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Remote Third Shift EAST Operation: A New Paradigm

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Scientists at General Atomics (GA) have conducted in the United States remote experimental operation of the Experimental Advanced Superconducting Tokamak (EAST) in China during their third shift. These experiments were led by scientists in a dedicated remote control room that utilized a novel computer science hardware and software infrastructure to allow data movement, visualization, and communication on the time scale of EAST's shot cycle. This Fusion Science Collaboration Zone and the remote control room were used to conduct remote experiments on EAST on vertical controllability by triggering vertical displacement events to assess vertical growth rate and nonlinear evolution while a team at EAST provided scientific assistance and engineering operations oversight. The level of capability deployed to remotely operate EAST required the creation of an infrastructure that was a major advancement over what had previously been achieved in the fusion community. One component of the Fusion Science Collaboration Zone is data movement, where large amounts of data can be moved between continents in a short time scale and real-time data from control systems can be moved basically instantaneously. The large datasets are moved with a computer networking technique that does not use the traditional transmission protocol of the Internet yielding a 300-fold increase in data transfer rate. Combining this speed with an event system tied to the EAST shot cycle allowed automatic initiation of data transfers, resulting in bulk EAST data to be transferred to GA within minutes. The real-time data transfer was accomplished by reading data directly from the EAST Plasma Control System memory through a networked, in-memory data structure server that received the data at GA to make it available to the scientific team. After the bulk data arrives at GA, it is served via MDSplus allowing an approved US client to securely and rapidly access EAST data. This architecture avoids multiple clients within the US from requesting data from EAST and competing for the long-haul network's bandwidth that is considerably slower than the network with the U.S. At present there are 35 approved scientists from 7 U.S. research institutions.

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