Introduction

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Slides include material from Vince Freeh (NCSU)
Instructor and TAs

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Average person’s view of storage

storage = computar does it !!
Average engineer’s view of storage

storage = thing inside computer!!
A few enterprise storage architectures (1)

A few enterprise storage architectures (2)

- From: http://wiki.abiquo.com/display/ABI20/Monolithic+Architecture
A few enterprise storage architectures (3)

A few enterprise storage architectures (4)

Why do all this? What problems are we solving?

• **Cost**: Is it cheap enough?
• **Capacity**: Can it hold enough?
• **Performance**: Is it fast enough?
• **Accessibility**: Can the data be accessed by everyone who needs it?
• **Security**: Is data protected from unauthorized access?
• **Reliability**: Is the downtime probability low enough?
• **Integrity**: Is data protected from hardware failures, disasters, and malicious attacks?
• **Compliance**: Do I keep data long enough safely?
• **Accountability**: Can I track all changes?
• **Space efficiency**: How much floor space do I need?
• **Power efficiency**: How many watts do I burn?
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Online course Info

• Course Web Page: static info
  
  http://people.duke.edu/~tkb13/courses/ece590-stor/

  • Syllabus, schedule, slides, assignments, rules/policies, prof/TA info, office hour info
  • Links to useful resources

• Piazza: questions/answers

  • Post all of your questions here
  • Questions must be “public” unless good reason otherwise
  • No code in public posts!

• GradeScope: Submit annotated PDFs for grading

• Sakai: just assignment submission and gradebook
Where to get info

• This info is fairly industry-connected, no great textbook
  • Semi-exception: “Evolution of the Storage Brain” by Larry Freeman (not a required text)

• Course material will come from lectures and supplementary readings
  • See course site for resources

• Additional independent research on your part will likely be necessary!
## Grading Breakdown

<table>
<thead>
<tr>
<th>Assignment</th>
<th>%</th>
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<tbody>
<tr>
<td>Homework/labs</td>
<td>45%</td>
</tr>
<tr>
<td>Project proposal</td>
<td>2%</td>
</tr>
<tr>
<td>Project outline</td>
<td>3%</td>
</tr>
<tr>
<td>Project milestone presentation</td>
<td>5%</td>
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<tr>
<td>Project final presentation</td>
<td>15%</td>
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<tr>
<td>Project demo</td>
<td>20%</td>
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<tr>
<td>Final exam</td>
<td>10%</td>
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</tbody>
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Project: 45%
HOMEWORKS AND LABS
Lab Motivation: What is a computer?

• Computers are:
  • Abstract theoretical math engines that float around on the internet?
  • PHYSICAL OBJECTS
  • MADE OF MATERIALS
  • IN THE REAL WORLD
  • AND YOU CAN TOUCH THEM
  • AND PUT THEM PLACES
  • WITH YOUR ARMS/LEGGS/FINGERS/BODY
  • AND LIKE A SCREWDRIVER OR WHATEVER!!!!!!!
Result: this course is HANDS ON

- Historically, the most popular assignments have been the realistic, hands-on ones. So I’ve added a *lot* of hands-on experience to the course.

- Each student group will be assigned a physical storage server which is downstairs in Hudson 06
- **Lab 0** will have you prepare and deploy this server.
- **Labs 1+** will have you do realistic storage tasks on it.
Labs vs Homeworks

**Labs**
- Group work
- Hands-on
- Usually on your server
- Submitted via GradeScope (and Sakai for code)
- Can discuss concepts with other groups, but not answers

**Homeworks**
- Individual work
- Pen-and-paper questions
- Submitted via GradeScope (and Sakai for code)
- Can discuss concepts with others, but not answers
Late penalties

- Late homework/lab submissions incur penalties as follows:
  - Submission is 0-24 hours late: total score is multiplied by 0.9
  - Submission is 24-48 hours late: total score is multiplied by 0.8
  - Submission is more than 48 hours late: total score is multiplied by the Planck constant (in J s)

- NOTE: If you feel in advance that you may need an extension, contact the instructor.
Labs are group work

- Lab assignments – done **together** as a group

- What does “together” mean?

- It means that everyone must understand all of it

- If I ask “How did this part work?”, you cannot answer “I didn’t work on that part”!

- How do we check? **Lab quizzes**: Quick in-class assignments that are easy to answer if you were involved in the lab work.
Class lab sessions to kickstart homework

- We’re going to schedule a few **class-wide lab sessions** so everyone can start to work on their server with instructor support
  - Why not a separate lab section? We don’t need every week...

- Be sure to respond to the **scheduling survey** that will go out...
You will eventually deploy your server in a real datacenter: the FitzWest server room in the CIEMAS basement.

This means you’ll have **badge access** to a real datacenter.

**Datacenter rules (you need to sign this to get access):**

1. **Don’t touch other people’s stuff.** Includes other racks, other equipment, and other group’s servers in this course. You can touch your server, its cables, and shared tools.

2. **Respect shared resources.** The room has LCD monitors, keyboards, carts, screwdrivers, etc., which you can use. You must not interfere with IT operations and you must put stuff away when done.

3. **Report issues promptly.** Tell me if anything’s wrong.

< Print, sign, and turn in to gain access>
THE PROJECT
The Project

• **Proposal**: Group up and say what you’re going to do.
  • Write-up plus 30-minute meeting scheduled out of class.

• **Outline**: Add detail. Say how you’re going to do it.
  • Write-up plus 60-minute meeting scheduled out of class.

• **Milestone presentation**: Present work done so far to class.
  • 5-minute talk in class.

• **Final presentation**: Present complete project to class.
  • 15-minute talk in class.

• **Final demo**: Defend your project to the instructor.
  • 60+ minute meeting scheduled out of class.

• **Read course page for details!**
The project is also group work

- Project work – also done *together* as a group

- The word “*together*” still means that everyone must understand all of it!

- Again, you can’t say “I didn’t work on that part”!
POLICIES
Grade Appeals

- All regrade requests must be in writing
  - Email the TA who graded the question
    (we’ll indicate who graded what)

- After speaking with the TA, if you still have concerns, contact the instructor

- All regrade requests must be submitted no later than 1 week after the assignment was returned to you.
Academic Misconduct

• Academic Misconduct
  • Refer to Duke Community Standard
  • Labs are groupividual – you do your own work
  • Common examples of cheating:
    • Running out of time and using someone else's output
    • Borrowing code from someone who took course before
    • Using solutions found on the Web
    • Having a friend help you to debug your program

• **I will not tolerate any academic misconduct!**
  • Software for detecting cheating is very, very good ... and I use it
  • 8 students were busted on Homework #1 in spring 2013, and 2 of them were referred to the Office of Student Conduct

• “But I didn’t know that was cheating” is not a valid excuse
Our Responsibilities

• The instructor and TA will...
  • Provide lectures/recitations at the stated times
  • Set clear policies on grading
  • Provide timely feedback on assignments
  • Be available out of class to provide reasonable assistance
  • Respond to comments or complaints about the instruction provided

• Students are expected to...
  • Receive lectures/recitations at the stated times
  • Turn in assignments on time
  • Seek out of class assistance in a timely manner if needed
  • Provide frank comments about the instruction or grading as soon as possible if there are issues
  • Assist each other within the bounds of academic integrity
Course summary

- We have **hard disks** and **solid-state drives (SSDs)**
- We can use **RAID** to combine performance and capacity while masking effects of drive failure
- The concept of files and directories comes from **File Systems**, a rich field of study.
- We can provide virtual disks to users over **Storage Area Network (SAN)** protocols
- We can provide file access to users using **Network-Attached Storage (NAS)** protocols
- We can provide **storage as a service (SaaS)** via cloud-type protocols.
- Storage efficiency can be improved with **data deduplication** and **compression**.
- We need to preserve **business continuity**: avoid downtime and lost data through **backups** and **high availability**
- Storage arrays are deployed based on **workload sizing**.
- Storage is often folded into a complete hardware/software stack: **converged architecture**.
- Storage systems are large enough that **management/monitoring** is its own challenge.
- Storage architects need to understand **basic finance** and **legal/compliance issues**