

Title:

Elevating the Edge to be a Peer of the Cloud

Abstract

Technological forces and novel applications are the drivers that move the needle in systems and networking research, both of which have reached an inflection point. On the technology side, there is a proliferation of sensors in the spaces in which humans live that become more intelligent with each new generation. This opens immense possibilities to harness the potential of inherently distributed multimodal networked sensor platforms (aka Internet of Things - IoT platforms) for societal benefits. On the application side, large-scale situation awareness applications (spanning healthcare, transportation, disaster recovery, and the like) are envisioned to utilize these platforms to convert sensed information into actionable knowledge. The sensors produce data 24/7. Sending such streams to the cloud for processing is sub-optimal for several reasons. First, often there may not be any actionable knowledge in the data streams (e.g., no action in front of a camera), wasting limited backhaul bandwidth to the core network. Second, there is usually a tight bound on latency between sensing and actuation to ensure timely response for situation awareness. Lastly, there may be other non-technical reasons, including sensitivity for the collected data leaving the locale. Sensor sources themselves are increasingly becoming mobile (e.g., self-driving cars). This suggests that provisioning application components that process sensor streams cannot be statically determined but may have to occur dynamically.

All the above reasons suggest that processing should take place in a geo-distributed manner near the sensors. Fog/Edge computing envisions extending the utility computing model of the cloud to the edge of the network. We go further and assert that the edge should become a peer of the cloud. This white paper is aimed at identifying the challenges in accomplishing the seamless integration of the edge with the cloud as peers. Specifically, we want to raise questions pertaining to (a) frameworks (NOSQL databases, pub/sub systems, distributed programming idioms) for facilitating the composition of complex latency sensitive applications at the edge; (b) geo-distributed data replication and consistency models commensurate with network heterogeneity while being resilient to coordinated power failures; and (c) support for rapid dynamic deployment of application components, multi-tenancy, and elasticity while recognizing that both computational, networking, and storage resources are limited at the edge.

Bio

Professor Umakishore Ramachandran received his Ph. D. in Computer Science from the University of Wisconsin, Madison in 1986, and has been on the faculty of Georgia Tech since then. For two years (July 2003 to August 2005) he served as the Chair of the Core Computing Division within the College of Computing. His fields of interest include parallel and distributed systems, computer architecture, and operating systems. He has authored over 100 technical papers and is best known for his work in Distributed Shared Memory (DSM) in the context of the Clouds operating system; and more recently for his work in stream-based distributed programming in the context of the Stampede system. Currently, he is leading a project that deals with large-scale situation awareness using distributed camera networks and multi-modal sensing with applications to surveillance, connected vehicles, and transportation. He led the definition of the curriculum and the implementation for an online MS program in Computer Science (OMSCS) using MOOC technology for the College of Computing, which is currently providing an opportunity for students to pursue a low-cost graduate education in computer science internationally. He has so far graduated 30 Ph.D. students who are well placed in academia and industries. He is currently advising 5 Ph.D. students. He is the recipient of an

NSF PYI Award in 1990, the Georgia Tech doctoral thesis advisor award in 1993, the College of Computing Outstanding Senior Research Faculty award in 1996, the College of Computing Dean's Award in 2003 and 2014, the College of Computing William ``Gus" Baird Teaching Award in 2004, the ``Peter A. Freeman Faculty Award" from the College of Computing in 2009 and in 2013, the Outstanding Faculty Mentor Award from the College of Computing in 2014, and became an IEEE Fellow in 2014.