Advanced Topics and Course Review

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Outline

- Other topics in *traditional* OSI and TCP/IP networks
  - Netzmanagement (V-WS, S-SS)
  - Security: Netzsicherheit (S-WS), Cryptography (V-SS, S-WS)
  - Physical layer, LANs, ATM, etc: Rechernetze (V-WS)
  - Praktikum “Telematik” (SS, WS) – practical (& collaborative) projects
- Advanced topics:
  - Mobile communications I-II (WS+SS)
  - Research seminar “Advanced topics in computer networking” (SS)
  - Overlay networks, peer-to-peer, content delivery, storage networks
  - Middleware and GRID
  - Web performance; network measurement
  - Satellite communication, optical/WDM networks, wireless LAN
  - Network processors, TOE
- Course review

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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

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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
- Related:
  - **networked storage**: clients communicate directly with a storage space over a network as in network-attached storage (NAS) or in storage-area networks (SANs)
  - **network processor**: TCP Offload Engine (TOE),

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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

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WWW and network measurement

- www: client (browser)/server(webserver) model, e.g., http
  - Basic support: TCP/IP; DNS
  - Performance & security
    - Persistent v.s. non-persistent TCP
- Domain Name System: translate names and domains into IP addresses (nslookup…)
  - UDP-based, structured as “tree”
  - Dynamic DNS; DNS security
  - DNS performance
- 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

TCP/IP over satellite & optical links

- Satellite link: longer transmission delay but low loss rate
- Traditional optical use: ATM over SDH/SONET
- Building TCP/IP directly over optical packet-switched networks/WDM: larger packets (than IP), small/marginal buffer in optical switches, …
- TCP: slow start, congestion control … maybe not well suitable
- Optical control plane: GMPLS
  - Path recovery/restoration

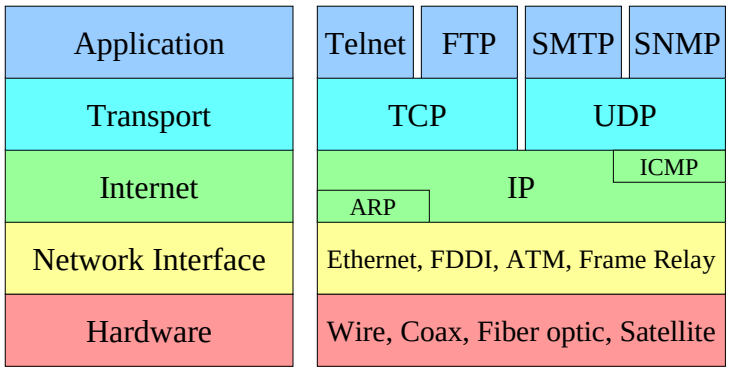
Course review: general concepts

- OSI concepts
  - Layering, services, protocols, peers …
- Networks
  - Packet switching v.s. circuit switching
- Services
  - connectionless, connection-oriented

Network Technologies

- Different link layer functions
  - Framing, error control, flow control, MAC …
- LAN, WAN
- Ethernet
  - CSMA/CD
- Token Ring
- WLAN
- Repeaters, switches, routers

TCP/IP Layers



TCP/IP Layers

- Difference between ARP, RARP, BOOTB, DHCP
- What functions ICMP performs
- NAT v.s. IPv6
- Difference between UDP and TCP
- Difference between UDP and IP

Internet Addressing

- Address classes (A, B, C)
  - Identify an address
- Subnetting
  - Purpose
  - Subnet mask

IP Layer

- IP Fragmentation and Reassembly
  - Why it is needed
  - How IP accomplishes it
- IP Routing
  - Direct delivery
  - Next hop routing
  - Time to live
  - Dijkstra's algorithm (link state)
  - Distance vector algorithm

IPv6

- Features
  - Similar to IPv4, addressing space
  - Implementation different
- Packet format
  - Fixed base header, extension headers
- Fragmentation
  - End to end
  - MTU discovery or 1280
- Checksum?
- Security
- Plug&play (autoconfiguration)
  - Router Solicitation/Router Advertisement
  - mobility support

TCP Properties

- Relationship between RTT, MSS
- Congestion Avoidance
  - Slow start, multiplicative decrease
- Reliability
  - Connection setup and release
  - Positive acknowledgement with retransmission
  - Acknowledgements are cumulative may not require retransmission

Other transport protocols

- UDP
  - Why needed
  - Socket concept
- SCTP
- DCCP
- XTP

Multimedia Networking

- Three categories of multimedia apps
  - Characteristics: delay, jitter, bandwidth, sometimes loss-tolerant…
- New functionalities in TCP/IP stack
  - Network? QoS/MPLS/…
    - Concepts of QoS (DiffServ/IntServ), MPLS, signaling
    - Difference between MPLS forwarding and IP forwarding?
  - End-Systems? RTP/RTSP/SIP/…

Security

- Building blocks
  - Hash
  - Symmetric key crypto.
  - Asymmetric key crypto.
- Building security services/protocols
  - Authentication
  - Confidentiality
  - Integrity
  - Certificates & PKI
- TCP/IP security protocols eg.
  - Kerberos (KDC)
  - IPsec (AH/ESP) + IKE(v2)
  - TLS/SSL (with handshake)