6.033 Spring 2015
Lecture #1

• Complexity
• Modularity and abstraction
• Enforced modularity via client/server models
http://mit.edu/6.033

Schedule

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
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<tr>
<td>Feb 2 Reg day</td>
<td>Feb 3 REC 1: Worse is Better</td>
<td>Feb 4 LEC 1: Enforced Modularity and Client/server Organization</td>
<td>Feb 5 REC 2: Therac-25</td>
<td>Feb 6 TUT 1: Introduction to system critiques (run by TAs)</td>
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<td></td>
<td>Preparation: Read Worse is Better</td>
<td>Preparation: Therac-25 paper</td>
<td>Assigned: Paper critique #1</td>
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<td>Assigned: Hands-on DNS</td>
<td>Supplemental Reading: Book sections 1.1-1.5, and 4.1-4.3</td>
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<td>First day of classes</td>
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<td>Feb 9 LEC 2: Naming</td>
<td>Feb 10 REC 3: DNS</td>
<td>Feb 11 LEC 3: Operating systems</td>
<td>Feb 12 REC 4: UNIX</td>
<td>Feb 13 TUT 2: How to read a paper (run by communication instructors)</td>
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<td>Supplemental Reading: Book sections 2.2, and 3.1</td>
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<td>Supplemental Reading: Book sections 5.1, 5.3, and 5.4</td>
<td>Preparation: Unix paper</td>
<td>DUE: Paper critique #1</td>
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<td>Preparation: Book section 4.4: &quot;Case study: The Internet Domain Name System (DNS)&quot;</td>
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<td>Assigned: Paper critique #2</td>
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<td>DUE: Hands-on DNS</td>
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<td>Assigned: Hands-on UNIX</td>
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Fill out form for recitation assignments
link on home page
what is a system?

a set of interconnected components that has an expected behavior observed at the interface with its environment
6.033 Approach to Systems

lectures: big ideas + examples
Katrina LaCurts, Hari Balakrishnan

recitations: read papers describing successful systems
Arvind, Mark Day, Dina Katabi, Sam Madden, Martin Rinard,
Karen Sollins, Peter Szolovits

hands-ons: play with successful systems

design project: practice designing and writing
TAs: Ellen Finch, David Goehring, Ameesh Goyal, Webb Horn,
Qian Long, Manali Naik, Andrew Nguyen, Amy Ousterhout, Cong Yan
Writing staff: Jared Berezin, Amy Carleton, Amelia Herb, Nora Jackson,
Janis Melvold, Juergen Schoensteen, Jessie Stickgold-Sarah,
Linda Sutliff, Michael Trice

exams: reasoning about system design

Katrina LaCurts | lacurts@mit | 6.033 2015
what is a system?

a set of interconnected components that has an expected behavior observed at the interface with its environment

what makes building systems difficult?

complexity
Today’s Systems are Incredibly Complex

source: http://www.informationisbeautiful.net/visualizations/million-lines-of-code/
Emergent Properties
(ethernet example)
Emergent Properties
(ethernet example)

collision not detected!

for collision-detection to work, endpoints must send for at least twice the latency of the link
Emergent Properties
(ethernet example)

A

3Mbps link, 5μsec latency

=> minimum-packet size of 30 bits
for collision detection to work

B

experimental ethernet: 3Mbps link, 5μsec latency, 40-bit packet headers
Emergent Properties (ethernet example)

10Mbps link, 12.5μsec latency

=> minimum-packet size of 250 bits for collision detection to work

first ethernet standard: 10Mbps link, 12.5μsec latency, 112-bit packet headers

minimum packet size was an emergent property of ethernet
how can we mitigate complexity?
how do we enforce modularity?
Stub Clients and RPCs

**Class webBrowser**
(on machine 1)

def main():
    html = browser_load_url(URL)
    ...

def browser_load_url(url):
    msg = url # could reformat
    send request
    wait for reply
    html = reply # could reformat
    return html

**Class webServer**
(on machine 2)

def server_load_url():
    ...
    return html

def handle_server_load_url(url):
    wait for request
    url = request
    html = server_load_url(URL)
    reply = html
    send reply
Challenges with RPCs

Client → internet → Server

load("buy.html?item&ccNo=xxx")

X

load("buy.html?item&ccNo=xxx")
Challenges with RPCs

Problem: server can still fail

Client

internet

Server

\text{load("buy.html")}

\text{state on server}

\text{client | UID | reply}

replay results from table instead of reprocessing order
• **Complexity**
  Comes from many sources, limits what we can build, causes unforeseen issues; can be mitigated with **modularity** and **abstraction**

• **Enforced modularity**
  One way to enforce modularity is with a **client/server model**, where the two modules reside on different machines and communicate with RPCs; network/server failures are still an issue

**next lecture:** naming, which allows modules to communicate

**subsequent lectures:** operating systems, which provide modularity on a single machine