Faculty





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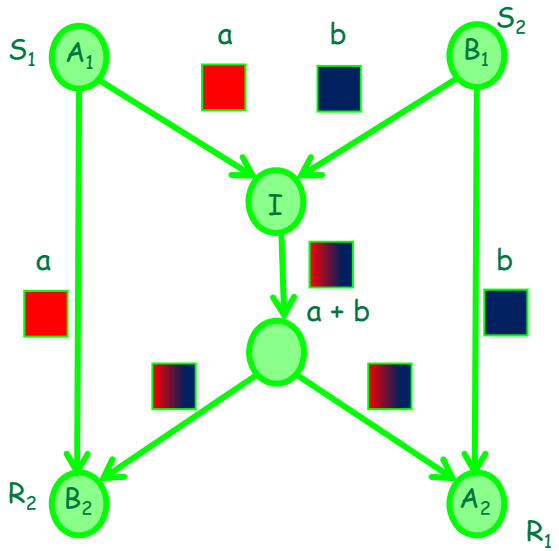
Network Coding

- **Basic Idea**
  - Allow intermediate nodes to combine packets
  - Receivers must decode to obtain source packets
- **Benefits**
  - Can improve throughput
  - Can make distributed scheduling easier
- **Potential Applications**
  - Wireless multihop networks
  - Peer-to-peer networks

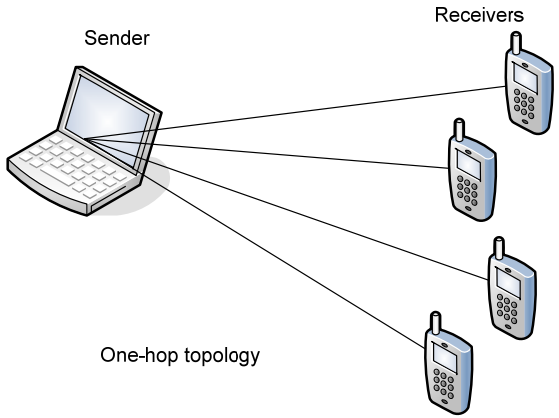


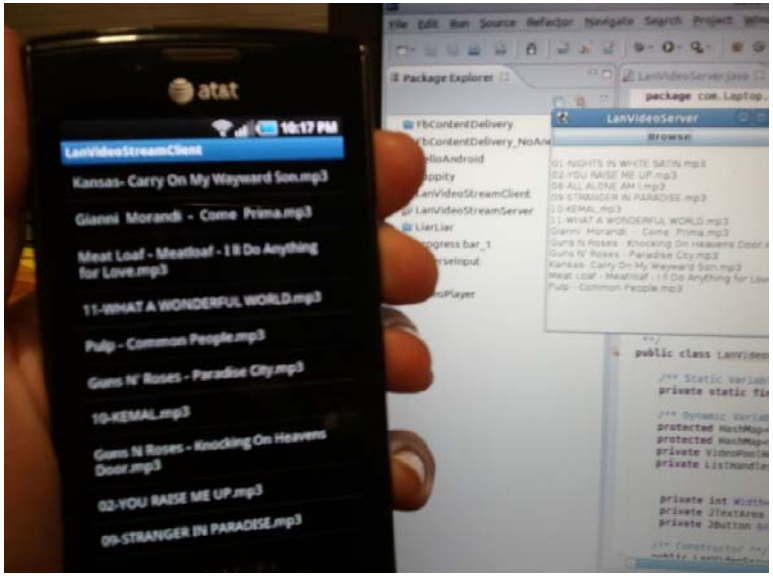
Network Coding

Example Projects

Making Network Coding Practical:

- **Cross-layer Optimization of Coded Wireless Networks**
  - Make network coding work best with TCP or video traffic and in the presence of loss [see poster]
- **Network Coding and Topology Inference**
  - Use network coding to reverse engineer properties of the network [see poster]
- **Network Coding and Security**
  - Network coding is vulnerable to byzantine pollution attacks
  - Novel security mechanisms are needed
- **Network Coding and Interference Alignment**
- **Implementation on Smartphones**
  - At the MAC (for wireless) or the application (for p2p) layers [see poster]



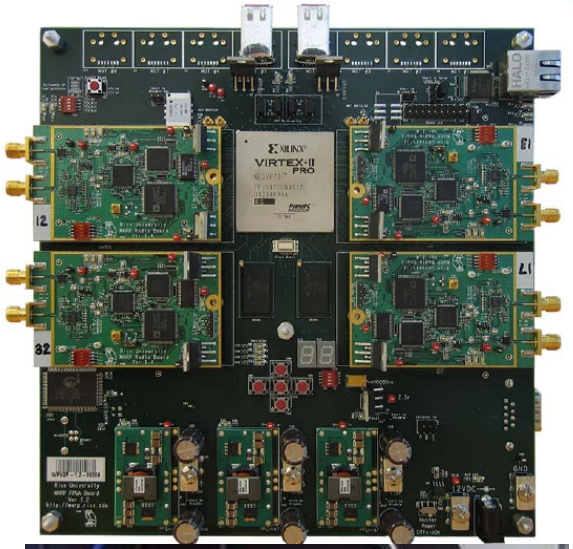


MIMO Radio Testbed

- **Developed reference OFDM and OFDMA systems to evaluate performance of key wireless communications algorithms**
  - **Spectral efficiency: Up to 4x4 MIMO**
  - **Reconfigurability:**
    - **Meters: providing signals to be used in the decision engine (cognitive and software defined radio research)**
    - **Capability to experiment with multiple algorithms: Modular design with de-centralized scheduling**
      - **Sphere decoding architectures**
      - **Channel estimation techniques**
      - **Low Power VLSI architectures**
      - **Reconfigurable architectures, e.g., FEC**
      - **Block boundary detection**
      - **Synchronization techniques etc.**

Radio Platform

- **WARP: Wireless Open Access Research Platform from Rice University**
  - **Programmable carrier frequency (2.4, 4.9, 5 GHz)**
  - **Virtex-II pro FPGA (PHY)**
  - **Embedded microcontroller (MAC)**
  - **Support up to 40MHz of bandwidth**
- **Daughter Card supports Virtex-5 FPGA for expandability**



Online Social Networks (OSNs)

More and more of human online activity is carried on or influenced by OSNs.
E.g., email communication; voice and video communication (skype); photos and videos (flickr, youtube); news; recommendation systems…

	Size	Rank
facebook	500 million	2
QQ空间 QZONE.QQ.COM	200 million	9
myspace.com a place for friends	130 million	12
orkut	100 million	43
twitter	75 million	10
LinkedIn	75 million	29

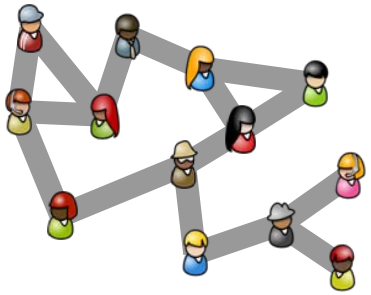
(in November 2010)

- > 1 billion users
- > 15% of world's population
- > 50% of world's Internet users

Online Social Networks

Example Projects

- **Sampling: Crawl OSN graphs and obtain representative samples**
  - **Random Walks on Facebook**
  - **Exploration techniques (e.g. Breadth-First-Search)**
  - **Multigraph Sampling of Last FM**
  - **Stratified Sampling of Facebook**



- **Content distribution**
  - **Content becomes popular over OSNs (overlay) but eventually is carried over the communication infrastructure (underlay)**
  - **3G operators can use mechanisms (pre-fetching, caching, ad-hoc connectivity) to off-load their network**
  - **[see Poster on "OSNs meet Smartphones"]**

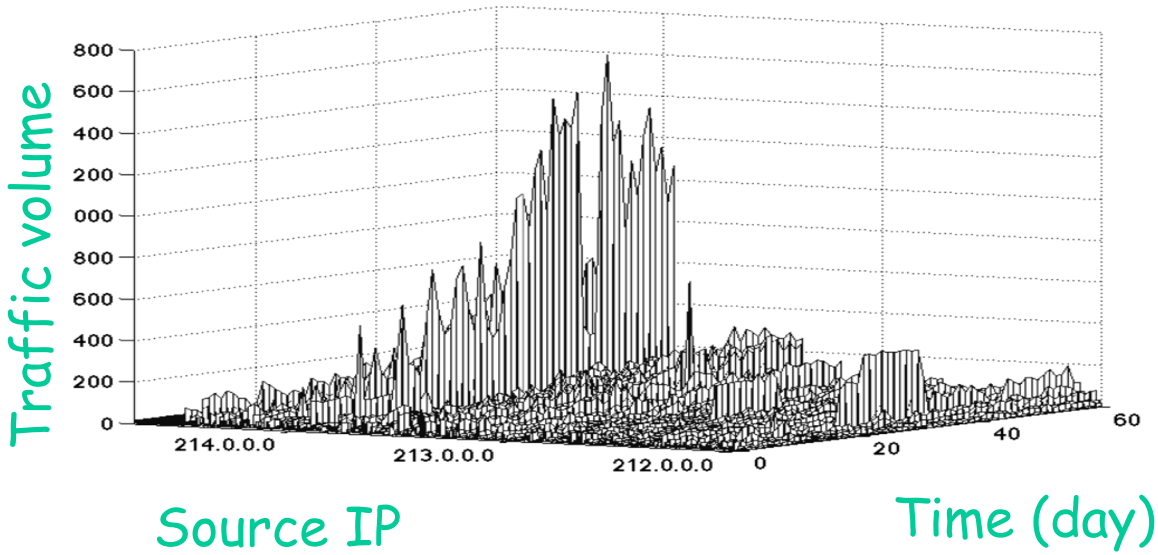
Network Security

UCI Work

Use measurements of network traffic and machine learning techniques on appropriately selected features to detect/predict malicious activity

Example of information logged per packet

Time	Victim network	Src IP	Dst IP	Src Port	Dst Port	Protocol	Flags



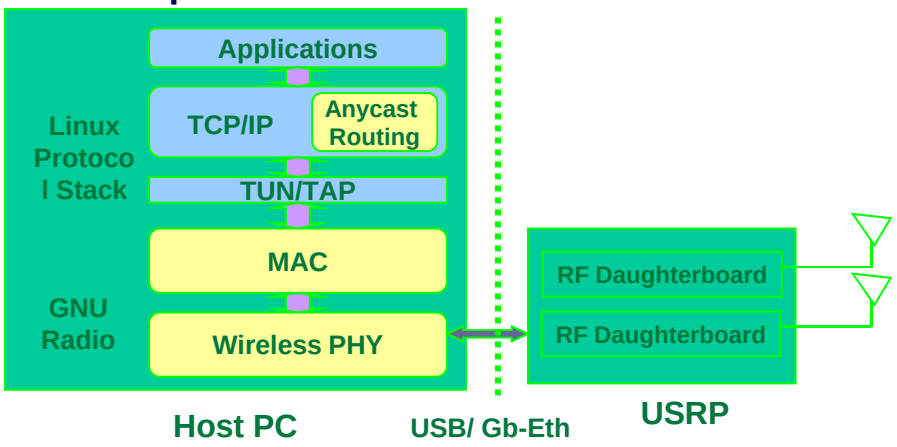
Network Security

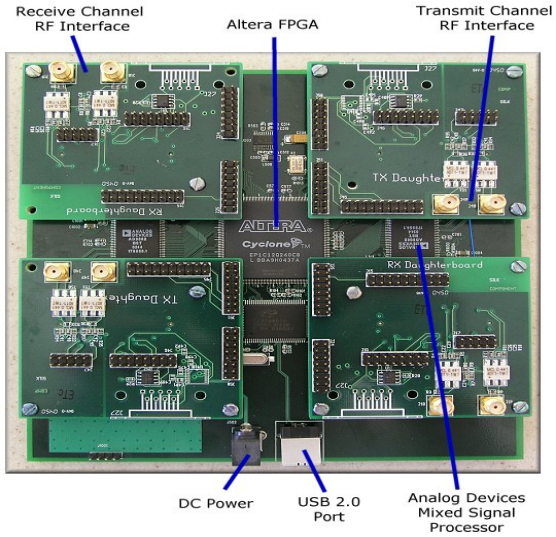
Example Projects

- **Stop Malicious IP Traffic (e.g. DDoS attacks)**
  - **At the edge of the network:**
    - **Predict future malicious traffic (using techniques from recommendation systems) based on past measurements at various places in the network**
    - **Block malicious traffic (using prefix-based filters in TCAM)**
- **Phishing**
  - **Classify phishing sites using machine-learning techniques on lexical features only (the URL name) [INFOCOM'11]**
  - **[see poster on PhishDef]**
- **Click-Fraud Detection**

SDR-Based MANET Testbed

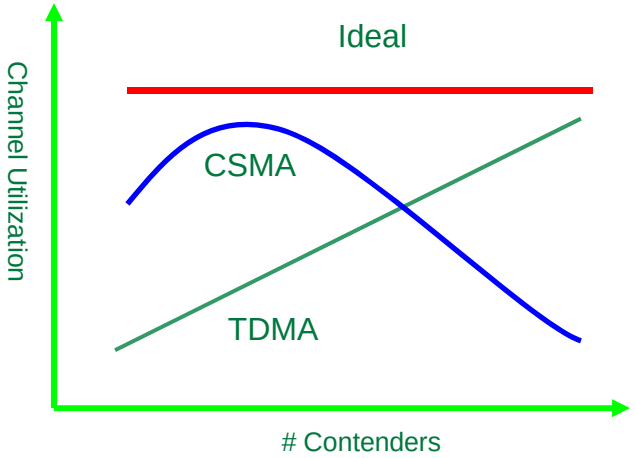
- **Universal Software Radio Peripheral (USRP)**
  - Enables rapid prototyping of SDRs
- **Hardware**
  - Motherboard Implements FPGA baseband
  - Connects to GPP using USB/Gb-ETH
  - Daughterboards implement RF front-end
- **Is Programmed Using GNU Radio**
  - Implemented in Python/C++ under Linux
- **Full IP Stack**
  - Is implemented in Linux

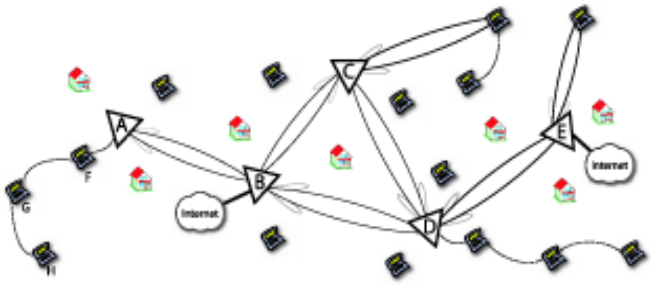


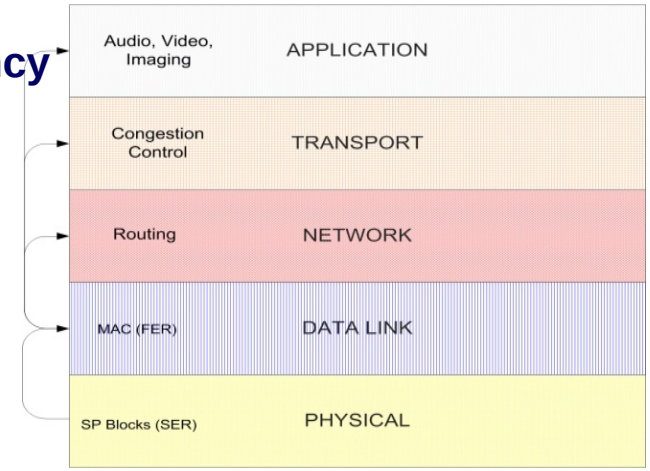


MANET Lower Layer Protocols

- **MIMO OFDM PHY**
  - MRC, STBC, STTC
- **Load Adaptive Hybrid MAC**
  - Hybrid CSMA-TDMA Behavior
  - Cooperative LA-MAC
- **PHY-MAC Interference Mitigation**
  - Simultaneously Transmit on Same Frequency
  - Use MIMO to Extract Collided Signals

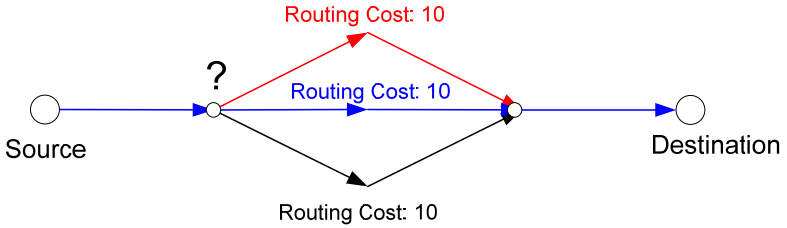


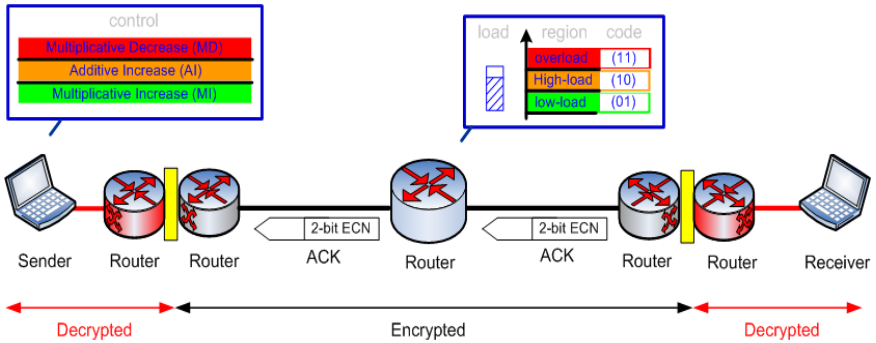


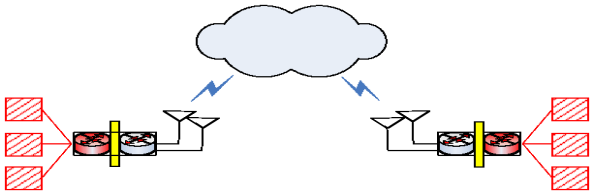


MANET Upper Layer Protocols

- **Cross-Layer Routing**
  - TCP BIC/CUBIC
  - VCP, MPCP
- **Cross-Layer Transport**
  - LA-MAC Assisted MDR
  - IPSec Encrypted
- **Applications**
  - File and Image Delivery
  - Stored/Live Audio Delivery
  - Stored/Live Video Delivery







Cognitive Network Monitoring

New Horizon

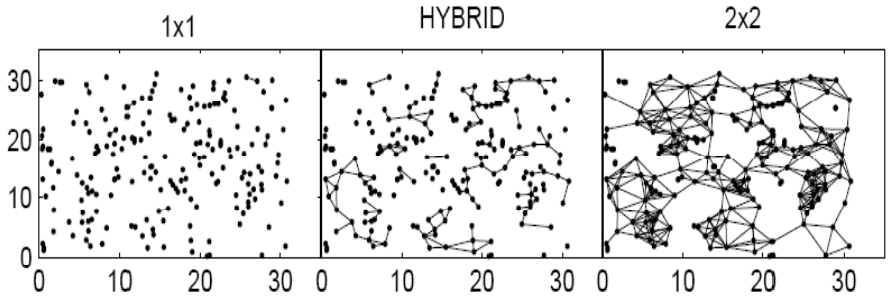
- **SOA-Based Monitoring**
  - **Heartbeat Statistics thru GPS-Based Laptops**
- **Connectivity Graphs (PHY/MAC/NETOWORK)**
  - **LA-MAC reports SINR, SER, and FER statistics**
  - **MDR HELLO messages reported to the monitoring console**
  - **Collect Performance Data (Link Quality, Loss, Delay)**
  - **SNMP MIBs**

- **Cognitive Policy-Based Network Mgmt (PBNM)**

Advantaged Node Placement

New Horizon

MIMO Nodes

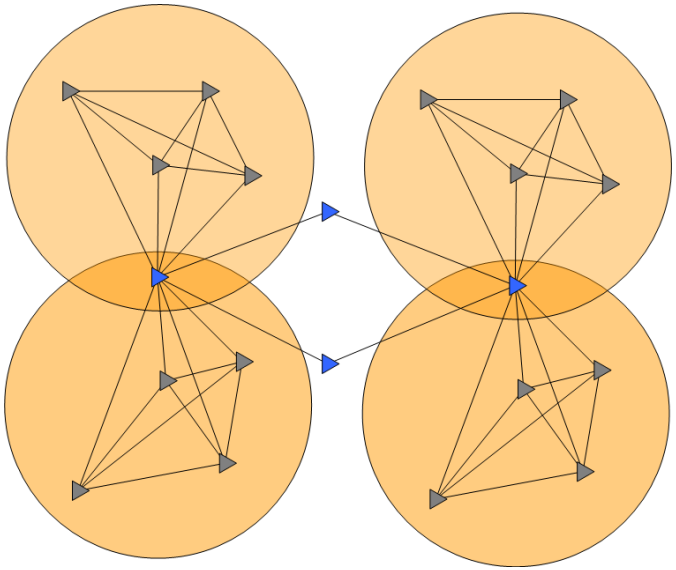


- **Apps thru NMS Monitoring**
  - **Healing Partitioned MANETs**
  - **Reach Back**
  - **Range Extension**

- **Connectivity Augmentation**

  A Small No of ANs
  - **USRP2, UAVs**
  - **AN Placement Algorithms**

    Small World Phenomenon, Percolation, and Graph Theory
  - **Formation of ANs Using Cooperative Comm Techniques**



Small Form Factor Sensors

New Horizon

- **Environments of Interest**
  - Position Location Monitoring
  - Battlefield Health Monitoring
  - Civilian medical Monitoring
- **Signals of Interest**
  - GPS, Audio, Video, Vital Signs
- **Technology Platform**
  - Hardware: Gumstix (Ocero Fire) and Motes (MICAz, IRIS)
  - Software: IP Stack under Development at UCI