DAPHNE Connects Satellites to the Cloud

How do we ensure our rainwater water is clean? How do we know about changes in Earth's connection to the Sun? Can we thrive on another planet? Getting climate and planetary data to the scientists who analyze it is what NASA does best. NASA's goal is to explore and advance knowledge for the benefit of human kind. To realize that, we at NASA reach up to space with scientific instruments to expand human understanding. Our probes collect vital data and send it back to Earth so that scientists can decode the universe's mysteries.

To receive data from satellite missions, NASA depends on a collection of ground station antennas located all around the world. Because missions frequently have different wireless communication requirements, these ground stations are often equipped with "mission unique" hardware to allow these specific requirements to be met. These requirements can include special wireless modulation, handshaking to confirm data was received properly, prioritization of certain types of data, checking science data for trends of interest, or distribution to special stakeholders. Having unique hardware to meet all of these needs adds cost to the government.

An added complexity is that the majority of ground stations are located at remote places. Maintenance of unique hardware requires travel and shipping of parts that may only support one mission. This reduces scalability of those resources. In addition, the Agency has historically covered the cost of owning telecommunication at these remote sites. Each of these adds to the annual cost.

Recently, a solution was developed at the Goddard Space Flight Center. The Telecommunication Networks & Technology Branch (Code 566) and its engineers created the "Data Acquisition Processing and Handling Network Environment" (DAPHNE) system. This system was developed and deployed to eliminate the need for mission specific hardware at ground stations.

The system is comprised of two parts: One piece of streamlined hardware which is local to the station, and a second "virtual" component in the cloud. The local DAPHNE system occupies a small footprint with general purpose, easy to maintain hardware. When a satellite mission passes overhead, DAPHNE ingests that data and securely pushes the prioritized data to its counterpart in the cloud. Once in the cloud, all the mission specific functionality can be executed using the full processing resources of our cloud partners.

Removing the need for multiple generations of mission specific hardware also significantly reduces the footprint at the ground station. It is reduced from racks of ever growing unique mission hardware, to just half a rack of a shared resource. In addition, DAPHNE removes the need for owning or leasing costly connections. The system is designed to connect to the nearest cloud backbone global infrastructure network, benefitting from economies of scale to reduce the communication cost significantly. This saves the Agency money, and positions NASA to take advantage of commercially upgraded and maintained technology.

The system also allows Missions to be more nimble. Within the cloud, DAPHNE is customizable, with an architecture that is fully data driven and scalable. Missions can spin up servers in seconds to process the influx of data with the hand-shaking and data protocols they need. When done, DAPHNE releases those servers and has no more financial commitment. This has accelerated and helped streamline the data

capture, process, and delivery. Once instrument data is delivered to the scientists, they can also access the full processing power of commercial cloud providers. Scientists can spin up thousands of servers to look for patterns in their measurements, for mere pennies to the Agency. The benefits extends from there to inter-agency data, science sharing, and collaborations.

Many cloud providers offer a suite of tools including Artificial Intelligence (AI), data mining and other innovations. This gives NASA scientists and their partners a rich tool box to understand our universe.

The DAPHNE team has deployed the system at two stations, one in Alaska, US and the other at the remote Arctic island of Svalbard, Norway. The team will deploy two more systems to other ground stations (Puntas Arenas, Chile and Wallops Island Virginia, US), with more stations to be integrated in the coming year from international partners in Asia and Australia.

The DAPHNE system is certainly a technological leap over existing systems. It has contributed to millions of dollars of savings to the Agency. Its true innovation is in its ability to drive new ideas. The system puts new methods of collaboration and processing within the reach of those able to expand human knowledge. To the science community, DAPHNE makes available computational resources that were previously difficult to navigate. From there, the sky is the limit.