Researchers developing cellular service standards for space missions to the moon and Mars

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Think getting good cellular service on Earth is difficult? Try doing it on the moon or Mars. A team of Simon Fraser University researchers is working hard to make LTE/4G and Wi-Fi communications systems on the moon a reality by 2022.

A group of nations, including the U.S. and Canada, is presently working on humans' return to the surface of the moon by 2024, under the umbrella of the Artemis Program. In October, NASA selected Nokia Bell Labs to build an LTE cellular test network on the moon, with the goal of validating the technology for building a communications infrastructure to support Artemis and to prepare for future human missions to Mars. But before that can happen, the network technology required for the network has to be must be proven to work effectively between various space agencies. As well, international recommendations will be required for using LTE, 5G and Wi-Fi technologies for space missions. Suggested standards must then be tested before they become internatonally accepted.

NASA and the Canadian Space Agency have entrusted that critical testing to scientists at SFU's renowned PolyLAB for Advanced Collaborative Networking, led by Stephen Braham. Together with partners Kevin Gifford and Siddhartha Subray at the University of Colorado Boulder (CU Boulder), SFU operates the Canadian component of the Exploration Wireless Communications (ExWC) testbed out of Vancouver's Harbor Center. This site tests interoperability standards to ensure future cellular and Wi-Fi networks in space can connect to any device.

"It sounds like far-out stuff, building networks on the moon, Mars and even further out in our solar system," says Braham. "But we're actually testing Nokia's technology right now here at Harbor Center.

"ExWC is what will allow us to build the ladder of technology standards needed to get cellular networks off Earth and into the solar system. Before space agencies can adopt these technologies, we need to prove we can operate between multiple vendors and different agencies, which is why NASA and CSA supports the ExWC testbed."

The ExWC testbed was specifically created in 2018 to help NASA and CSA hone high-speed wireless communications in space, especially around 5G-forward LTE solutions and advanced Wi-Fi. Both SFU and CU have their own radio networks that communicate with control networks, called cores. SFU radios, in the lab and on masts and mountains in B.C. and the Yukon, talk both to the SFU-based core and the CU Boulder core, which talk back to SFU.

The team is conducting tests between vendors, including Vancouver-based Star Solutions

International, and across national borders at CU Boulder, where the Nokia components are. SFU also uses a range of cellular client devices, such as LTE and Wi-Fi gateways from Sierra Wireless, another local company, that allow Braham to prototype and validate vehicle-based communication.

Because of wireless' ability to send huge amounts of information quickly over great distances, Braham has been an early advocate for the wireless technologies that are known today as Wi-Fi, LTE and 5G networks.

"I remember telling people what we could accomplish with cellphones before we had broadband cellular data networks, over 20 years ago, when it seemed like a very improbable stretch for devices that could, then, only do voice and text," he says.

"People would ask how astronauts could receive information and Gifford, myself, and our colleagues predicted it would be on small computers that look a lot like the smartphones we have today.

"These technologies will work in space the exact same way you and I use them on earth now. We are very excited to see these missions use these networks on the surface of other worlds in our solar system finally moving forward. NASA selected Nokia for the first lunar cellular network experiment."

Braham and associate professor Peter Anderson, who directs the SFU Telematics Research Laboratory that includes PolyLAB, share a long history of working on communication studies and analog systems for NASA and the Canadian Space Agency. Their work includes extensive research on predecessors to cellular and modern Wi-Fi networks in the Canadian High Arctic with the SETI and Mars Institutes, dating back to 1998, and developing the SFU PlanetNet architecture for exploring the surfaces of other worlds. Other collaborators have included Canadian space technology company MDA and the Canadian Communications Research Center. Collaborations with CSA and MDA include communications studies for a Mars communications orbiter, moon and Mars surface wireless communications, lunar rover direct-to-Earth and orbital relay communications missions.

Braham and CU Boulder's Gifford have published several papers on how LTE and 5G technologies can be applied to next-generation space missions, especially for crewed missions that need spacesuit and rover communications.

Anderson and Braham have been integrating related concepts since 1997 for next-generation public safety communications, building on many decades of Anderson's research. This work has been a major component in developing and testing concepts for a Canadian Public Safety Broadband Network and for international standards for operating just-in-time deployable cellular networks for major emergencies.

They are presently operating pilots in B.C. and the Yukon for such networks, which includes working out how to manage them during the COVID-19 pandemic.

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