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Greetings Fellow Space Developers. I am the AVATAR of Pete Worden, Director of the NASA Ames Research Center. I am speaking to you today from Space Port Alpha in Second Life – a virtual world that I'll tell you more about today. I am standing in front of a model of the Ares I rocket developed by members of the International Space Flight museum. Before I begin, fly with me over to our presentation platform illuminated by that artificial sun ahead on NASA CoLab island.

What I'd like to show you today are the fantastic opportunities unfolding in our Vision for Space Exploration. I'm sure everyone knows that we are on our way into the solar system – beginning with the moon. This is nothing less than the next step in settling the solar system. I'm convinced the parents of the first child to be born off-planet are in school today – perhaps they are even here. NASA is busy building the rockets and spacecraft that will take them to the moon and beyond. But there's much more to the Vision than working on the capabilities for human spaceflight. Fundamentally, the Vision we share with you and people throughout the world is one of unlimited opportunity. These are opportunities for economic and technological expansion to be sure. But perhaps the most interesting opportunity is that we are all going into space. That's what I will discuss today.

We at NASA are working hard to create opportunities for what I might call "participatory exploration." We are doing this in a lot of ways. This virtual world, 2nd life is one way. Its part of an initiative we have called CoLab. Other parts of CoLab include opportunities for software experts – whom I might better call "geeks" to help us develop open-source software to support a wide variety of space exploration needs-- we're calling this CosmosCode. We are forging new partnerships with industry – in particular, we are seeking partnerships with non-traditional industries in the IT and bio-technology areas. For example we are working closely with Google – a company a few of you might have heard about before NASA started working with them! We are also working with the emerging space entrepreneurial community such as Virgin Galactic – another company that some here might just have heard of. Finally, I want to underscore that NASA's exploration missions include not only manned missions to the moon – but a strong component of robotic exploration missions to the moon and mars as well. I'm particularly excited about the potential of small, low-cost missions. The revolution in our ability to do big things with small satellites – using off-the-shelf technology means we can mount frequent small robotic spaceflights to the moon. These could carry scientific and exploration instruments. But due to their low cost – potentially only a few million dollars - small lunar and other deep space missions of the "nanosat" class weighing a few kilograms might be supported through wholly private means.

Let me tell you a little more about CoLab. In many areas new business possibilities and other endeavors are being developed in collaborative work spaces. This means that folks

with widely different areas of expertise and objectives share common workspaces. They share workspace resources such as business and communications equipment. But most important they have the opportunity to interact and cross-fertilize ideas. For example a person or group working on a NASA small satellite concept could share space with people looking for a new medical treatments, new energy solutions, or even political activists. While none of these people or groups has any initial knowledge, or even purpose in the other areas, their ability to easily interact often results in dramatically new solutions to each other's goals. To further this approach we have established a small collaborative element in a collaborative workspace in San Francisco – sharing this with people from many different perspectives and many different goals. Already several impressive results have emerged.

To carry our collaborative concept further – and make it even easier we are using the power of virtual environments to expand our reach. Today, there are over 100 virtual environments in the United States alone used for a number of purposes. Second Life is an exciting new opportunity that began just outside of NASA Ames – in San Francisco, CA. They have constructed a virtual world where anyone can enter through their computer and interact with each other through their Avatar. An Avatar is a virtual replica of yourself – or what you would like yourself to look like. Other Avatars can show up and interact with me via written messages – and now audio as well. You see some of them around me now. This one of me is clearly cooler than I am in real life. NASA has set up a space island as a collaborative workspace in this virtual environment. As I noted I'm speaking to you from that Island.

The CoLab team started this island differently than others may have guessed. We did not contract with a vendor to build content here, instead, we opened our doors and started having meetings to build a community. More people started coming, and the community started to form. We held a competition for the design of the island and the CoLab community decided which design would win. Leaders emerged from the community, such as Troy McCluhan, independent groups formed to create meeting spaces and offices, such as the Space Riggers, and others helped to create my avatar today (special thanks Rocket Sellers).

We are looking at how this island can be a portal for all to fly along on space missions. Real data from real missions such as the international space station can be ported into virtual environments and allow all to accompany key space missions. For example, I can imagine a future robotic rover mission to the moon where we can all walk or fly along with a lunar rover as it makes its way over the lunar landscape. As the rover streams its data back to earth we can build up an increasingly accurate virtual model of the land it is traversing. Your Avatar can explore along with those of scientists and engineers managing the mission. You might just have some expertise or simple knack in geology and could shout to the mission manager: "Hey – over here, isn't this carbonaceous mineral!" In this manner we can all participate in space exploration. When the next people step on the surface of the moon in a little over a decade your Avatar could be with them. Of course we haven't yet figured out how to address the light travel time delay so you will be with them a few seconds in the past! But as our technology improves and human ability to interface

with cyberspace increases, the fidelity of this new reality to the real solar system will only grow. It won't be long before the fanciful holo-decks of Star Trek will become a real tool for us all to share in, participate and contribute to the Vision for Space Exploration.

Speaking of contributing, we do want your help directly. Across the IT industry computer experts are finding that so-called "open source" software is far more useful and even secure than traditional proprietary software systems. In these open source approaches the full source code is openly available. If one wishes to modify it for a particular special purpose it is easy to do so – and make your new application an additional open source resource for others to use and build upon. The entire LINUX operating system has been developed in this way. Initially a plaything for computer geeks, LINUX is perhaps the most powerful tool for many top-end applications, including those for space science and exploration. Ironically, the open source software is more secure than proprietary systems since any user can see the full code and ensure directly that no malicious software is lurking. Recently, experts – or geeks as the case may be, at NASA Ames developed a new application for problem reporting and tracking modifying the open source software "Bugzilla." This only took a few weeks and is now a central part of the PRACA system being used as we develop the Vision hardware for the Constellation Program Office.

Approximately two years ago, the NASA Open Source Agreement, or NOSA, was established to release NASA-developed code as open source. While this is a great step forward, the true power of open source is realized when you create an active community engaged in the development of a project. As such, the CoLab team is working hard at creating CosmosCode to create a community of "space hackers" to actually develop in the public domain, not just release it. This way, after NASA finishes the project, there is already an active community able to keep the momentum moving forward, and extend the functionality.

Through CoLab we are beginning other efforts to allow people to easily see what problems we are working and themselves contribute to solutions – another key way for all to participate in the Vision!

Let me turn now to an area I believe is already revolutionizing everything we do in space. The word space used to always carry big dollar signs – the "billion" word all too distressingly appears. Frustrated space experts around the world – sadly more so outside the United States than here – developed some concepts to fix this. Using so-called micro satellites – weighing a few hundred kilograms rather than thousands as their high price relatives – these folks were able to get 80% the capability at 10-20% the cost. And that cost was only a few tens of millions – Euros or Pounds or Canadian dollars that is. Moreover, by mounting these missions as secondary payloads – piggy-backing on a large mission the launch costs could be very small. Now, we are applying this at NASA to space exploration. In a little over a year America's next mission to the moon – the Lunar Reconnaissance Orbiter or LRO will be launched on an Atlas V rocket. It is designed to orbit the moon to get the detailed mapping and scientific data we need to land people on the moon a decade or so later. But it doesn't touch the moon and can't answer a very key question as to the possible presence of ice in the permanently shadowed craters at the lunar

pole. So NASA is developing a low-cost secondary mission called LCROSS – or Lunar CRater Observation and Sensing Satellite. The LCROSS costs only $75Million and stays attached to the Atlas upper stage after LRO is released. It directs that upper stage and eventually itself into an impact in those permanently shadowed lunar polar craters. That impact will blow ejecta up to 100 kilometers above the lunar surface where it can be assayed by LCROSS, LRO and other systems in space and on earth to see if water is present.

Let's move over to the NASA Island screen and with a little help from Ella Fitzgerald show you how LCROSS will work. When it actually flies I hope your Avatars will fly along with it in "real" life too!

[Show Clip]

But as they said in the old TV commercial "Wait there's more!" Technology is marching on. If microsatellites weighing 100 kilograms can do 80% what a big sat does – how about a "nanosatellite" weighing 10 kilograms doing 80% of the microsat mission. Not only do we believe it can – we have done it. A few months ago an Air Force Minotaur rocket lifted off from NASA's Wallops launch complex in Virginia. It carried a microsatellite for the USAF that is getting 1 meter class imagery of the earth. But it also carried a NASA nanosatellite weighing just 8 kilograms. This GENESAT has successfully showed that biological experiments – in this case measuring how the space environment and microgravity effect gene expression in e-coli bacteria – can be quickly and affordably mounted. Many other biological and other space exploration experiments are in development or planned using nano-satellites. The entire mission costs only a few million dollars – putting meaningful space capabilities within reach of a huge segment of the community – including fully privately funded space exploration missions.

I'd like to stop here before I start waxing eloquent about pico- and even femto-satellites. But I think you get the message. This is not your father's space program. The new technology of virtual life and cyberspace means we can all participate in the Vision for Space Exploration. The revolution in nano-technology means we can do pretty surprising things in very small packages too. I haven't gotten into all the possibilities of new bio-technology – that's for another talk – but all of these mean that as we expand into and settle the solar system we will all be going!

I'd be happy to address questions – either from my colleagues here on the NASA Island or in the audience here in Dallas.