CSE3300: Computer Networks and Data Communications

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Instructor and TA

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• Office hours: Thursday 4:00-5:00pm
• Course website
  – www.engr.uconn.edu/~song/classes/cn/index.html
  – Slides and reading materials will be available on course website
  – Related course: CSE4709/5095 Networked Embedded Systems
  – http://engr.uconn.edu/~song/classes/nes/index.html
Internet and Networked Embedded Systems

- Internet of Things (Trillion nodes)
- Smart metering
- Industrial automation
- Logistics
- Transportation
- Personal sensors
- Phones
- Building automation

- Core Internet (Million nodes)
- Fringe Internet (Billion nodes)
Instructor and TA (Cont.)

• TA: Mr. Tao Gong
• TA email: tao.gong@uconn.edu
• Office: ITEB 311
• Office hours: Mon and Wed 2:00-3:00 PM
Textbook and Reference Materials

Waiting list or sitting in

Please send email to the instructor: 1) Your name and netID; 2) Which year are you in? 3) Courses have taken.
Homework, Programming Assignments and Exams
Instructor’s Research and Development Work
Research Overview

Real-Time Data Management

- Maintaining data freshness for a fixed update task set
- Periodic task model
- No Jitter
- Half-Half
- More-Less
- JBML
- SJBML
- Jitter
- Sporadic task model
- Algorithm and analysis
- Overhead reduction
- Schedulability test
- Deferrable Scheduling

Co-scheduling of update tasks and control tasks
Maintaining data freshness in flexible cyber-physical systems

Large-scale Real-Time Data Analytics

Structured and unstructured data
process data, spectral, vibration, images

- Data Selection & Cleaning
- Sensitivity Analysis
- Supervised Learning

- Data Alignment
- Causality Analysis
- Unsupervised Learning

Real-Time Wireless Communication Platform

- Wireless QoS Abstraction
- Reliable Graph Routing Design
- Network Scheduling & Controller Co-Design
- Adaptive Synchronization
- Network Co-existence
- Online Spectral Sensing
- High-speed Network
- Configurable MAC Design
- Energy Minimization
- Network Disturbance Modeling
- Distributed Network Management
- Dynamic Network Resource Adjustment
Guiding Applications

Network-based Rehabilitation System

Real-Time Analytics Platform for Process Control

Remote and Real-time Welding System
CPS Application – Cyberphysical Avatar

Dynamic Model and Control Structure Design

Real-time Avatar-Human Interaction

Skill Acquisition through Machine Learning

Prototype Testbed

Cyberphysical Avatar: A semi-autonomous robotic system
(joint project with Human Centered Robotics Lab, UT Austin)
CPS Application – Mobile Gait Rehabilitation System

Data-driven Mobile Gait Rehabilitation System
(joint project with ASU, UC Berkeley and UC San Francisco)
CPS Application – Mobile Gait Rehabilitation System (Cont.)
CPS Application - Real-time Data Analytics Platform for Process Monitoring and Control

Real-Time Analytics Platform for Process Monitoring and Control
(joint project with Emerson and Microsoft)
CPS Application - Real-time Data Analytics Platform for Process Monitoring and Control

Real-Time Analytics Platform for Process Monitoring and Control
(joint project with Emerson and Microsoft)
WirelessHART: Applying Wireless Technology in Real-Time Industrial Process Control
Background and Challenges

• Low-power and secure real-time wireless protocol

• Network management techniques
  - Wireless mesh
  - Reliable graph routing
  - Real-time data link layer scheduling

• Make industrial wireless sensor and control networks Internet ready

• System design and implementation
System Design, Implementation and Deployment
System Design, Implementation and Deployment (Cont.)

Hardware Platforms

- Freescale 1322x SRB Evaluation Board
- Custom Designed Mother Board with Sensor Support
- Custom Designed Board with EnergyMicro EFM32 MCU
System Design, Implementation and Deployment (Cont.)

Compliance Testing Suite

Testing Engine 16-Channel Sniffer Virtual Network Approach
System Design, Implementation and Deployment (Cont.)

Network Manager and Simulator

Simulating a real-time wireless network with 100 devices:
- reliable broadcast graph
- device communication schedule
Network Management Techniques

Reliable Broadcast Graph

Reliable Uplink Graph

Reliable Downlink Graph
Making Industrial Wireless Sensor and Control Network Internet Ready

Application Layer

CoAP APP Layer

Socket API

UDP

ICMP

6LoWPAN

Enhanced NWK Layer

Data Link Layer

Transport Layer

802.15.4 PHY

Network Topology

CoAP-HTTP Server

Intra-system Service

Web Service
System Design, Implementation and Deployment (Cont.)

Testbed setup in UConn Wireless Sensing and Control Lab

Divided Wall Column at the J.J. Pickle Research Campus at UT Austin
Internet Applications – Social Media Examples
Internet Companies

Technology – Access – Interest – Channel

TAIC – SIMO business model
Screen – Internet – Media – Operator

Apple rules
Business
Assets
Companies
Trend

Software reservoir

Content, people, ideas, literature, music, films, art, hobbies, culture, civilization, history, science, drama
The History of Internet

http://www.youtube.com/watch?v=9hIQjrMHTv4
Covered Topic: Internet Architecture
A visualization of routing paths through a portion of the Internet (Wiki)
Covered Topic: Internet Protocol Suite
Chapter 2: application layer

Our goals:
• conceptual, implementation aspects of network application protocols
  – transport-layer service models
  – client-server paradigm
  – peer-to-peer paradigm

• learn about protocols by examining popular application-level protocols
  – HTTP
  – FTP
  – SMTP / POP3 / IMAP
  – DNS

• creating network applications
  – socket API
Chapter 3: transport layer

our goals:

• understand principles behind transport layer services:
  – multiplexing, demultiplexing
  – reliable data transfer
  – flow control
  – congestion control

• learn about Internet transport layer protocols:
  – UDP: connectionless transport
  – TCP: connection-oriented reliable transport
  – TCP congestion control
Chapter 4: network layer

4.1 introduction
4.2 virtual circuit and datagram networks
4.3 what’s inside a router
4.4 IP: Internet Protocol
  – datagram format
  – IPv4 addressing
  – ICMP
  – IPv6
4.5 routing algorithms
  – link state
  – distance vector
  – hierarchical routing
4.6 routing in the Internet
  – RIP
  – OSPF
  – BGP
4.7 broadcast and multicast routing
Chapter 5: link layer, LANs

5.1 introduction, services
5.2 error detection, correction
5.3 multiple access protocols
5.4 LANs
  ▪ addressing, ARP
  ▪ Ethernet
  ▪ switches
  ▪ VLANS
5.5 link virtualization: MPLS
5.6 data center networking
5.7 a day in the life of a web request
Chapter 6 Wireless and Mobility

6.1 Introduction

Wireless
6.2 Wireless links, characteristics
   – CDMA
6.3 IEEE 802.11 wireless LANs ("Wi-Fi")
6.4 Cellular Internet Access
   – architecture
   – standards (e.g., GSM)

Mobility
6.5 Principles: addressing and routing to mobile users
6.6 Mobile IP
6.7 Handling mobility in cellular networks
6.8 Mobility and higher-layer protocols
6.9 Summary
Chapter 8 network security

8.1 What is network security?
8.2 Principles of cryptography
8.3 Message integrity, authentication
8.4 Securing e-mail
8.5 Securing TCP connections: SSL
8.6 Network layer security: IPsec
8.7 Securing wireless LANs
8.8 Operational security: firewalls and IDS
COURSE SCHEDULE