Relativity

**Testimony of**

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Chairman Cruz, Ranking Member Markey, Members of the Committee – thank you for the opportunity to testify here today, and for your leadership in guiding America's ambitions in space. I firmly believe that this Committee's work in the weeks and months ahead has the potential to inspire and empower the next generation of space entrepreneurs.

Relativity is a stealth-mode startup reimagining the way orbital rockets are built and flown. We are creating a new launch service for orbital payloads enabled by never-seen-before technologies, allowing for a high degree of launch schedule certainty at significantly reduced cost. The ability to get back and forth from space inexpensively and on a reliable launch schedule will unleash not only economic opportunities on Earth and beyond, but also push forward humankind's desire to explore the heavens we have gazed at in wonder for thousands of years. At the moment, however, there is a paucity of affordable launch options capable of addressing emerging market demands. Satellite and other payload customers increasingly require new models to access space on short lead-times, at lower cost, with high frequency, and with scalable services. From India to China and Russia to Europe, other countries are racing to address these market needs, and at Relativity, we intend to help preserve and expand U.S. dominance in commercial space.

When Dwight D. Eisenhower created the interstate highway system he helped to catalyze the American automobile industry. I believe that this Committee finds itself at a moment of similar opportunity. Smart and aggressive updates to our national space infrastructure and regulatory framework have the potential to unleash a new generation of American ingenuity in space. Public-private partnerships will be critical to continuing this tradition of bold innovation. Partnerships build upon the enabling foundations NASA and other U.S. Government agencies have created for private companies. They act as accelerators that open doors of opportunity which might otherwise remain closed.

Today, due to a confluence of private investment, emerging markets, the continued strong support of the United States Government, and the maturation of revolutionary new technologies, commercial space is on the cusp of changing forever. My testimony will reflect our company's unique perspective from the intersection of these exciting trends. I am hopeful that our conversation here today will help us develop a deeper understanding of the challenges facing the next generation of commercial space companies and the ways in which new legislation could address these challenges.

**COMPANY INTRODUCTION**

I co-founded Relativity in December 2015 with Jordan Noone. We are alumni of Blue Origin and SpaceX, where we were both propulsion development engineers and worked on programs such as BE-4, New Glenn, Crew Dragon, and Cargo Dragon.

I proudly spent my first eighteen years as a resident of Plano, Texas, with both sides of my family residing among the great aerospace states of Texas, Florida, Colorado, and Alaska for generations. Relativity is based in Los Angeles, California, with testing operations in Mississippi, and we are exploring potential test facility expansion and launch opportunities in Florida, Alaska, Georgia, Texas, California, and Hawaii. As cofounders, Jordan and I originally met seven years ago as students at the University of Southern California in the Rocket Propulsion Laboratory. We led the first student group in the United States to attain FAA clearance to launch a suborbital rocket above the Von Karman line of 100km, a project that ambitiously involved us designing and building our own rockets from scratch as young students. We were inspired by the long and storied history of the great American innovators who were willing to dream big and boldly claim: Impossible is nothing.

In January 2016, Relativity joined Y Combinator, a Silicon Valley-based startup accelerator that is widely recognized as the most prestigious accelerator in the world and whose notable alumni include Airbnb, Dropbox, Stripe, and others among its combined $80 billion company portfolio valuation. In March 2016,

Relativity graduated from the Y Combinator program and shortly afterwards, we raised an eight-figure funding round led by Silicon Valley venture firm Social Capital, with participation by Y Combinator Continuity, Phillip Spector (formerly of Intelsat), the University of Southern California, Stanford University, and other private investors. Still just two cofounders, we expanded to our current Los Angeles facility in July 2016, and worked to scale up a bigger and extraordinarily talented core team.

Relativity has begun testing of our liquid oxygen/liquid methane engine with over six dozen hot fires across multiple test articles at NASA Stennis Space Center, with plans for continued routine testing. Additionally, we are hard at work developing a series of novel, never-seen-before technologies for creating our own orbital launch service and changing the way things get to space. Altogether, we made significant progress in the last ten months and achieved dramatic results that we will begin sharing publicly once out of stealth. We are happy to discuss more details of our progress specifically with government policy makers and regulators to ensure there is early awareness of development plans for Relativity's capabilities, and form public-private partnerships that will help get us there.

**THE VENTURE PERSPECTIVE**

Relativity is an entirely privately funded company and, as such, we believe we have a rather unique perspective on building a successful private space business.

As first-time founders, Social Capital, Y Combinator, and our other investors and advisors taught Jordan and me some fundamental lessons about how to run a successful startup. This advice may best be distilled by the proverbial motto: "Make something people want." Relativity was founded on the belief that people crave a fantastic future, a future that pushes the boundaries of what we dream to be possible and then brings those dreams to life. The very idea of America is predicated on pushing the limit of what is possible, both in technology and in spirit. Space is the ultimate stage for exploring our humanity. We are convinced that an incredible future waits for us among the stars, and that America will lead it. We believe this is "something people want."

But to help make this vision a reality Relativity must first build a thriving business and, while Relativity's investors share our conviction and ambition to build an iconic company, they also have very real financial targets that we must reach, together, to be successful. Working alongside some of the top venture capitalists (VC's) in Silicon Valley, we have learned that investors generally focus on the following key criteria when deciding whether or not to fund a company:

- **Potential for Outsized Returns:** small capital investments create large company value increases, normally in a 5-10 year return on investment (ROI) timeframe

- **Large Total Addressable Market:** the target market needs to be $1B+, growing quickly, or emerging and highly disruptive

The VC funding model is fantastic for creating industry-disrupting innovation in a relatively short timeframe, but it comes with some non-intuitive quirks. Venture capital is predicated on the financial model that approximately one-third of companies funded will fail, one-third will simply break even, and one-third will successfully pay for all the others and then some. Often, only a few breakout successes within an investment portfolio constitute a vast majority of the ROI for a venture capital firm. Thus, private investors seek to quickly determine if a bet placed on a company will succeed or fail, primarily focusing their attention on the ones that show the most promise. This dynamic means startups often have only 12-24 months of funding remaining to

prove they are worth continued support from the venture community, or left behind in the annals of entrepreneurial endeavor.

It is worth noting that investors have the entire economy's array of industries on which to place their bets – space is but one sector, and effectively must compete for limited investment capital against scalable businesses in the software, consumer product, industrial, biomedical, and a multitude of other sectors as well.

I mention this because in addition to the critical, daily challenge of proving our technological concept, we must also reckon, on a daily basis, with the equally critical challenge of meeting growth metrics sufficient to remain an attractive private investment in repeated 12-24 month do-or-die timeframes.

**THE STARTUP PERSPECTIVE**

The above business-building parameters have real and immediate implications for the way in which we think about and approach many aspects of our R&D. For example, as capital is infused in discreet funding rounds spaced approximately 12-24 months apart, we face not only short-term execution timelines, but also must simultaneously focus on achieving long-term goals that may be years into the future, well past our current funding amounts. Interruptions to this timeframe, even on the order of weeks or months, are highly impactful and can cause an increase in business risk.

As a startup in the launch services industry, test infrastructure is paramount to validating our technologies. However, this infrastructure is extremely slow and expensive to procure, develop, and operate. In the context of already enormous initial risks, neither founders nor VC's have much desire to spend the bulk of our precious time and capital toward de-risking what we view to be commodity infrastructure: test sites, launch facilities and ranges, and other commonly required development facilities.

Growing a small business in the environment sketched above has serious ramifications for the way we think about potential partnerships with the government and it will continue to do so at every stage of our company's life cycle, exemplified by the many "Series" of investment rounds a startup goes through and the partnerships that would be of maximum use at each stage:

- **Early Stage – "Series Seed":** Lower barriers to entry through contracts: NASA's Tipping Point, Announcement of Collaborative Opportunity (ACO), Small Business Innovation Research (SBIR) program, DARPA and DoD opportunities
- **Product Development – "Series A":** Test stands, bigger infrastructure, Venture Class Launch Services, DARPA and DoD opportunities
- **Growth – "Series B/C":** Launch pads and infrastructure, launch licenses and regulation, larger government contracts and recurring payload launch procurement
- **Scale – "Series D+":** Certification for flying government payloads, large procurement contracts like Commercial Resupply Services (CRS), Commercial Orbital Transportation Services (COTS), and Commercial Crew Development (CCDev) incentivize early private investments and close the loop on investor ROI as well as bootstrap commercial success

Our key partnership to date has involved working closely with NASA's Stennis Space Center. After a brief description of our engagement with Stennis, the remainder of this testimony examines the ways in which

Relativity has approached vital government partnerships. It includes a discussion of specific policy and regulatory fixes we believe could go a long way towards unencumbering the next generation of commercial space companies.

**WORKING WITH NASA STENNIS SPACE CENTER**

In February 2016, Relativity was contacted by the DoD accelerator MD5 to be one of their pilot companies. MD5 is a public-private partnership between the DoD, NYU, and other top research universities that accelerates startups by helping provide and facilitate access to government infrastructure. As a result, Relativity signed a Reimbursable Space Act Agreement with NASA Stennis Space Center in mid-2016 for an extensive engine test campaign on an existing test stand. This agreement has allowed Relativity to reimburse NASA for direct costs incurred during the facility buildup, upgrade, and testing of our in-house designed rocket engines.

We are pleased to report we have completed over six dozen hot fire tests to date with routine testing ongoing. We thank NASA Stennis Director Dr. Richard J. Gilbrech, along with David Coote, Gary Taylor, Ray Nichols, and the rest of the Stennis team for their work in helping us achieve these results to date, and look forward to our continued progress in the future.

Relativity chose to partner with NASA and was initially drawn to partnership opportunity with Stennis due to the fact that the testing infrastructure was already built and that its team previously ran several successful testing campaigns. Working with NASA has saved Relativity almost a year toward commencing hot fire testing, enabling us to meet our targets far sooner than if we had to build our own engine stand from scratch and it allows us to develop faster against our current funding timelines. It is also important to note that our public-private partnership with Stennis allowed Relativity to invest in other unique elements of our technology development because we had capital available to deploy for those key initiatives rather than being forced to spend money on building our own engine test stand. Investing in the truly unprecedented side of our technology development, which is a critical element of our planned business model, has the additional benefit of putting us in a better position to receive further private funding.

By partnering with the U.S Government and using NASA's existing infrastructure, Relativity was able to more quickly test our proprietary new technologies, grow our operations, and ultimately accelerate our time-to-market so that we will eventually be competing with domestic and foreign competitors on an international scale. Working with Stennis on a "lean team" approach has provided solid learning experiences for both sides, and we wish to take these lessons learned and carry them forward in an expanded, future public-private partnership if Relativity's business needs can be optimally met.

**POLICY RECOMMENDATIONS: STARTUPS & THE FUTURE OF PARTNERSHIPS**

Public-private partnerships have provided critical resources for our company's initial success. However, we have learned a lot about working with the government along the way and would like to offer a few suggestions for improvement. Our desire here is not merely self-interested: We firmly believe that opening and strategically building up specialized government infrastructure could act as an "accelerator" of space startups, in much the same way that President Eisenhower created the highway system and catalyzed the automobile industry.

We recognize that the commercial space legislation under consideration today and in the weeks ahead may not be the proper vehicle for space infrastructure investments. But we also recognize that infrastructure writ large is very much a topic of discussion in Washington and an issue that generates bi-partisan support. Ultimately, we believe that if public-private partnerships can incentivize and maximize investment into the

space industry from private sources they will, in turn, maximize the impact the U.S. Government can have in fostering the industry, further consolidating our nation's dominant position when it comes to exploring the cosmos.

**1) Maximizing & Updating Launch Infrastructure**

As mentioned above procuring and qualifying launch infrastructure – launch pad, ground support equipment, range and communication systems, and flight termination safety systems – is a daunting task for any company, and particularly for a startup that is simultaneously developing new manufacturing technologies and an orbital rocket on a timeline of just a few years.

Relativity strongly support initiatives like NASA's development of a mobile Universal Propellant Servicing System (UPSS) and the Autonomous Flight Termination Systems (AFTS) developed by DARPA and NASA, as these are perfect examples of the types of commodity infrastructure development by the government, which adequately meet the needs of private companies looking to reach operational status more quickly and cost effectively.

Of particular note is that for small class launch vehicles, the lack of accessible West Coast launch sites able to meet polar, sun synchronous, and retrograde orbital inclinations leaves many small satellite customers stuck with launching on foreign rockets from India, Russia, and Europe. Internationally located FAA-licensed launch sites, such as in New Zealand, are privately developed and not open to other U.S. companies, and have technical advantages that are nearly impossible to replicate in the United States other than potentially in Hawaii or other remote Pacific islands. One potential near-term option is to help create a small launch vehicle pad similar in design to KSC's 39C at Vandenberg Airforce Base in California, or another suitable West coast location. Regardless, with emerging small satellite customers split between desiring launches from the East coast and West coast due to the orbits they provide, startups like Relativity must think about multiple launch facilities and operations spread across the country.

The lack of a singular launch complex able to serve the bulk of small satellite customers is a thorny problem to solve, but we have postulated that the use of an offshore drone ship launch platform could potentially alleviate this problem by launching in international waters under an FAA license. The concept we envision is less complex than the repurposed oil platform known as "Sea Launch," and is more akin to the reverse of the drone ships and barges SpaceX and Blue Origin have pioneered for landing recovered boost stages. We believe it is worth mentioning as a potential area for further regulatory and technical investigation. The expected influx of massively higher frequency of launches in the coming years will present new regulatory challenges. It could cause an eventual bottleneck where multiple small launchers and satellite constellations alike would be constrained in servicing a new wave of commercial customer needs. Even proposing an uncharted solution like international drone ship or barge launch goes to show just how dire the launch bottleneck could be with current regulatory processes and launch site limits to the total number of flights possible per year in the United States. This is also a key issue that is pushing companies to investigate air launch as an alternative solution, again with daunting technical unknowns and operational challenges.

Finally, we are grateful for the government's foresight in helping to create ready-access launch pads and propellant loading systems such as 39C in Kennedy Space Center. However, Relativity is concerned that 39C is located too close to the Space Launch System (SLS) pad 39B, potentially risking multi-month schedule delays as a national asset like SLS will rightfully take schedule priority. Due to this proximity to SLS, we are nervous about potential insurance premium increases that launching at 39C could entail. We also believe it will be difficult to serve multiple companies effectively from the same location, and while there appear to be several available

moth-balled facilities at Cape Canaveral, for example, the growing scarcity of mature launch pads will hinder new entrants' ability to meet customer demand.

**2) A New Model for Service Agreements**

The current incarnations of the Space Act Agreement (SAA) and Commercial Space Launch Act (CSLA) agreement contain problematic provisions for handling conflicting test stand priorities.

We fully understand that in the event of a national emergency the government may require the use of test infrastructure. Our primary concern is that as the SAA and CSLA are currently drafted, if another commercial company wants to use the same test stand as us (or any other launch startup) NASA would be required to accommodate them in a presumed "one-month on, one-month off" type testing arrangement. This is troubling to a startup company where a delay of this sort could seriously jeopardize our ability to hit milestones with enough momentum required for further private funding. This is precisely the sort of scheduling conflict that could wreak havoc with development deadlines, and thus force us to seek highly inefficient alternatives, i.e. building our own infrastructure. We are willing to reimburse direct costs and pay site maintenance fees in exchange for additional guarantees. If launch startups had a window of time during which we could lease engine and stage test stands this would go far to make us more comfortable relying on government infrastructure during critical development phases before operation.

Agreements with local centers like Stennis are extremely valuable but risky mechanisms in the way they are formed. They save new small launch startups precious time and money but they are negotiated in an ad-hoc, case-by-case manner which creates a significant risk variable. A more certain framework and policy stance for making agreements between privately funded startups and the U.S. Government for infrastructure use could greatly help startups in particular navigate public-private partnerships.

Relativity thus proposes the creation of a "Commercial Space Lease Agreement" – a new framework similar to a reimbursable SAA or CSLA but with provisions for leasing development testing infrastructure at direct cost in much the same way launch infrastructure like LC-39A and LC-13 at Kennedy Space Center is leased. To ensure competition for an agreement of this type, public notices much like LC-39A and LC-13 could be held for a period of time, with similar optionality on proposing either exclusive-use or multi-user operations. Investment dollars from venture capital often follow – not precede – winning these types of agreements, worth noting for comparison of proposals versus more entrenched and initially-funded competitors. Potentially leasable facilities which are not considered moth-balled could be selectively duplicated or expanded to ensure a higher number of participants have equal access as the space industry grows. Continued support for flexibility in the Company's choice of using either Company or Government personnel, and supporting Company-funded facility upgrades and modifications are critical to ensuring the best-of-both-worlds in a testing infrastructure public-private partnership. As we envision it, a Commercial Space Lease Agreement framework would lower competitive barriers to entry and promote significantly more efficient use of private capital and time, while reducing risk across the breadth of company development phases by providing more certainty in negotiation outcomes.

**3) Reimagining Procurement**

While Relativity is currently entirely privately funded, the opportunity for any company to apply for competitive partnership contracts provides essential support and valuable signaling to potential commercial customers.

As a startup operating under aggressive financial goals, Annual Recurring Revenue (ARR) is a key long-term metric and far superior to helping build our bottom line than one-off revenue generating events such as

Venture Class Launch Services (VCLS). VCLS is an excellent opportunity for a company like ours because it enables us to gain initial traction, generate revenue, and validate that we can attract new commercial customers. While I strongly support any further rounds of flight opportunities where we may apply for funding, a one-off launch contract is unable to move the needle on a private investor's ROI expectations – although we understand that with the current incarnation of VCLS, that outcome perhaps was not the intent. We would also point out that delays in contract awards, yearly submission cycles, and any lags in funding a company once a contract has been awarded may cause undue harm to a startup where weeks and months are counted.

We would encourage NASA to investigate a modulated version of the program that provides for recurring and larger launch contracts over multiple launches. This could include a hybrid model of sorts, one that predicated the award of a full contract on the successful execution of an initial run of two-three launches over an agreed-upon period time. Failure to meet clear benchmarks along the way would result in the immediate termination of such an agreement. Alternatively, some version of new public-private contracts like the Commercial Resupply Services (CRS), Commercial Orbital Transportation Services (COTS), and Commercial Crew Development (CCDev) that is geared towards smaller and newer launchers would also incentivize early private investment.

**4) Avoiding the Licensing Logjam**

The question of adequate resources for the Office of Commercial Space Transportation has been raised in previous hearings, but as a company that plans to soon join the ranks of those applying for launch licenses with greater and greater frequency, it is of the utmost importance in our minds that AST receive sufficient funding and personnel to avoid a significant back up in licensing applications. We understand that there is a broader and healthy debate taking place about AST's role vis-à-vis that of the Department of Commerce's Office of Space Commerce but this should in no way supplant a critical focus on ensuring AST is equipped to carry out its current mission.

**5) Continuing to Support a Robust Satellite Market**

Low cost, frequent, predictable orbital launch is simply the first step in accessing space and creating a large impact above Earth and beyond. Support of satellite companies – both established and emerging – is needed to ensure the large total addressable market investors need to see grows and matures. Issues such as orbital debris reduction need to be tackled in a way that do not limit the potential revenues of satellite companies or the launchers that fly them. Limits to the total number of satellites in orbit would be more damaging than service lifetime limits, tracking requirements, or end-of-life deorbit requirements. This is especially true as many proposed orbital constellations specifically benefit from a high number of payloads circling the globe with rapid iteration of their technologies. We also support innovative solutions to spectrum rights that increase the number of satellite companies able to cost-effectively serve their customers without interference. Our potential customers need to access space today to prove their business models and survive until tomorrow, and we do not wish to hinder them in doing so. Thus, we do not support an explicit ban on unsubsidized foreign launchers as we wish to instead work on public-private partnerships to create other incentives toward fielding a low-cost U.S. designed, manufactured, and flown – non-ICBM derived – orbital vehicle for small satellite constellations.

**CONCLUSION: A STARTUP VISION FOR COMMERCIAL SPACE IN THE 21st CENTURY**

For the most part, Relativity has had an overwhelmingly positive experience in its partnerships with NASA and MD5. However, we believe it is important to point out that from conversations with our peers not every commercial space startup feels the confidence to rely on public-private partnerships in key development infrastructure roles yet.

Take, for example, this vital question of engine and vehicle stage testing infrastructure. A dearth of available stands, an occasionally cumbersome engagement process, an uncertain prioritization process – those challenges and more will push many startups to spend valuable private funds building their own test stands and support hardware. Building our own development testing infrastructure continues to be an expensive and inefficient process that results in a loss of time, money and creative energy that could be better spent on cutting edge innovation rather than on items which are proven commodities – and which the U.S. Government is perfectly placed to provide access to be it via existing infrastructure or through the targeted, gradual buildup of new infrastructure to meet the demands of a new generation of private space exploration companies.

Lastly, it is worth noting that no matter which strategy a company pursues, startups like Relativity initially compete directly with much larger and more well-funded competitors through new ideas, development speed, equity ownership, and novel big-payoff technologies. It is that willingness to innovate in the face of uncertain risk that uniquely bonds startups, even as competitors. There is one other thing that any startup worth its salt has in common: ambition. We grind and labor and persevere not merely to get rich – there are probably easier ways to do that – we do it to change the world. Commercial space startups do it because we want to change the world by reaching the cosmos.

Relativity is here today as a representative example of a successful partnership with the United States Government. We also recognize that we are here today as one humble example of the hundreds of dynamic space startups currently hard at work in suburban garages and repurposed airplane hangars all across America. The United States Government has not always been known for the nimbleness of action that characterizes your average startup. But I would be so bold as to venture that we are united by one thing that is greater than all of us: A vision. A vision of the Stars and Stripes on the first spaceship to safely land men and women on Mars. A vision of how we will guide this world, our home, into a more fantastic future by learning to understand new worlds and applying that knowledge to our own. A vision of all the other missions that will expand the limits of our known universe and the bounds of the human spirit. What could be more human and American than aspiring to do something in the face of the impossible – and succeeding?

Chairman Cruz, Ranking Member Markey, Members of the Committee – thank you for this opportunity.

I look forward to working with you in the months and years ahead.