

## Advanced Topics in Networking

### + Course Review

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## Outline

- Other topics in *traditional* OSI and TCP/IP networks
  - Network management: network & system management course (WS)
  - Network security (firewall, access control, encryption, public key, integrity, authentication...): 19.01.04 (H. Tschofenig); network security seminar (WS)
- Networked multimedia (VoIP etc.): 26.01.04 (C. Werner)
- Advanced routing:
  - Mobile IP and mobile ad hoc networks: mobile communications I-II (WS+SS), sensor networks
  - QoS routing
- Overlay networks, peer-to-peer, content delivery, storage networks
- Middleware and GRID
- Www performance; network measurement
- Transport protocols: **TCP**, UDP, SCTP, DCCP, XTP
- Satellite communication, optical/WDM networks, wireless LAN
- Course review

## Mobile Computing and Wireless Networking

- Mobile devices' ubiquitous access to network resources: active field
- Three challenges:
  - Wireless communication
  - Mobility
  - Poor local resources due to portability
- Mobile IP:
  - Mobile node has its permanent "home address" and obtains a "care of address" when traveling away from its home network
    - Add a "binding cache" to some network node to redirect MN's data via its care of address, via "home agent" / "foreign agent"
- Mobile ad hoc routing:
  - No centralized control entity like HA or FA
  - Conventional routing protocols not well-designed for this type; simple, efficient route discovery & maintenance needed
- Wireless communication:
  - Limited range, limited bandwidth (802.11b ~11mbps), lossy, insecure channel

## Overlay networks

- Current limitations of the Internet
  - Internet provides e2e data transport services for individual applications
  - But its client-service model (well-known, centralized server) v.s. bandwidth & server performance, network-centric way of information processing
  - We hope Internet to be everywhere as a basic, global available service just as an electronic plug in the wall → application-centric, distributed control of resources
- Overlay networks: virtual network of applications-level "routers" on top of a physical network (e.g., Internet); small, but value-added (e.g., multicast), flexible deployment
- Peer to Peer networks
  - No clear definition of servers & clients, or at least clients & servers divide their jobs among themselves
  - "P2P is a class of applications that takes advantage of resources (storage, cycles, content, human presence)." Peers coordinate with each other.
- Content distribution network
  - Traditional: all clients access a single copy of the page stored in a single server
  - DFS servers distribute a large number of pages to a few geographically distributed locations
  - CDN: edge services provide a certain number of Point Of Presence thru the Internet; overlay networks constructed to move content around efficiently
- Networked storage
  - Clients communicate directly with a storage space over a network as in network-attached storage (NAS) or in storage-area networks (SANs)

## Middleware & GRID

- TCP/IP networks: 4 or 5 layer model, applications work directly upon transport services
- (Computational) Grid: to build a large-scale computing infrastructure by linking computing facilities at many distributed locations
- Middleware: the software packages that enable & support Grid.
  - Somewhat analogical to presentation & session layers which resides between applications and transport services

## WWW and network measurement

- www: client (browser)/server(webserver) model, e.g., http
  - Basic support: TCP/IP; DNS
  - Performance & security
- Domain Name System: translate names and domains into IP addresses (nslookup...)
  - UDP-based, structured as "tree"
  - Dynamic DNS; DNS security
- Network measurement, a way to understand the Internet
  - Range from *workload and traffic characterization* to *protocol characterization* (e.g., *routing protocol such as BGP*) and *networked application characterization*
  - Within the network & e2e measurement

## Transport Protocols

- TCP: streaming, reliable, congestion-controlled, used by most popular apps:
  - It comprises 91% of Internet traffic ← S. McCreary and K. Claffy, "Trends in wide area ip traffic patterns, a view from Ames internet exchange." (Monterey, May 2000)
  - Performance is a big issue!
    - Congestion control v.s. "TCP-friendly" (e.g., AQM)
    - Over wireless/mobility?
    - Over asymmetric, high-speed, or satellite links?
    - Impacts of non-TCP apps (e.g., streaming media)?
- UDP: used by many video & audio apps, unreliable, no congestion control
  - RTP provides real-time support for applications, such as timing reconstruction, loss detection
  - It does not address QoS control, but relies on RSVP etc.
- SCTP (Stream Control Transmission Protocol):
  - Message-oriented, multi-streamed & multi-homed support, rate-adaptive (like TCP)
  - Usage example: telephony signaling, multimedia documents delivery over a single session
- DCCP (Datagram Congestion Control Protocol): congestion-controlled, unreliable for support of e.g., streaming media or on-line games.
  - It enables Explicit Congestion Notification (ECN), connection management and feature negotiation, along with conformant e2e congestion control

## Course Review

- Basic concepts: packet switching & circuit switching, protocol, services, peers, layering and functions of each layer, error control (CRC) and flow control (ARQ)
- Link layer: framing, various MAC & LAN technologies
- Network layer: link state routing, distance-vector routing, IP fragmentation and addressing
- Transport layer: TCP congestion control & overall operation; TCP v.s. UDP; ATM v.s. TCP/IP
- QoS: principles, RSVP, IntServ v.s. DiffServ
- Security: threats & goals, cryptography, key distribution, IPsec v.s. TLS, Email & http security, firewall
- VoIP: components & principles, performance; H.323, SIP