Planetlab Tutorial

Alessio Botta

Consorzio Interuniversitario Nazionale per l’Informatica CINI
Università di Napoli “Federico II”

“Onelab - Planetlab Europe” information day, Napoli, July 22st, 2008
Outline

- Introduction
  - Distributed research testbeds

- Planetlab architecture
  - Nodes
    - Vserver
  - Network

- Using planetlab
  - Creating sites, users, slices
Experiments running on distributed testbeds

- **Continuously-running services**
  - inherently robust to variations of resource availability
  - benefit from the availability of a **realistic** execution environment (e.g. the real Internet)
  - usually implemented as overlay testbeds on top of Internet, since it is difficult to involve in the experiment intermediate nodes (routers) of the real Internet

- **Short-term experiments**
  - aimed at producing replicable results in **controlled** conditions
  - admission control mechanisms to ensure sufficient capacity is allocated for the duration of a run and that the experiment may run in the desired conditions
  - ability to inject exogenous events
  - implemented as emulation testbeds or as experimental networks reproducing real nets
Resource sharing in a distributed testbed

- To maximize the benefit/cost ratio, the infrastructure must be able to support multiple concurrent experiments at the same time.
- As always in the case of concurrency, resource sharing must be properly handled.
- Resources to be shared:
  - CPU
  - Memory
  - Communication resources (IP addresses, port numbers, link bandwidth, radio channels, …)
  - Storage
  - Other specialized hardware
  - …
Approaches to resource sharing

- In traditional OSes, resources are shared in time-sharing by means of proper schedulers
  - Usually, these schedulers aim at fairness
  - In real-time OSes, special schedulers combined with proper admission control tests, are able to provide guaranteed amount of a shared resource per task

- In distributed testbeds, a portion of the testbed resources, called a slice, is assigned to each experiment

- Slicing is usually implemented by means of virtualization techniques
Distributed research testbeds

- **Orbit**
  - laboratory emulator/field trial wireless network testbed designed to achieve reproducibility of experimentation, while also supporting evaluation of protocols and applications in real-world settings

- **Emulab**
  - allows to specify an arbitrary network topology, providing a *controllable, predictable, and repeatable environment*. Allows to have full "root" access on some hosts running operating systems of choice

- **Vini**
  - virtual network infrastructure that allows network researchers to evaluate their protocols and services in a realistic environment. It allows to test also routing protocols thanks to the use of tunnels between the hosts

- **Planetlab**
What Is PlanetLab?

● It is NOT:
  ○ A Grid infrastructure
  ○ A simulator (e.g. NS-2, Opnet)
  ○ A research network separated from the Internet, (e.g. Internet-2/Abilene -US, Canarie - CA)

● It is:
  ○ A testbed for distributed applications in a global scale, using the Internet as a communication media
PlanetLab Goal

“...to support seamless migration of an application from an early prototype, through multiple design iterations, to a popular service that continues to evolve.”
Currently: 899 nodes at 461 sites
Differences with other testbeds

- **Network size**
  - # of nodes available for application execution

- **Node geographic distribution**
  - It is possible to test an application under real Internet traffic conditions
  - High variability, non-controllable (generally) network conditions (bandwidth, delay, etc.)

- **Node conditions**
  - Machines shared among a great # of users
  - Nodes can die, be rebooted, reinstalled, present high load, etc.
PlanetLab Architecture 1/2

● **Node-level**
  - Several *virtual machines* on each node, each running a different service
    - Resources distributed fairly
    - Services are isolated from each other

● **Network-level**
  - Node managers, Slice and management authorities, PLC services
PlanetLab Architecture 2/2
Node Architecture

- Provide a virtual machine for each service running on a node
- Isolate virtual machines
- Allow maximal control over virtual machines
- Fair allocation of resources
  - Network, CPU, memory, disk
Services Run in Slices

PlanetLab Nodes

Virtual Machines

Service / Slice A
Service / Slice B
Service / Slice C
Inside nodes
PlanetLab Virtualization: Vservers 1/2

- Kernel patch to mainstream OS (Linux)
- Gives appearance of separate kernel for each virtual machine
  - Root privileges restricted to activities that do not affect other vservers
- Some modification: resource control (e.g., File handles, port numbers) and protection facilities added
PlanetLab Virtualization: Vservers 2/2

- Extend the idea of `chroot(2)`
  - New vserver created by system call
  - Unique filesystem, SYSV IPC, UID/GID space
  - Limited root privilege
    - Can’t control host node
  - Irreversible
Vserver Scalability

- Reduce disk footprint using copy-on-write
  - Immutable flag provides file-level CoW
  - Vservers share 508MB basic filesystem
    - Each additional vserver takes 29MB
- Increase limits on kernel resources (e.g., file descriptors)
  - Is the kernel designed to handle this?
PlanetLab node boot

1. PlanetLab Nodes boot a small Linux OS from CD, run on RAM disk
2. Contacts a bootserver
3. Bootserver sends a (signed) startup script
   • Boot normally or
   • Write new filesystem or
   • Start sshd for remote PlanetLab Admin login

● Nodes can/could be remotely power-cycled
PLC architecture

● Core components
  ○ Web server
  ○ XML-RPC API server
  ○ boot server
  ○ database server

● Key roles
  ○ Slice authority
  ○ Management authority
Roles and Tasks 1/2

- **Management Authority**
  - Controls software running on node, secure boot up
  - Logs auditing information

- **Slice Authority**
  - Provides slice namespace management on nodes
  - Creates slices for users on nodes

- **PlanetLab Central is both an MA and an SA**
Roles and tasks 2/2

- **PlanetLab Nodes**
  - Owner 1
  - Owner 2
  - Owner 3
  - Owner N
  - ...

- **Service Providers**

**Slice Authority**
- Create slices
- Request a slice
- New slice ID
- Identify slice users (resolve abuse)
- Learn about nodes
- Auditing data
- Software updates
- Access slice

**Users**
Dynamic Slice Creation

1. Node Manager verifies tickets from PLC
2. Creates a new vserver
3. Creates an account on the node and on the vserver
Using Planetlab
Terminology

- **Site**
- **Principal Investigator**
  - Responsible for the institution’s users and equipments
  - Manage PL users, nodes, slices
- **Technical contact**
  - Responsible for installing or administering the institution’s nodes
- **Node**
- **Slice**
  - Set of virtual machines at different PL nodes
- **Sliver**
  - Instance of a slice on a certain host
PlanetLab Europe

PlanetLab Europe 4.2 Upgrade Schedule

PlanetLab Europe will be upgraded to the latest PlanetLab software. At the end of the upgrade, all machines will be re-installed and include the following new features:

- Reference image changed from Fedora Core 4, to Fedora 8.
- Upgrade kernel from 2.6.12 to 2.6.22.19 and VServer from 2.0 to 2.3
- SMP support!
- Adding Vsys as a replacement for Proper
- Upgraded PlanetFlow
- Allow multiple VServer reference images
- New kernel features (ipvs, fuse, chopstix, kvm) available for the future.

Schedule:

read more

Welcome to PlanetLab Europe

PlanetLab Europe is the emerging European portion of the publicly available PlanetLab testbed. PlanetLab Europe's control centre in Paris is federated with the worldwide PlanetLab control centre in Princeton. PlanetLab Europe is also working to federate with PlanetLab Japan.

Those who join PlanetLab Europe have access to the entire system, composed of hundreds of computers across the globe. They also participate in the initiatives built around PlanetLab in Europe.
Creating a site 1/3

PlanetLab Europe

PlanetLab Europe 4.2 Upgrade Schedule

PlanetLab Europe will be upgraded to the latest PlanetLab software. At the end of the upgrade, all machines will be re-installed and include the following new features:

- Reference image changed from Fedora Core 4 to Fedora 8.
- Upgrade kernel from 2.6.12 to 2.6.22.19 and VServer from 2.0 to 2.3
- SMP support!
- Adding Vsxs as a replacement for Proper
- Upgraded PlanetFlow
- Allow multiple VServer reference images
- New kernel features (ipv6, fuse, chopstix, kvm) available for the future.

Schedule:

read more

Welcome to PlanetLab Europe

PlanetLab Europe is the emerging European portion of the publicly available PlanetLab testbed. PlanetLab Europe's control centre in Paris is federated with the worldwide PlanetLab control centre in Princeton. PlanetLab Europe is also working to federate with PlanetLab Japan.

Those who join PlanetLab Europe have access to the entire system, composed of hundreds of computers across the globe. They also participate in the initiatives built around PlanetLab in Europe.
Creating a site 2/3

PlanetLab Europe

New Site Registration

Site Information:
- Site name: *
- Login base: *
- Abbreviated name: *
- URL: *
- Latitude: 
- Longitude: 

Postal address:
- Address: *
- Address (2): 
- Address (3): 
- City: *
- Postal Code: *
- State: *
- Country: *

Principal Investigator Information

PlanetLabEurope login

- E-mail: *
- Password: *

Forgot your password?
- Create an account
- File a site registration

“Onelab - Planetlab Europe” information day, Napoli, July 22nd, 2008
Creating a site 3/3

Address (2):
Address (3):
City: *
Postal Code: *
State: *
Country: *

Principal Investigator Information:
PI First Name: *
PI Last Name: *
PI Title:
PI Phone: *
PI email: *
PI password: *

Technical Contact Information: Same as PI
Tech First Name: *
Tech Last Name: *
Tech Title:
Tech Phone: *
Tech email: *
Tech password: *
Need user role:

Register
Our site at Planetlab Europe

Site Università di Napoli Federico II details

Full name: Università di Napoli Federico II
Login base: uninaonelab
Abbreviated Name: Università di Napoli Federico II
URL: http://www.unina.it
Latitude: 40.8283
Longitude: 14.1906
# Slices Used/Allocated: 1/10
  uninaonelab_cdn plc-instantiated
# Users: Total 6 users
  PI(s): roberto.canonico@unina.it
  a.botta@unina.it
  Tech(s): walter.deconato@unina.it
  roberto.canonico@unina.it
# Nodes: 3
  planetlab01.dis.unina.it boot
  onelab01.dis.unina.it boot
  planetlab02.dis.unina.it boot
Creating a user 1/2

Planetary Lab Europe

Planetary Lab Europe 4.2 Upgrade Schedule

Planetary Lab Europe will be upgraded to the latest Planetary Lab software. At the end of the upgrade, all machines will be re-installed and include the following new features:

- Reference image changed from Fedora Core 4 to Fedora 8.
- Upgrade kernel from 2.6.12 to 2.6.22.19 and VServer from 2.0 to 2.3.
- SMP support!
- Adding Vsys as a replacement for Proper.
- Upgraded PlanetFlow.
- Allow multiple VServer reference images.
- New kernel features (ipv6, fuse, chopstick, kvm) available for the future.

Schedule:
read more

Welcome to Planetary Lab Europe

Planetary Lab Europe is the emerging European portion of the publicly available Planetary Lab testbed. Planetary Lab Europe's control centre in Paris is federated with the worldwide Planetary Lab control centre in Princeton. Planetary Lab Europe is also working to federate with Planetary Lab Japan.

Those who join Planetary Lab Europe have access to the entire system, composed of hundreds of computers across the globe. They also participate in the initiatives built around Planetary Lab in Europe.
Creating a user 2/2

Account Registration

First name: 

Last name: 

Title: 

Telephone: 

E-mail address must be able to receive e-mail and will be used as your username:

E-mail: 

Password: 

Select the site where you belong:

Site: Select a site

Do not select the Principal Investigator or Technical Contact roles unless you have spoken with the current PI of your site, and you intend to assume either or both of these roles.

Use Command-Clic to unselect or for multiple selection

Additional roles:
Principal Investigator
Technical Contact

Register

PlanetLab Europe login

E-mail: 

Password: 

Log in

Forgot your password?
Create an account
File a site registration
My user at Planetlab Europe 1/2

### PlanetLab Europe
- Home
- News
- About
- Join us
- Support
- Documentation
  - AUP
  - Guides
  - API

### Alessio Botta Account Information

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name</td>
<td>Alessio</td>
</tr>
<tr>
<td>Last Name</td>
<td>Botta</td>
</tr>
<tr>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:a.botta@unina.it">a.botta@unina.it</a></td>
</tr>
<tr>
<td>Phone</td>
<td></td>
</tr>
<tr>
<td>URL</td>
<td></td>
</tr>
</tbody>
</table>

#### Keys

- This user has no known key

#### Sites

- Università di Napoli Federico II
  - Remove

#### Roles

- Role
- user
- tech

#### Slices

- No slices found for that user

---

Onelab - Planetlab Europe” information day, Napoli, July 22nd, 2008
Adding a node 1/3

PlanetLab Europe

Welcome to PlanetLab Europe

PlanetLab Europe is the emerging European portion of the publicly available PlanetLab testbed. PlanetLab Europe’s control centre in Paris is federated with the worldwide PlanetLab control centre in Princeton. PlanetLab Europe is also working to federate with PlanetLab Japan.

Those who join PlanetLab Europe have access to the entire system, composed of hundreds of computers across the globe. They also participate in the initiatives built around PlanetLab in Europe.

PlanetLab Europe 4.2 Upgrade Schedule

PlanetLab Europe will be upgraded to the latest PlanetLab software. At the end of the upgrade, all machines will be re-installed and include the following new features:

- Reference image changed from Fedora Core 4, to Fedora 8.
- Upgrade kernel from 2.6.12 to 2.6.22.19 and VServer from 2.0 to 2.3.
- SMP support!
- Adding Vcows as a replacement for Proper.
- Upgraded PlanetFlow.
- Allow multiple VServer reference images.
- New kernel features (pvfs, fuse, chopstix, kvm) available for the future.

Schedule:
read more

Add Node

a.botta@unina.it
Adding a node 2/3

Add A New Node

This page will allow you to add a new machine to your site. This must be done before the machine is turned on, as it will allow you to download a configuration file when complete for this node.

Even for DHCP, you must enter the IP address of the node.

Node Details

Hostname: 
Model: Custom

Network Settings

Addressing Method
○ DHCP ○ Static
IP Address
Netmask
Network address
Gateway Address
Broadcast address
Primary DNS
Secondary DNS (optional)
Adding a node 3/3

Node onelab01.dis.unina.it details

<table>
<thead>
<tr>
<th>Choose Action</th>
</tr>
</thead>
</table>

| Hostname: | onelab01.dis.unina.it |
| Model: | HP Proliant DL380g3/minhw |
| Version: |  |
| Boot State: | Install |

**Download**
- Download Mode
  - All in one images
  - Download ISO image for onelab01.dis.unina.it
  - Download USB image for onelab01.dis.unina.it
  - Floppy + generic image
  - Download Floppy file for onelab01.dis.unina.it
  - Download generic ISO image (requires floppy)
  - Download generic USB image (requires floppy)

**All site nodes:**

<table>
<thead>
<tr>
<th>IP Address</th>
<th>Method</th>
<th>Type</th>
<th>MAC</th>
<th>Bandwidth Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>143.225.229.153</td>
<td>static</td>
<td>ipv4</td>
<td>00:0b:cd:10:be:5b</td>
<td></td>
</tr>
</tbody>
</table>

Add a node network

Node Networks

Node Groups
Creating a slice

PlanetLab Europe

Slices

Create Slice

You must provide a short description of the new slice as well as a link to a project website before creating it. Do not provide bogus information; if a complaint is lodged against your slice and PlanetLab Operations is unable to determine what the normal behavior of your slice is, your slice may be deleted to resolve the complaint.

There are three possible "instantiations" stated for a slice. PLC creates a slice with default settings, Delegated creates a ticket to use on each node. None allows you to reserve a slice name, you may instantiate the slice later.

NOTE: All PlanetLab users are strongly encouraged to join the PlanetLab Users mailing list. Most questions about running software on PlanetLab can be answered by posting to this list. Site administrators often use this list to post announcements about service outages. New software releases and available services are announced here as well.

Name: univswlbb
URL: http://

Description:

Instantiation: PLC

roberto.cannone@uniroma.it
### Our Slice at Planetlab Europe

#### PlanetLab Europe

<table>
<thead>
<tr>
<th>Slice details for uninaonelab_cdn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slice Name:</strong> uninaonelab_cdn</td>
</tr>
<tr>
<td><strong>Description:</strong> Slice created to test a novel CDN system developed at Uni. of Napoli</td>
</tr>
<tr>
<td><strong>URL:</strong> <a href="http://www.camics.unina.it">http://www.camics.unina.it</a></td>
</tr>
<tr>
<td><strong>Expirations:</strong> Aug 16, 2002</td>
</tr>
<tr>
<td><strong>Instantiation:</strong> 08:08:08</td>
</tr>
<tr>
<td><strong>Site:</strong> Università di Napoli Federico II</td>
</tr>
<tr>
<td><strong># Nodes:</strong> 31 nodes</td>
</tr>
<tr>
<td><strong># Users:</strong> 3 users</td>
</tr>
</tbody>
</table>

**Contacts**

**PI's:** Roberto Canonico roberto.canonico@unina.it

---

Back to slice list
Adding nodes to a slice

PlanetsLab Europe

Slice unina@onelab_cdn - Nodes

Select a site to add nodes from.

<table>
<thead>
<tr>
<th>check</th>
<th>Hostname</th>
<th>Boot State</th>
<th>Last Update</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>onelab01.dis.unina.it</td>
<td>boot</td>
<td>2008-06-25</td>
</tr>
</tbody>
</table>

Nodes currently associated with slice

Check boxes of nodes to remove.

<table>
<thead>
<tr>
<th>check</th>
<th>Hostname</th>
<th>Boot State</th>
<th>Last Update</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>planetlab2.es.unibo.it</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>planetlab2.m informatica.sistemi.sns.it</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>planetlab1.it.ac3m.es</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>pl1.rennes.univ-rennes1.fr</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>pl2.rennes.univ-rennes1.fr</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>planetlab02.ethz.ch</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>planet2.zib.de</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
<tr>
<td></td>
<td>planetlab3.it.ac3m.es</td>
<td>boot</td>
<td>2008-06-26</td>
</tr>
</tbody>
</table>
Managing users of a slice

PlanetLab Europe

Slice unina@one-lab_cdn - Users

Select a site to add people from:

<table>
<thead>
<tr>
<th>Email</th>
<th>First Name</th>
<th>Last Name</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:a.botta@uniroma1.it">a.botta@uniroma1.it</a></td>
<td>Alessio</td>
<td>Botta</td>
<td>tech user</td>
</tr>
<tr>
<td><a href="mailto:giovanni.dieste@uniroma1.it">giovanni.dieste@uniroma1.it</a></td>
<td>Giovanni</td>
<td>Di Stasi</td>
<td>user</td>
</tr>
<tr>
<td><a href="mailto:christian.esposito@uniroma1.it">christian.esposito@uniroma1.it</a></td>
<td>Christian</td>
<td>Esposito</td>
<td>user</td>
</tr>
</tbody>
</table>

Add People

People currently associated with slice

Check boxes of people to remove:

<table>
<thead>
<tr>
<th>Email</th>
<th>First Name</th>
<th>Last Name</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:marco.albano@gmail.com">marco.albano@gmail.com</a></td>
<td>Marco</td>
<td>Albano</td>
<td>user</td>
</tr>
<tr>
<td><a href="mailto:roberto.caronico@uniroma1.it">roberto.caronico@uniroma1.it</a></td>
<td>Roberto</td>
<td>Caronico</td>
<td>tech user</td>
</tr>
<tr>
<td><a href="mailto:walter.didonato@uniroma1.it">walter.didonato@uniroma1.it</a></td>
<td>Walter</td>
<td>de Donato</td>
<td>user tech</td>
</tr>
</tbody>
</table>

Remove People

Back to Slice

roberto.caronico@uniroma1.it
Renewing a slice

PlanetLab Europe

Slice Renewal

Slice uninounsLab_cdn Renewal

You must provide a short description as well as a link to a project website before renewing it. Do not provide bogus information; if a complaint is lodged against your slice and PlanetLab Operations is unable to determine what the normal behavior of your slice is, your slice may be deleted to resolve the complaint.

NOTE: Slices cannot be renewed beyond 8 weeks of today (Monday Sep 15-08 14:50:53 GMT).

Name: uninounsLab_cdn
URL: http://www.conic.unina.it
Description: Slice created to test a novel CCB system developed at Univ. of Napoli
Expiration Date: Friday Aug 15-08 00:35:43 GMT
Renewal Length: One week (Friday Aug 22-08 00:35:43 GMT)

roberto.camoscio@unina.it

- Home
- News
- About
- Join us
- Support
- Documentation
  - app
  - codes
  - API
User logs in to PlanetLab Node

E.g. “ssh -i .ssh/mykey uninaonelab_cdn@planetlab00.dis.unina.it”

- /bin/vsh immediately:
  1. Switches to the account’s associated vserver
  2. Chroot()s to the associated root directory
  3. Relinquishes true root privileges
  4. Switch UID/GID to account on vserver
  5. Provides a shell

  Transition to vserver is *transparent*: it appears the user just logged into the PlanetLab node directly
Setup per la valutazione della CDN su PlanetLab
References 1/2

- **PlanetLab Site**
  - www.planet-lab.org

- **Main Documentation**
  - https://www.planet-lab.org/doc
  - PlanetLab mailing lists
    - https://www.planet-lab.org/lists
    - Users Mailing List
      - http://lists.planet-lab.org/mailman/listinfo/users

- **Planetlab architecture overview**
References 2/2

- **Main Docs**
  - Acceptable User Policy
    - https://www.planet-lab.org/aup

- **User’s Guide**
  - https://www.planet-lab.org/doc(guides/user

- **PI’s Guide**
  - https://www.planet-lab.org/doc(guides/pi

- **Technical Contact’s Guide**
  - https://www.planet-lab.org/doc(guides/tech

- **FAQs (Wiki-based)**
  - https://www.planet-lab.org/doc/faq

- **myPLC**
  - https://www.planet-lab.org/doc/myplc
The end

Any question?