CS199-6: Wide Area Application Design, Deployment, and Management

http://cs199.planet-lab.org/

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Tuesday 20th January 2003

PLANETLAB

Overview of today's talk

- What's this course about?
- Planetary-scale Applications
  - What are they?
  - How are they different?
- PlanetLab as a platform
  - What is it?
  - How does one use it?

What's this course about?

- Writing distributed services to run in the wide area Internet
  - spread over a large no. of machines and large geographical area
  - which can be deployed over PlanetLab
  - which might become part of PlanetLab
- Experience in the design of large systems
  - Network programming
  - Handling failures
  - etc.
- Introduction to real systems research
- Emphasis on *building* rather than lectures

Mothy and Brent's goals

- Give you a feel for what implementing large distributed systems is like
- Help you get experience designing, building, testing, and debugging real wide-area services
- Not to simply feed you information
- => Ask questions, arrange meetings, etc. etc.

Approach

- Programming experience is assumed
- Few introductory lectures
- Reading material
- Get into design and implementation as soon as possible
- Work in teams of 2-3 people

Phase 1: Introduction

- Lectures on
  - Planetary-scale services
  - PlanetLab
- Initial assignment
  - Simple geographical lookup service
- Location: Soda 310

Phase 2: Project Proposals

- Form teams of 3 people for projects
- Put together project proposals
- Review projects
- Location: 310 Soda

Phase 3: Building a service

- Implementation of project proposals
- Weekly meetings with each team
- Milestones:
  1. Initial prototype
  2. Enhancements
  3. Final delivery
- Meeting location: Intel Research
  - (downtown – the PowerBar building)

Phase 4: Reporting

- Each team gives a presentation and demonstration of their service
- Project writeups due
- Location: Soda hall

Tentative Schedule

Week 1:

- Introductory lectures
- Initial assignment

Week 2:

- Project discussion
- Form teams

Week 3:

- Review proposals

Thereafter:

- Implementation and Team meetings
- Project Milestones

Milestones

- 28th January: Initial assignment due
- 4th February: Team project proposals due
- 24th February: Initial prototype due
- 17th March: Enhancements to prototype
- 21st April: Deliver final service
- 27th April, 6th May: Presentations/demos
- 16th May: Project writeups due.

Reading material

- See:

  `http://cs199.planet-lab.org/reading.html`

- Required reading for next week:
  - "A Blueprint for Introducing Disruptive Technology into the Internet"
  - "A Note on Distributed Computing"
  - "Hints for Computer System Design"

Planetary-scale and wide-area distributed systems

What is a distributed system?

- Distinct components running on distinct machines
  - WWW, NFS, CIFS, Email, Ultima Online, Quake3, Saber, SS7, etc., etc.
- Characterized by:
  - Concurrency
  - Partial failures
  - Latency
- Writing distributed systems is *hard*
  - C.f. Waldo et.al.

Distributed systems: concurrency

- Concurrency can often be dodged in centralized systems
  - Event-driven systems, one-offs
- Alternatively, locks are available
  - E.g. Java concurrency primitives
- Distributed systems are inherently concurrent
  - And shared-memory-based synchronization is not an option

Distributed systems: latency

- Typical procedure call: ~1ms vs. ~10ns.
- High-level system design must take this into account
  - Pipelining
  - Parallelism
  - Etc.

Distributed systems: partial failure

- "A distributed system is in which I can't get my work done because I computer I've never heard of has failed"
  - Butler Lampson
- Dist. Systems are not fail-stop
  - Bits keep running
  - Failures may be undetected
  - Etc.

Distributed Systems

- Despite all this, distributed systems are, these days, relatively commonplace
  - Some are well-engineered
    - » e.g. SS7, Ultima, etc.
  - Some are sufficiently simple
    - » e.g. WWW
  - Some people just live with
    - » e.g. WWW, NFS, CIFS
  - Some people are told to just live with
    - » e.g. most corporate calendaring systems

Wide-Area (or Planetary-Scale) Systems

- Wide area applications are for people who find ordinary distributed applications too easy :-)
- Wide-area applications span a significant portion of the globe
  - Google is *not* a planetary-scale system
  - Akamai *is* a planetary-scale system

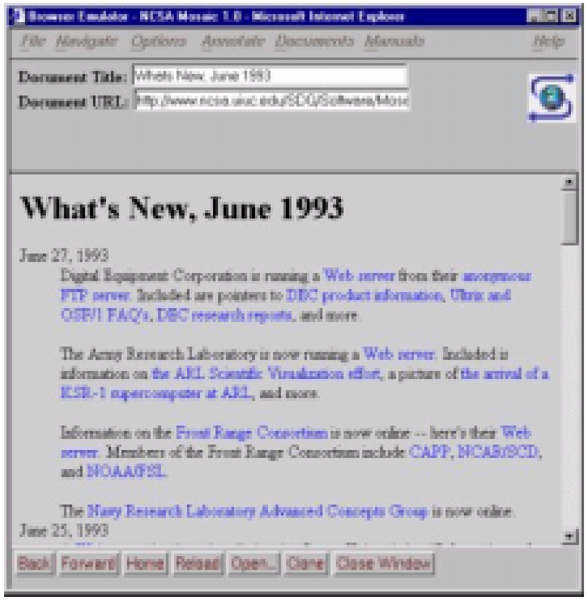
Why build planetary-scale systems?

- Latency
  - Beating the speed of light
  - Move computation and data closer to users
- Multilateration
  - Stand in 1000s of viewpoints at the same time
  - Triangulation, correlation, measurement
- Politics
  - Spanning boundaries
  - Selecting (or avoiding) domains
  - judicial, financial, administrative, national, etc

Examples of wide-area systems

- Content-distribution networks
  - Akamai, Inktomi, etc.
- Overlay routing networks
  - RON (Resilient Overlay Networks), etc.
- Global storage systems
  - OceanStore, PAST, etc.
- True Peer-to-peer systems
  - FreeNet, KaZaA, etc.

Content Distribution, 1993



Document Title: What's New, June 1993

Document URL: http://www.ncsa.uiuc.edu/SDG/Software/Mosa

What's New, June 1993

June 27, 1993

Digital Equipment Corporation is running a Web server from their anonymous FTP server. Included are pointers to DEC product information, Ultrix and OSF/1 FAQ's, DEC research reports, and more.

The Army Research Laboratory is now running a Web server. Included is information on the ARL Scientific Visualization effort, a picture of the arrival of a KSR-1 supercomputer at ARL, and more.

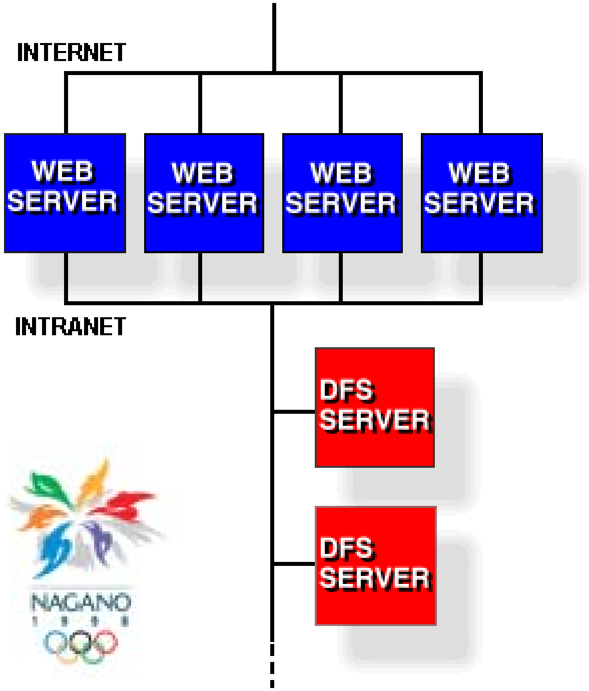
Information on the Front Range Consortium is now online -- here's their Web server. Members of the Front Range Consortium include CAPP, NCAR/SCD, and NOAA/FSL.

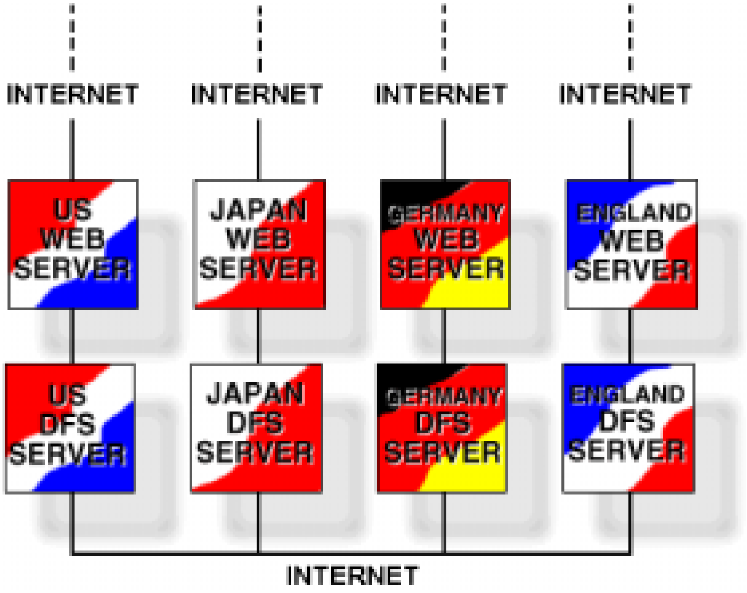
The Navy Research Laboratory Advanced Concepts Group is now online.

June 25, 1993

- NSCA's "What's New" the most viewed page on the web (100K accesses per month).
- *All* clients access a single copy of the page stored on a single server.

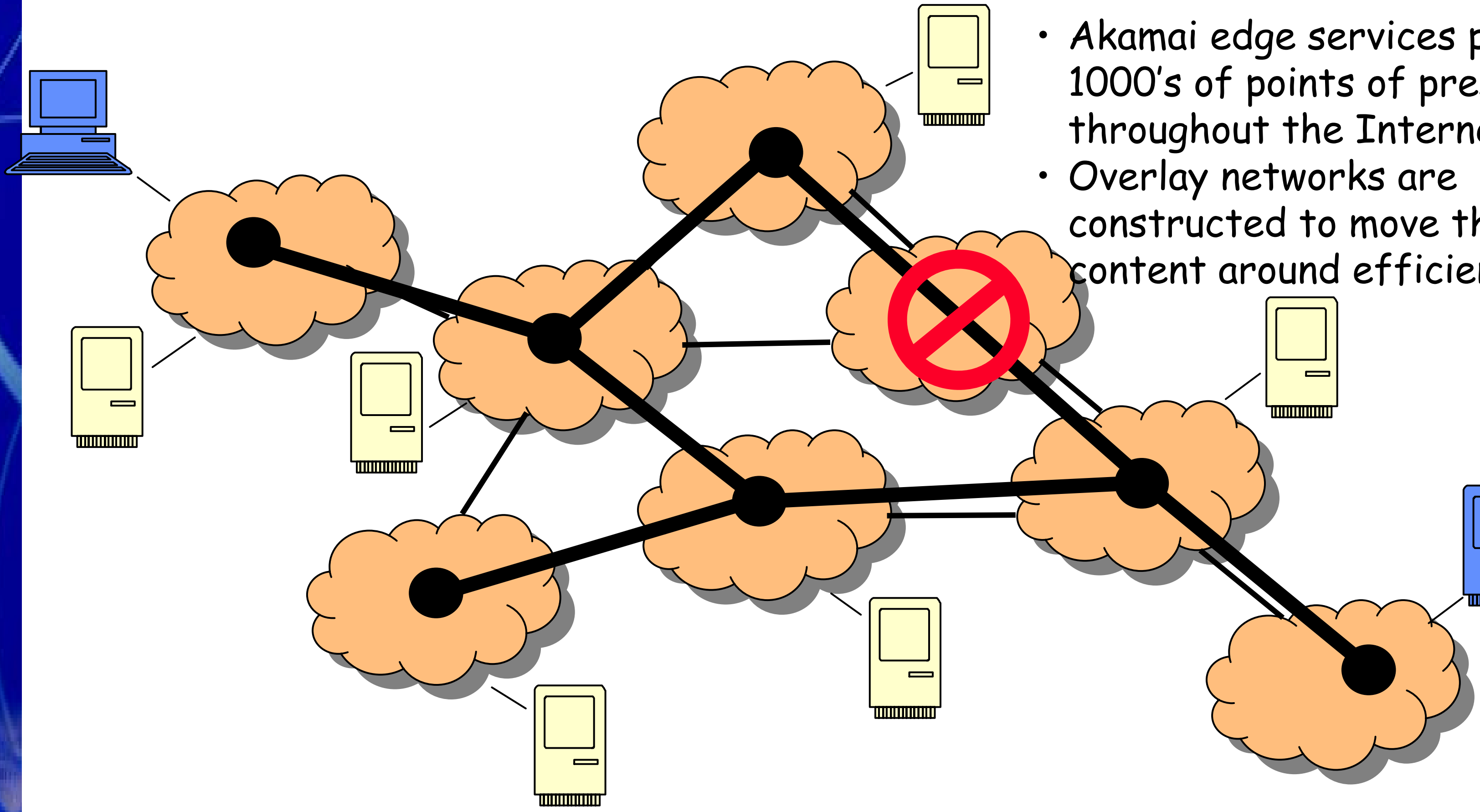
Content Distribution, 1998





- IBM web “server” handles a record 100K hits per minute at the Nagano Olympics
- Over 10^9 pages served in a two week period
- DFS running on SP2’s used to distribute 70K pages to 9 geographically distributed locations

Content Distribution Today



- Akamai edge services provide 1000's of points of presence throughout the Internet
- Overlay networks are constructed to move the content around efficiently

To be effective, the application level overlay network must adapt to changes in the underlying Internet

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Other examples:

- See the reading list
- Of perhaps particular interest:
  - FreeNet
    - » & Mnemosyne, etc.
  - Chord
    - » & Tapestry, Pastry, CAN, etc
  - Oceanstore
    - » & CFS, PAST, etc.
  - Resilient Overlay Networks
    - » & End System Multicast, etc.

What's hard about these systems?

- Scalability
  - > 100,000s users
- Reliability
  - System should never go down
- Performance
  - It shouldn't suck
- Management
  - How does something this big stay manageable?

Just like any other distributed system, but more so

What's hard (and new) about these?

- Heterogeneity
  - Lots of different machines, and different components which have to talk to each other
- Security
  - We're now spanning organizational boundaries
  - Perimeter-based security doesn't really work
- Evolution
  - Parts of the system must change incrementally over time
  - We can't just restart everything.

Wide-area application research

- Lots of recent research work:
  - RON, ESM…
  - Storage: Oceanstore, IBP, CFS, Past…
  - DHTs: Tapestry, Chord, CAN, Pastry…
  - Event systems: Scribe, Herald, Bayeux...
  - CDNs
- Results tend to be based on:
  - Simulation
  - Emulation (clusters, etc.)
  - Small-scale deployment (call your friends)

PlanetLab: What and Why?

Doing all this for real…

- … is hard for a researcher
- Where do you get access to 1000 geographically dispersed machines?
- How do you do it legitimately?
  - No worms
  - No cracking
  - No Venture Capital

So what is PlanetLab?

- An open, shared testbed for developing, deploying, and accessing planetary scale services
- http://www.planet-lab.org
- Boils down to:
  - A set of machines to run your code on all over the world
  - An operating system to make this safe
  - Management software to keep it working
  - Useful services to save you time and effort

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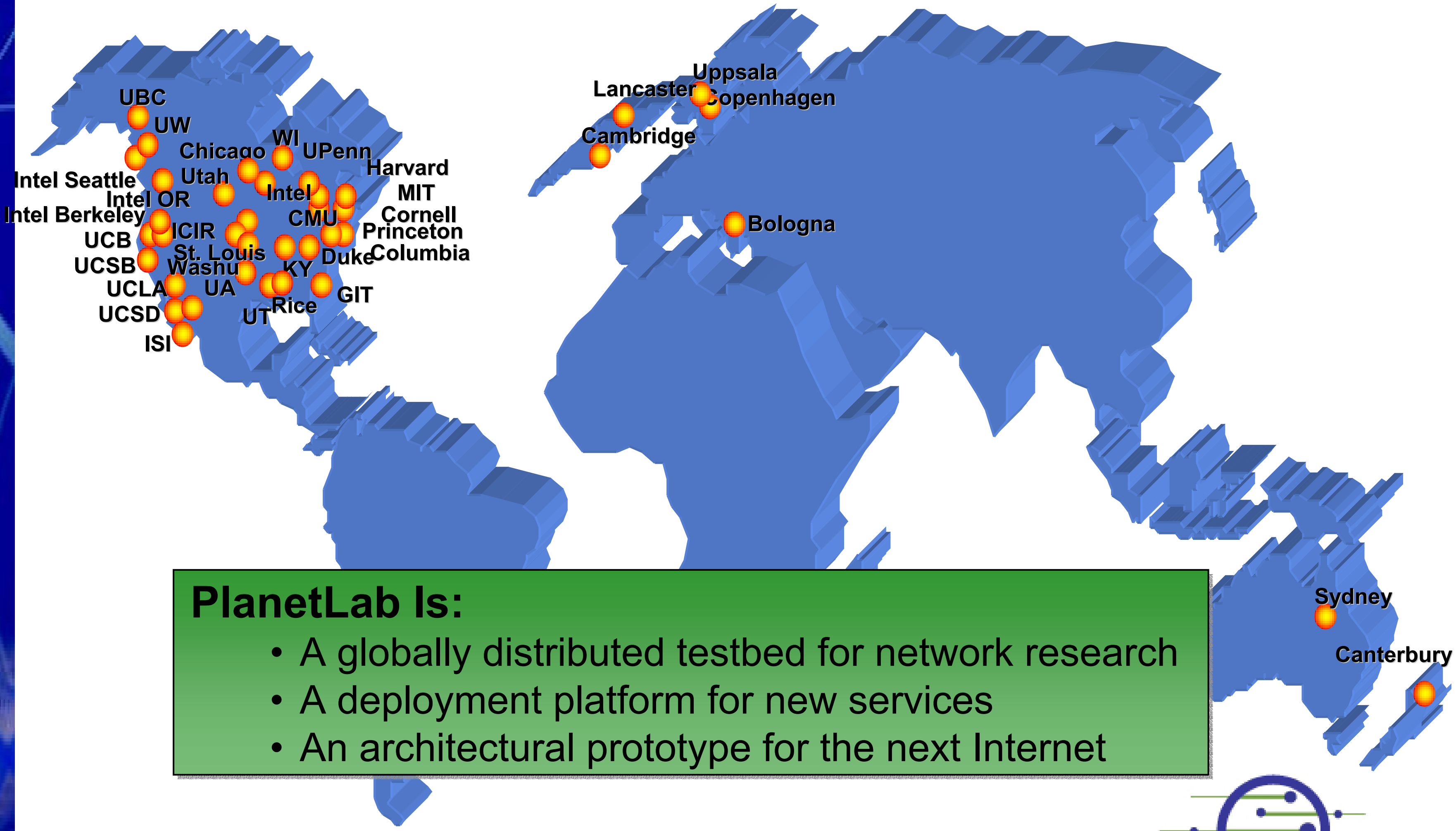

PlanetLab Is:

- A globally distributed testbed for network research
- A deployment platform for new services
- An architectural prototype for the next Internet

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PlanetLab

- A testbed for network research
  - 1000 nodes at various sites around the Internet
    - » Geographically distributed
    - » Distributed across networks
  - A representative sample of the Internet
    - » Diverse bandwidth & latency
- A deployment platform for new services
  - Apps: content distribution, distributed DOS response
  - Middleware: overlay networks, DHT's
  - Network: traffic measurement
- The next Internet
  - The network is designed for extensibility
  - Extend the network upwards, push applications down

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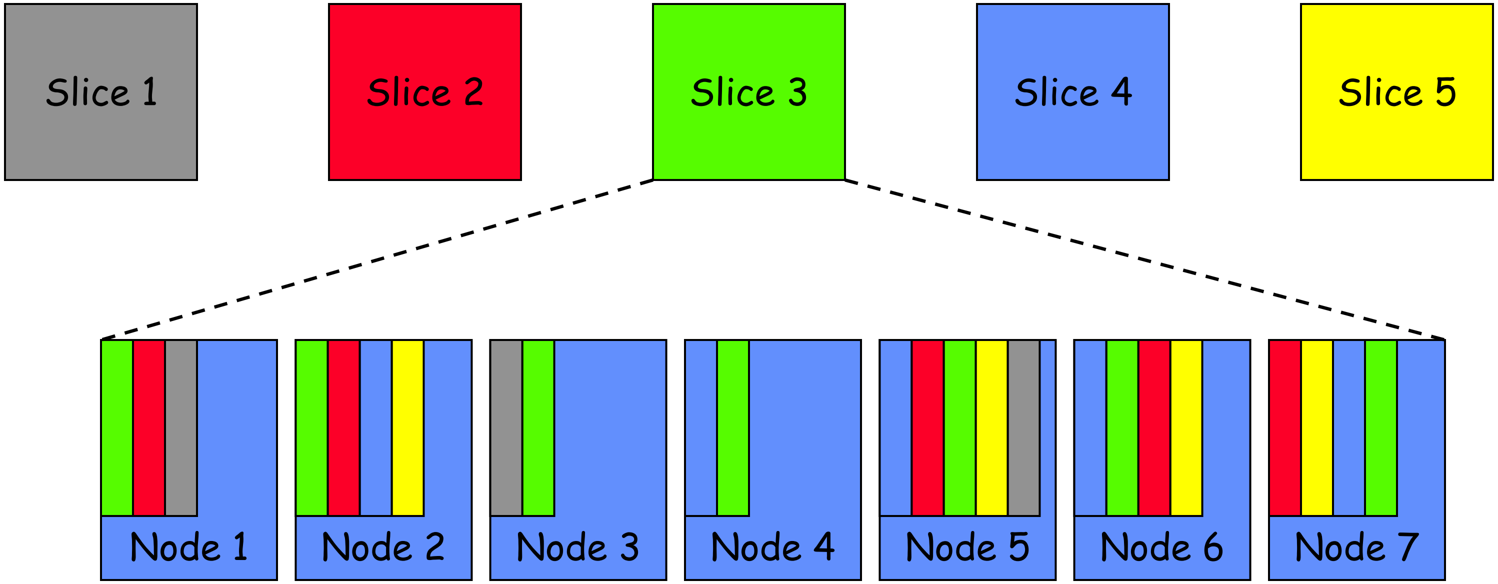
Distinguishing Properties

- Slice-ability
  - Each service runs in a slice of PlanetLab
  - VMM on each node enforces slices
  - Global admission control policy
- Distributed control of resources
  - Services deployed over a chosen set of nodes
  - Local control of services that run on a node
- Unbundled management
  - Partition management into orthogonal services
  - Core services versus competing alternatives
- Application-centric interfaces
  - Stable platform versus research into platforms
  - Separate isolation interface and application interface

PlanetLab Slices/Slivers



A network service is broken into components that can be distributed throughout the Internet

- Slice: total resources for the service
- Sliver: resources required on a specific node

What does PlanetLab give you?

- PlanetLab gives you (yes you!)
  - Ability to deploy a service around the world
  - Chance to contribute to the research
- PlanetLab is under development
  - Management services
  - Naming and location
  - Etc.
- PlanetLab is shared
  - Responsible use is called for!

Tomorrow:

- More detail on:
  - how to use PlanetLab
  - That initial project assignment
  - How to contribute project proposals
  - Some we've thought of
- Meantime, questions?