CSE 486/586 Distributed Systems Wrap-up

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CSE 486/586 Administrivia

- Final
  - 5/6 (Monday), 3:30PM - 6:30PM
  - 101 Davis

Building a Distributed System

- *"The number of people who know how to build really solid distributed systems…is about ten"*
  - Scott Shenker, Professor at UC Berkeley
- Are you confident now?
- What were the most interesting topic to you?

Things We Discussed (Midterm)

- Networking basics (feat. the Internet)
- Failure detection
- Time synchronization
- Logical time & global states
- P2P & DHT
- Reliable multicast
- Consensus basics
- Mutual exclusion & leader election
- RPC

Things We Discussed

- Transactions & concurrency control
- Replication
- Gossiping
- Distributed file systems
- Distributed shared memory
- Paxos
- BFT
- Security

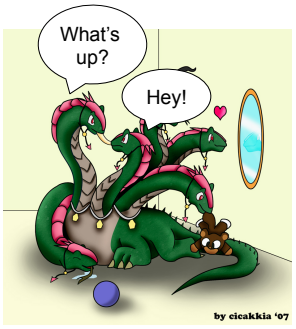
The Way I See It

- We've learned some of the building blocks & fundamental results…
  - Networking basics, failure detection, logical time, reliable multicast, mutual exclusion, leader election, transactions, concurrency control, replication, gossiping, Paxos, BFT, …
- …and how real systems get built using those…
  - P2P, DHT, Dynamo, Chubby, …
- …and also got some experience in building/using the fundamental building blocks…
  - Ordered multicast for messaging, a DHT, and a replicated key-value storage

Distributed Systems 10 Questions

- Course goal: answering 10 questions on distributed systems
  - At the end of the semester, if you can answer only 10 questions about distributed systems, you'll probably get an A.
  - Easy enough!
- What are those questions?
  - Organized in 6 themes
  - 1~2 questions in each theme
  - A few (or several) lectures to answer each question

Theme 1: Hint



Theme 1: Communications

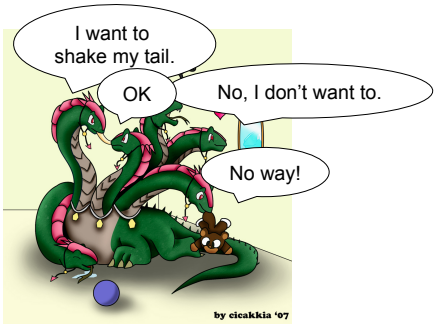
- Q1: how do you talk to another machine?
  - A: Networking basics
  - Know how to use socket now?
- Q2: how do you talk to multiple machines at once?
  - A: Multicast
  - What is "reliable multicast"?
  - What orderings are there for ordered multicast?
- Q3: can you call a function/method/procedure running in another machine?
  - A: RPC
  - What is a stub compiler (generator)?

Theme 2: Hint

Theme 2: Concurrency

- Q4: how do you control access to shared resources?
  - A: Distributed mutual exclusion, leader election, etc.
  - Ring election? Modified ring election? Bully algorithm?

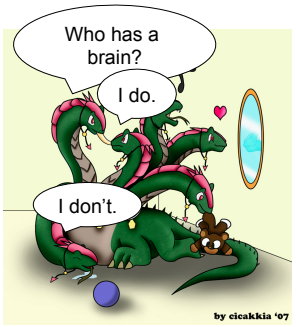
Theme 3: Hint



Theme 3: Consensus

- Q5: how do multiple machines reach an agreement?
  - A: it's impossible! (the FLT result), but algorithms do exist that get around the impossibility (Paxos, BFT, etc.)
  - What are the phases for Paxos?

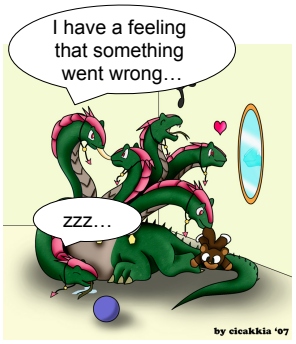
Theme 4: Hint



Theme 4: Storage Management

- Q6: how do you locate where things are and access them?
  - A: DHT, distributed file systems, etc.
  - Consistent hashing?

Theme 5: Hint



Theme 5: Non-Byzantine Failures

- Q7: how do you know if a machine has failed?
  - A: Failure detection
  - What is the fundamental limit of a failure detector?
- Q8: how do you program your system to operate continually even under failures?
  - A: Replication, gossiping
  - Linearizability? Sequential consistency? One-copy seriarizability?

Theme 6: Hint

Theme 6: Byzantine Failures

- Q9: how do you deal with attackers?
  - A: Security
  - What is onion routing?
- Q10: what if some machines malfunction?
  - A: Byzantine fault tolerance
  - To tolerate *f* faulty nodes, how many nodes do we need in total?

Acknowledgements

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