# Further Experience with Teaching Distributed Systems to Undergraduates

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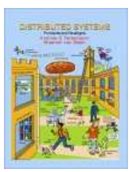
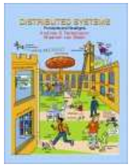


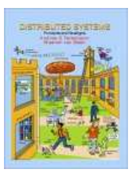
# The First Day of Class

- *Are you ready?* You must become comfortable with the theory and practice of the design, implementation, and analysis of distributed systems and algorithms
- *I'll never go back to a single address space again:* students realize that building distributed systems is challenging and fun!
- Ricart and Agrawala who? distributed mutual what? why is Lamport stamping time? epidemic algorithms?
- *I think I just had a page fault*: students must manage a variety of complexity sources



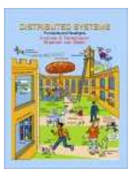
# Distributed System Challenges

- Students need to be familiar with (or willing to learn!) material about programming languages, operating systems, networks, theory, and algorithms
- Nuts and bolts: RPCs in C, RMIs in Java, Java virtual machines, Jini 1.2 and 2.0, JavaSpaces, and the `CLASSPATH`
- Include concepts from concurrency such as semaphores and monitors with real implementations in Java
- *What are we measuring?* students must be able to conduct experiments to evaluate the relative strengths and weaknesses of algorithm and implementation choices



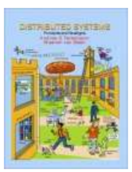
# Course Objectives

- Explore the *principles* and *paradigms* associated with distributed systems
- Principles: communication, naming, distributed scheduling, synchronization, mutual exclusion, consistency, replication, and fault tolerance
- Paradigms: become very familiar with object-based distributed systems using Jini and JavaSpaces
- Include a discussion of special topics such as distributed hash tables (DHTs), tuple spaces, and data stream management systems (DSMS)

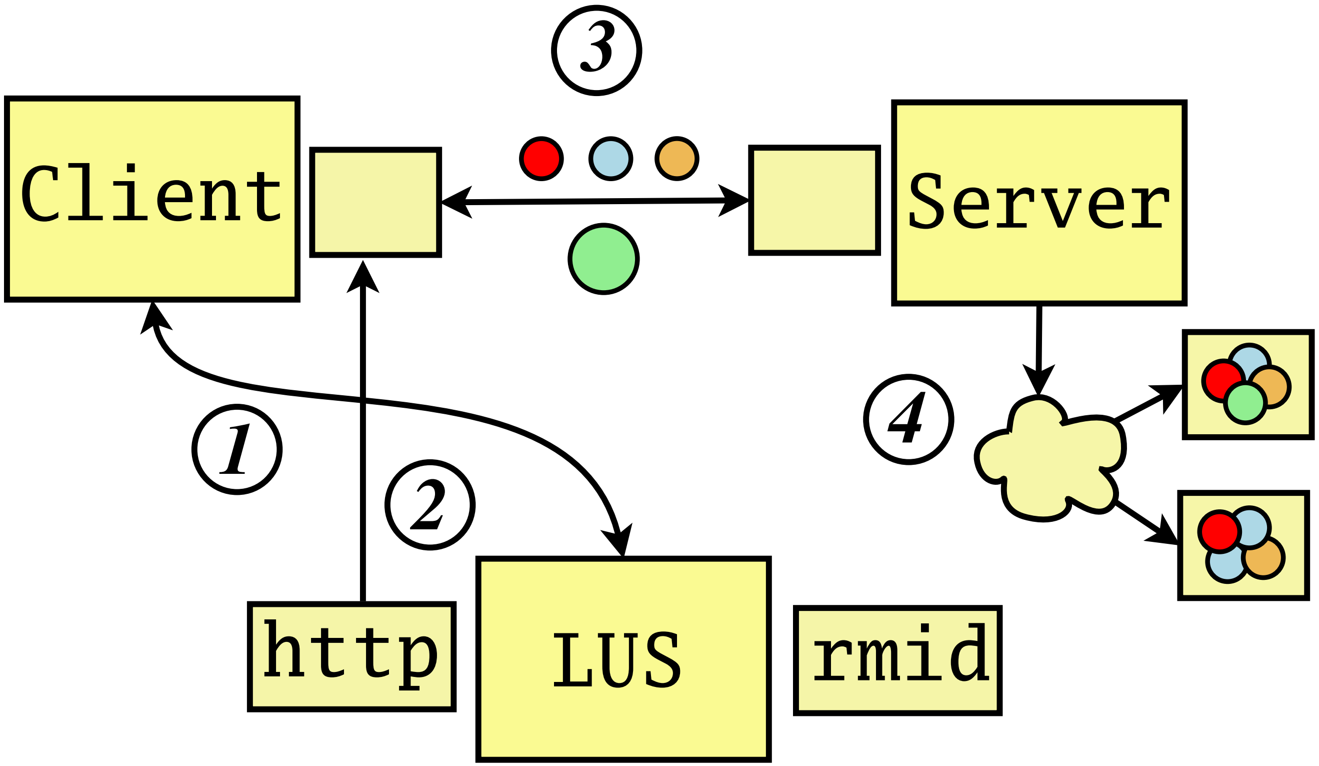


# Instructional Objectives

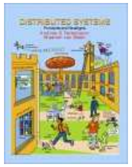
- Course difficulty should be worn as a badge of honor
- Create exciting laboratory assignments where the students actually implement interesting systems and measure their performance
- A “gloves off approach” with a safety net: try to hide some complexity while ensuring that students retain perspective and understand many low-level details
- Require students to keep laboratory notebooks where they record hypotheses, data, observations, and design choices
- Read many scholarly and a few popular presss articles



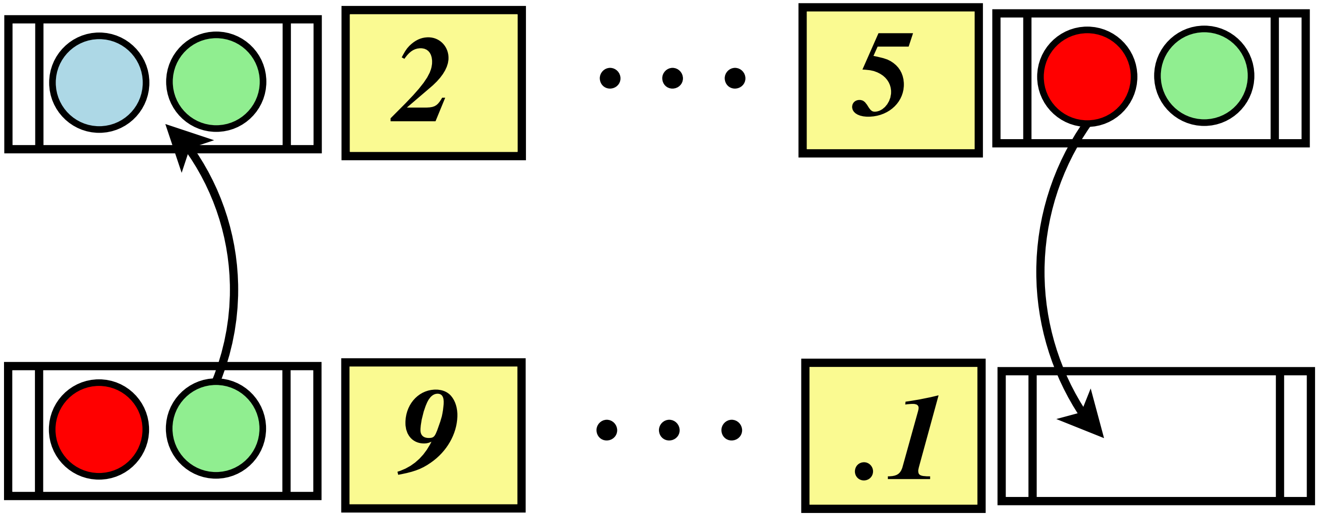
# Topic: Remote Communication



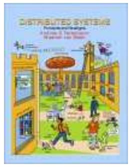

- Discovery, code downloading, parameters, transparency
- Local, remote, and distributed objects



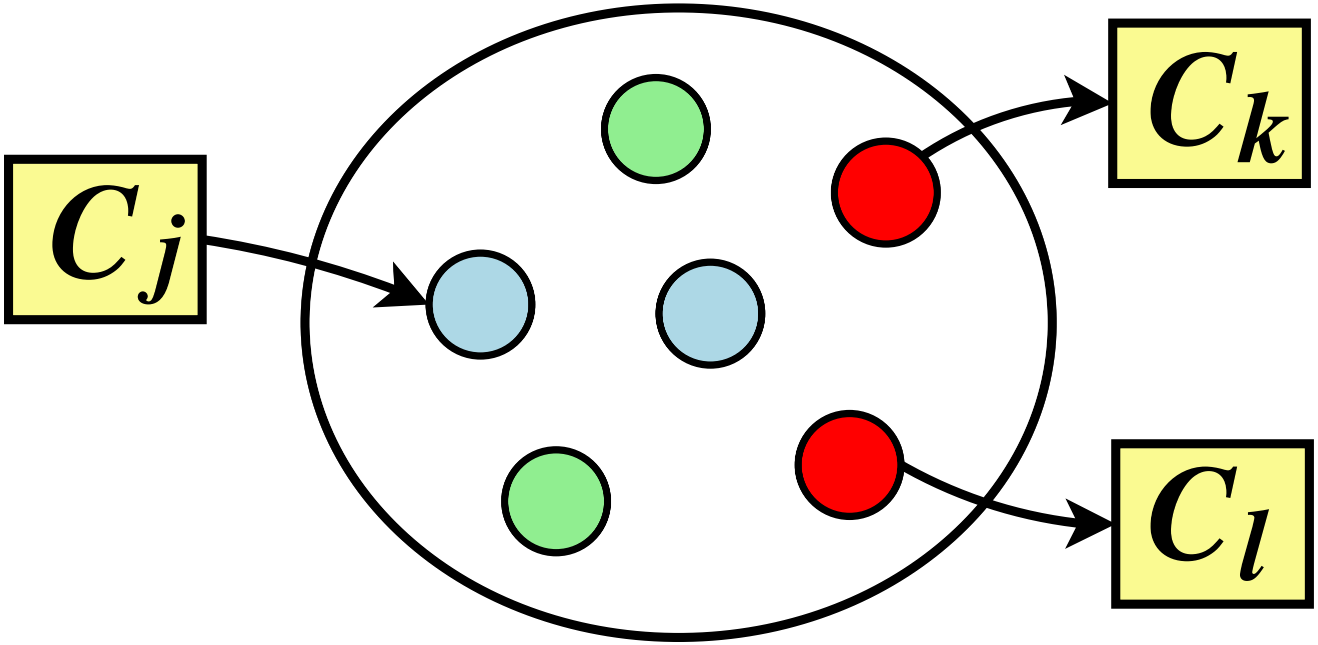
# Topic: Distributed Scheduling



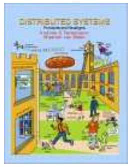

- Unshared state, resource matching, and process migration
- Case studies: Sprite, Condor, Frugal, ComputeFarm for scientific computation and distributed testing
- Load balancing vs. load sharing and the cost/benefit tradeoff



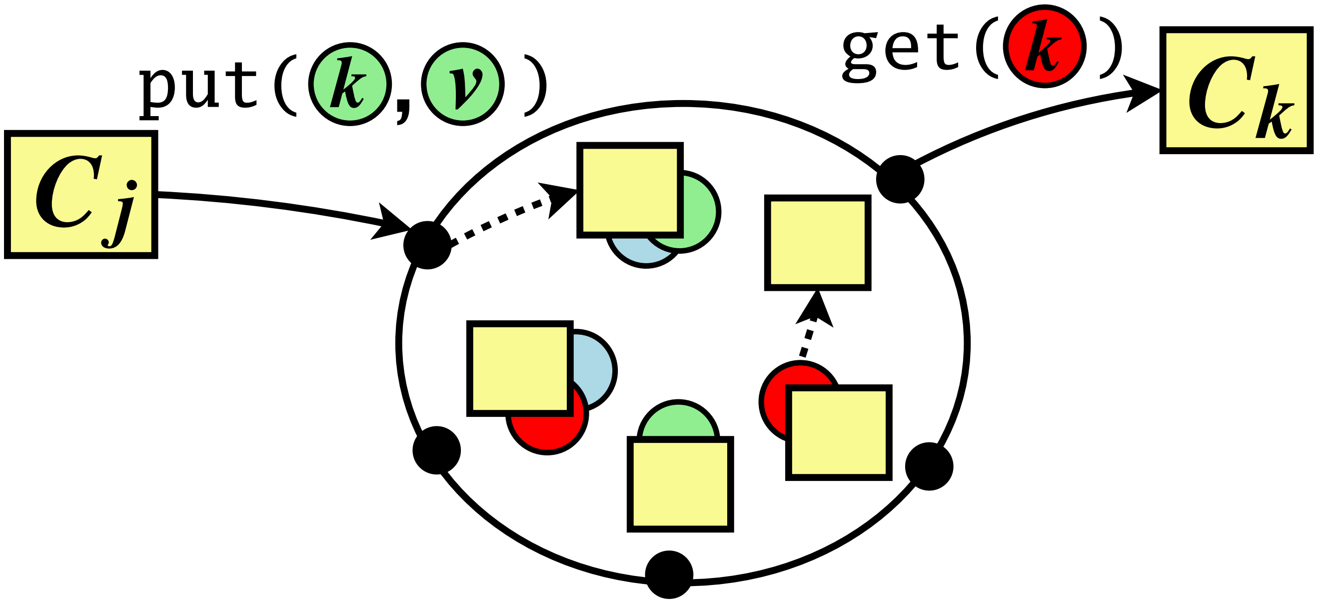
# Special Topic: Tuple Spaces




- Space clients can `write`, `take`, and `read` `Entry` objects
- How do we measure performance and/or correctness?

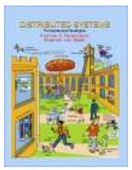


# Special Topic: OpenDHT

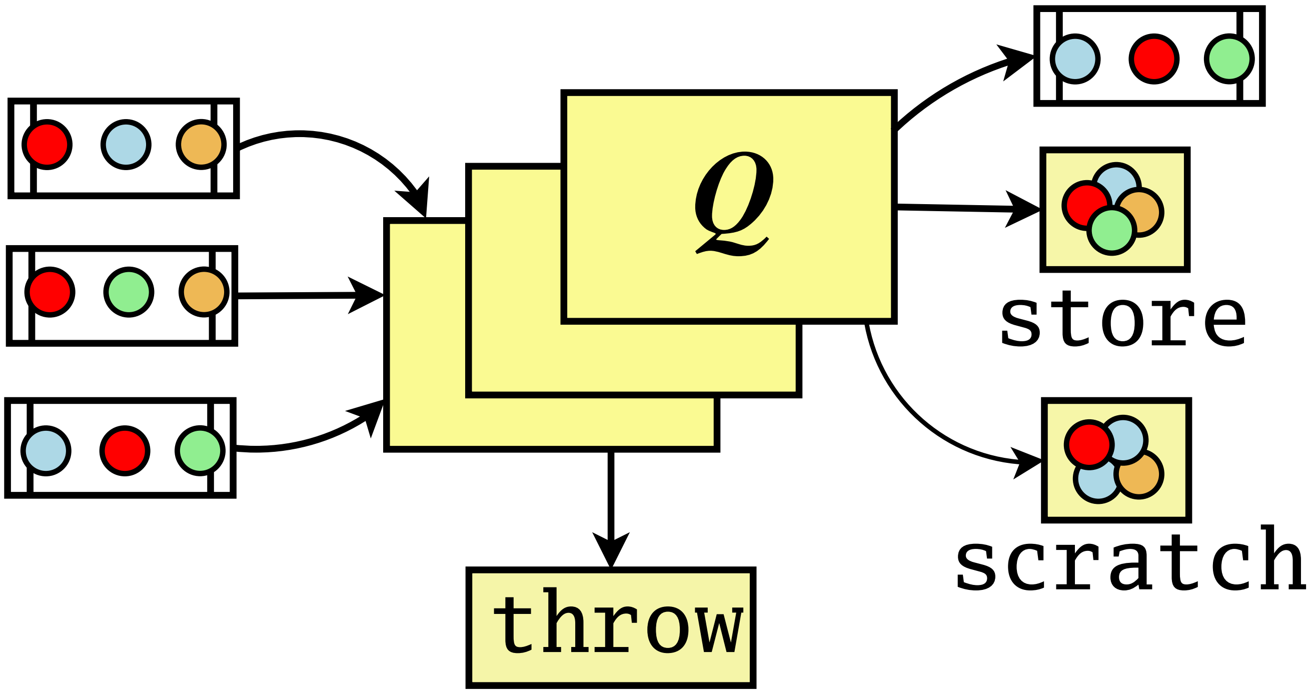



OpenDHT & PlanetLab

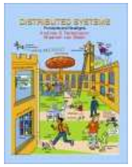
- Clients can `put` and `get` with Sun RPC or XML-RPC
- How do we measure performance and/or correctness?



# Special Topic: Data Streams

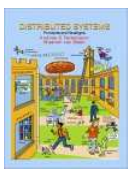



- Continuous streams of data and queries
- Case studies: STREAM, TelegraphCQ, load shedding

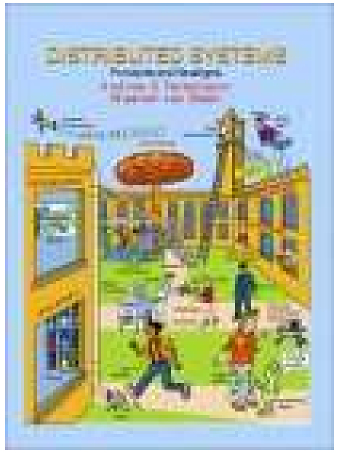


# Conclusions

- The design and implementation of distributed systems is challenging, fun, and rewarding
- Current distributed systems textbooks are generally very good (there are still surprises, though!)
- There is a wealth of well-written literature from good conferences and journals
- Most students enjoy laboratories with Jini, JavaSpaces and Python (OpenDHT) while RPC programming in C is seen as tedious



# Resources




- Your comments, suggestions, and participation are invited!

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