

High-Speed Networking

A Systematic Approach to High-Bandwidth Low-Latency Communication

Dr. James Sterbenz, BBN Technologies

Tutorial Outline

This tutorial presents a comprehensive introduction to all aspects of high-speed networking, based on the book *High-Speed Networking: A Systematic Approach to High-Bandwidth Low-Latency Communication*, James P.G. Sterbenz and Joseph D. Touch, John Wiley, 2001. The target audience includes computer scientists and engineers who may have expertise in a narrow aspect of high-speed networking (such as switch design), but want to gain a broader understanding of all aspects of high-speed networking and the impact that their designs have on overall network performance. This tutorial is not about any particular protocols and standards, but is rather a systemic and systematic approach to the principles that guide the research and design of high-speed networks, protocols, and applications.

The network is a complex system of systems, and high-speed networking does not result from the design of individual components or protocols in isolation. Thus, this tutorial presents a systemic approach to high-speed networks, where the goal is to provide high bandwidth and low latency to distributed applications, and to deal with the high bandwidth- \times -delay product that results from high-speed networking over long distances. A set of fundamental axioms is presented (Know the past present and future, Application primacy, High-performance paths, Limiting constraints, and Systemic optimization), followed by the major topics:

- Network architecture and topology
- Network control and signalling
- Communication links
- Switches and routers
- End systems
- End-to-end protocols
- Networked applications

A set of design principles are defined and applied to each of the topics:

1. Selective optimization
2. Resource tradeoffs
3. End-to-end arguments
4. Protocol layering
5. State management
6. Control mechanism latency
7. Distributed data
8. Protocol data unit structure

A set of design techniques (scaling time and space, masking the speed of light, specialized hardware implementation, parallelism and pipelining, data structure optimization, cut-through and remapping) are introduced and applied as appropriate.

Biography of Instructor

Dr. James P.G. Sterbenz (jpgs@ieee.org) is a Senior Network Scientist and Research Group Manager at BBN Technologies in Cambridge, Mass. He is a principal investigator and program manager for several DARPA and NASA funded research programs in high-speed, mobile, wireless, and active networks. He worked on gigabit networking and broadband multimedia services at GTE Laboratories in Boston and IBM Research in Hawthorne NY and Milford CT. He received a doctorate in computer science from Washington University in 1991, with dissertation work on the first zero-copy gigabit host--network interface.

He is Senior Member of the IEEE, member of the IEEE Communications and Computer Societies, past chair of the IEEE Communications Society Technical Committee on Gigabit Networking, and been program chair for several Gigabit Networking Workshops (GBN). He is program co-chair of the IFIP International Working Conference on Active Networks (IWAN 2002), chair of the IFIP Protocols for High-Speed Networks International Steering Committee (program co-chair for PfHNS'99). He is a member of a number of ACM SIGs, and was vice-general chair of ACM SIGCOMM'99. He is a member of the Interplanetary Interest Group of the Internet Society. He has been on numerous technical program committees, including IEEE INFOCOM, ICNP, HPCS, HotI, NOSSDAV, and OpenArch, ACM SIGCOMM, and IFIP PfHNS and HPN. He is on the editorial boards of IEEE Network, Computer Networks Journal (North-Holland), and KICS/IEEE Journal of Communications and Networks.

He is principal author of the book *High-Speed Networking A Systematic Approach to High-Bandwidth Low-Latency Communication* (Wiley 2001). He is a co-author and presenter of the tutorial "Active Networks". He has given keynote and invited lectures in high-speed and active networking at PfHNS'94, IEE Towards Gigabit Networking, IZS 2002, ANTA 2002, and PfHNS 2002.