Hey what's up everybody welcome welcome welcome back to NASA in Silicon Valley live if this is your first time with the show NASA in Silicon Valley live is a conversational show out of NASA's Ames Research Center where we talk about all the nerdy NASA news you need to know about.

I'm your host today Abby Tabor and I have with me the extraordinary Daniel.
Carmichael hi everybody I am your
co-host Danielle Carmichael and it is
great to be back if you don't know we
are simultaneously live on twitch
YouTube face Facebook and periscope but
if you want to participate in the chat
and ask our guest some questions there's
only one place to do that and that's a
www.twitch.tv/esa okay so speaking of
NASA news we have a really big
announcement to make today are you guys
ready are you ready okay we are
returning astronauts to the moon and
this is really exciting so we have for
you today two of our experts we're gonna talk about some of the plans that NASA has for returning to the moon so let me introduce you to Tony and Kimberly so why don't you two tell the audience who you are a little bit about yourselves Kimberly I'm Kimberly Annika Smith I'm a research astrophysicist here at NASA and I work on space missions viewless thanks I'm Tony Cole pre I'm also here at NASA Ames Research Center I'm a planetary scientist and work on space instruments space missions things like
that all right cool so let's start with

44
00:03:01,080 --> 00:03:08,010
the basics of returning humans to the

45
00:03:03,840 --> 00:03:10,020
moon when's this gonna happen the clock

46
00:03:08,009 --> 00:03:11,129
I think up in front says yeah

47
00:03:10,020 --> 00:03:26,469
[Music]

48
00:03:11,129 --> 00:03:29,859
do the math 656 days counting down the

49
00:03:26,469 --> 00:03:33,000
days until the Year 2024 which is when

50
00:03:29,860 --> 00:03:36,250
the first woman and the next person

51
00:03:33,000 --> 00:03:37,810
perhaps it's a man perhaps a woman will

52
00:03:36,250 --> 00:03:40,509
set foot on the moon right that's right

53
00:03:37,810 --> 00:03:42,789
that's be a historic hour stork moment

54
00:03:40,509 --> 00:03:44,979
exactly so let's talk about this mission

55
00:03:42,789 --> 00:03:47,530
let everybody know what it's called to

56
00:03:44,979 --> 00:03:53,019
start us off well we're calling it

57
00:03:47,530 --> 00:03:54,370
Artemis right so why why Artemis
like what's so significant about that name

well she's a if you know your Greek mythology Greek mythology Artemis is the twin sister of Apollo about the Apollo program that's when we did send the first humans to set foot on the moon exactly so the next we're going under the Artemis mission and I might add that when I was in fifth grade we did Greek mythology and my goddess was Artemis pretty sure that played into the choice so why the moon what is so exciting for a couple of scientists about going back
to the moon oh boy where to start the

moon is a spectacular place it's it's

her nearest neighbor it's a treasure

trove of science of exploration its

place where we can learn about the

history of the earth in our solar system

it's also really a launching pad in

terms of our exploration beyond Earth

there's resources there we can utilize

to explore but there's also just the

opportunity to test our abilities or

technologies or processes for extended

missions beyond the moon to Mars for

example that's the ultimate destination
beyond me the moon right now but
even beyond that to asteroids in other
places Wow so it's a it's a huge sandbox
if you will have really learned in and
and demonstrate what we can do to

looking at just the moon itself we know
a lot about it but we've not really
visited a lot fraction of the surface or
even the environment of the moon there's
a lot of mysteries still yet to be
uncovered yeah yes on the surface and
underneath the surface okay and yeah
absolutely and you know mention the
Apollo program we've been there robotically we have a robot there spacecraft orbiting it now but we've only barely scratched the surface in terms of the amount of area we've explored on the moon there's so much more to learn imagine awesome all right so you were anxiously anticipating very 1656 days from now you'll be watching that clock closely I guess yeah all right so tell us a little bit more specifically where are we sending astronauts in 2024 well this is what I was gonna actually just say was what's really really exciting us where you are
going where we never been before and
that's to one of the poles of the moon
and very specifically the South Pole or
the moon which is my favorite pole and
it's an incredible place and we can
talk about that as we go but it's full
of spectacular topography moving shadows
extreme temperatures it's unlike
anywhere we've ever visited and we are
gonna talk all about that later I'm
excited for that
but you mentioned resources now there's
water there isn't there yes true
statement okay so why is that so
important obviously I know humans need water to survive but but what do you see us using that for lots of other purposes

right yeah

well water is key in water is so important for two different reasons one it’s incredibly scientifically interesting and understanding the water now exists on the moon is really important to understanding the processes that have acted on the moon and the earth over the last several billion years Wow yeah and I like to think of
the ice at the poles is almost like ice cores here on earth if we can examine

that water ice we can actually look back into the history of the solar system but also just as important it is a valuable resource and as we probably all know water contains two hydrogen and an oxygen atom and hydrogen and oxygen are exactly the ingredients that go into rocket fuel and rather than spending lots of rocket fuels to bring rocket fuel into space which is what we need now right it’d be great if we could actually find a resource and produce
rocket fuel outside the gravity well of Earth that would not only make things more affordable it actually could be enabling of new architectures for exploring Mars and beyond the oxygen in itself is what we breathe yeah of course and the techniques and the approach to how we excavate water on the moon is applicable to even doing it on Mars so if you're looking for long-term human presence on other worlds and truly becoming interplanetary species we can be creating the oxygen that we breathe in the habitats in which we're living in off world that we're actually talking
about that you know is it future reality

not just a plot line I actually have a couple of shout outs so snail says that

the Earth and Moon shirt is awesome said

it's great to see Tony and Kimberly

again yeah

[Music]

Wow all right do you have any questions

yet Daniella I do so moon mo most writes

wants to know like what's the end

long-term goal of the Artemis mission

because we've been talking it up but

yeah that's a great question you want to

so Artemis is a term to describe it a
whole series of missions to the lunar surface and using a an orbital tugboat called the Gateway it's a big architecture but in the long term opening it up with many partners are long on this journey we have a sustainable presence on the moon where we are you know providing the infrastructure for us to stay there for building materials to creating the rocket fuel to exploring areas that we've never been before the you know actually going into the the depths of craters that we haven't explored yet and
pieces of moon we don't see so that

long-term presence on the moon but while

we're using those techniques that's

become applicable for to that next step

you know we're living off Earth on

another world in a harsh environment and

learning to deal with those challenges

and solving those challenges and once

we've got that under our belt and we've

understood our neighborhood background

our backyard we can take that easily to

Mars yeah oh cool I see lots of other

great questions but I know that some of

them are going to answer yes see in the
next few minutes so let's keep going I

just want to touch back on the water a

little bit how much are we actually

talking about I know you two have worked

together on a past mission that found

some water launched 10 years ago

yesterday yesterday

[Music]

and the mission we launched with LRO

the Lunar Reconnaissance Orbiter is

still in orbit around moon still

collecting data and making fantastic

maps of the lunar surface which actually

was really enabling of Artemis able to

go forward awesome yeah
yeah so the yeah Kim and I were both part of the L cross mission which was a mission that crashed a spent upper stage of rocket into a permanently shadowed crater at the South Pole of the moon and the purpose was to understand the nature of hydrogen we had measured there prior with a different mission and saw an excess of this hydrogen we didn't know if the hydrogen was water or just sort of protons which is hydrogen atoms trapped in the soil or what and and our job was to actually understand it to see if it could potentially be a resource so
it was a very targeted mission see what

that water a little bit

what is a permanently shadowed crater

good question and the illumination of

the Sun there are places at both poles

of the moon where the extreme topography

the rims of the craters of the moon the

Sun didn't does not get above those rims

so the basin's of those craters are in

permanent shadow and they have been in

permanent shadow for you know four billion years Wow and being in the

shadows if you remember if you're out in

a hot day and you go underneath the
shadow of a tree you'll notice that things get a little cooler well and if you're in a permanently shadowed place on the moon things get really really cold so these these what was interesting of atoning was mentioning this orbiter mission that had found hydrogen it was concentrated at the poles and there was a correlation with the permanently shadowed craters so there was this connection between lots amounts of hydrogen in very cold places that had never seen sunlight and actually it was theorize that these craters would have
cold bottoms and could hold water as early as 1961

oh really first we'll really understand

in topography even before the Apollo running and so it wasn't though until

four ten years ago we verified the form of that hydrogen and one of these cold craters as water ice so let's review

now that was El cross which is observation and sensing satellite yes

okay all right okay we hit a crater at the Lunar South Pole and that's Tony's favorite and we're the future astronauts will be landing exactly wait okay and do
you remember how much water L cross saw

yes point measurement right it made a

crater about 35 meters across half a

football field or so the Quran and so

yeah it brought ejecta up into sunlight

so we could examine it and it's the soil

up shadow eventually reaches sunlight

and let's I always like to think about

that that's that soil and seen sunlight

in billions of years it's crazy

yeah and in just the dirt we threw up

into the cloud or into the Sun sorry we

saw about 152 gallons of water okay and

if you take all if you take that
measurement and all the other measurements we have of hydrogen at the poles and make some assumptions about how its distributed with depth we're talking ten million potentially up to a hundred million tons metric tons oh wow of water ice it's a lot I think so I think Kim and I were talking beforehand and it was science and yeah to be clear none of this is flowing liquid water this is crystal temperatures are about minus 200 and to minus 240 or so below zero centigrade okay and this was the first time we ever
sampled the bottom of a permanently

shadowed crater I mean since then this

has the experiment has been repeated

okay and in not only did we find water

but there was a bunch of other things

that were excavated as well gold mercury

argon carbon monoxide and so it's

opening up these questions when we're

gonna have humans and robots going to

the polls of their South Poles of Moon

we're gonna get the boots on ground the

wheels on ground and really understand

what's there because we've never been

there before and we just have this you


know simple impactor experiment that

opened more questions than it answered

but it answered one particular one right

the hydrogen is definitely in the form

of water ice and enough such that there

is the resources to enable the

exploration exciting yeah another good

way to put in perspective is El cross

about five percent by weight water up

water in the regular thing the dirt

regular this lunar dirt for comparison

that's about what you have it in the

Sahara okay places on the moon is as wet

as the driest places on earth okay

that's the engineering challenge ahead
that we will solve it excavated cuz we

know it's there we can extract um you

know water has been extracted from very
dry places okay yes yeah that can be
done it can do it how exciting

awesome so I want to know then what's

next okay we know the people will get

they're gonna send people there let's
talk about how so what's the rocket

that's going to take people on the fur

on the order of Artemis missions to the

moon who wants to take that Space Launch

System that's it yeah we have an

animation I think of it too that's right
00:17:24,849 --> 00:17:34,750
yes there it is largest rocket ever

00:17:28,779 --> 00:17:38,230
built and it's to bring humans not only

00:17:34,750 --> 00:17:41,200
to the moon but actually beyond to there

00:17:38,230 --> 00:17:42,940
it carries them in a capsule that's on

00:17:41,200 --> 00:17:46,419
the very tip of that that just went past

00:17:42,940 --> 00:17:49,679
the frame called the Orion capsule very

00:17:46,419 --> 00:17:58,000
small capsule up there but that capsule

00:17:49,679 --> 00:18:00,940
you'll see them is designed to take an

00:18:00,940 --> 00:18:06,820
incredible amount of material to you

00:18:00,940 --> 00:18:06,820
know deep space so it is servicing Moon

00:18:04,028 --> 00:18:09,159
and Mars and also elsewhere I mean it

00:18:06,819 --> 00:18:10,658
also has amazing commercial spin-offs as

00:18:09,159 --> 00:18:12,669
well because you can actually put up a

00:18:10,659 --> 00:18:19,990
replacements of say the GPS satellites
and in a single SLS rocket we do other types of things in the agency so it's one of many uses of a large rocket that's been you know can be utilized how awesome Danielle you jump in whenever you have to the question but otherwise we're gonna keep talking about so that was SLS the rocket and so let's see the Orion capsule animation and tell us a little bit about so Ryan is there it is a the capsule that will bring the astronauts wherever they're gonna go and this indeed can go not just to the moon but also beyond the Mars and after
you know a lot of analysis and study it

386
00:18:58,690 --> 00:19:03,759
was eventually concluded that the the

387
00:19:01,720 --> 00:19:06,399
Apollo shape the blunt-nosed reentry

388
00:19:03,759 --> 00:19:10,359
system that Apollo used is still a best

389
00:19:06,398 --> 00:19:11,888
way to go forward look how roomy if

390
00:19:10,359 --> 00:19:13,658
you're looking into this video

391
00:19:11,888 --> 00:19:18,969
look how roomy this one is compared to

392
00:19:13,659 --> 00:19:20,769
the Apollo documentary that the movie

393
00:19:18,970 --> 00:19:25,329
theaters you get a feel for how tight

394
00:19:20,769 --> 00:19:28,019
and all this this is for and it's a lot

395
00:19:25,329 --> 00:19:32,009
more powerful in every single way from

396
00:19:28,019 --> 00:19:35,380
information systems guidance payload

397
00:19:32,009 --> 00:19:37,690
everything and and and it's meant to be

398
00:19:35,380 --> 00:19:40,929
able to carry humans a longer distance

399
00:19:37,690 --> 00:19:43,269
way beyond the moon okay so it is really
is Apollo on steroids I’d like to say

yeah that's awesome I love that it's

kept up some of the same design as

Apollo way to go Apollo engineers

would you do it he solve some pretty
tough challenges and they made happens I

guess we know we can do this actually

have a question from digital don don

jure he wants to know are you using

specifically any apollo-era research or
tech on the quest to return back to the

moon well the the shape I just mentioned

is really was derived originally through

the Apollo program the shape of that
capsule is very critical to enabling the
re-entry and and and this capsule is
meant to re-enter parachute and splashed
down and the ocean just like the Apollo
program did and speaking of reentry here
at NASA Ames we develop and test the
thermal reentry materials and for the
Apollo program is chemic chemical
compound called avcoat
and therefore that re-entry through the
atmosphere and they would oblate so they
would absorb the heat and then you know
protect the capsule to a successfully
returned to preparation for orion
engineers looked at F coat and he modified the chemistry of that and did a lot of the testing so there's a direct connection even with the materials that were used during Apollo pretty cool and it is modified for the shape of the capsule but for to and to support even re-entry from further destinations say you're coming back from an asteroid or say you're coming back from Mars orbit or something like that to be different so it's smarter yeah all around I love that excellent and I love these apollo connections but then on the flip side
how is the Artemis program different

00:21:28,349 --> 00:21:35,849 from Apollo well an element that we that

00:21:34,559 --> 00:21:39,929 I've mentioned briefly sorry about the

00:21:35,849 --> 00:21:42,089 spoilers is a is actually one of the

00:21:39,930 --> 00:21:44,430 cooler parts of the Artemis program it's

00:21:42,089 --> 00:21:48,299 this this object called the Gateway okay

00:21:44,430 --> 00:21:50,519 and the Gateway is our first

00:21:48,299 --> 00:21:51,779 interplanetary spaceship and this is

00:21:50,519 --> 00:21:53,069 something that nASA has never really

00:21:51,779 --> 00:21:55,710 built before hmm

00:21:53,069 --> 00:21:59,309 and that's why in a sense it's exciting

00:21:55,710 --> 00:22:01,500 I mean this space module sometimes we'll

00:21:59,309 --> 00:22:04,649 call spaceship will

00:22:01,500 --> 00:22:07,109 be in lunar orbit and it will provide

00:22:04,650 --> 00:22:11,340 the way to access all different parts of
the moon and it's also going to be crude

but not 100% of the time so it has to be

autonomous it'll have a lot of autonomy

in it and it also would be providing a

way to be a space laboratory so we can

put experiments onboard for

understanding biology outside our

magneto spirit

it also can dock with all the different

commercial and international partners it

has an open architecture the port

designs are gonna be available for

anyone who wants to build things that

connect to it the Apollo will connect
Apollo will collect connect to and service modules but it has ability to change its orbit mm-hmm so it can also become this interplanetary tugboat because it can move things around and first enable travel I mean it's the transportation backbone for Mars exploration and we're going to this space ship will oh and we have an animation showing of this orbit in which the Gateway for the lunar exploration will have really is enabling and this is the part of the Artemis program it's very this is Apollo didn't do this so
Paul took everything with them and everything came back so Artemis is building up a sustainable presence and this gateway is key to that yeah and one part that I’d like to emphasize that can mention as is really different from Apollo is this open architecture aspect is NASA's not doing this alone and it's and it's even beyond what we did for the International Space Station where we had lots of other government agencies involved there is a huge involvement from the private commercial sector that's involved in all parts of this so
this Artemis program and lunar

exploration going forward has got a commercial element a private sector commercial element a lot of people call it new space part of it that didn't exist during Apollo so we are really I think at the you know at the dawn of a new age of exploration and in space beyond Leo as Tony was saying about this it's sort of a space economy have a lot of partners we're on the verge of you know if you were to go back in time and ask the Wright brothers to look at modern-day today and see that oh I can
fly from place to place on this planet

using an airplane that they did the

center or go back and talk to Alexander

Graham Bell invented the telephone and

we all look at using our smart phones

that communicate we have no clue what

the future of space will be when we

involve the cameras it is really

unbounded future that's monumental we'll

be able to do things we could never have

done before before well let's move into

our rapid fire section so I'm not gonna

give any user names but I'm just gonna

go ahead and just spit out some
questions the human body on the moon

long-term effect of the human body on the moon or the environment on the human body it's actually a really interesting question from the science standpoint in particular these cold air because these in the craters are what are called cold traps they're so cold any molecules that get in there freeze out so every time we've gone to the moon and the astronauts vented water or vented other things or out gassed out gas means stuff subliming off of equipment those molecules some of those molecules very
likely found their ways to the poles of the moon froze out okay there now forever until the meteorite might release them if we go once we go exploring not just we NASA but the world will bring more and more of these volatiles and other materials to the moon that will be trapped in the cold trap so if you're trying to understand some pristine environments to understand the history the last three billion years you want to do it in a way that you can understand what contaminants
you've brought there yourself and we

557
00:26:48,279 --> 00:26:55,480
actually we NASA Ames flew of mission

558
00:26:52,690 --> 00:26:56,740
not long ago long ago called ladee the

559
00:26:55,480 --> 00:26:59,349
lunar atmospheric dust environment

560
00:26:56,740 --> 00:27:00,910
Explorer and its principal purpose was

561
00:26:59,349 --> 00:27:03,579
actually to understand the lunar

562
00:27:00,910 --> 00:27:06,310
atmosphere the exosphere in its pristine

563
00:27:03,579 --> 00:27:07,569
state with the anticipation that more

564
00:27:06,309 --> 00:27:10,029
and more countries and commercial

565
00:27:07,569 --> 00:27:11,409
people's would be going to the moon and

566
00:27:10,029 --> 00:27:15,220
so we wanted to get kind of a background

567
00:27:11,410 --> 00:27:19,630
before we start impacting the baseline

568
00:27:15,220 --> 00:27:21,490
before we touched it right from a impact

569
00:27:19,630 --> 00:27:23,950
on the human body radiation is one of

570
00:27:21,490 --> 00:27:26,460
the principal concerns and there's a lot
of very clever solutions being looked at

in terms of shielding and and we talked

about water as a resource there's lots

of other resources at the moon and

especially at the poles including

lighting for the solar power but also

the dirt itself the regolith can be an

efficient insulator okay so as kimberly

was talking about living off the land

involves using whatever you got whatever

you situation better yeah excellent

next question how many launches until

the first base is set up hmm that's a

good question
well we're turning about a base so

there's two phases to the Artemis the one is the the return of the first

humans and that's the 2024 milestone and

then there's a later milestone 2028

where we have a more established presence there prior to the first humans

going on the moon will have the first

launch of Artemis Artemis one which will

not have humans on board but will carry

space satellites and robots in the light

some will go to deep space a second

Artemis mission will actually go to the moon or in orbit around the moon it's on
that third launch of the SLS that we
would be carrying the humans and that's
the 2024 milestone
so we should see a sequence of
incremental steps towards proving out
the new long system and the new
capabilities in addition the first
module of the Gateway which is the solar
propulsion element which is a really
cool technology advancement we've never
seen an engine like this on a spaceship
before that's gonna be launched by a
commercial rocket and so that's you know
we're gonna be having all these
different types of infrastructures

getting us all part of the Artemis

program and that's it this really brings

out an important point it's not a it

will be done by this date it will be a

continuous development and build up in a

to reach a an eventual sustained

presence and so the exact date when that

becomes a base or whatever you want to

call it isn't defined because it's

really building up of capabilities over

time there will be longer and longer

stays as they move through these various

phases as Kimberly stayed as just

mentioned for the astronauts on the
surface okay so we have time for two

short questions this gateway gonna be

inhabited by astronauts when it's

finished that's a good question I mean

it's variable the the key point is that

that spaceship needs to be able to

operate without humans because it will

be pers and which humans aren't on board

so don't know the exact fraction of it

but it's going to be have two different

modes when the humans are on board and

when they're not yeah I've heard numbers

up to 30 days at a time okay so they're

not gonna be up there for a year like we
do on Space Station they'll go up there and then come back in a month or two and so that's to Kimberly's point is a lot of the time you don't have to have robots running the house so last question someone wants to know like what's the coolest thing about Gateway I've heard you vote for this power well Kim I call it the tugboat this is electric propulsion system and it's at a power level we've never built before and what's neat is it allows it to change its orbit around the moon so it is
really a spaceship it's not just going in orbit it can actually steer this entire space station size kind of thing
are in space okay and then ultimately it's it's the kind of engine that's gonna be used to bring us to Mars and -
droids in - whatever else so okay and it's a slow ride acceleration acceleration it is slow but it's powerful it allows you to get to the kinds of velocities with a lot of mass and you need to do interplanetary travel and I like the open architecture I don't think that's all the engineers to figure
out all the wonderful uses of gateway

671
00:31:33,470 --> 00:31:37,490
mm-hmm because it's a little I mean it's

672
00:31:36,170 --> 00:31:39,980
gonna be designed for a certain purpose

673
00:31:37,490 --> 00:31:42,559
and will achieve those purposes allowing

674
00:31:39,980 --> 00:31:44,259
the docking of multiple vehicles from

675
00:31:42,559 --> 00:31:46,549
different countries and companies

676
00:31:44,259 --> 00:31:48,950
allowing astronauts to stay for periods

677
00:31:46,549 --> 00:31:51,019
of days months being in constant

678
00:31:48,950 --> 00:31:52,580
communication with the earth being in

679
00:31:51,019 --> 00:31:54,889
communication with the surface of the

680
00:31:52,579 --> 00:31:56,119
Moon being able to deliver things to the

681
00:31:54,890 --> 00:31:59,750
surface of the Moon at different

682
00:31:56,119 --> 00:32:02,179
latitudes I mean it's very versatile but

683
00:31:59,750 --> 00:32:04,400
they could also be a testbed for testing

684
00:32:02,180 --> 00:32:06,769
other types of vehicles that actually
might be made in space someday hmm and
then watch them from there I mean it has
a lifetime that will keep giving we're
only thinking about how to you know do
that first step is the first step and
the return to the moon the forward to
the moon part but there's a lot more
than it can get okay yeah you both keep
mentioning learning at the moon and then
we'll go on and you know SLS could take
us to Mars so let's talk really quickly
a little bit about Mars so what are some
favorite fun facts about Mars you can
share with us okay well if we have a
picture of Mars it took you people than

what Mars looks like it's what's the

called planet around the Sun

it's a red planet the red is primarily

due to iron into the rocks on the

surface of Mars Mars has polar caps it

has you know it's when the other bodies

besides the earth that has frozen ice

it's water ice and carbon dioxide ice at

the polar poles it's it has an

atmosphere but its atmosphere is

different than Earth's it's partly made

of carbon dioxide where's our atmosphere

is nitrogen raised and if you its
support where the earth is the third planet and Mars is the fourth planet we're both circling around the Sun if you imagine racetrack write cars on a racetrack um so at our closest distance between the Earth and Mars is about thirty four million miles and that happens every 26 months otherwise we're doing laps right so this is a reason why when we launch our you know robots to Mars and few in the future the human the crewed missions to Mars taking advantage of the close that twenty six month period of of alignment okay crazy helps
shorten the distance cuz even at that

shortest distance the trip is still

about six or nine months okay alright

and the moon you say is gonna help us

practice for what we might do so much of

what we will be doing on the moon is

extensible to to Mars and and everything

from the kinds of tools we use to the

procedures and processes and the

technologies learning to really work and

and build and construct and different

environments that the Moon and Mars

everything from gravity to low up little

to no atmosphere etc it's really

important and bring it back to water and
as kimberly mentioned mars has got water

we've known that for a while it's got a lot more water than the moon okay and but that is the one of the key connections between the moon and mars is as we learn to utilize water the moon everything from locating it excavating it processing it well that can be carried over and applied to how we do that on mars which we want to do we want to excuse me live off the land at mars - we don't want to bring everything with us to mars eventually we will of course the first few times but
you can't it's too far away

all right I was mentioning earlier is months were really comfortable with this

whole approach on excavating the water and processing ordering and transferring

it to rocket fuel or oxygen or other

utilizations because water can be used in many different ways that's a totally applicable system for Mars you know directly and also the most likely there will be wonderful spin-offs that can be used back here in ours oh yeah I mean

directly in a closed system is usually very power conscious you're not using a
lot of energy things will have you know

very improved technology from the chat

looks like king gold boy gamer ones you

know like when are we actually going to

go to Mars but it would be and you know

a couple decades it's the first we're

gonna practice we're gonna learn to

excavate water and process it and all

that and also the most fragile part in

this whole amazing exploration adventure

is the human body the human body outside

the magnetosphere you know we've had

only 24 individuals who've been outside

that we are now going to have the
ability to really study biology and how

00:36:47,670 --> 00:36:51,900
the human body is reacting this this

00:36:49,559 --> 00:36:54,269
will make us totally prepared for that

00:36:51,900 --> 00:36:55,950
long trip to Mars because a mission to

00:36:54,269 --> 00:36:59,130
the moon is three days and you're on the

00:36:55,949 --> 00:37:01,469
surface for weeks months come back but

00:36:59,130 --> 00:37:03,690
you're you're close to home when you go

00:37:01,469 --> 00:37:05,608
to Mars we're talking a two-year and how

00:37:03,690 --> 00:37:07,079
is the bond you know it's link is six

00:37:05,608 --> 00:37:08,338
months and I wants to get there gonna be

00:37:07,079 --> 00:37:10,170
there for a few months you come back you

00:37:08,338 --> 00:37:11,440
want to take advantage of the shirt

00:37:10,170 --> 00:37:13,480
close by so you

00:37:11,440 --> 00:37:17,200
bianna sort of a two-year time scale

00:37:13,480 --> 00:37:20,079
just think about it you know what we're
going to learn to protect the human body

and you know enable all the infrastructure to allow the human body to survive and thrive we all saw that by being on them yeah

so tell me quickly so so I want to know what's coming up then you know what's in the news coming up next in the process so human Landers will be built by by NASA by partners what do you guys know about that there was a I believe there was a bid that went out on the street for companies to provide lunar landers and docking with the Gateway or
not because there commits an open it's a different type of architecture you can use but yeah okay yeah there's and there's a variety of Landers being pursued with the commercial sector with NASA and there are smaller Landers being built now and we've actually NASA just recently selected three to be carrying NASA payloads so instruments and things next year and and a couple in the summer of 21 July 20 21 and what's really neat is these these companies are providing telling them we need a lander like this
no it's they're building a lander that provides a service and selling that service then ok NASA here's an example of one on the screen of one of these small commercial Landers and these companies and have plans to increase this the the scale and the scope of these Landers so they can carry more and more to the surface so the human Landers are discriminately said right now being discussed with commercial companies as to who's going to participate and build them going forward and it's really kind of exciting because again this is a
totally new paradigm we NASA's always

00:39:17,769 --> 00:39:23,559
built the Landers with commercial

00:39:21,068 --> 00:39:26,409
companies but they've done it in

00:39:23,559 --> 00:39:29,410
a very much requirement driven process

00:39:26,409 --> 00:39:31,688
we need you to build this for us okay

00:39:29,409 --> 00:39:34,449
see this is very different this is I'm

00:39:31,688 --> 00:39:36,129
buying my airline ticket to fly across

00:39:34,449 --> 00:39:40,209
the country I'm not telling you how to

00:39:36,130 --> 00:39:44,289
build your everybody that's what we're

00:39:40,208 --> 00:39:48,659
doing and other other folks can pay to

00:39:44,289 --> 00:39:56,769
use the services so it's opens up the

00:39:48,659 --> 00:39:59,469
accessibility of the Moon the chat a

00:39:56,768 --> 00:40:01,419
spaced space TV net wants to know are

00:39:59,469 --> 00:40:03,729
any of these vehicles gonna be like the

00:40:01,420 --> 00:40:06,068
lunar roving vehicle hmm yeah there's
actually commercial Rovers actually being discussed - so NASA's working on some Rovers as well but and Rovers come in all shapes and sizes but also for the humans beyond 2024 there's definitely plans for large even pressurized Rovers that they would go in so I see way beyond what we did in an Apollo era I think the Martian remember but at some of these commercial Landers the ones going in the next year and a half or so are carrying very small Rovers five kilogram 10 kilogram Rovers and eventually those Rovers will be also
providing a service

so the Landers provide the landed service and commercial Rovers can provide a roving service so I can put my instrument on a rover that we can buy space on rather than NASA having to build all that okay now speaking of your instrument I know that you have did you bring it today well I brought part of it all right and tell us what its gonna do up there I don't drop it so something like this is flying to the moon in the next year or two yes so this was selected to fly on one of the three
Landers that is going to the moon in the next few next couple years and this is it's called nervous.

It is of course an acronym near-infrared volatile spectrometer system okay and what it does is it finds water that's its principal purpose is to find volatiles but especially water okay so it's a prospecting instrument and we'll think about when we look for minerals and resources an earthy prospect to go and look at this is what this instruments mean yeah sniffing out where the water is exactly and this is an
engineering unit this is a unit that we

use to develop the technology make sure

we can make the measurements and meet

the goals we want to meet and then we

then test it in the similar environments

it's going to see for example it has to

survive launch landing oh yeah vacuum

radiation etc make sure it works and you

can see it's just got a bunch of eyes on

it what it's meant to an important

aspect of this is is it needs to work

both in sunlight and in darkness just

like Kimberly was saying these are dark

so yeah we have to go down there

and we have to look at the scales we're
gonna yeah because the data from orbit is giving us hundreds of meter kind of footprints of where the the resolution is yeah this is gonna give us human scale you know in the meter and that's an unknown you know so we do need to exactly so real quick this this if this little guy right here can get the nice blue shine of it this is an infrared lamp yeah and and then ten of this is to actually provide infrared light for the other instruments so we can see in the dark likewise all these things over here these little guys those are LEDs of
various colors so they provide illumination from the ultraviolet to the near-infrared for a camera system which is right here this is a lens to the camera system this black thing this allows us to image the area very high-resolution understand the chemical makeup the mineralogy the morphology and things like that and the last thing are the four sensors right underneath the camera these four right here that's really hard to do it's like doing it in a mirror before there those are thermal sensors
it's a thermal radiometer and what that does it allows us to measure temperatures of the scene we're looking at because we're interested in not only understanding if water is there but we aren't want to understand the environment we are finding water and not finding water because ultimately we will use this data to build what is called a resource map on earth we call a mineral so if the United States Geological Survey provides to a company that's interested in finding minerals and and we're going to do this on the
moon basically build these maps and

understand the location this is one

instrument of several that is dedicated

to do this kind of work oh yeah yeah all

working in tandem and the next iteration

of this is to be handheld by the

astronauts all right

guard shows wants to know how is NASA

going to protect these Rovers from lunar

dust is a unique Beast and it's really

is unique in that it's only generated

because of the environment on the moon

is generated through the impact

processes and so the dust and has never

eroded there's no air there's no wind to
make warm water flowing liquid water to

have smooth things out so it's jagged

and jagged it locks in place and you

know complain about you know got into

their lungs and they scratch their suits

the suits were all ripped to shreds and

the way you protect there's a lot of

ways you can protect it everything from

electrostatic barriers are working on so

one nice thing about the lot of the

lunar dust is it has a magnetic property

to it it's got some ferric iron in it

nano phase iron and so you can actually

repulse it with electric fields you can
officer develop

and also number of other mechanical
gasket materials basically things that
go between bearings on wheels and
whatnot that make it very difficult for
the dust to get to the bearings that the
delicate parts these are kind of
torturous past there's been a couple of
lunar settlement simulants that have
been made modeled on the Regulus that
was brought back the Apollo astronauts
and so companies and engineers who are
looking at wheel design and rover design
they can test out their designs as best
as possible with this kind of jagged

kind of connection in fact one of the

big industries about the permanently

shadowed regions when RL cross

experiment that we did it a decade ago

finding water and caballos it revealed

that perhaps the Regulus and those

permanently shadowed craters are

actually different than the Apollo sites

oh it's learning to do the best

knowledge they have now using a simulant

designing the wheels and the excavation

we're gonna have challenges with drills

and scoops and all that the same thing
that they what the beast that is the
dust yes but we'll overcome those but
we're gonna have to get there on the
scene at the South Pole and the polar
regions and go hmm that dust is
different my favorite section today you
guys describe the South Pole as
unexplored territory and you keep
referencing that it's really extreme
it's gonna be tough so let's go through
some of those Civic challenge I mean
it's it's like you know wanting to go in
the deepest minds on earth oh really and
the deep you know the deepest undersea
exploration you know it is because it's
so different from what we're used to or

is it really deep really deep and so the
topography is extreme it's completely

unlike a lot of the part of your song

Apollo at lower latitudes they landed in
flat areas okay

and we'll be landing perhaps in areas
that are ridges that are sitting on top
of crater that looks down into a six
kilometre hole so I was like that's like
three miles yeah exactly about three
miles down and and you can stay they'll

be standing on the edge of these vistas

overlooking what mountains that are many
miles high into craters that are ten miles across and three miles deep.

never knew is that extreme then the lighting conditions because of the low angle of the Sun you can have shadows that are being cast from a ridge of a crater that's hundreds of kilometers away.

really shadows will be sweeping across you over time skills of ours and as we mentioned earlier when you're in shadow your temperature drops uh-huh and so your gonna be experience of course you're in though a suit that's keeping
you regulated but I didn't think about

it the whole lighting condition the

whole dealing with the swing of

temperatures is gonna stress out your

systems and there are areas of this

permanent shadow darkness is proving

darkness but there's also areas that

have what I like to say that persistent

sunlight so there are some of these

peaks because they're so extreme that no

matter what time it year it is it has

very often sunlight at it so it's often

at the rims or crests of some of these

ridges near these craters and so those

are very attractive for the reasons Kim said is you won't be getting these deep shadows sweeping across you all that often on Ken when they do it might just be four of five six seven days as opposed to you know three months and yet something like that so so these are are they're great places to put your power station structure again it's sort of you know if you're gonna explore and you're learning about where you're exploring take advantage of the gifts that were given to you by Nature be aware of the dangers and you know of course so you keep talking about those
the poles we actually have this really
cool anime our video showing some light
cycles at that South Pole exactly right
yeah yeah so can tell us what we're
seeing this is a following we started at
a low latitudes looking at the moon as
we see the moon and what you saw was the
the Sun moving across the face of the
Moon there is no Dark Side of the Moon
every side of the Moon gets some point
14 days of sunlight 14 days of darkness
and we just don't see that we just don't
see that because we always see the
nearside now this was done is this
movies swung down so you're looking at
the South Pole of the moon that crater

nice circular one right in the middle

that Shackleton crater is almost exactly
at the South Pole of the moon it is

about 15 miles across and about four
miles deep and what you see are these
shadows that are sweeping across and

it's because again as Kim kimberleigh
explained earlier the tilt to the moon

on its axis is very small so the sun's
always just hugging the horizon creating

these shadows and and you can see in

some of these craters like the big
Shackleton itself and the larger ones

just above it the floors of those

craters never get some like they are in

permanent shadow

they just say dark you can just stare at

a piece of the you know pick out a point

in a video and look at it and you can

see over the course of the shadow

pattern what gets light or not yeah and

then you also saw there were these rims

[Music]

extreme so lighting conditions are

extreme topographies extreme

temperatures are extreme the dust we


sort of know what it's made of but maybe

1127
00:51:41,469 --> 00:51:48,669
not but it could have some other

1128
00:51:46,179 --> 00:51:49,960
benefits too we just have to we haven't

1129
00:51:48,670 --> 00:51:51,340
explored it mm-hmm

1130
00:51:49,960 --> 00:51:56,530
and we haven't explored it with robots

1131
00:51:51,340 --> 00:51:58,840
yet either so and in general we see this

1132
00:51:56,530 --> 00:52:01,090
increase of hydrogen at the poles and

1133
00:52:01,090 --> 00:52:04,090
we've seen an increase in hydration of

1134
00:52:04,090 --> 00:52:08,200
the soils meaning hydroxyl OAH or water

1135
00:52:08,200 --> 00:52:08,200
molecules bound

1136
00:52:05,739 --> 00:52:10,589
to the soils even in sunlight and

1137
00:52:10,589 --> 00:52:13,960
increased amounts towards the poles so

1138
00:52:13,960 --> 00:52:15,369
just the composition and even in the

1139
00:52:15,369 --> 00:52:17,079
sunlight areas it's gonna be different

1140
00:52:17,079 --> 00:52:19,119
from anything we've ever seen before
Wow and that's gonna just make the
modelers go crazy because we're gonna
have a lot of Toni's types of
instruments you know looking for the
water on these scales and then we're
gonna try to piece together quite a
complex puzzle mm-hmm
but it's a nice it's an interesting
puzzle to have I mean it's only been 10
years now 10 years is not a long time
but it's long enough for like to realize
that you know this moon is a place that
we have full of things that we don't
know what's going on it's more active
than I ever it is it's very active and

more extreme especially at the poles

gonna picked a better place to go you

know speaking of that you guys don't

forget if you do have any questions

please type them into the twitch chat

it's www.hs twitch.tv backslash nasa so

we're gonna move into our rapid-fire

section so just a 5 7 8 wants to know

about the nervous instrument is it

ultrasound ir in visual it is a little

bit of everything so I always like to

say we go in with our eyes wide open for

all the reasons you just said because
you don't exactly know what you're going
to see so it is actually a combination of near-infrared and for you geeks out
there that's between about 1.2 and 4 microns thermal infrared that's between about 8 and 25 microns and ultraviolet visible which is we run about 0.35 to 0.94 microns okay so ultraviolet colors that are below but we can see our visual spectrum and energy is beyond what we can see into the thermal infrared I mentioned is that businesslike this is a front-end with the cameras but the infrared is
gonna be connected to a spectrometer on

00:54:09,909 --> 00:54:13,239
the backend okay because it's from the

00:54:11,650 --> 00:54:14,769
spectrometer spreading the light out

00:54:13,239 --> 00:54:16,179
into different wavelengths and it's over

00:54:14,769 --> 00:54:17,889
the infrared that you're gonna see the

00:54:16,179 --> 00:54:19,119
water signature or the hydroxyl

00:54:17,889 --> 00:54:21,609
signature in the mineral

00:54:19,119 --> 00:54:23,469
yeah and so this is a very it's a

00:54:21,610 --> 00:54:25,000
compact instrument with both cameras and

00:54:23,469 --> 00:54:27,549
thermal sensors to get the temperature

00:54:25,000 --> 00:54:35,230
plus the spectrometer to get the amount

00:54:27,550 --> 00:54:37,030
of composition so dude dudette wants to

00:54:35,230 --> 00:54:40,740
know is there a sample return planner

00:54:37,030 --> 00:54:47,590
for lunar water yeah that's absolutely

00:54:40,739 --> 00:54:48,879
they do want to return with the humans
going in 24 because they're gonna bring samples back okay no worry we're gonna be so excited question is will we get a rover to get us a sample return before the humans don't know yet that would be awesome too but yeah we're certainly gonna get some we're gonna get something in specifically there's a lot of discussion about cryogenic sampling because when you sample something that's at minus 230 degrees below center I don't think that there's a lot of debate right now whether or not you need to keep it that cold yeah or do you just
need to seal it and make sure you don't lose as it Sublime's as it warms and the ice is sublime yeah it was a mission concept for sampling off a comet and we had that same debate because we're gonna bring it back to the earth the question is you keep it in cryo storage or do you allow it to come up to room temperature but then you've lost some information but you're right they're gonna have to solve that issue I never thought about that you're right we're gonna bring back our water samples from the moon give me a good chiller so
it looks like greg daeun wants to know

he wonders what is the moon smell like

good question well we don't know but

according to the Apollo tapes they smell

they said it smelled like gunpowder

gunpowder that was the it's reported by

several the astronauts so my husband

died our geeks we kind of listen to the

audio tapes of all the Apollo

[Applause]

and more than once they would say it

smelled like gunpowder that would be

ture I mean it's just that's error to be

clear that's air in the caps here on the
capsule when they got after their EVs

capsule when they got after their EVs

00:56:24,340 --> 00:56:27,220
this extra vehicle activity and are

00:56:25,900 --> 00:56:28,420
romping around on the surface and I'm

00:56:27,219 --> 00:56:30,309
coming back in and they're taking off

00:56:28,420 --> 00:56:35,019
their coat that's when they smell it

00:56:30,309 --> 00:56:36,519
because you know yeah the atmosphere but

00:56:35,019 --> 00:56:38,079
there wasn't a pure oxygen atmosphere

00:56:36,519 --> 00:56:39,460
I don't know what that changed anything

00:56:38,079 --> 00:56:41,679
maybe it has something to do with the

00:56:39,460 --> 00:56:43,510
dust they think is because again this

00:56:41,679 --> 00:56:47,649
dust is really unique it's never been as

00:56:43,510 --> 00:56:49,780
it gets fractured and melted and re

00:56:47,650 --> 00:56:52,480
solidified by impacts on the surface it

00:56:49,780 --> 00:56:55,090
creates what are called very open active

00:56:52,480 --> 00:56:56,710
sites on the surfaces that they're again
on earth we have all this oxygen around

us that reacts exosphere meaning a

molecule can leave the surface of the

Moon and never encounter an ever another

molecule as long as it or is that just a

human thing hook up to it some sniffing

[Music]

instruments with the nanotubes that

measure can measure specific chemicals

to extrapolate aside what we would

experience so these open surfaces and

reacts with the oxygen that's our only

one data point right so we're looking

forward to more wants to know all new
suits be made specifically for longer stays on the Martian surface or sorry the moon surface they are working on the next generation suit and I'm afraid I don't know the name of it the designation of it but they are working on a new generation suit that is meant to be more mobile a lot more mobility to it and to allow the astronauts to be able to do things like that they couldn't do on Apollo for example if you saw a national fall over on Apollo they would have to do a push-up to get themselves
up that couldn't bend the knees will not

least and so they'd have to do a push-up

a few times and so they got enough

momentum to get themselves back up were

crushed up against the edges and they're

all bruised and everything so we want

the astronauts on the moon to be very

physically active excavating all this

water for us and building off habitats

and doing that so the new suits are 1961

how do you communicate with a probe down

in the crater what are the challenges so

this is kind of really interesting point

a dark crater does not mean we can't see

this is kind of really interesting point
into the crater from Earth aha good

1298
00:59:29,800 --> 00:59:32,769
point

1299
00:59:30,219 --> 00:59:34,389
so in one instance you can use what's

called direct to earth communications

1300
00:59:32,769 --> 00:59:38,039
that's where is what we did do in Palo

1301
00:59:34,389 --> 00:59:38,039
you can see Earth from a PSR from the

1302
00:59:43,800 --> 00:59:48,700
floor of a permanently shadowed region

1303
00:59:47,199 --> 00:59:49,329
or crater

1304
00:59:48,699 --> 00:59:51,159
other instances you'll be able to look

1305
00:59:49,329 --> 00:59:53,409
up overhead and see gateway so you can

1306
00:59:51,159 --> 00:59:55,269
relay you can look straight up and talk

1307
00:59:53,409 --> 00:59:59,049
to a relay satellite or Gateway they've

1308
00:59:55,269 --> 01:00:01,090
also talked about having repeaters yeah

1309
01:00:01,090 --> 01:00:03,190
so some of these commercial service

1310
01:00:03,190 --> 01:00:07,630
providers aren't just talking about
providing landed services I can take you to the moon but they're also talking about setting up infrastructure on the moon like Landers that are going actually will communicate with the small Rovers and whatnot with Wi-Fi and they're actually talking about both communication power all kinds of relay systems building infrastructure to actually assist in the exploration and science and and build-up yeah that's cool yeah that helps me picture better the crater and communicating you're gonna have to go up
but if you're you can put a repeater

cool okay so I have another question Cal

cooze wants to know are you gonna send

Rovers to these craters first before we eventually send the next woman or not

the next person and if so when mm-hmm we really want to and we're working on plans along those lines that still are being formulated so yes you need mobility to really understand the distribution of water and and I think everyone appreciates that so that is one of the higher priorities right now to understand the resources at the poles is
to get a rover at the poles at least one

and more you really probably want more

and to start prospecting and

characterizing and identifying him

that's the instrument I showed was built

specifically to go on a rover just like

that oh yeah yeah and so hopefully

before 2024 okay I mean that's an ideal

situation but there's also alternative I

mean if if if we get the human visiting

the moon before we get the Rovers the

Rovers rule 24 does not depend at all

the astronauts are gonna land is

unexplored territory non-stop you know

so many we're gonna do this slightly

01:02:04,869 --> 01:02:07,869
different life I mean that's exactly

01:02:06,489 --> 01:02:10,239
what happened on Apollo with the six

01:02:07,869 --> 01:02:12,338
landed missions each of them built upon

01:02:10,239 --> 01:02:13,719
the experience of the prior oh yeah and

01:02:12,338 --> 01:02:15,369
we all do that in science and in

01:02:13,719 --> 01:02:18,458
engineering we learn what works what

01:02:15,369 --> 01:02:20,259
doesn't work and we we expand in fact

01:02:18,458 --> 01:02:21,788
perhaps we might have a scenario where

01:02:20,259 --> 01:02:23,438
the humans get first men they're gonna

01:02:21,789 --> 01:02:25,449
like I want a Rover to go over there

01:02:23,438 --> 01:02:27,818
because you know what I haven't yet

01:02:25,449 --> 01:02:32,289
developed my harness to do rappelling

01:02:27,818 --> 01:02:34,028
off of I can do it with you know some

01:02:32,289 --> 01:02:35,319
sort of design and then a couple years
later I've got my rappelling harness ready to go so you know we have time for one last question so xxx YHVH triple X once is radioactivity really a major concern when traveling to and from earth and how does this radiation affect your instruments mm-hmm it is it absolutely isn't it needs to be designed into all your considerations both for the instruments and for humans and so our instrument uses components and electronic parts that are what was called flight qualified for flight and
what that means is they've undergone testing to show that radiation doesn't affect them okay electronics.

we've been sending probes to Pluto and the voyagers of the solar system time and space electronics point of view.

we're kind of smart on making things robust I mean the challenges are when you have new materials and really smaller transistors transistors and the like that you'll have to do but we have facilities here to test them so for that.

for the biology is the other note yeah so the biology is the one that we're
gonna have to be learning and adapting

and reacting to and being proactive as

we go forward and also we're gonna be

wanting to monitor when the big solar

storms come our understanding I mean we

have sentinels out in space right now

that are monitoring the solar behavior

and whenever we get these solar storms

that could you know you know when it

happens in our astronauts are on the

International Space Station they go to a

certain part of the Space Station that's

more scenarios like that with our humans

on the moon as well and on you know

on the moon as well
wherever they are next so it is a

01:04:20,219 --> 01:04:24,539
concern but it's it's we're gonna learn

01:04:23,070 --> 01:04:27,990
and we're gonna adapt and we're gonna

01:04:24,539 --> 01:04:30,929
you know be react and be also preventing

01:04:27,989 --> 01:04:33,000
things I don't anything that is another

01:04:30,929 --> 01:04:34,500
great use of water is radiation

01:04:33,000 --> 01:04:36,539
shielding one of the best radiation

01:04:34,500 --> 01:04:38,789
shields there is is water so there are

01:04:36,539 --> 01:04:40,650
discussions about using regulate but

01:04:38,789 --> 01:04:43,108
also in the safe room where you really

01:04:40,650 --> 01:04:45,269
need extra protection well you have a

01:04:43,108 --> 01:04:48,059
layer water that you

01:04:45,269 --> 01:04:49,500
and then once at other places like when

01:04:48,059 --> 01:04:51,710
they need discoveries that the Lunar

01:04:49,500 --> 01:04:53,519
Reconnaissance Orbiter this is a moon
spacecraft in orbit on the moon for last 10 years has you know uncovered these places that are lava tubes these underground caverns in the moon hmm and they're also places that we have to explore they're not quite at the poles but once we've set up this infrastructure it allow us to go anywhere on the lunar surface yeah I bet you an early destination after going to the poles will be good to explore the underground caverns and that's also a place for potentially you could take advantage of the you know what nature
gave you as a shield

right under ground Mars - that's right

so you can figure out if you can work

this whole thing out of the moon you've

got it sorted from Mars excellent

1,650 six days to do say before we have
to wind up we've been talking about all

these challenges and you guys sound

confident that we're gonna figure it out

but we're gonna need a lot of help right

so there might be people listening who

want to get you know on that so do you

do you guys have an answer for what's a

what's a good way to prepare to help
NASA tackle these challenges down the road are there particular you know majors in college you would do or skills you develop it's it one thing is it's important to note that this isn't going back to put a new footprint on the moon and then come home it really is to be a sustained presence that is with an open architectures can really describe so it's involving everybody from the commercial side to industry the government's foreign the NASA agencies all NASA agencies so I really do think we're at a dawn of a new age of
exploration and so the opportunities are

1469
01:06:50,460 --> 01:06:55,829
going to be incredible and vast in terms

1470
01:06:52,710 --> 01:06:57,960
of being able to participate not only

1471
01:06:55,829 --> 01:06:58,559
within a government agency to get into

1472
01:06:57,960 --> 01:07:01,500
space

1473
01:06:58,559 --> 01:07:02,909
but you can now go work at a company and

1474
01:07:01,500 --> 01:07:06,150
get into space yeah

1475
01:07:02,909 --> 01:07:08,909
and eventually I do not doubt that there

1476
01:07:06,150 --> 01:07:17,970
won't only be NASA astronauts there will

1477
01:07:08,909 --> 01:07:21,599
be corporate astronauts keep an

1478
01:07:17,969 --> 01:07:25,199
infrastructure going you can do anything

1479
01:07:21,599 --> 01:07:30,179
just from business to engineering to

1480
01:07:25,199 --> 01:07:32,909
science medicine you know philosophy and

1481
01:07:30,179 --> 01:07:37,519
in the law I mean this is it opens up an

1482
01:07:32,909 --> 01:07:41,730
entire new area of international law
interplanetary that we haven't even
begun to scratch really and it's the
basis of becoming a spacefaring
civilization yeah that's what's next yep
we're there we're there all right well
that is all the time we have for today
so a huge thanks to you guys our guests
and to everyone who joined us in the
twitch chat with your amazing questions
we will be back on Thursday July 18th
when we talk about the 50th anniversary
of the Apollo moon landing and then tune
in the next day Friday July 19th for a
special live broadcast from NASA centers
across the country celebrating the Apollo 50s as we go forward to the moon

so for more info on that go to wwsz gov

slash Apollo 50 and we will see you next

time thanks for watching