CSci 5105

Introduction to Distributed Systems

Administrivia, Intro
Today

• Introductions
• Administrivia
• Distributed Systems Introduction
Welcome to 5105!

• Me:
  – Jon Weissman
  – CS Professor: Distributed Systems at UMN since 1999
  – Call me “Jon”

• TA:
  – Kwangsung Oh

• You
  – Highly motivated CS or ECE student
Logistics

• Lecture
  – T/Th 9:45 - 11:00, Mech Engr 108

• Jon’s office hrs
  – 11-11:50 T/Th, KH 4-225D
  – Also come by when door is open
  – Can email for appointment other times

• Kwangsung’s office hrs
  – TBD, KH 2-209
Introduction

- CSCi 5105 is a graduate class
  - strong upper-level undergraduates as well
- Expected background
  - CSCi 5103 (inside OS), CSCi 4061 (systems)
    - fluent in: virt memory, synch, concurrency, ....
  - Know how to edit, program, debug on preferably Linux systems
  - Strong programmer in C/C++ or Java
  - BUT can also program in the other
  - Can go off and figure stuff out from docs
Goals

• Expose you to the principles and practice of Distributed Systems
  – concepts, techniques, algorithms, systems
  – examine real distributed applications and systems that use the above

• Acquire basic distributed programming skills

• Learn how to analyze and assess conflicting issues and designs
Class Materials

Web site:
http://www-users.cselabs.umn.edu/classes/Spring2014/csci5105
  – Submit on line via moodle
  – Forum on line via moodle


Code: on website
Lecture

• Presentation of key ideas based on book and/or paper readings
  – do these ahead of class!

• Discussion periods
Class Etiquette

1. Be attentive in class
2. Talk occasionally (to us)
3. Do not distract me or your classmates
4. Disagreeing with me is par for the course
Grading

• In class midterm: 15%
• In class final: 15%
• 3 Programming projects: 45%
  – allow C/C++ or Java for some; others may mandate a single language
  – group of 2-3
  – not Plan C projects!
• 3 Written homeworks: 15%
• Participation: 10%
  – “make yourself known”
Policies

• Late work
  24 hrs with a 10% penalty afterwards, not accepted
• Work your interview schedule around my class
• **Cheating? 0 tolerance.**
• Re-grading window
  – 1 week from time graded work is returned
• Use of the Web
  – Without citation ... see cheating above
Topics

• Week 1: Distributed Architectures
• Week 2: Communication: RPC
• Week 3: Advanced Communication: MoM, MPI, multicast, streaming
• Week 4: Naming
• Week 5: Synchronization, Mutual Exclusion
• Week 6: Replication and Consistency
• Week 7: Fault Tolerance
• Week 8: Exam, TBD
• Week 9: Consensus
Topics (cont’d)

• Week 10: Classic Design, Distributed Scheduling
• Week 11: Distributed File Systems
• Week 12: Case Studies: Grids, P2P
• Week 13: Case Studies: Cloud, Data-Intensive-1
  Week 14: Case Studies: Data-Intensive-2, Security
• Week 15: “Cool” Techniques, Wrapup
Waiting List

• We have 59 so far; some will drop
• We will cap the class at 60
• We will decide by the end of the week
• Priority to CSE MS/PhD
Questions?
Let’s Begin

Distributed System Definition:

A collection of independent computers that appears to its users as a single coherent system

Examples?

The Internet
Google.com

Not Example?
Multi-core
Distributed System Middleware

Software that provides services needed to achieve “single coherent system” (buzzword: transparency)
Discussion

Transparency = complexity reduction

Sources of complexity in realizing “single coherent system”? 
# Transparency in a Distributed System

<table>
<thead>
<tr>
<th>Transparency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Hide differences in data representation and how a resource is accessed</td>
</tr>
<tr>
<td>Location</td>
<td>Hide where a resource is located</td>
</tr>
<tr>
<td>Migration</td>
<td>Hide that a resource may move to another location</td>
</tr>
<tr>
<td>Relocation</td>
<td>Hide that a resource may be moved to another location while in use</td>
</tr>
<tr>
<td>Replication</td>
<td>Hide that a resource is replicated</td>
</tr>
<tr>
<td>Concurrency</td>
<td>Hide that a resource may be shared by several competitive users</td>
</tr>
<tr>
<td>Failure</td>
<td>Hide the failure and recovery of a resource</td>
</tr>
</tbody>
</table>
Openness

Can I build an equivalent implementation of a system: are protocols and dependent interfaces public?

e.g. I can implement TCP

Related to interoperability: can I replace a component of a system with my own?
Scalability

• Important metric for distributed systems
• How do we want our systems to scale?
  – Size: easy to add resources, users, ....
  – Geographically
  – Management: across domains
Scalability (cont’d)

• Obstacle?
  – Centralization (service, data, algorithm)
  – Centralization makes things easy
    • management, consistency, security
Challenges to Decentralization

• Lack of global state
  • Decisions must be made based on local information
• Many more failure modes
• No global clock
Scaling Examples

- **Partitioning (~ service)**
  - Local web form vs. server processing

- **Distribution (~ data)**
  - Web
  - DNS, BGP routing (~ algorithm)
Scaling Examples (cont’d)

• Replication (~ service + data)
  – content-delivery network (CDN)
Types of Scaling

• Scale-up

• Scale-out
Distributed Computing Systems

- Tightly-coupled: **cluster**

- Key issue: Massive clusters: failure is prevalent
Distributed Computing Systems

• Loosely-coupled: Grid

• Key issue: Multiple Admin Domains: security
Distributed Information Systems: Distributed DBs

Key issue: ACID (atomic, consistent, isolated, durability)
Distributed **Pervasive** Sensor Systems

- Small unreliable elements
- Ad-hoc

Key issue: Resource constrained (e.g. battery)
Next Time

Read Chapters 1, 2 TVS

Explore website: schedule, dates, syllabus

Next topic: Architectural Styles