For context, I want you to think of getting to Mars as the big Mission that we are trying to align our efforts toward.

We're going to be **moving to cis-lunar space by the 2020s**, and this is what I would equate with later flights of **our Gemini timeframe** (rendezvous, EVA, etc.).

**Our big "M" Mission to Mars requires that a lot of little m's come together and get refined.**

We call the area around the moon the **proving ground**, because it's where things like **solar electric propulsion, habitats and other technologies will be used for the first time in their intended environment.** We'll do shakedown of them while we're still just a few days away from Earth instead of weeks or months. The **Space Launch System and Orion** will be the backbone of our transportation system, getting us where we need to be and helping us learn even more about propulsion and rocket systems, and a new human rated vehicle for deep space.

These missions – and I count the Asteroid Redirect Mission, or **ARM**, among them -- will continue our work on the human angle, with advanced **spacesuits and EVA technologies**. For the first time in quite a while, except for perhaps the Hubble servicing missions, where, again, we built on what we've learned, we'll be doing a new kind of EVA, outside of smaller spacecraft and around a large space boulder, for starters, or in orbit around the moon.

We'll be learning **how to interact with another planetary body** like an asteroid, developing new docking protocols perhaps, developing **sample return technology**, living in the type of quarters that are going to have to house human beings for months at a time on our way to Mars, but still while we're 5-6 days from home.

At this point, perhaps we have moved the learning curve to a point where we're at about a **50/50 ratio as far as what we're learning about the human organism in space vs. the science, technology and robotics** data that we're gaining.

By the time we get to the **Apollo level** of proficiency, we're ready to go to the Mars neighborhood. It's a big leap, and we have a lot of work to do to get there, a lot of problems to solve.

In deep space, we'll **need to have everything we need**, or make it, or have it sent on ahead. The life support systems will need to be self-sustaining. Better communications systems will need to cut down the delay in communications, although the astronauts are still going to be on their

own should there be a problem with the spacecraft, a medical emergency, or really just in meeting their own daily needs for food, water, air and exercise.

Luckily, **we've already been at Mars for quite a while**, 50 years to be exact. Right now there are multiple rovers and orbiters helping us learn more about the Mars environment, from climate to radiation to soil content and potential local resources, whether or not the planet could have supported life (or still does?), where the best landing sites might be, and where the water is!

**What other robotic missions can we do in the 2020's** to better help us understand? We are looking at defining that just like we are looking at what we can do in cis lunar space.

**Next year, InSight** will head for Mars to study the planet's core and seismology. But as of this minute, there's not a Mars mission on the books beyond the **Mars 2020** rover.

So we have **a lot of data to gather now about the planet**, and I'm not saying there won't be more science missions, but **at some point, the 21<sup>st</sup> century's Gemini and Apollo stages, we're going to make those technology breakthroughs** that make it possible for the fragile human being to travel the 35 million miles and reach the dream we've held for

I think **we'll be ready, because of this staged approach**. This strategy where there are no one-offs, where everything contributes to the greater

journey. It takes a maniacal approach to ensure that alignment is there. By that I mean an incredibly tight control on all of these details and how they integrate, support and advance each other.

**Today's journey to Mars**, the work of the "real" Martians as we call them, is **taking place right now at NASA** centers and with partners across the nation.

So we will do it, but we're talking about a **multi-decadal national, really international, effort** that crosses multiple Administrations. And right now we're working with one-year budgets, often not even really budgets, but a continuation of the past year's funding.

What we are going to **have to provide, as the space community, is a sustained march**. I'm not talking about just NASA, but everyone who has a hand in what we're doing here. That's all of you, that's our industrial base, that's all the organizations that support space exploration, international partners, the students who want a career in the aerospace fields, the strongest die-hard supporters in Congress.

**NASA has always led space exploration** and the journey to Mars is ours to lead as well, but it is going to **require a lot of energy for this long haul**. I know there will be a lot of exciting milestones along the way, and a lot of things that may not even technically be on our journey to Mars -- say the next exciting images from a science mission to another world -- but it all contributes to the inspiration and excitement that engages everybody in this big thing that we have always done well and been proud of as a nation.

It's going to be an exciting time, and it is already. We are at a place where we are operating in space today and running development efforts akin to the Apollo effort. We're working to build confidence in our systems **across the range** of everything we do. With each success and, even those that don't go so well, those precious learning opportunities, we build confidence that our journey to Mars is NOT too big or too hard or too far-fetched. We do have the ability to make this happen. It's going to be a function of our will and our willingness to extend ourselves. To believe and to work really, really hard. That's nothing new.

We, all of us in this room, can do one thing to help this. **Let's start talking about what we CAN DO, not what we CAN'T DO.** Yes, it is a challenge to go to Mars and there will be many steps and often mis-steps along the way, but in a world where U.S. global leadership is often questioned in so many areas, the **EXPLORATION OF SPACE is CLEARLY ours to lead.** We need ALL of us remember that and remember **we CAN DO this.**

Thank you.