

Alright, the Gateway to Mars. So here we are. Here we are at the newly incorporated Starbase, Texas.

This is the first new city made in America in, I think, quite a few decades. At least that's what I'm told. And a very cool name.

And it's named that because it is where we're going to develop the technology necessary to take humanity and civilization and life as we know it to another planet for the first time in the four and a half billion year history of Earth. So we'll go with this little video here. This is how it started off, with basically nothing.

So Starbase started off as basically a sandbar, with nothing. Even those little things we built, obviously. That's the original sort of Mad Max rocket.

This is where you discover lighting is very important for that Mad Max rocket. So yeah, not that long ago, there was basically nothing here. And in the space of about five or six years, thanks to the incredible work of the SpaceX team, we've built a small city.

And we've built two gigantic launch pads and a gigantic rocket factory for a gigantic rocket. And the cool thing is for anyone out there who's watching this, you can actually come and visit because our entire production facility and launch site are on a public highway. So anyone who comes to South Texas can come and see the rocket pretty close up, and see the factory.

So anyone who's interested in seeing the largest flying object on Earth can come here anytime they want and just drive down the public highway and see it, which is pretty cool. So then we progress to where we are now, Starbase 2025. So we're now at the point where we can produce a ship roughly every two or three weeks.

Now, we don't always produce a ship every two or three weeks because we are making design upgrades. But ultimately, we're aiming for the ability to produce a thousand ships a year, so three ships a day. So that's where things are now.

I'm standing in that building. That's our hovercraft. We're driving a booster down the road to the launch site.

You can see the megabay. And as I said, the cool thing for those out there watching this video is that you can actually just literally come here, drive down the road, and see it, which is the first time in history that that's been possible. So all this cool stuff, that road on the left there, that highway, is public, and you can just come here and see it, which I recommend doing.

I think it's very inspiring to see. That's our gigabay, where we're expanding integration to produce a thousand starships per year. Well, yeah, that hasn't been built yet, but we're building it.

That is a truly enormous structure. That'll be one of the biggest structures, I think by some measures the biggest structure in the world, and it's designed for a thousand starships a year. We're also building a gigabay in Florida.

So we'll have two facilities, one in Texas and one in Florida. It's actually difficult to gauge the size of these buildings because you need a kind of human for scale. When you see how tiny a human is next to that building, you realize just how enormous it is.

So when we look at our build comparison vehicles per year, and so you look at Boeing and Airbus making airplanes, Starship will be making at some point probably as many starships for Mars as Boeing and Airbus make commercial airplanes. So this is really at a scale, an enormous scale. And each starship will have a capability.

Each starship is bigger than a 747 or an A380. Like, it's truly enormous. And then in terms of Starlink satellites, the version 3 satellites, making on the order of 5,000 a year, maybe at some point closer to 10,000 a year.

And those Starlink V3 satellites are each the size of roughly a 737. They're pretty big. That compares to the B-24 bomber in World War II.

Now, it's still small compared to Tesla, and Tesla will probably be doing double or triple that volume in the future. So it just puts things into perspective that it is actually possible to build a vast number of interplanetary starships. And even when you can compare things on the tonnage standpoint, Tesla and other car companies are still building far more complex manufactured tonnage than SpaceX, which just really is a way of saying that it's very achievable.

Like, these numbers, while they are insanely high by traditional space standards, are achievable by humans because they have been achieved in other industries. Progress is measured by the timeline to establishing a self-sustaining civilization on Mars. That's how we're gauging our progress here at Starbase.

So with each launch, especially in the early days of Starship, each launch is about learning more and more about what's needed to make life multi-planetary and to improve Starship to the point where it can be taking ultimately hundreds of thousands, if not millions of people to Mars. Ideally, we can take anyone who wants to go to Mars, we can take to Mars and bring all of the equipment necessary to make Mars self-

sustaining so Mars can grow by itself in a worst-case scenario. Getting to the point where the fundamental fork in the road for human destiny is where Mars can continue to grow even if the supply shifts from Earth stop coming for any reason.

At that point, we've achieved civilizational resilience where Mars can potentially come to the rescue of Earth if something goes wrong, or maybe Earth can come to the rescue of Mars. But having two planets that are both self-sustaining and strong, I think is going to be incredibly important for the long-term survival of civilization. So I think any given civilization is likely to last maybe 10 times longer, maybe much longer if it is a multi-planet civilization than if it is a single-planet civilization because there's always some chance that, you know, us humans could do something crazy like World War III.

Hopefully not, but it's possible. Or that there could be some natural event like meteors or supervolcanoes or something that we don't expect. And then if we only have one planet, then that could be curtains.

But if we have two planets, we keep going. And then we go beyond Mars ultimately to maybe the asteroid belt, the moons of Jupiter and beyond, and ultimately to other star systems. And we can be out there among the stars making science fiction no longer fiction.

So in order to achieve this goal, we have to make rapidly reusable rockets so that the cost per flight, the cost per ton to Mars is as low as possible. So for that, rapidly reusable rockets. It's actually four R's.

It's like a pirate. It's like rapidly reusable, reliable rockets is the key. Congrats to the SpaceX team on making incredible progress on catching a giant rocket.

So it's really mind-blowing that the SpaceX team has been able to catch the largest flying object ever made multiple times using a very novel method of catching it out of the air with giant chopsticks. I mean, have you ever seen that before? Yeah, congrats again. That was an incredible achievement.

So the reason we are catching it in this way, which has never been done before, is in order to achieve the rapidly reusable portion of the... in order to make the rocket rapidly reusable. So if the super-heavy booster, which is gigantic, it's like 30 feet in diameter, if it were to land with landing legs on a landing pad, we would then have to pick it up, stow the legs, and put it back in the launch pad. And it's quite difficult to transport such a large thing.

But if we catch it with the same tower that is used to put it in the launch mount to begin with, that is the best case outcome for rapid reuse. So it literally gets caught by the same arms that placed it in the launch ring, and then it is placed back in the launch ring immediately. So in principle, the super-heavy booster can be reflown within an hour of landing.

So it comes back in about 5 or 6 minutes, one way or another, and then it gets caught by the tower arms, placed back in the launch mount, and then you can refloat the propellant in about 30 to 40 minutes, and place a ship on top of it, and in principle, reflight the entire booster every hour. Maybe every two hours to give it a little bit of extra time. But let's just say it's in the limit of rapid reuse.

And the next thing we need to do is catch the ship too. So we haven't done this yet, but we will. So that's what we hope to demonstrate later this year, maybe as soon as 2 or 3 months from now.

And then the ship would be placed on top of the booster, and then again refilled with propellant and flown again. With the ship, it takes a bit longer because it's got to orbit Earth a few times until the ground track comes back over the launch pad. But the ship is also intended to be reflown multiple times per day.

This is the new Raptor 3, which is an awesome engine. Big hand to the Raptor team for this, this is very exciting. So Raptor 3 is designed to require no basic heat shield, saving a lot of mass on the bottom and actually improving reliability so that if there is, for example, a small fuel leak from the Raptor engine, it will simply leak into the existing flaming plasma and not really matter.

Whereas a fuel leak when the engines are contained in a box is a very scary thing indeed. So this is Raptor 3. It'll take probably a few kicks at the can, but it is a massive increase in payload capability, in engine efficiency, and in reliability. So this is really a revolutionary engine.

The Raptor 3 is really, I'd say, kind of alien technology rocket engine. I mean, even industry experts, when we showed a picture of the Raptor 3, said that engine is not complete. So then we said, well, here's the engine not complete, firing at a level of efficiency that has never been achieved before.

So, I mean, that is one clean engine. So in order to make the engine like that, we had to simplify so many parts of the design, incorporate secondary fluid circuits and electronics in the structure of the engine itself, so everything is contained and protected. It is a marvel of engineering, frankly.

And one of the other technologies that's key for Mars is doing orbital propellant transfer. So you can think of this like similar to aerial refueling for airplanes, but in this case it's orbital refilling of rockets, which has never been done before. But it is technically feasible.

I always feel like these things are a little NSFW, sort of. Listen, you've got to transfer fluid somehow. There's no, this has got to be done.

So the two starships would get together, and one starship would transfer fuel and oxygen, and actually most of the mass is oxygen. It's almost 80% oxygen that gets transferred, a little over 20% fuel. So you'd send a starship to orbit that's full of payload, and then you'd send a bunch of other starships up, and you would refill the propellant on that starship.

And once the propellant tanks are mostly full, then you can depart for Mars or the Moon. So this is an important technology, which we should hopefully demonstrate next year. One of the toughest problems to solve is the reusable heat shield.

So no one has ever developed a truly reusable orbital heat shield. So it's extremely difficult to do so. Even the shuttle's heat shield required several months of refurbishment, basically fixing broken tiles, testing each tile, because it's an extremely hard problem to be able to withstand the extreme heat and pressure of reentry.

And the only things that can really withstand this level of heat are advanced ceramics, basically glass, alumina, some types of carbon-carbon, but very little actually can survive with reusability, without eroding or falling off or cracking, can survive the stresses of reentry. So this will be the first time that it's done, that a reusable orbital heat shield is developed. And it needs to be, obviously, extremely reliable.

So this will be something they'll be working on for a few years, I think, to keep honing the heat shield. It is an achievable thing, so we're not trying to do something that isn't achievable. It is within the realm of physics to get this done, just an extraordinarily difficult thing to get done.

And the Mars atmosphere is carbon dioxide, which at first may seem better, but actually it ends up being worse, because when the CO₂ turns into a plasma, you actually end up with more free oxygen entering on a Mars atmosphere than on Earth's atmosphere. So Earth's atmosphere is only around 20% oxygen, and Mars ends up being basically more than double that, maybe triple that, when the CO₂ becomes a plasma and you get carbon and O₂. So that wants to oxidize the heat shield, basically burn the heat shield.

So that's why we test it very rigorously in a CO₂ atmosphere, because it's got to work not just for Earth, but also for Mars. We want to use the same heat shield for Earth that we use for Mars, because there are many other factors with the heat shield, such as making sure the tiles don't crack or fall off or anything like that. So we want to have the same heat shield structure, same material on Earth as on Mars, so we can test it hundreds of times on Earth before going to Mars, and be confident that when it goes to Mars, it will work.

So we're developing some next-generation starships, which have a number of improvements versus our current gen. It's taller, for example, and has the interstage between the ship and the booster. You can see the sort of struts there.

That makes it easier for the flame... Ah, right there. When doing hot staging, which is when we light the ship's engines while the booster's engines are still firing, the flame from the ship's engines can more easily exit through the open struts of the new interstage. In this case, we'll bring the strut's interstage back with us instead of throwing it away.

So a little more height here, 72 meters from around 69. Propellant capacity, I think we'll probably push that up a little, maybe 3,700 tons. Long-term, my guess is we're maybe around 4,000 tons.

This will keep getting up. My guess is ultimately we're 4,000 tons here, close to 10,000 tons of thrust. But this is kind of the next level, or the next version of the Super Heavy.

So the booster will look a little naked on the bottom because the Rafter 3 engines don't require a heat shield. So it looks like there's kind of parts missing, but that's just because the Rafter 3 does not need a heat shield. So it's just standing there in a bathed in flaming plasma, but it's a lot lighter.

Yep, integrated hot stage. I think it looks amazing. And the ship's a little longer, a little more capable, moving to 1,500 tons of propellant capacity.

My guess is this probably ends up 20% more than this long-term. The heat shield is sleeker, so much smoother boundaries. As the boundary of the heat shield going to the leeward side is very smooth, no more jagged tiles.

I think it looks very sleek. And this version, we still have six engines, but a future version will have nine. But with the Rafter 3, again, we have reduced mass, higher specific impulse.

The Starship version 3 is really the version that I think achieves all of the key elements. Generally, with any new technology, it takes three major iterations of any new technology to have it really work well. And with Rafter 3 and Starship and booster version 3, it should be able to achieve all of the things that I just mentioned, which is a rapidly reusable, reliable rocket with orbital refilling.

Basically, all of the ingredients necessary to make life multi-planetary will be achieved with version 3 of Starship, which we're aiming to launch for the first time at the end of this year. Yeah, so you can see this is kind of where things are on the left, where things will be end of this year in the middle. And as I was saying, where things will be probably long-term.

Yeah, 142 meters. But the one in the middle will be fully capable of doing Mars. And thereafter, it'll be a lot of performance improvements.

And as has been the case with Falcon 9, we always end up making the rocket longer and increasing payload. So that's the game plan. Pretty straightforward.

It's important to emphasize, even with the rocket that we'll be launching just at the end of this year, it will be capable of making life multi-planetary. And thereafter, it's just about continuing to hone the efficiency and capability of the rocket and reduce the cost per ton and reduce the cost per person to Mars. And like I said, ultimately make it so that anyone who wants to move to Mars and help build a new civilization can do so.

So anyone out there, how cool would that be? And even if you don't want to do it, maybe you have a son or daughter who wants to do that or a friend who wants to do it. And I think it would be the best adventure that one could possibly do, is to go and help build a new civilization on a new planet. So yeah, ultimately we'll have 42 engines, which it was inevitable.

As the prophecy foretold by the great prophet Douglas Adams in his book, *The Hitchhiker's Guide to the Galaxy*, the answer to the meaning of life is 42. And so inevitably, the Starship stack will have 42 engines. And in terms of payload to orbit, what's remarkable is that Starship will have 200 tons payload to orbit with full reusability.

So this is twice the capability of the Saturn V moon rocket. The Saturn V moon rocket was fully expendable. Starship is fully reusable, but will have twice the payload to orbit of the next biggest rocket that made it to orbit, which is the Saturn V. In fact, without reusability, Starship would have about 400 tons of payload to orbit.

So this is a very big rocket, is what I'm saying. But you need a big rocket to make life multi-planetary. And then along the way, we could do very cool things like have a moon base, like Moon Base Alpha.

Long ago, there was a TV show about Moon Base Alpha. You couldn't think about the physics of that too much, because apparently the moon base was drifting away from Earth. But anyway, we should have a Moon Base Alpha, which is the next step after the Apollo program, would be to have a base on the moon.

So you could have a gigantic science station doing research about the nature of the universe on the moon. It would be very cool. So in terms of when can you go to Mars? So you can go to Mars every two years or every 26 months.

So the next Mars opportunity is at the end of next year in about 18 months. So November, December is the next Mars opportunity. So we'll try to make that opportunity if we get lucky.

I think we'll probably have a 50-50 chance right now, because we've got to figure out orbital refilling in order to have enough capability to go to Mars. But if we achieve orbital refilling in time, then we will launch the first uncrewed starship to Mars at the end of next year. So this gives you an illustration of how does a spaceship go from Earth to Mars.

So you've got blue Earth there and red Mars. And the actual distance traveled on the ark is close to 1,000 times further than the moon. So you can't just go straight to Mars.

You have to create this elliptical orbit with Earth at one point and Mars at the far end of the ellipse, and then time where you are in that ellipse to intersect with Mars. So this is the orbital transfer, how you do orbital transfer from Earth to Mars. And if you look on your Starlink Wi-Fi router, you'll see this image, because the Starlink Wi-Fi is what is... Starlink Internet is what's being used to pay for humanity getting to Mars.

So I'd just like to thank everyone out there who has bought Starlink, because you're helping secure the future of civilization and helping make life multiplanetary and helping make humanity a space-bearing civilization. Thank you. So this is a tentative game plan here that we're hoping to achieve, where we increase the cadence of flights to Mars dramatically with every launch window.

So every roughly two years, we are dramatically increasing the number of ships that go to Mars and ultimately try to get to 1,000 or 2,000 ships per Mars rendezvous. I mean, as a rough order of magnitude, this is just guesses, obviously, but we need to get about a million tons, is my guess, to the surface of Mars to make a civilization on Mars self-sustaining and get to that critical point where, if the resupply ships from Earth stop coming for any reason, Mars still succeeds. Mars can still grow.

And so you can't be missing anything. You can't be missing even the equivalent of vitamin C or anything. You've got to have everything you need for Mars to grow.

That's essential. So my guess is that's about a million tons, but it might be 10 million tons. I hope it's not 100 million tons.

That'd be a lot. But we want to try to get to that point and secure the future of civilization as quickly as possible. So we're looking at different locations.

The lead candidate right now is the Arcadia region. Mars has a lot of real estate, but when you combine all of the factors and say, okay, we can't be too close to the poles, we need to be near ice to get water, and

can't be too mountainous for the rockets, then it narrows down to a smaller region. So Arcadia is... my daughter's name is Arcadia, actually, is one of the options.

We've got the first starships on Mars, gather critical data. So the first flights there we'll send with the Optimus robot, so we can go out there and explore and kind of prepare the way for humans. That'll be a very cool image if we're able to achieve it by launching at the end of next year.

It would actually technically arrive in 2027, but that would be an epic picture to see Optimus walking around on the surface of Mars. And then with launching two years later, we'd be sending humans. Assuming the first missions are successful and they land successfully, we'd send humans on the next mission, and we'd really start building the infrastructure for Mars.

So anyway, maybe just to be safe, we might just do two landing episodes with Optimus and do the third one with humans, we'll see. That classic picture of the workers on the Empire State. And then for communications on Mars, we'll be using a version of Starlink to provide Internet on Mars.

Even moving at the speed of light, your best-case scenario is, I guess, running around 3 1/2 minutes to Mars, and then worst-case is 22 minutes or more because Mars is on the other side of the sun from Earth. So anyway, it's quite challenging to do high-bandwidth communications with Mars, but Starlink will achieve that. Yeah, and then we'll have the first humans lay the groundwork for permanent presence on the surface.

And yeah, the goal, like I said, will be to make Mars self-sustaining as quickly as possible. So it's just a sort of rough idea of what things will be like for the first city on Mars. My guess is we'll probably put the launch pads a little further away, or the landing pads, just in case.

But for Mars, we're going to need a lot of solar power. You can't really walk around on the surface of Mars, at least as yet, until Mars is terraformed to be like Earth. You need to walk around with a Mars suit and be initially in kind of like glass domes.

But it would work, and eventually we can make Mars into an Earth-like planet. We want to get to the point where we're transferring over a million tons at every Mars transfer window. That's like a serious civilization, a megaton per transfer window.

We'll have a lot of spaceports. Because of the fact that you can't fly there continuously and you have to transfer in these windows, you'd have a gathering of 1,000 ships, or 2,000 ships, or more than that. So we'll have this kind of like Battlestar Galactica feel, where all these ships are in orbit, waiting to depart, and then they all depart.

I think it's an amazing image of all these ships departing at once. And then you're going to need, obviously, a lot of launch pads, a lot of landing pads on Mars. Or you'll need to move the ships off the landing pad pretty fast.

So if you've got, I don't know, a few thousand ships inbound, you'll probably need at least a few hundred pads, landing pads. Anyway, we'll solve that problem later. Anyway, this is like an incredible thing to have this amazing city on Mars, the first city on another planet, a new world.

And it's also an opportunity, I think, for the Martians to rethink how they want civilization to be. So you can maybe rethink what kind of form of government do you want, what new rules do you want to have. There's a lot of freedom and opportunity in Mars to do a recompile on civilization, which will be up to the Martians.

Let's get it done! Thank you, everyone.