White Paper

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Biography:

Dr. Jain is currently a Professor of Computer Science and Engineering at Washington University in St. Louis. Previously, he was one of the Co-founders of Nayna Networks, Inc - a next generation telecommunications systems company in San Jose, CA. He was a Senior Consulting Engineer at Digital Equipment Corporation in Littleton, Mass and then a professor of Computer and Information Sciences at Ohio State University in Columbus, Ohio. He is the author of ``Art of Computer Systems Performance Analysis,'' which won the 1991 ``Best-Advanced How-to Book, Systems'' award from Computer Press Association. His fourth book entitled " High-Performance TCP/IP: Concepts, Issues, and Solutions,'' was published by Prentice Hall in November 2003. He has recently co-edited "Quality of Service Architectures for Wireless Networks: Performance Metrics and Management,'' published in April 2010. Raj Jain is a Fellow of IEEE, a Fellow of ACM, a Fellow of AAAS, a winner of 2015 A.A. Michelson Award, ACM SIGCOMM Test of Time award 2006, CDAC-ACCS Foundation Award 2009, IISc Distinguished Alumnus Award 2014, WiMAX Forum Individual Contribution Award 2008, and ranks among the top 90 in Most Cited Authors in Computer Science. Prof. Jain has 14 patents, and has written 16 book chapters, 70+ journal and magazine papers and 110+ conference papers.

Research Challenges and Opportunity

The next generation 5G networks will carry a significant amount of traffic due to increasing usage of smart phone applications, Internet of Things, and Video oriented applications. This will be accompanied by an increase in mobility and increase in diversity of applications. The current mobile network structure designed for voice traffic needs a new design to minimize the CapEx and optimize the Quality of Experience (QoE).

Internet service providers (ISPs) are moving towards network function virtualization (NFV) for 5G core networks. They plan to use multiple clouds to reduce their capital expenditure and operational expenditure by using virtualization, programmability, dynamic scaling, automation, and easy management of resources. Other businesses (called Application Service Providers or ASPs), such as banking, financial sector, retail, government, and education can also benefit from a multi-cloud based deployment. The key problem with such deployments is that the inter-cloud wide area network (WAN) links are expensive and have limited capacity as well as high-cost, which affect the performance. Unlike a single-cloud deployment, proper placement of the virtual application modules among geographically disparate clouds and service chaining is important to ensure acceptable latency and performance. Two key challenges in such inter-cloud deployments are: Heterogeneity and the impact of networking delays on the performance of real-time applications.

Travel Funding: Required