

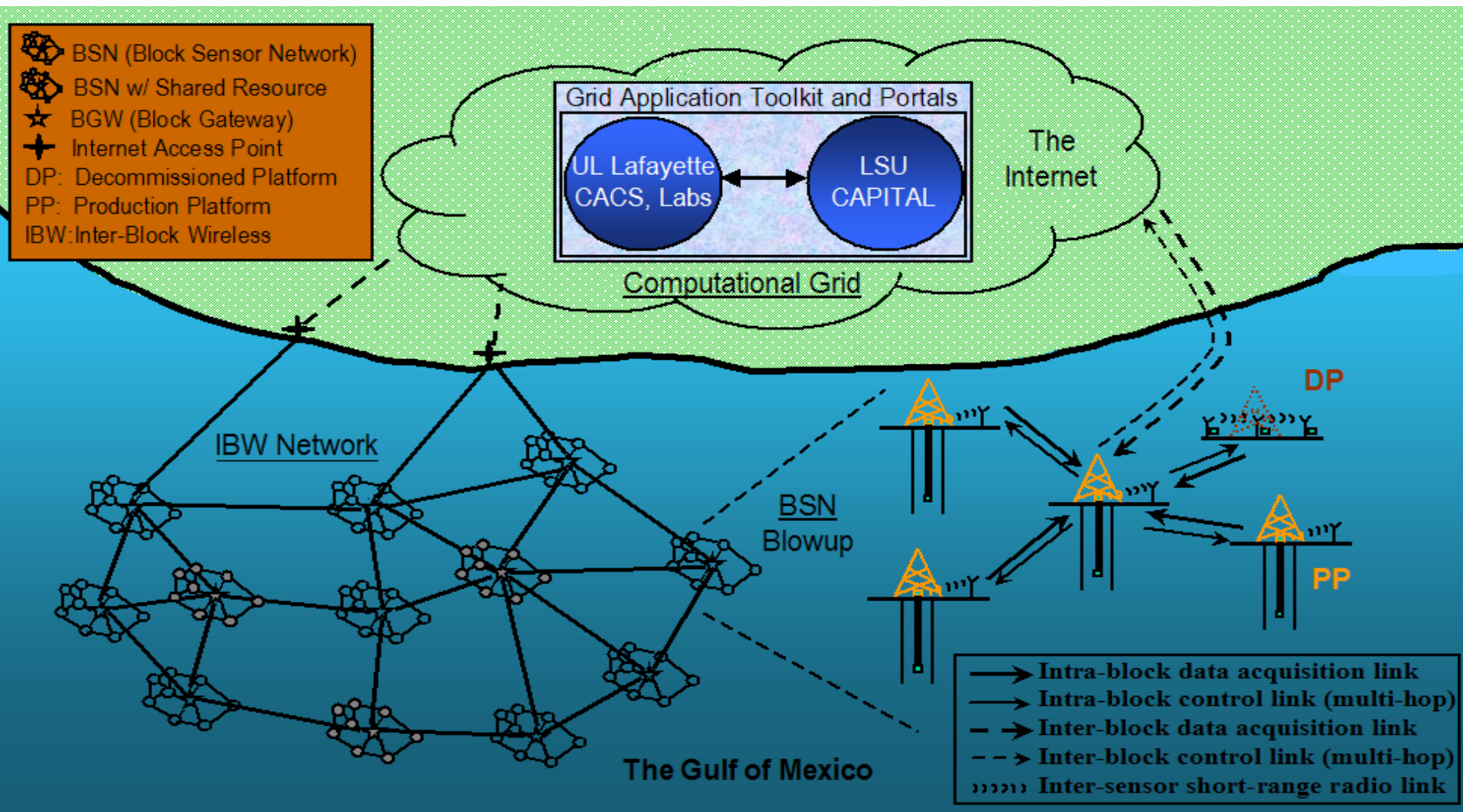
Ubiquitous Computing and Monitoring System (UCoMS) for Discovery and Management of Energy Resources



Wireless and Sensor Networks



System Overview

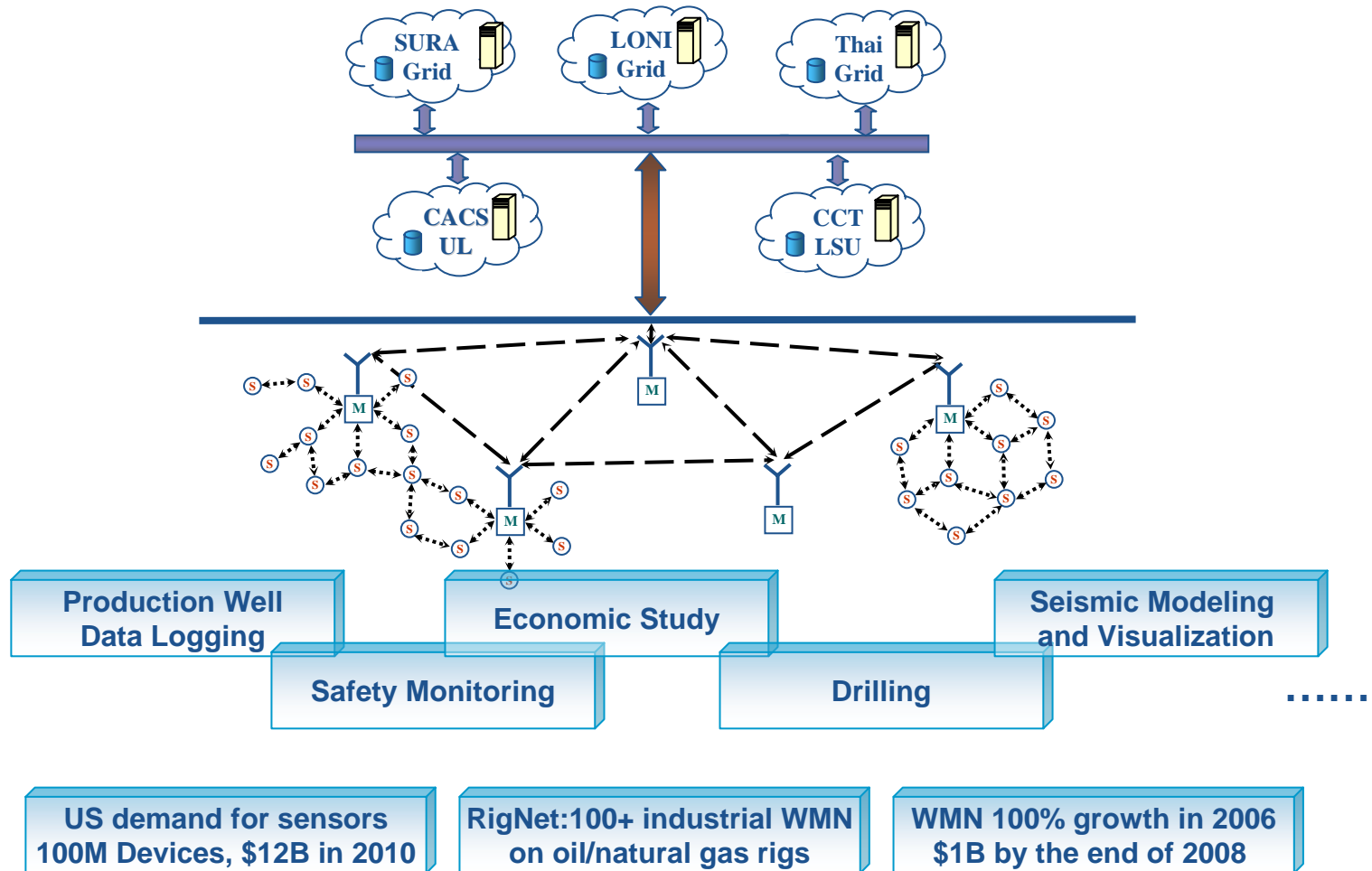


- BSN (Block Sensor Network)
- BSN w/ Shared Resource
- BGW (Block Gateway)
- Internet Access Point
- DP: Decommissioned Platform
- PP: Production Platform
- IBW: Inter-Block Wireless

- Intra-block data acquisition link
- Intra-block control link (multi-hop)
- Inter-block data acquisition link
- Inter-block control link (multi-hop)
- Inter-sensor short-range radio link

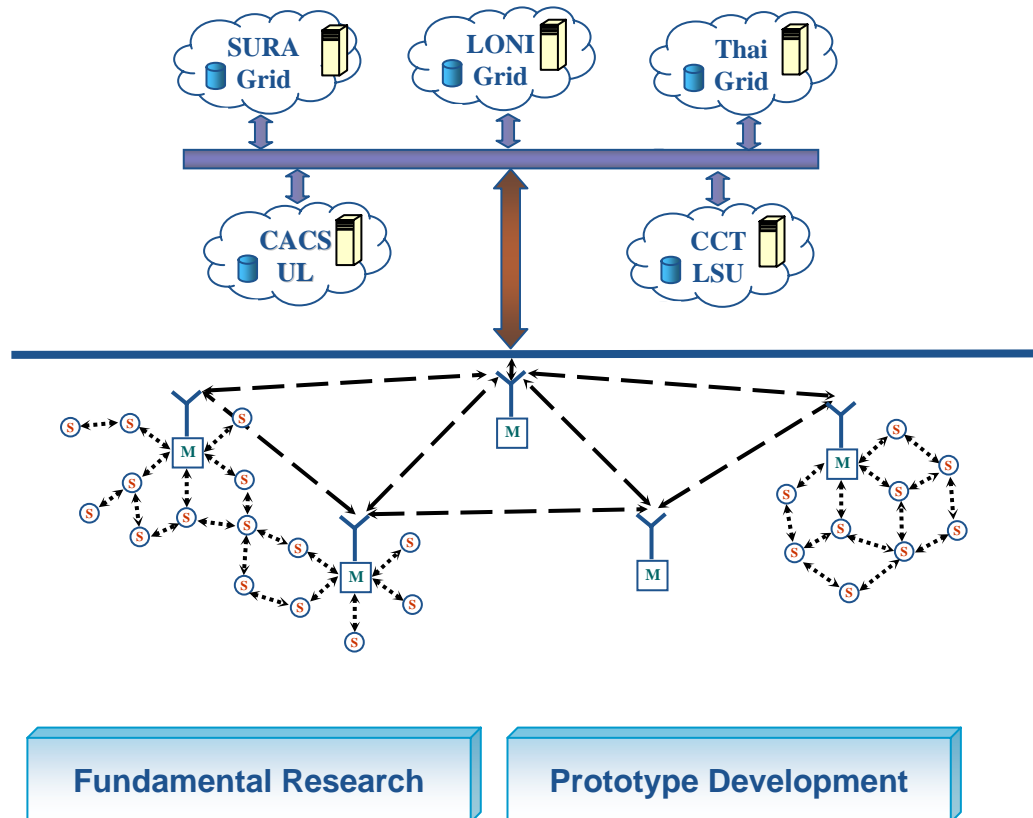


System Overview



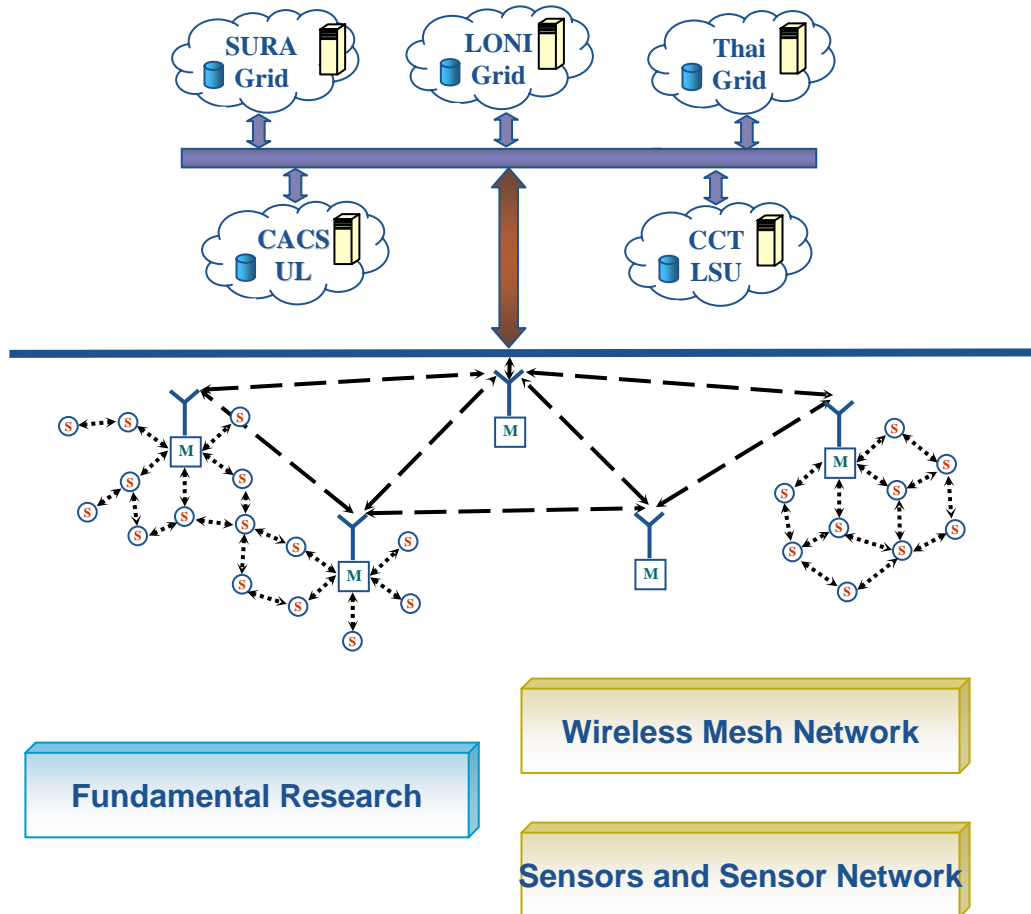


System Overview





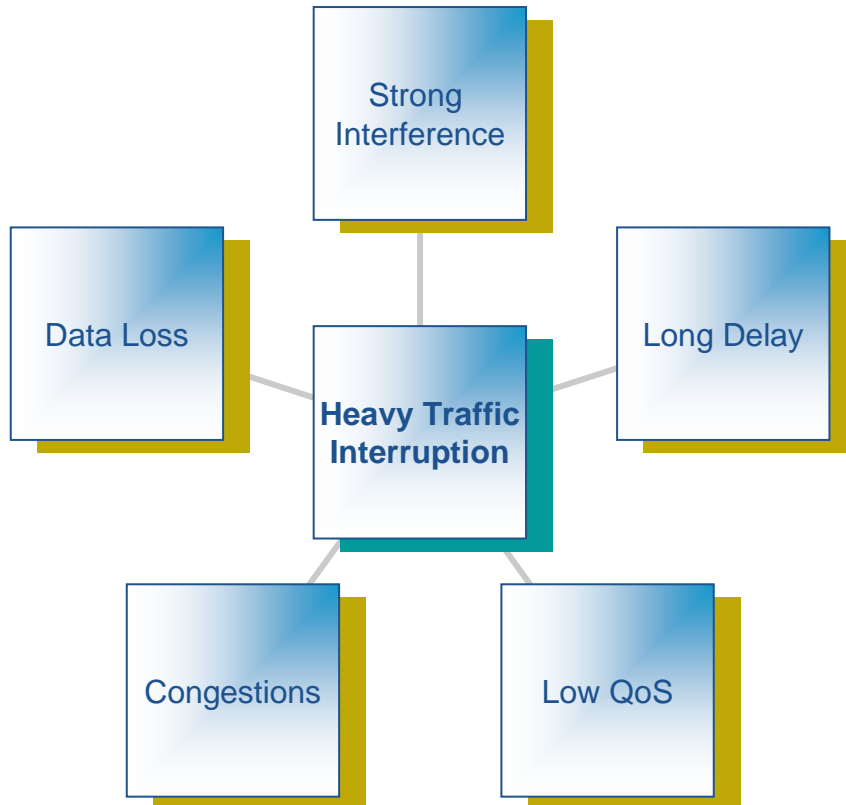
System Overview





Challenges and Goals in IBW

- Challenges

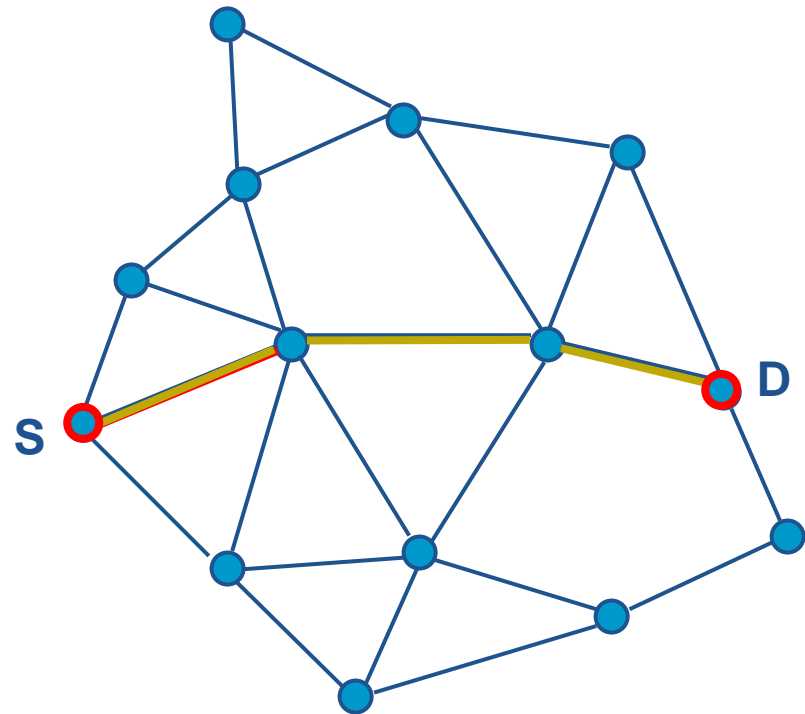
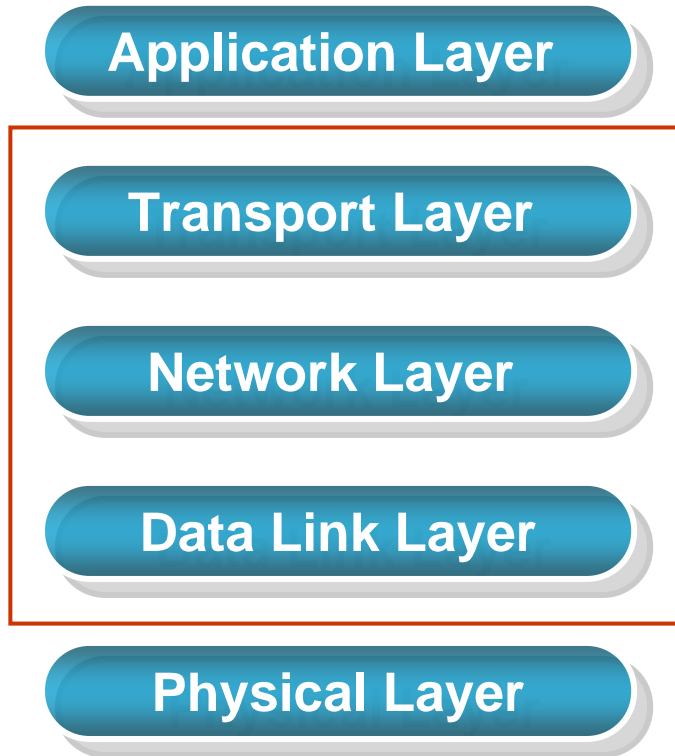


- Goals

- Sustained data rate of 10 Mbps
- Support delay-tolerant data delivery
- Support fault tolerability
- Support application oriented QoS
- Support self-configurability



- Typical Network Layer Structure





- Typical Network Layer Structure

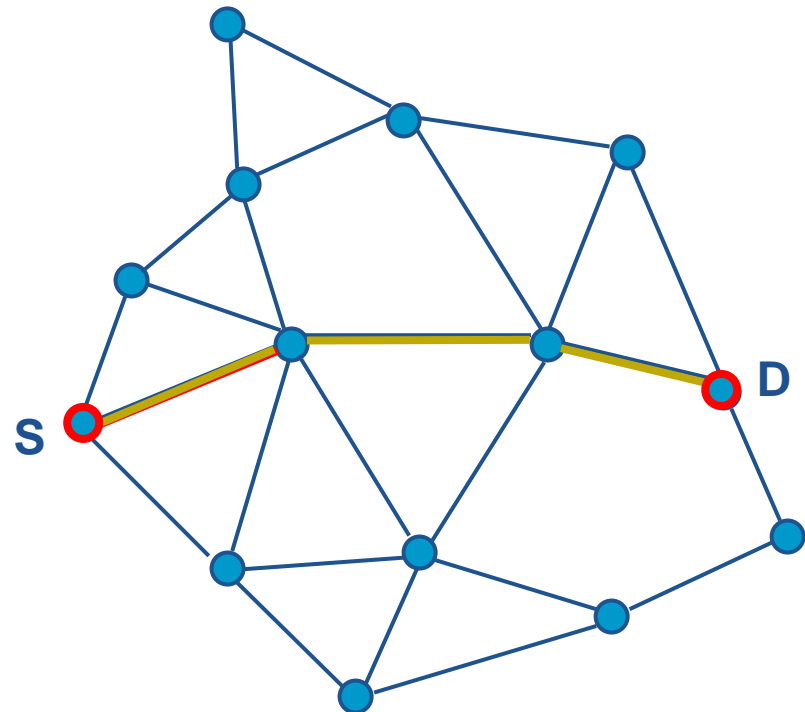
Application Layer

Transport Layer

Network Layer

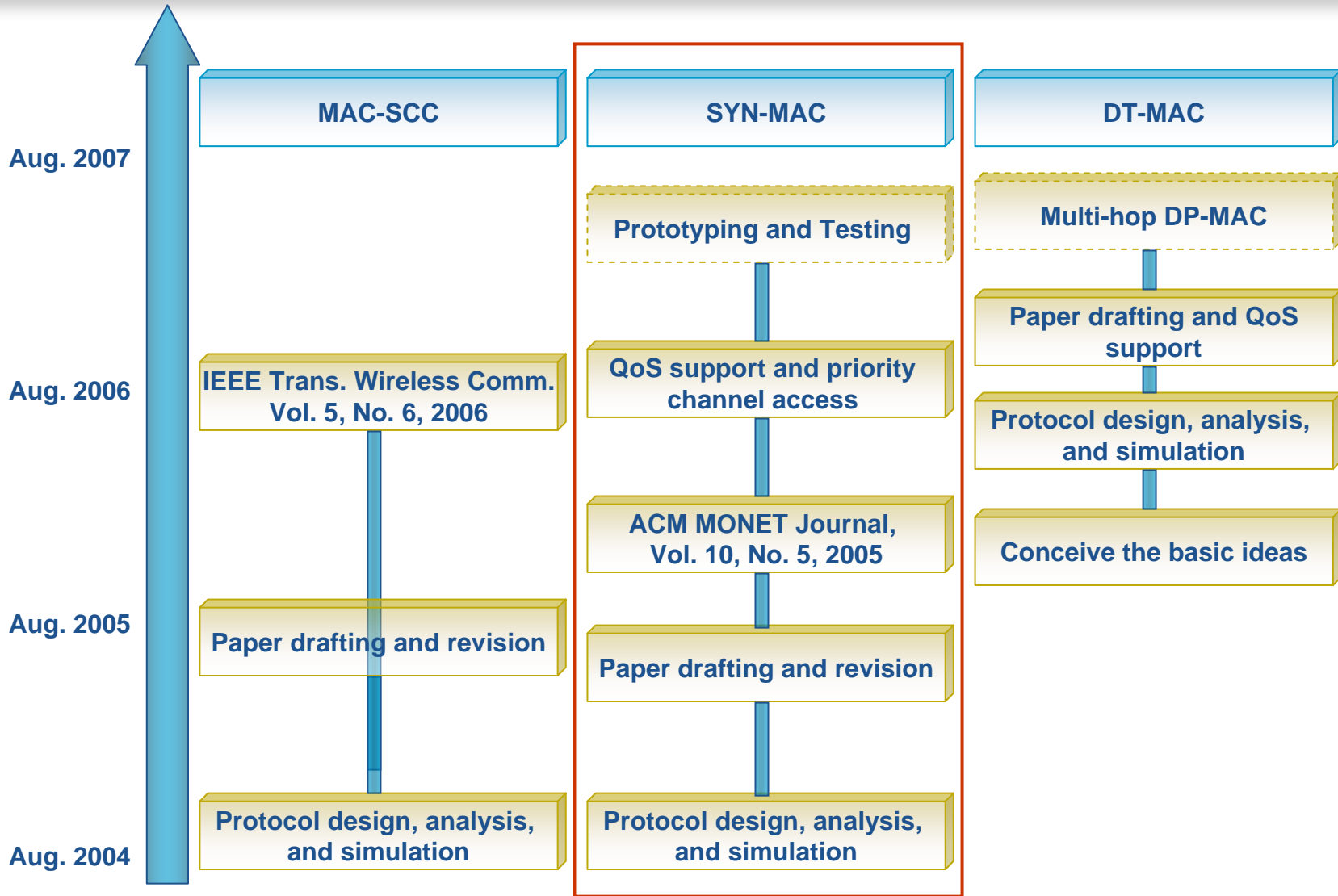
Data Link Layer

Physical Layer





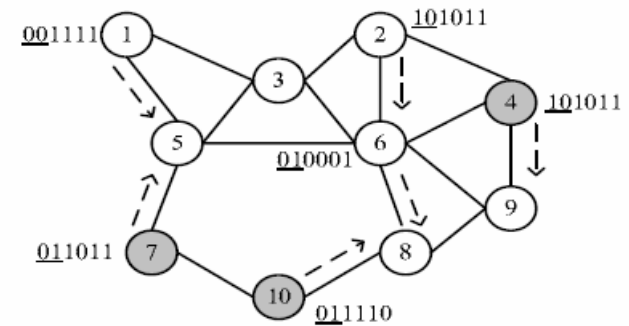
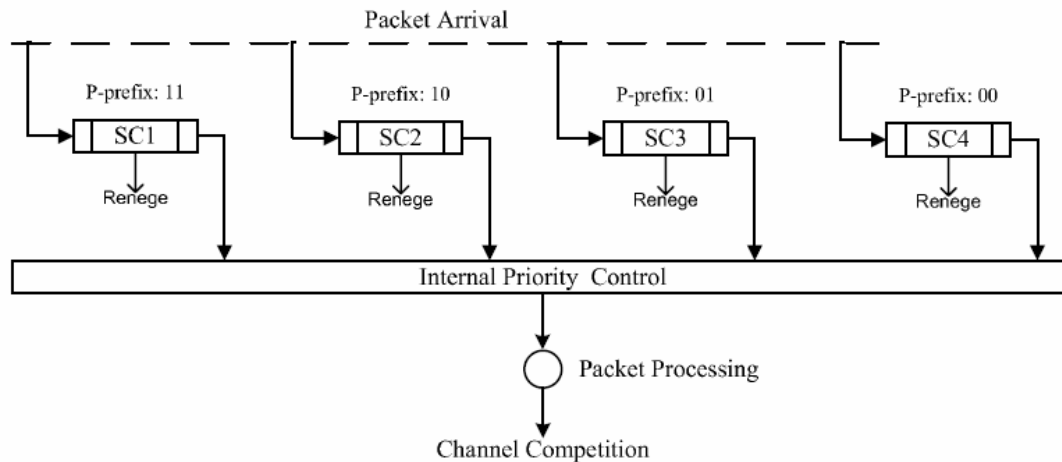
Medium Access Control





Prioritized MAC

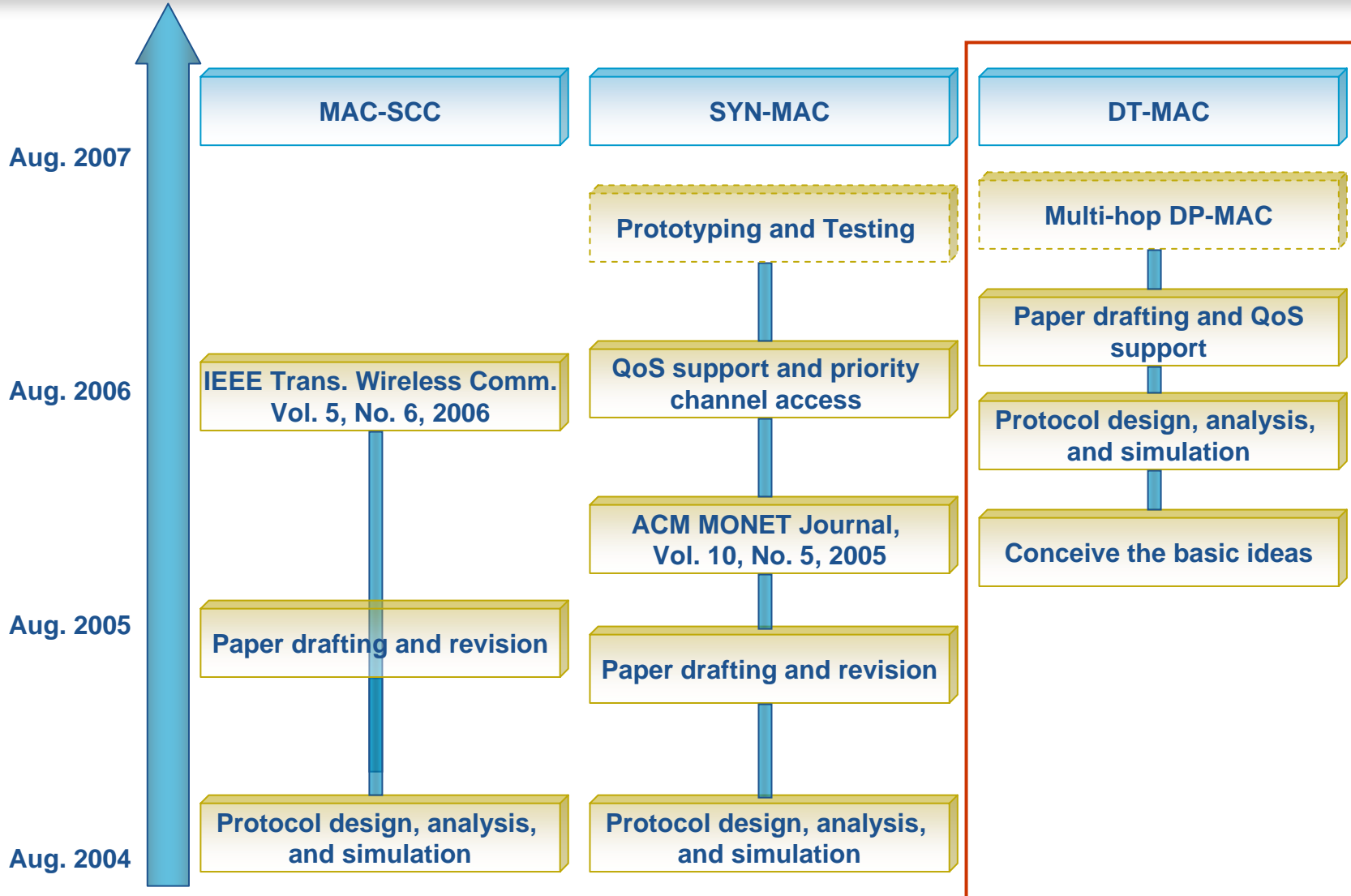
- Data are prioritized into classes



- Binary countdown for channel contention
- Prefix for channel prioritization
- Completed design, analysis, and simulation
- To be prototyped in the next year



Medium Access Control





- Distributed Tree-based MAC Protocol (DT-MAC) for Multi-hop Wireless Networks
 - Main Objective:
 - Minimal channel access delay at low loads
 - Maximum channel efficiency at high loads
 - Basic Idea:
 - A distributed adaptive tree walk protocol designed for multi-hop wireless networks.
 - Progress:
 - Single-hop model design, analysis, & simulation completed.
 - Paper draft in progress.
 - Continue work on multi-hop DP-MAC



- Typical Network Layer Structure

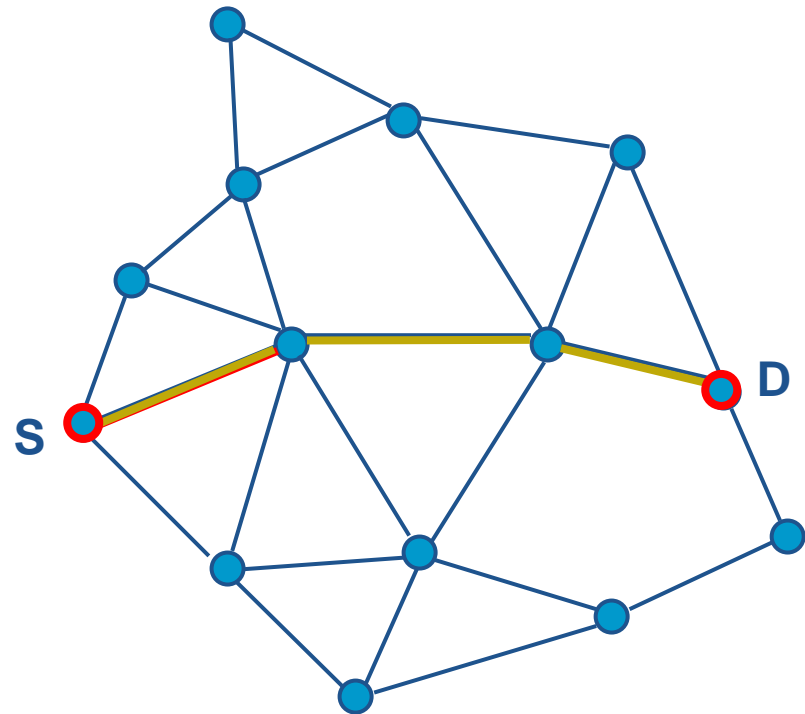
Application Layer

Transport Layer

Network Layer

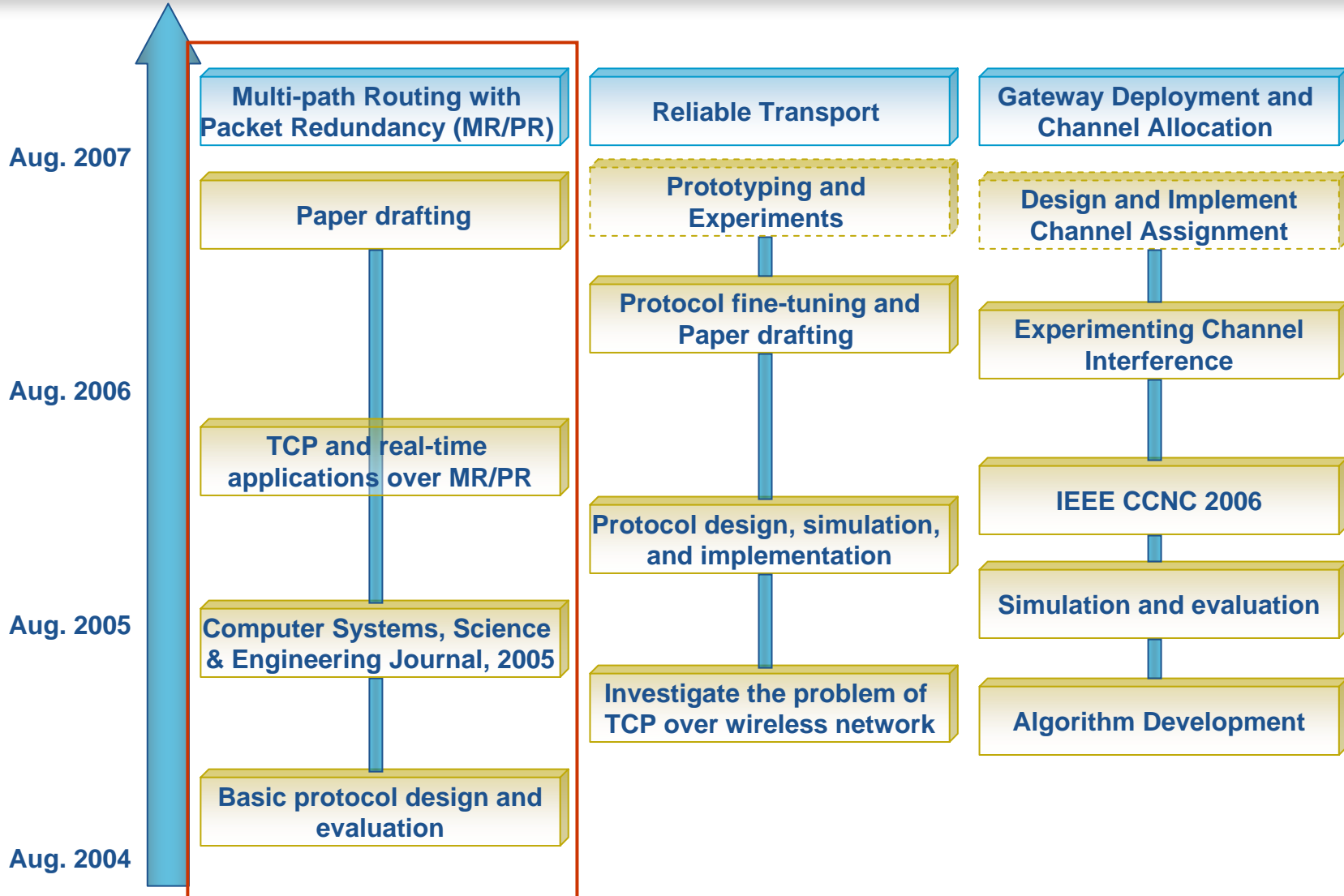
Data Link Layer

Physical Layer





Routing and Transport

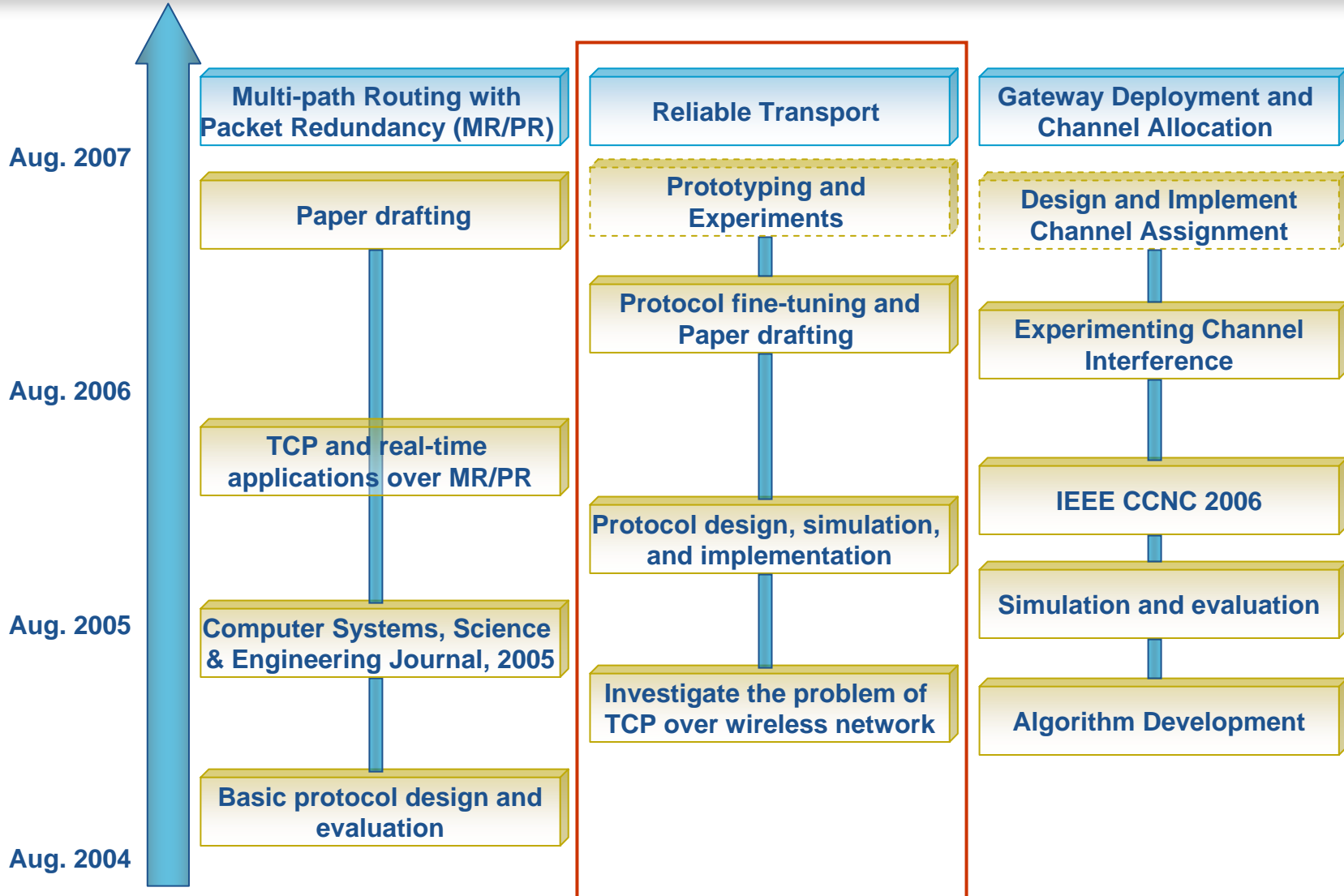




- Multi-path Routing with Packet Redundancy
 - Main Objective:
 - Reduce random and bursty packet loss
 - Basic Idea:
 - Route data along multiple routes: *reduces packet loss burst length*
 - Use packet level FEC to recover lost packets: *reduces transport and application layer timeouts and reduces retransmissions*
 - Progress:
 - Simulation complete
 - Evaluation TCP over MR/PR complete



Routing and Transport



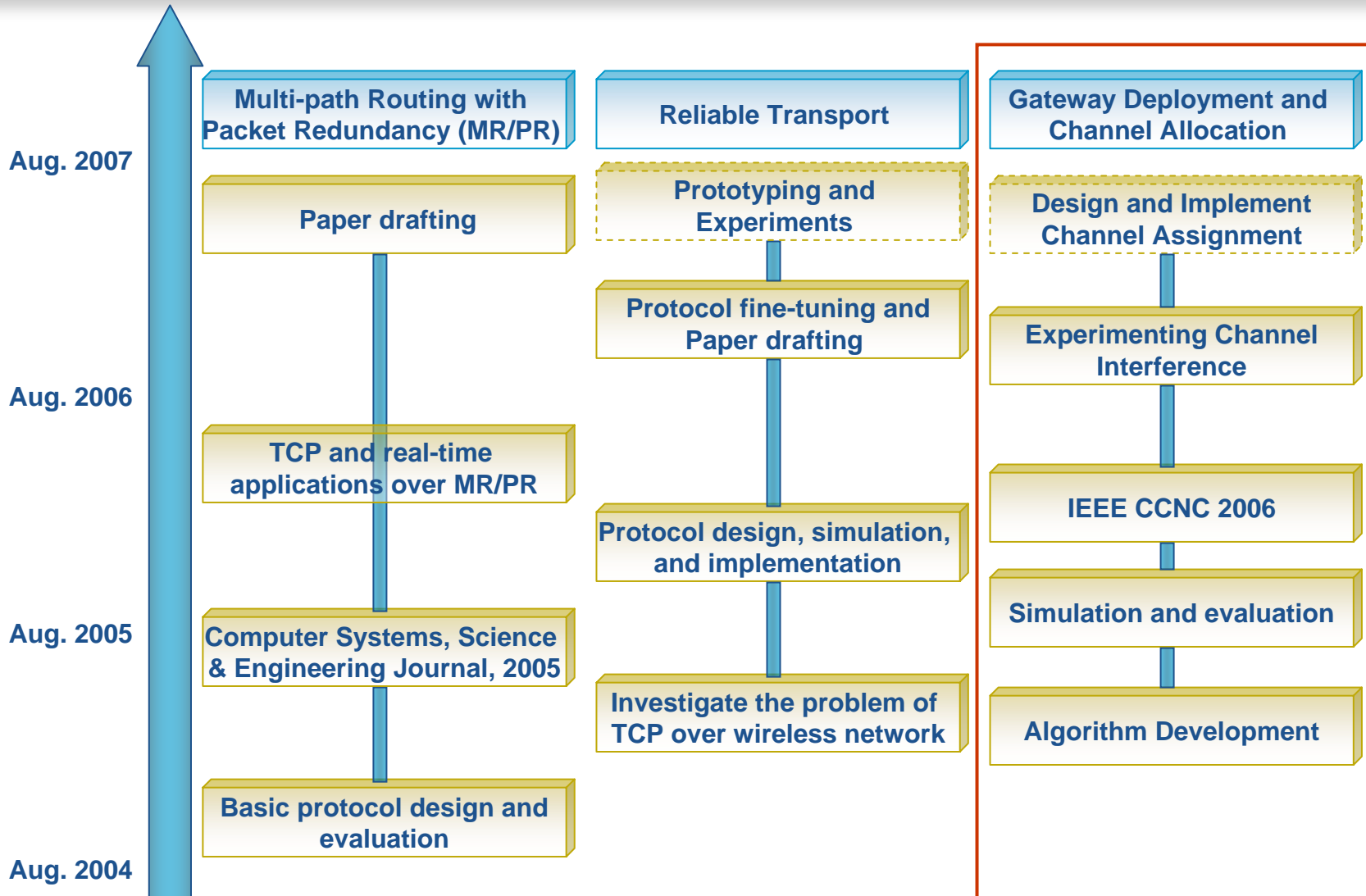


Reliable Transport in MWN

- End-to-end Congestion Management
 - Main Objective:
 - Improve TCP throughput in multi-hop wireless networks
 - Basic Idea:
 - Control sending rates (e.g., congestion window) by approximating the gradient projection algorithm based on channel utilization and path failure frequency.
 - A combined cross-layer approach (physical, MAC, routing)
 - Progress:
 - Protocol design and simulation complete.
 - Paper draft in progress
 - Linux-based testbed implementation to begin January 2007.



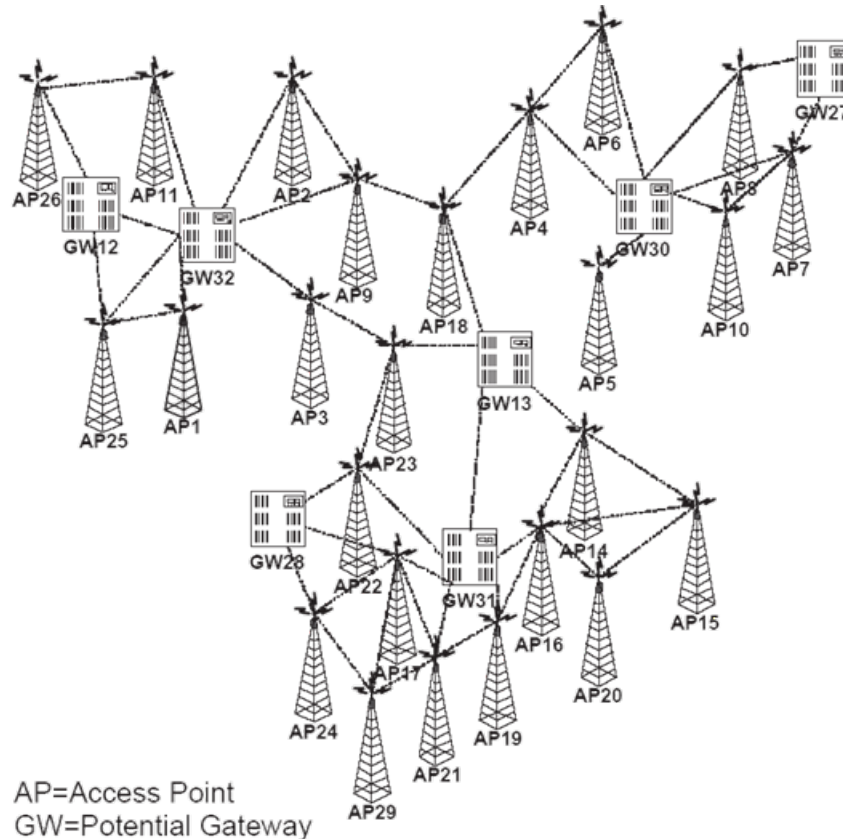
Routing and Transport





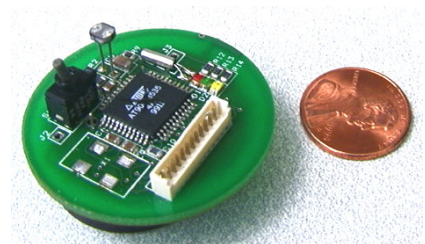
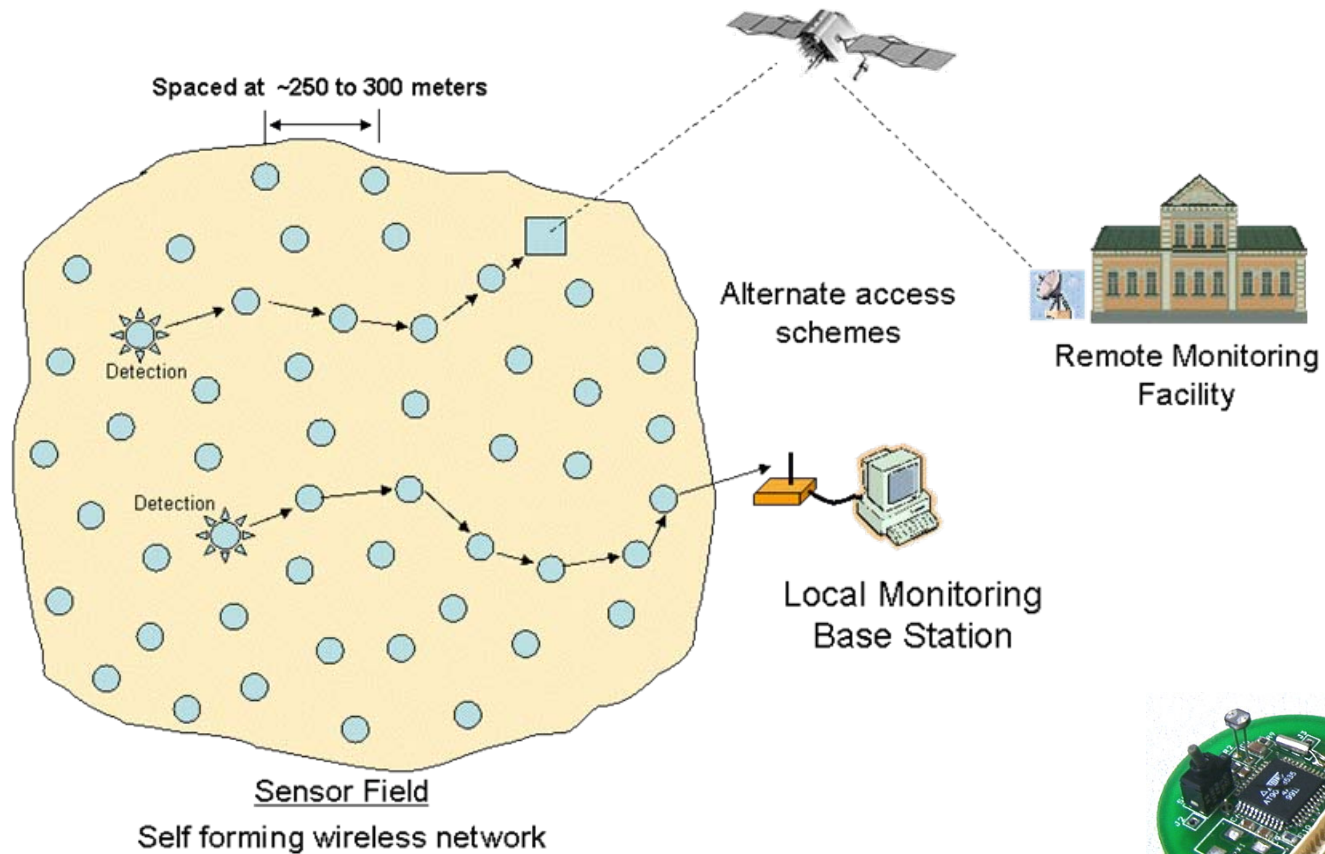
Gateway Deployment and Channel Allocation

- Identify best gateways
- Allocate channel to each wireless link





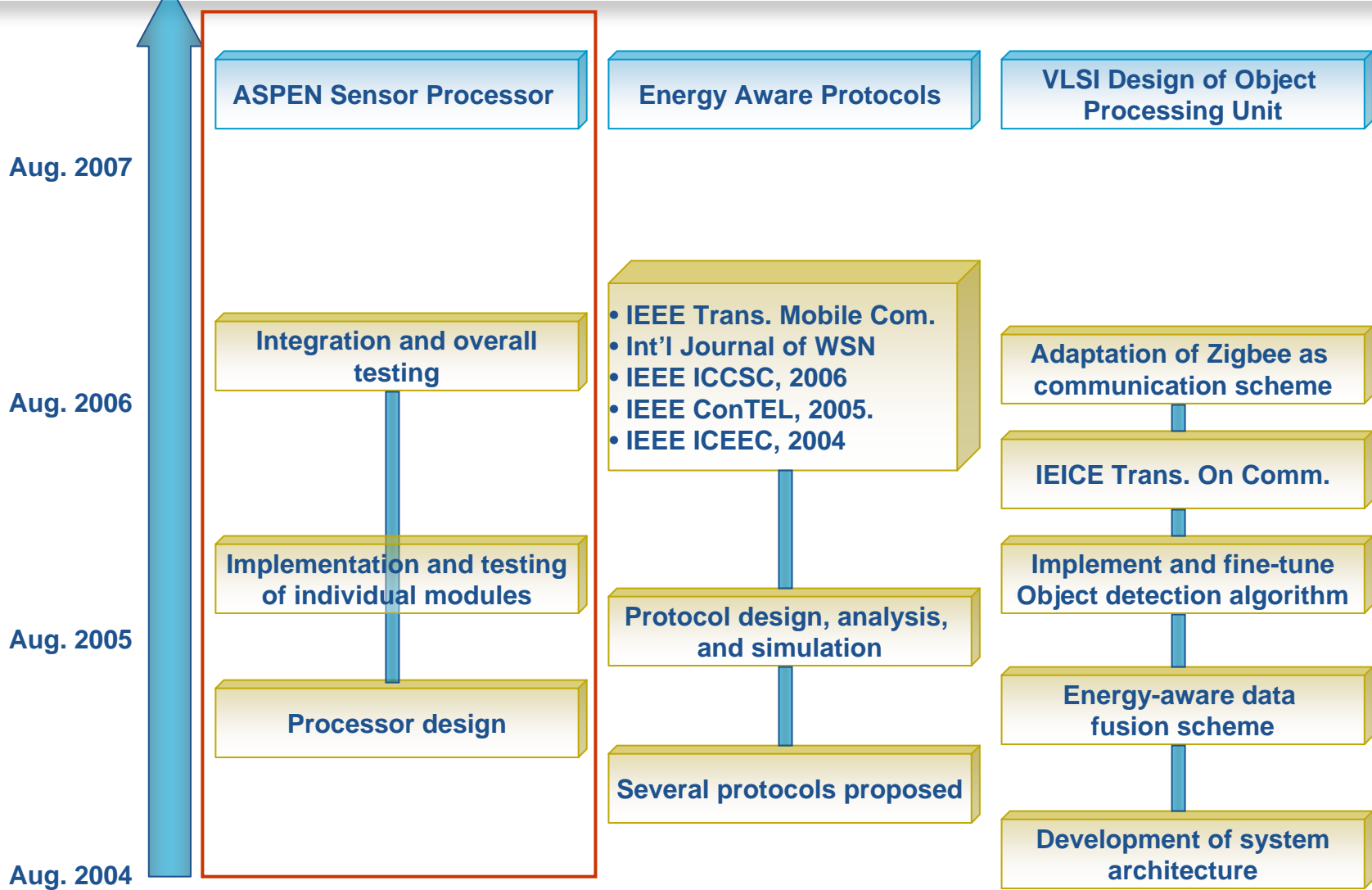
Wireless Sensor Network



Main challenge: energy efficiency



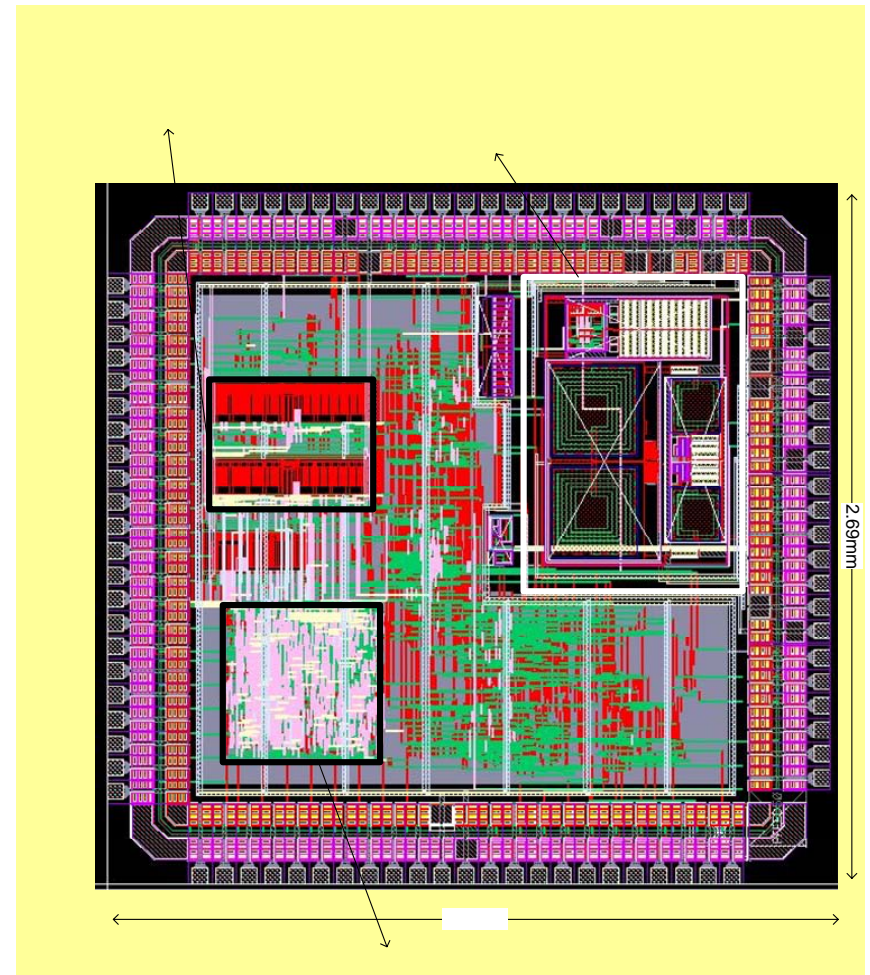
Sensors and Sensor Networks





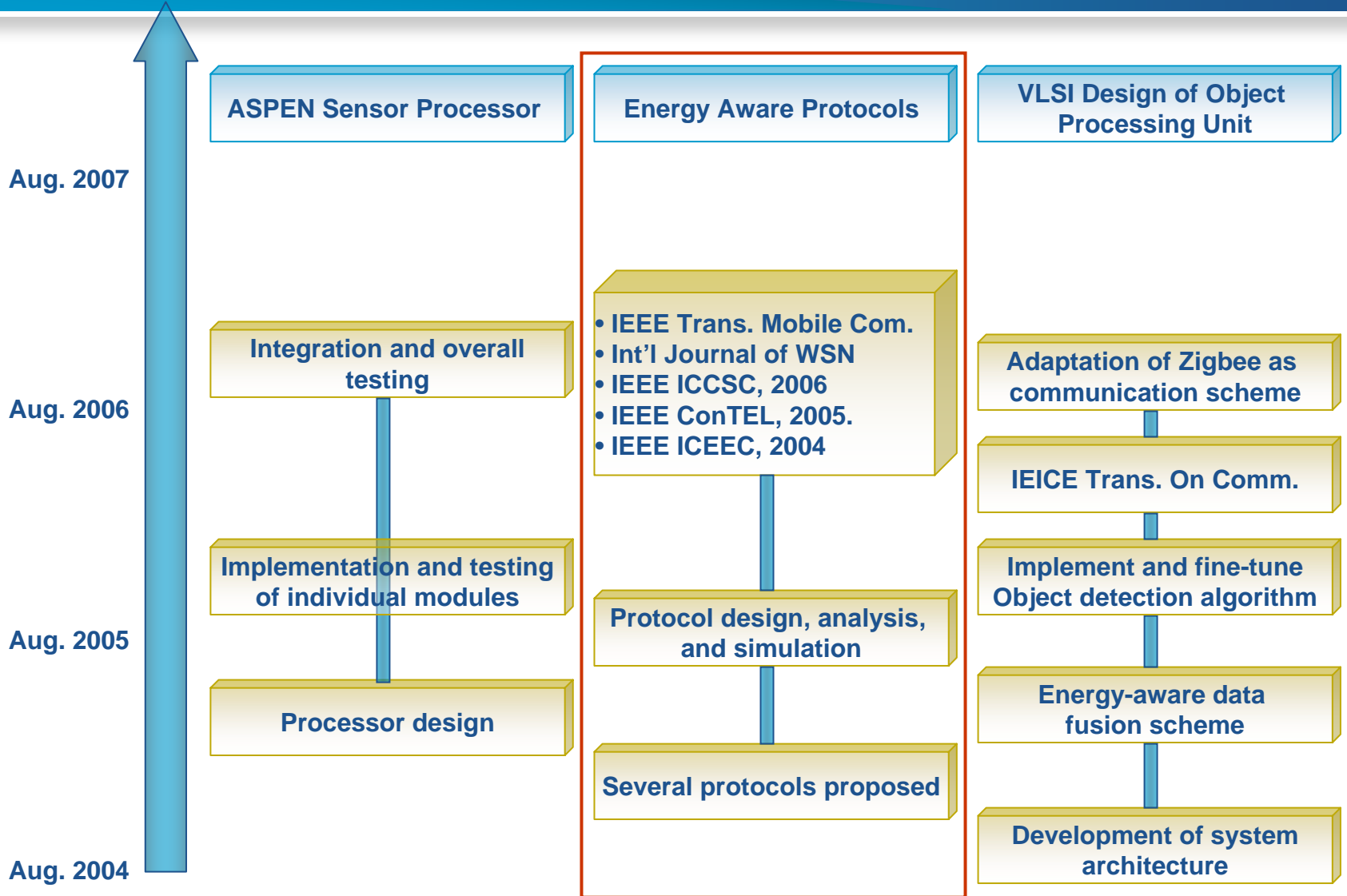
ASPEN Sensor Processor

- New sensor processor for low energy consumption.
- Emphasis on sensor processing by introducing DSP capabilities at the node instead of contemporary microcontroller based approaches.
- Use of Asynchronous Digital Signal Processing Architecture
- Final implementation in 90nm CMOS
- Soumik Ghosh completed his Ph.D. defense on the proposed processor.





Sensors and Sensor Networks



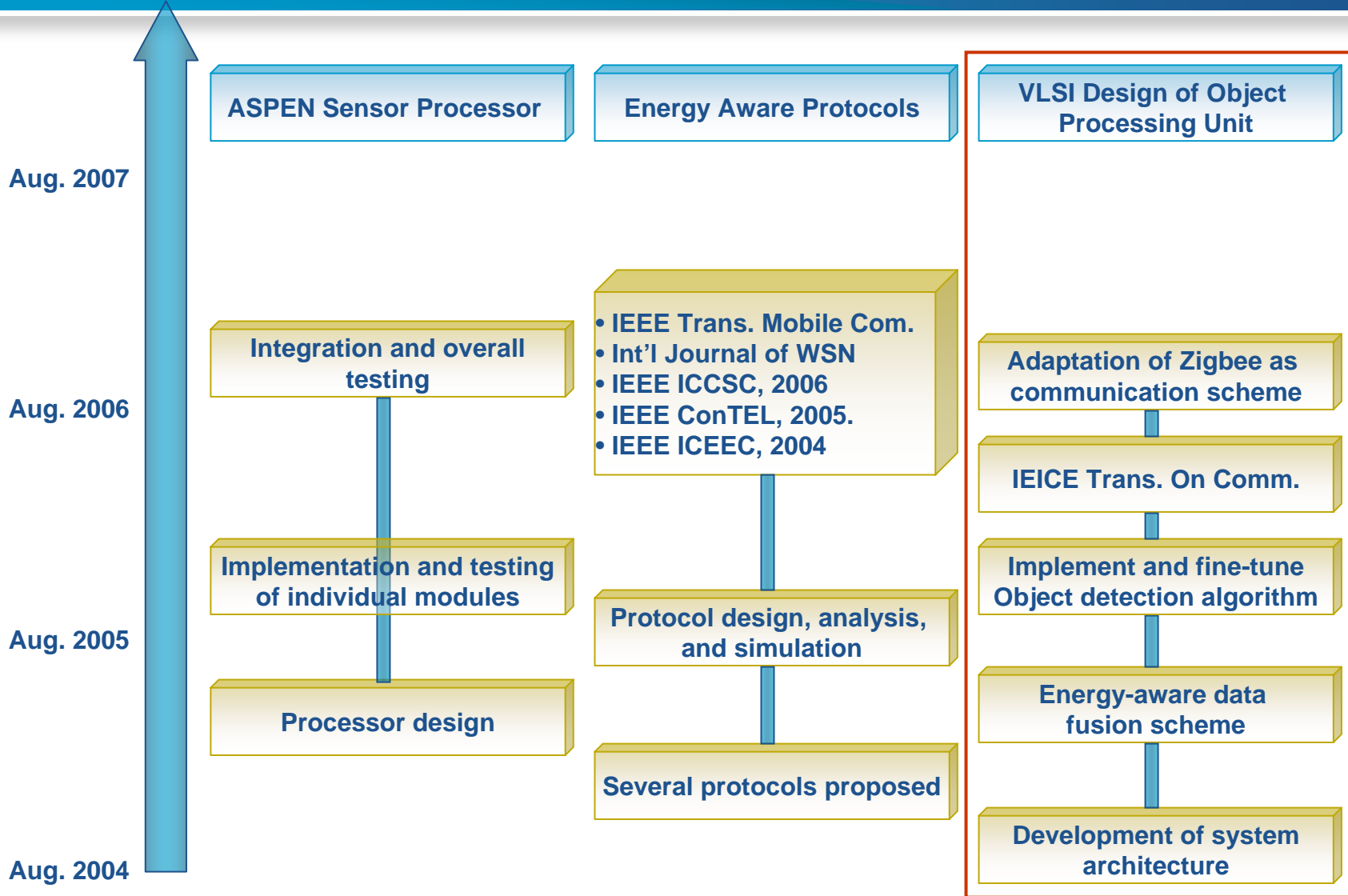


Energy Aware Protocols

- Two algorithms have been developed to assess residual energy in wireless sensor network (clusters).
- One algorithm has been developed to use caching in sensor nodes in order to save transmission energy (i.e., send less number of bits using cache tags rather than the actual data)
- One algorithm has been developed for query reduction (i.e., energy savings in the form of less number of transmitted bits) for wireless sensor network.
- Ongoing Tasks:
 - Implementation of a statistical energy assessment technique
 - Design of new battery-aware protocols
 - Implementation of a learning based query optimization in WSN.

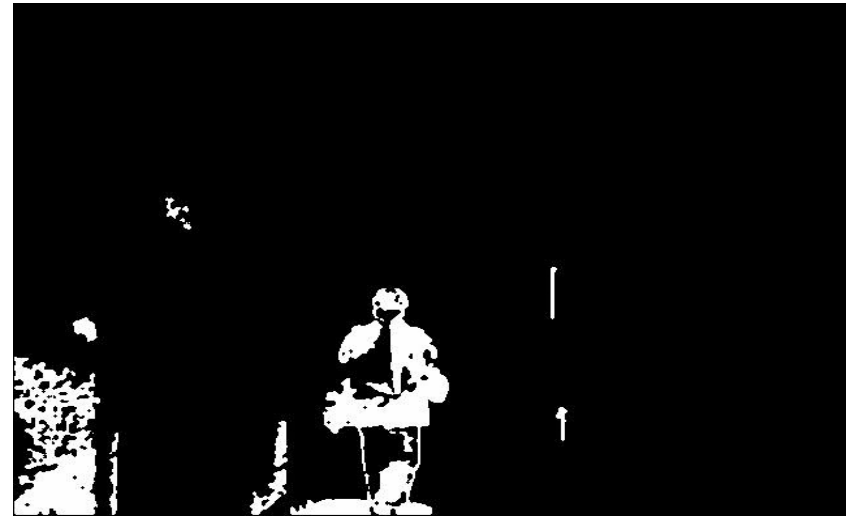


Sensors and Sensor Networks





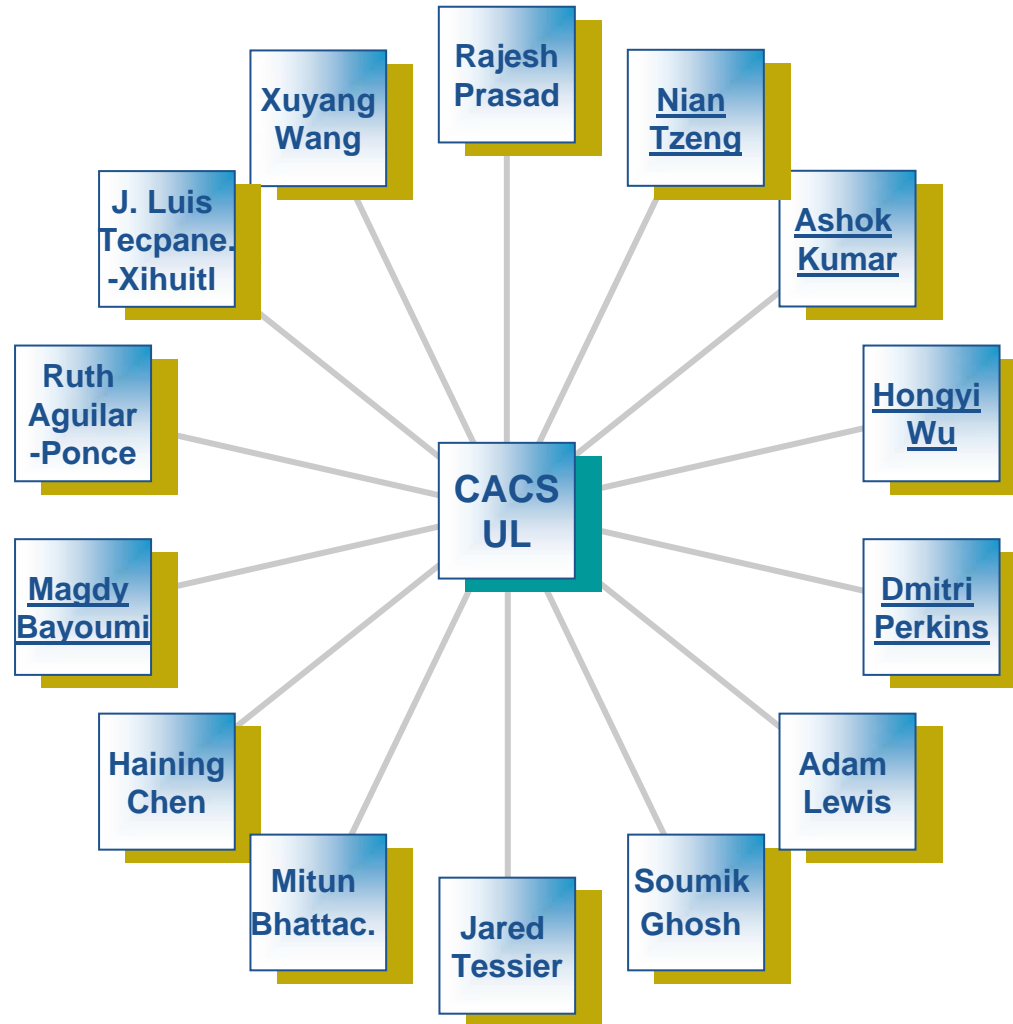
Object Detection





Team

Five faculty members, ten graduate students, and three undergraduate students





Thank You

Questions, Discussion

