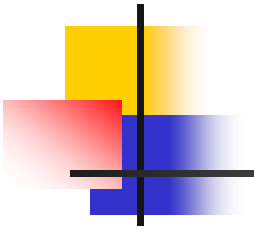


Review

Fundamentals of wireless communications

- Wireless signal and interference
- Digital Modulation
  - Amplitude Shift Keying (ASK)
  - Frequency Shift Keying (FSK)
  - Phase Shift Keying (PSK)
- Multiplexing Techniques
  - Frequency-division multiplexing (FDMA)
  - Time-division multiplexing (TDMA)
  - Code-division multiplexing (CDMA)
    - Correction of two CDMA codes

Fundamentals of Cellular Networks

- Cells are modelled as Hexagons
  - Channel reuse
  - Umbrella cells
- Cell size and density of users
- Frequency assignment
- Channel reuse factor
  - How to calculate interference in hexagon model
  - SIR in hexagon model
  - Calculation of channel reuse factor K to meet required SIR

Cellular Network Protocols

- Cellular System Infrastructure
  - BTS/BSC/MSC/Routers
  - HLR-VLR/HA-FA/Mobile IP
- Hand-off and Roaming
  - CoA and Packet Tunneling
- Multicasting for mobile nodes
  - Remote Subscription
  - Bi-directional Tunneling (BT)
    - Packet duplication problem
    - Tunnel convergence problem
      - Mobile Multicast protocol (MoM)

WLAN

- Wireless LAN types and modes
  - 802.11 a/b/g, infrastructure and ad hoc modes
- Medium Access Control of WiFi
  - CSMA/CA is the solution
  - DCF (Distributed Coordination Function) protocol
    - DCF: Basic Access Mode (DIFS/SIFS mode)
      - Contention based method: random back-off to avoid collision
      - Not efficient due to possible collision of data transmission and backoff waiting
    - DCF: RTS/CTS Mode
      - Channel reservation for transmission of data and ACK via RTS and CTS
      - Overhead of RTS/CTS

Wireless Mesh Networks (WMNs)

- What's WMN and why
- Topology control
  - Physical network topology
  - Local network topology
- Power control to define physical topology
  - Link interference
  - Node interference
- Channel assignment
  - Dynamic and static channel assignment
  - Joint channel assignment and routing

Wireless Sensor Networks (WSNs)

- Data centric of WSN
  - Data queries in WSNs
  - Data aggregation in WSNs
- Flat Routing Structure
  - Directed Diffusion
  - Sensor Protocols for Information via Negotiation (SPIN)
- Hierarchical Routing (Cluster-Based Routing Protocol)
  - Low-Energy Adaptive Clustering Hierarchy (LEACH)
    - Energy efficient routing in WSNs
    - Cluster-head self election (rotate CH with equal chance)
    - CDMA/TDMA for parallel data transmission among clusters

Vehicular Ad-hoc Networks (VANET)

- Introduction to vehicular networks
  - What are vehicular networks?
  - Why vehicular networks?
- Characteristics of VANETs
- Routing in VANETs
  - Ad hoc routing
    - Prediction-based AODV
  - Position-based routing
    - GPSR
    - GPCR
  - Cluster-based routing
    - Forming stable cluster structure

P2P Systems

- Purely distributed P2P and Hybrid P2P
- Napster
  - A central server for index and data files on peers
- Gnutella – a general file sharing system
  - Rely on ultrapeers to form a dense core network for routing
  - Each node (peer or ultrapeer) maintains a Query Routing Table (QRT)
- BitTorrent – a system for sharing of large video files
  - Tracker, seeder, swarm and a .torrent file
  - Tit-for-Tat and Rarest-First policy
- Pastry
  - A routing method combined of ring and tree structures
  - Each node keeps a routing table of 32 rows (128bits ID) & 15 columns

Satellite Networks

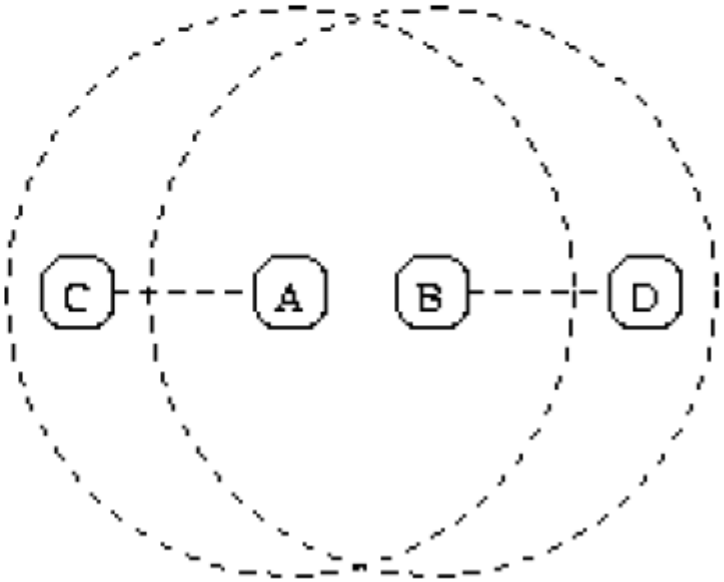
- Satellite System Infrastructures
- Call Setup for satellite phones
  - Incoming call to and outgoing call from a satellite phone
- Handoff in Satellite Systems
  - Intra-satellite handoff (cross spotbeams)
  - Inter-satellite handoff (cross footprint of satellites)
  - Satellite-ES handoff (satellites switch from one ES to another)
- GPS
- Inter-Satellite Link Routing
  - Logical grid based routing
  - Space-time graph based routing

Distributed mutual exclusion, election and agreement

- Distributed mutual exclusion
  - Central algorithm
  - Token-ring algorithm
  - Distributed Algorithm (Ricart and Agrawala's)
  - Voting Set Algorithm (Maekawa's)
- Elections
  - Ring-based Algorithm
  - Bully Algorithm
- Consensus
  - Distributed Consensus with crash failures
  - Byzantine Generals Problem

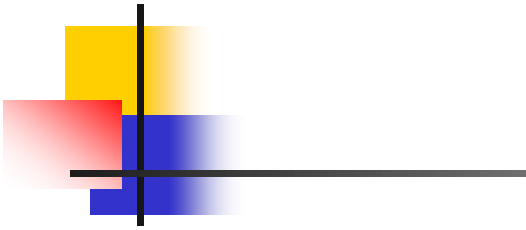
Sample of past questions

B) [16 marks] RTS/CTS is criticized to be over strong. See the following diagram. It is OK that node B transmits data to D at the same time as A transmits to C. But RTS/CTS prohibits this simultaneous transmission. Modify the RTS/CTS protocol, such that A and B can transmitsimultaneously in this case. (Assume all clocks are perfectly synchronized and all data packets are of the same size.



Bitcoin and Blockchain

- Data structure of transactions and blocks
- Decentralization of transactions and blockchain
- Distributed consensus of blockchain and block mining
  - Proof-of-Work
- Business aspects of Bitcoin



B) [15 marks] Accuracy of a GPS system highly depends on the clock synchronization between the satellite and the GPS receiver (on earth). Estimate the error range of the GPS system if the error of clock synchronization is $\pm 10^{-3}$. Assume the satellite is 20,000 km above the earth and a GPS receiver is currently at 30^0 from the upright line between the earth and the satellite. The speed of radio signal is 300,000 km/s.