Advanced Topics in Computer Networks

[GC-72010 (at CUNY Graduate Center)]

[Transferred as I4300/I4722 for CCNY M.S. students (under cross-campus PERMIT)]

Fall 2021;   (*Instructor: K. Ravindran*)

Rationale

The aim of the course is to provide a consolidated description of the technological developments in the area of high speed data transport network architectures & protocols, data-center networking, and cloud communications. The course has assumed importance in light of the evolving applications that require the transfer of large amounts of digital information & content at high 'data rates' and with low 'data delays' across geographically separated sites. Sample applications are multimedia/video conferencing (e.g., Zoom, Teams, Webex), virtual reality environments, digital TV, content delivery networks (e.g., AKAMAI, NetFlix), and tele-medicine. Development of such bandwidth-hungry and quality-aware applications requires a co-evolution of the underlying networking technology and the system-level architecture: new ways of designing communication subsystems and their interconnections. Following is an approximate structure of the course — a total of 42 lecture hours of 50-minutes each or an equivalent total duration (the exams will be of take-home type – we may spend 1-2 hours discussing the exams and projects during class lectures):

Networking fundamentals (4 *hours*)

- Packetization, error recovery

- Protocol layering

- Network performance

Transmission and switching techniques (4 *hours*)

- Asynchronous Transfer Mode (ATM) and Synchronous Transfer Mode (STM)

- Time Division Multiplexing (TDM), Wavelength Division Multiplexing (WDM)

Bandwidth management (10 *hours*)

- Traffic characterization: continuous and bursty (packet voice and video)

- 'statistical bandwidth sharing' techniques

- Admission control techniques: 'leaky bucket' and traffic shaping schemes, traffic policing

- Flow & QoS based routing

- Congestion control: credit-based and rate-based schemes (ATM forum proposals, IETF RTCP, AIMD)

- Bandwidth measurement over Internet

Point-to-multipoint communications (6 *hours*)

- Multicast support in ATM and IP networks

- Case studies: CBT, DVMRP, PIM

- 'application-level' multicast, proxy-based multicast

- Reliable multicast protocols

Protocols for high-speed networks (4 *hours*)

- Light-weight protocols and application-specific protocols
  (case studies: NETBLAST, X-Kernel)

- 'integrated layer' protocols

Network traffic & QoS control (6 *hours*)

- Diffserv and Intserv models

- Economic principles in flow & QoS management

- Intelligent network management

End-to-end Network architectures (8 *hours*)

- Scalability: topology aggregation, flow grouping

- Overlay network services; Enterprise networks

- Software-defined Networks & Systems

- Data-center networks; cloud-network communications

- PlanetLab test-bed for networking studies

<u>References</u>

I.   *High Speed Networks and Internet: Performance and Quality of Service*, by **W. Stallings**, Prentice-Hall Publ.

II.   *Computer Network Protocols: A System-oriented Approach* by **L. Peterson** and **B. Davie**, Morgan-Kaufman Publ.

III.   *An Engineering Approach to Computer Networking*, by **S. Keshav**, Addison-Wesley Publ.

IV.   *Computer Networks: A Top-Down Approach*, by **J. Kurose** and **K. Ross**, Pearson Publ. (8th ed., 2021).

IV. IEEE and ACM SIGCOMM Conference proceedings on *Communication Architectures and Protocols*

V. IEEE/ACM Journals on *Communications and Networking*

Evaluation procedure (Total 150 points)

1. Programming project on video transfer protocols: **50 points**

2. Mid-term exam: **40 points**

3. Final exam: **60 points**

Prior knowledge desirable

System programming on UNIX-like systems, C/C++ language, interprocess communications in operating systems, usage of networked systems.