Statement of

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before the
Committee on Science, Space and Technology

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Chairman Smith, Ranking Member Johnson, and other Members of the Committee, I am delighted to appear before you to describe recent progress in NASA's Europa Clipper mission.

The ice-covered world Europa—a moon of Jupiter similar in size to Earth's moon—shows a landscape of cracks, ridges, and jumbled, chaotic terrains indicative of a tumultuous past. The Galileo spacecraft, which orbited Jupiter beginning in the late 1990s, provided images, compositional information, and gravity and magnetic data that point to a remarkable conclusion: Europa likely has a global ocean of liquid water beneath its icy carapace, maintained by tidal flexing and heating due to its slightly non-round orbit about Jupiter. From what we know of the tenacity of life, Europa could be one of the best places in the solar system to search for life beyond Earth.

For these reasons, future detailed investigation of Europa is one of the top priorities for planetary exploration, as expressed in the National Research Council's 2011 planetary science Decadal Survey. The Europa Clipper mission responds directly to the Decadal Survey in its top-level goal—*Explore Europa to investigate its habitability*—and in its top-level science objectives to understand Europa's ice shell and ocean, composition, geology, and recent or current activity.

The last of these science categories includes the possibility that Europa may have active plumes that spew water vapor into space, and which could directly reveal Europa's internal composition and suitability for life. This tantalizing evidence for plumes is provided by the Earth-orbiting Hubble Space Telescope, searching at the extreme of its detection limits.

In the tradition of the 19th Century trading ships for which this mission was recently named, the Europa Clipper will sail past the Jovian moon at a rapid clip, and as frequently as every two weeks, providing many opportunities to investigate Europa from as close as 16 miles above the surface. During each flyby, the spacecraft will spend just a short time within the challenging radiation environment near Europa.

The prime mission plan includes 40 to 45 flybys of Europa from Jupiter orbit, during which the spacecraft will interrogate the moon in unprecedented detail. This will include: imaging to understand its geological history; compositional analyses including direct sampling of materials

knocked off the surface; ice-penetrating radar to examine the three dimensional structure of its icy shell; and gravity, magnetic, and plasma measurements to understand its hidden interior and interactions with the Jupiter environment. The mission can also lay the foundation for future exploration of Europa, providing critical global context and scouting potential landing sites for a potential future landed mission.

As its Project Scientist, I represent the science and scientific integrity of the Europa Clipper mission, ensuring it will address the top-level goal and objectives, and that it will be appropriately balanced in doing so. I first testified before this Committee two years ago, just after NASA had competitively selected nine science instruments for the mission, and had given the green light to begin Phase A, known as mission formulation. In February of this year, NASA completed its second major milestone review, so today, we are in Phase B, refining details of how the instruments will work together to achieve the mission's science, and developing preliminary yet detailed design plans for the spacecraft and its subsystems, including the science instruments. The science instruments are led by teams at NASA's Jet Propulsion Laboratory, the Johns Hopkins Applied Physics Laboratory, the Southwest Research Institute in San Antonio, the University of Texas at Austin, Arizona State University, and the University of Colorado Boulder.

Progress on the instrument suite has been outstanding. Instrument concepts have been reviewed; designs have matured; subsystem vendors are being selected; prototype parts are being built; detectors are being tested; and additional tests are being conducted to ensure robustness against the harsh radiation environment in Europa's vicinity. Beginning this fall and into next spring, each spacecraft subsystem and each instrument will undergo a Preliminary Design Review, to assure that the defined science can be achieved by the instruments and spacecraft in combination. These Phase B reviews are in preparation for the mission to proceed to Phase C around October 2018; it's also at this key decision point that NASA would make a final commitment as to a launch readiness date and baseline mission cost. Then during Phase C, flight hardware would be built.

The members of the science team for this mission are working cooperatively together to define the synergistic science which I see as this mission's hallmark. No one instrument will definitively affirm the ocean's existence or tell us convincingly of Europa's composition. Instead, each instrument technique provides a piece of the puzzle, and from the combined science data, the Europa science team and the greater planetary science community will mature a complete picture of how Europa works as a complex system: from its submerged rocky core to its ocean, to the capping ice shell and surface, to its thin atmosphere, and to the surrounding environment of jovian space.

The clipper ships of the late 19th century were an expression of speed and grace in the Golden Age of Sail. We are now in a golden age of Solar System discovery, and the Europa Clipper mission will return to us untold scientific riches.

Thank you, and I look forward to your questions.