An Open Federated Laboratory Supporting
Network Research for the Future Internet

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TopHat: A measurement infrastructure in support of applications in a future-internet testbed

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Outline

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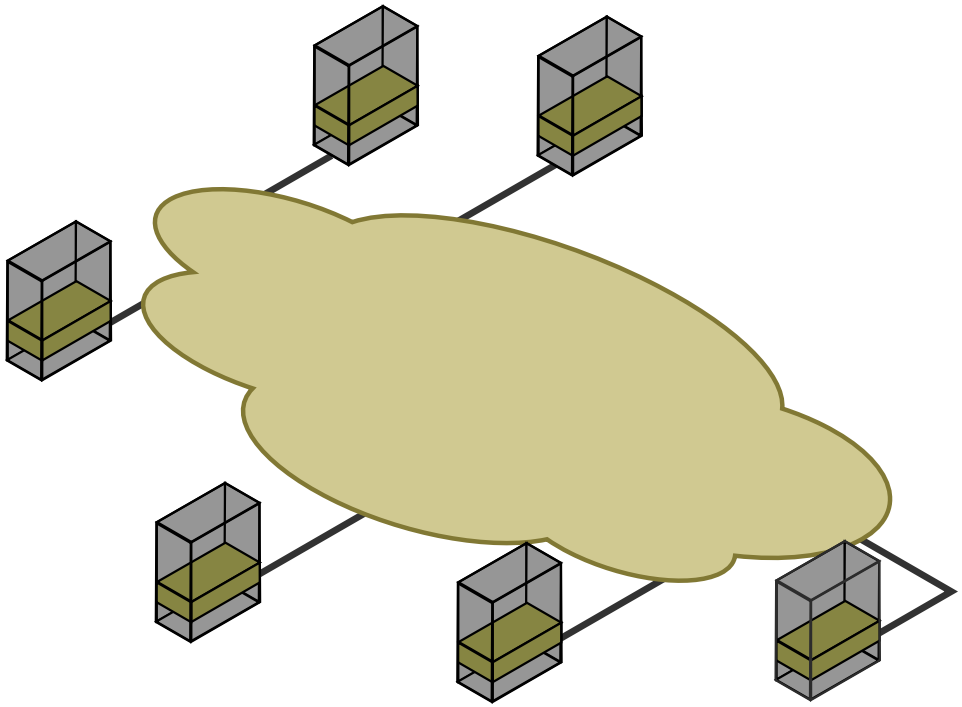
Motivations



- PlanetLab testbed allows creation of overlay applications
  - P2P, CDN, etc.

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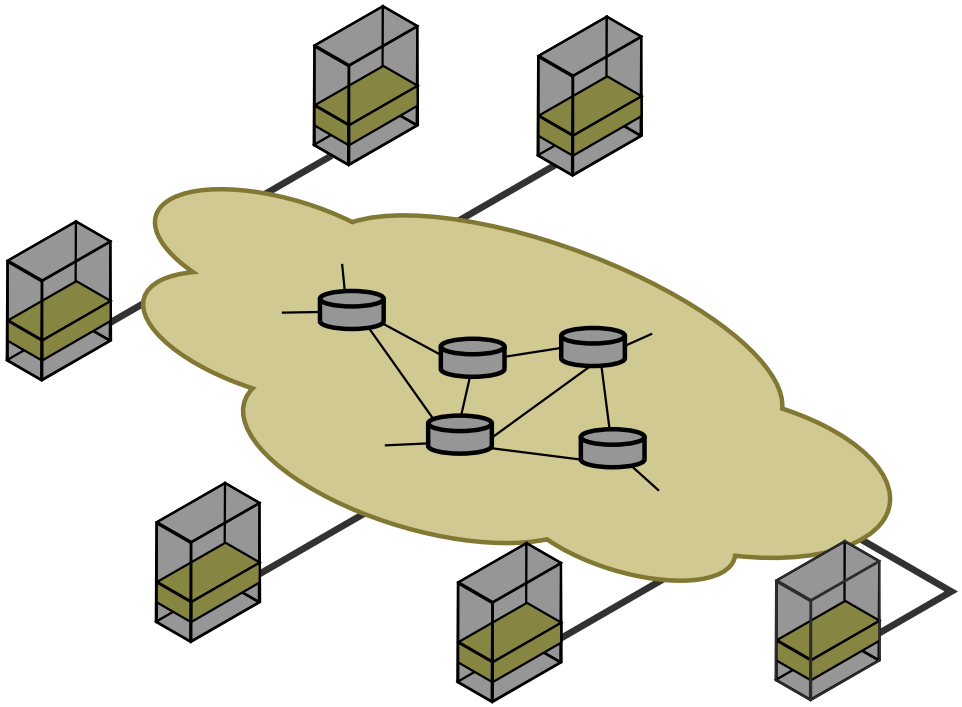

- PlanetLab testbed allows creation of overlay applications
  - P2P, CDN, etc.
- the underlay is unknown
  - topology,
  - delays,
  - *and their evolution...*

Motivations

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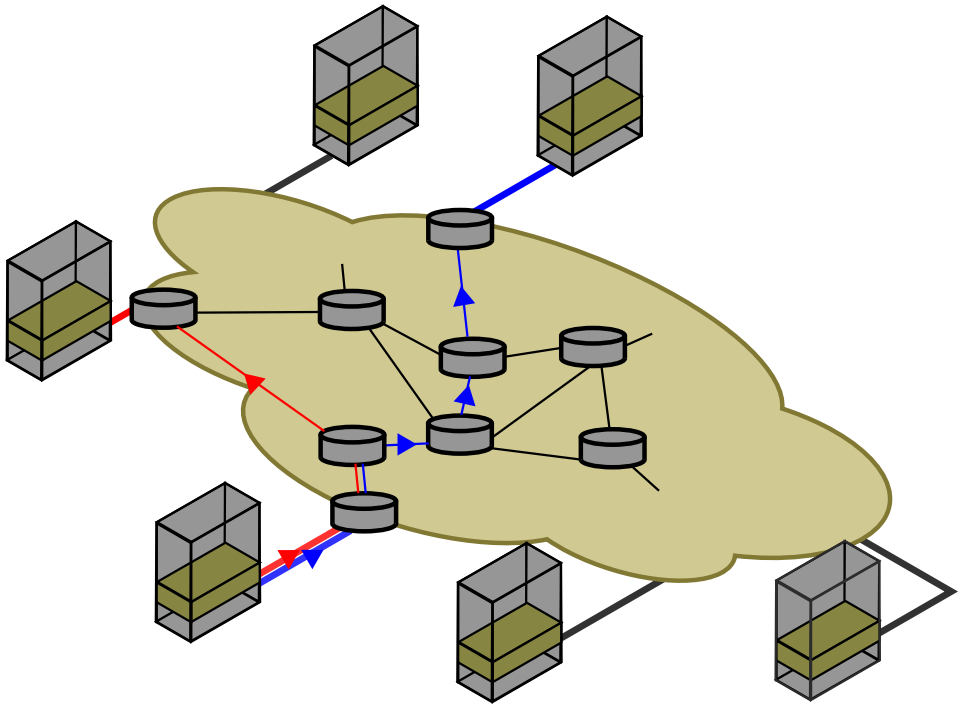

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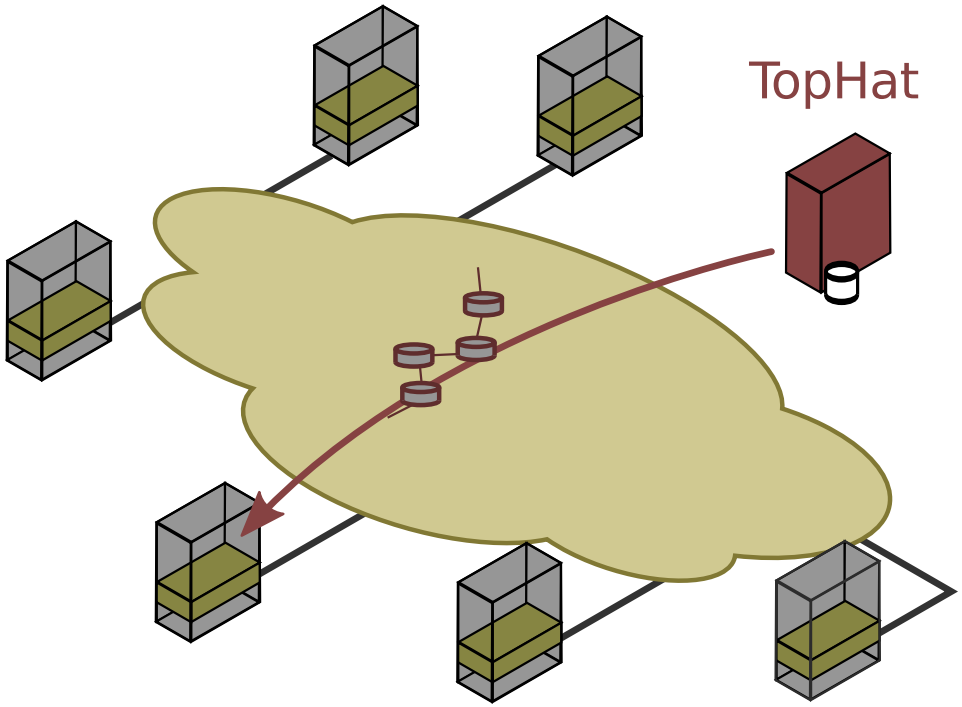

- PlanetLab testbed allows creation of overlay applications
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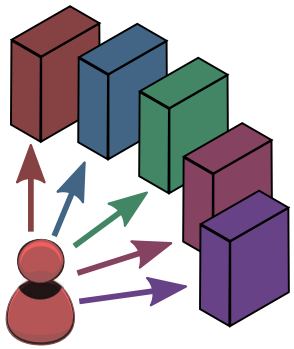
- the underlay is unknown
  - topology,
  - delays,
  - *and their evolution. . .*
- measurements are needed. . .

- . . . but a measurement service is better:
  - users can focus on developing the overlay instead of writing monitoring code
  - it allows the use of methods reducing the strain on the network,
  - it generally provides more efficient, correct and accurate results.

TopHat characteristics



- Many measurement systems
  - DIMES, ETOMIC, Ark/Archipelago, iPlane, Scriptroute, ...
- Some are even specifically designed for testbeds:

- TopHat is oriented towards the support of applications running on the PlanetLab testbed
  - from setup through completion
  - provides live measurements to the application
  - callbacks are used to communicate information to the application
- TopHat draws from partner projects with whom it is interconnected
  - to extend its scale, scope and functionalities
- We expect to work closely with application developers.

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Services in support to applications

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- **four broad ranges of services**, following the application lifecycle.

  Setup : help the user choose nodes before launching his experiment

  Live : provides real-time information about application underlay (callbacks)

  Rewind : access to historical data related to an experiment

  Viz : interface to visualization tools to help the user to represent its experimental data

- a Web interface
  - more convenient for most of an experimenter's tasks
- a XMLRPC API + commandline tool
  - interaction with the application
  - also for experienced users via a commandline interface

Setup: choosing the nodes

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- TopHat provides topological information for the choice of nodes
- Leveraging PlanetLab topological and geographical diversity

Sample query:

Give me twenty relatively unloaded, reliable nodes that are each **at least five traceroute hops away** from each other with **stable routes** and **no load balancer** on the paths

Live: supporting running experiments

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- classical set of topological queries provided directly via the API

Akihiro Nakao, Larry Peterson, Andy Bavier,
A routing underlay for overlay networks,
in proceedings of SIGCOMM'03, pp.11–18, 2003.

- callbacks are provided for events, periodic and async. measurements
  - XMLRPC call, email, rss, etc.
- past events displayed on the web interface
- react by logging only or by overlay reconfiguration/optimization
  - available measurements allow for greater reactivity

Example: alert me when the delay between two nodes changes by more than 20%

Postprocessing of historical data

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- typically, same experiments rerun with different parameters
  - many uncontrolled parameters
  - allows to track what changes the results
- repository of measurements done while an application was running
  - cf. Networm measurements Virtual Observatory worked on by ELTE.
- TopHat performs regular measurements in background
  - complements and anticipate user requests
  - aggregated information complements node/path characteristics
- anonymized data should also be available for people not running applications

Measurement query interface

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Functions to get measurements (Get), manage the list of callbacks, etc.

Prototype of the Get function

```
RET = Get(Auth, Method, Timestamp, Input, Output, Callback)
```

Method : *traceroute*, *delay*, *active bandwidth*

Timestamp : date, interval, description(*today*, *latest*, etc.)

Input : a node/a set of nodes, a path/a set of paths

Output : subset of available fields, depends on Method

Callback : used for periodic measurements

Illustration of the API through later samples.

TopHat architecture

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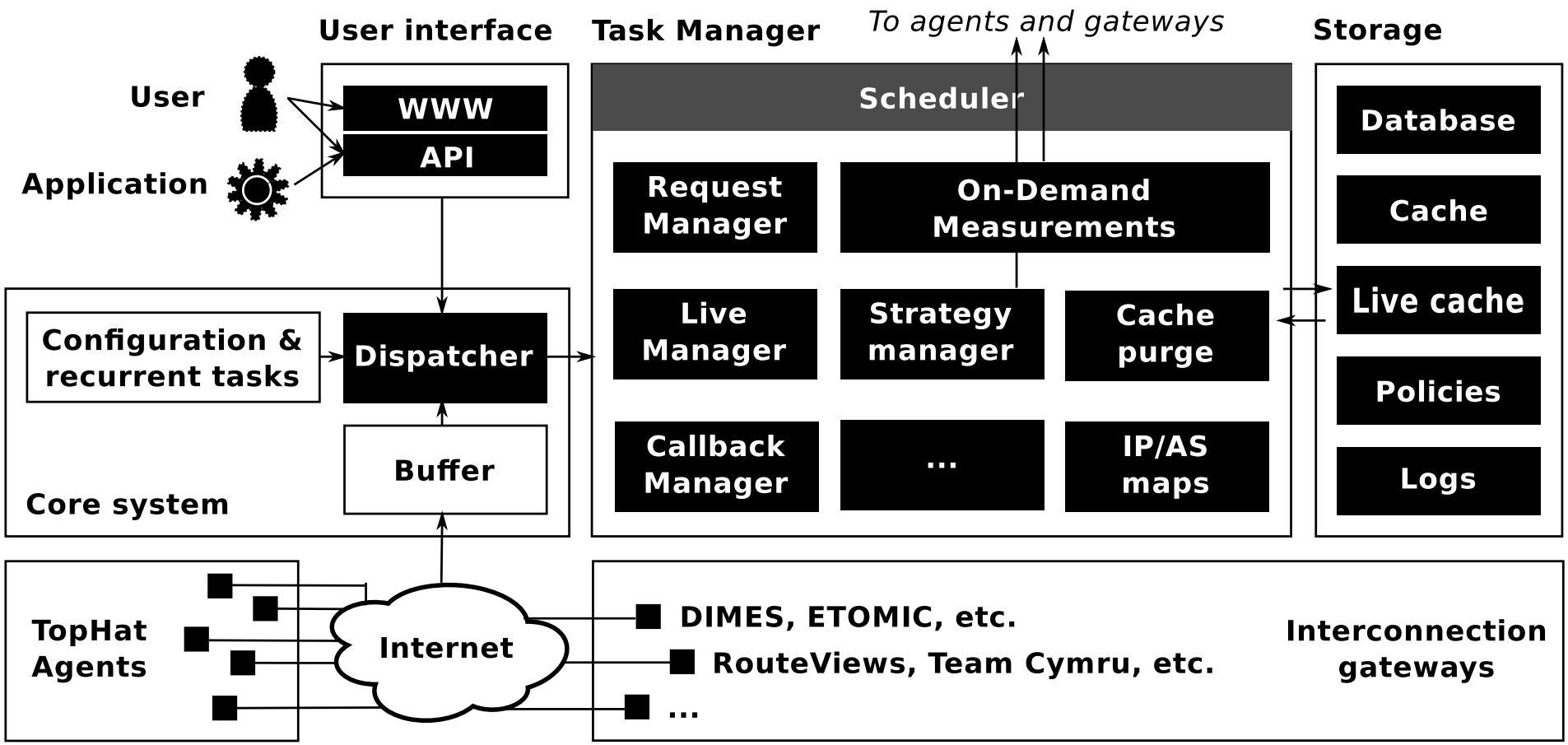

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Extending TopHat scope and scale

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Ongoing interconnection with partners within the OneLab2 project

Team Cymru, pWhois: brings AS level information

DIMES: brings measurements from outside PlanetLab

- PlanetLab application might interact with the rest of the Internet
- ex. AS-distance between a given AS and a PlanetLab node

ETOMIC/SONoMA: brings high-precision measurements

- some nodes are colocated with PlanetLab nodes
- one-way delays, available bandwidth, geolocalization, etc.
- SONoMA provides a webservice for on-demand measurements

TopHat data is used by MySlice: a front end interface for PlanetLab users

MySlice user front-end

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- help researchers deploy and manage their experiments
  - on PlanetLab and future federated facilities
- uniform access to testbed data
  - system information from CoMon (reliability, load, etc.)
  - topological information for TopHat and interconnected systems
- for example, AS-level information in the default interface

MySlice user front-end

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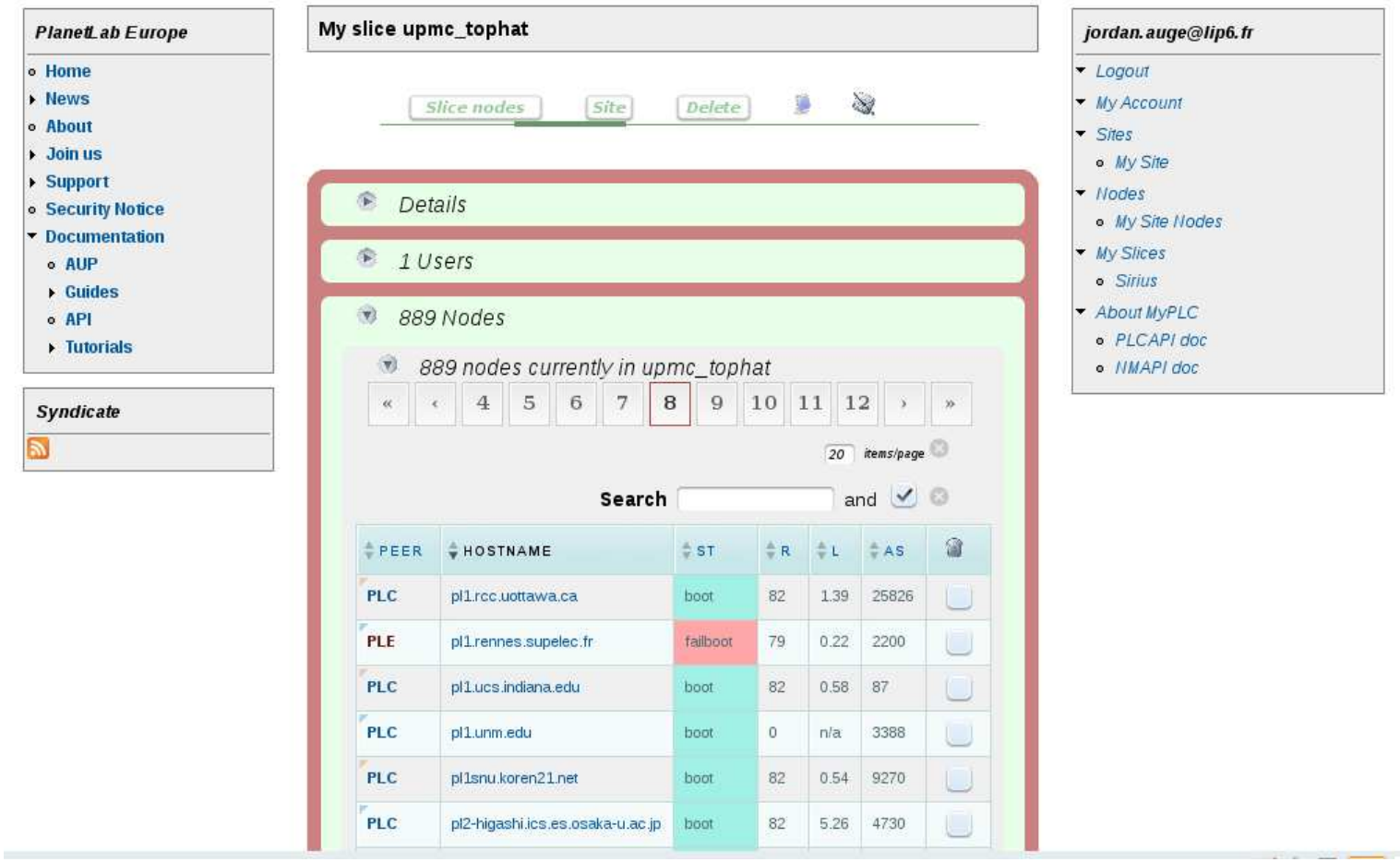
PlanetLab Europe



MySlice user front-end

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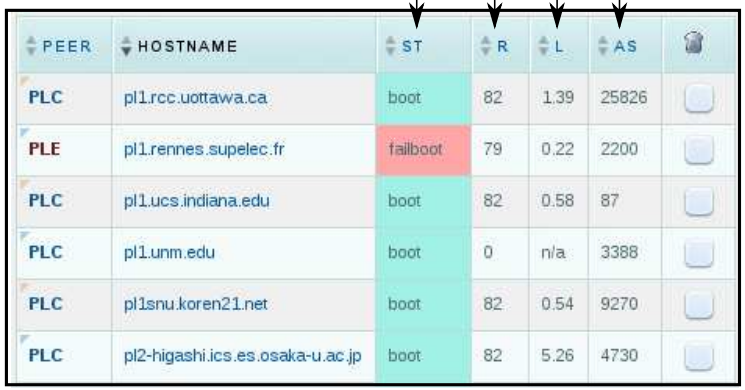
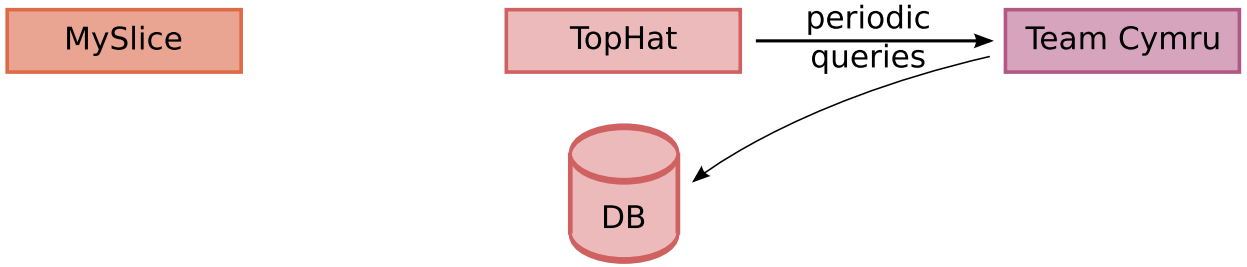
ST = status of the node
R = average reliability (% uptime) over the last week
L = average 5min. load over the last week
AS = Autonomous System Number

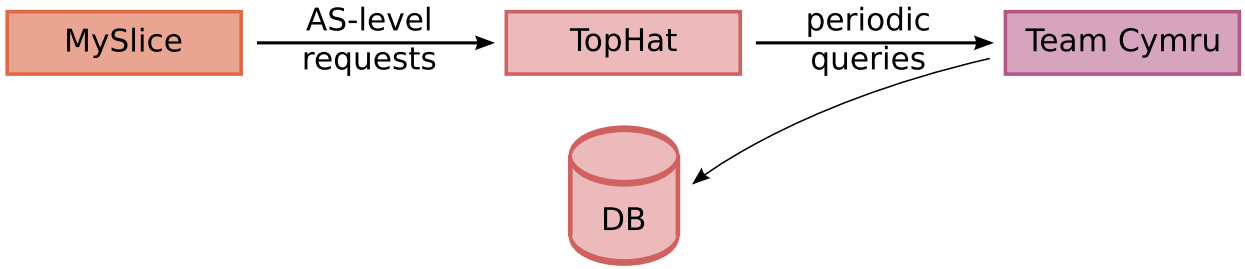


PEER	HOSTNAME	ST	R	L	AS	
PLC	pl1.rcc.uottawa.ca	boot	82	1.39	25826	
PLE	pl1.rennes.supelec.fr	failboot	79	0.22	2200	
PLC	pl1.ucs.indiana.edu	boot	82	0.58	87	
PLC	pl1.unm.edu	boot	0	n/a	3388	
PLC	pl1snu.koren21.net	boot	82	0.54	9270	
PLC	pl2-higashi.ics.es.osaka-u.ac.jp	boot	82	5.26	4730	

MySlice-TopHat interconnection



MySlice-TopHat interconnection



Sample query:

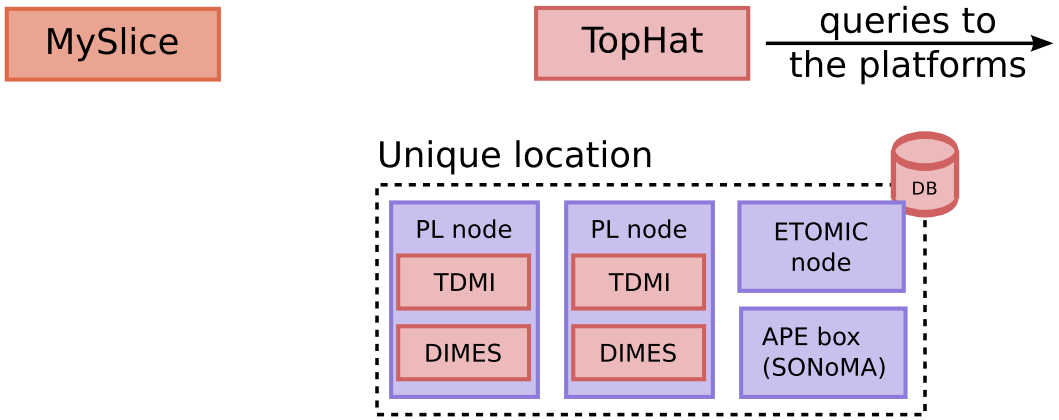
```
ip_list = ['planet2.elte.hu', 'planetlab-europe-02.ipv6.lip6.fr']
Get(auth, 'latest', 'nodeinfo', ip_list, ['hostname', 'prefix', 'asn', 'as_name'])
```

Result:

```
[{'hostname': 'planet2.elte.hu',  'prefix': '132.227.0.0/16',
        'asn': '1307', 'as_name': 'FR-U-JUSSIEU-PARIS'},
 {'hostname': 'planetlab-europe-02.ipv6.lip6.fr', 'prefix': '157.181.0.0',
        'asn': '2012', 'as_name': 'ELTENET ELTENET'
```

Co-location information

- Many measurement agents in the same location
  - Same physical view of the network
  - Differences: measurement abilities, precision, availability, etc.
- Use co-location information to request for node capabilities and measurements transparently



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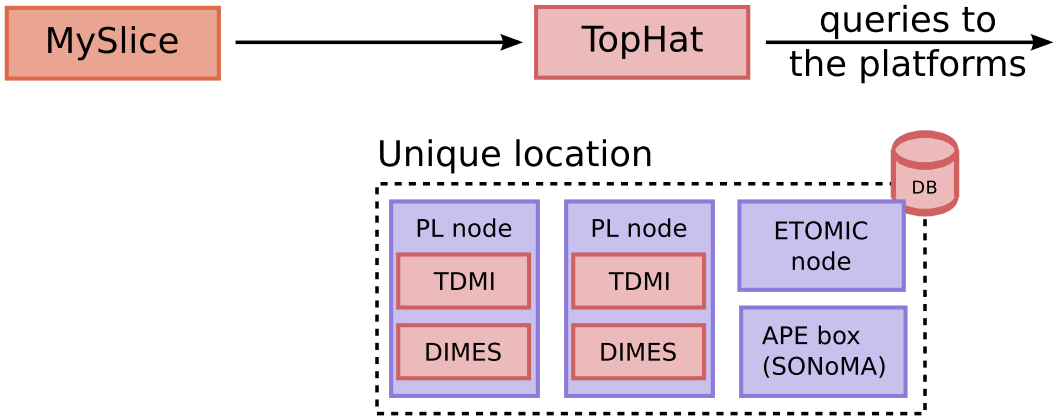


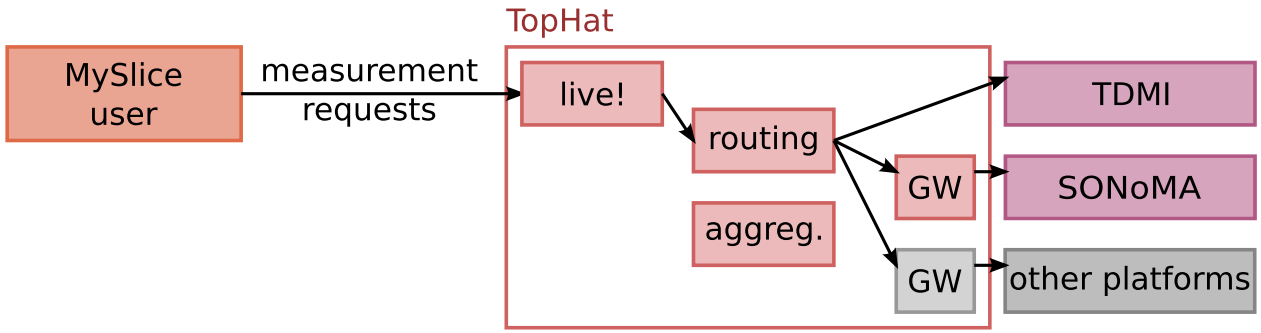
Sample query:

```
ip_list = ['planet2.elte.hu']
Get(auth, 'latest', 'nodeinfo', ip_list, ['hostname', 'colocated'])
```

Result:

```
[{'hostname': 'planet2.elte.hu',  'colocated': [
      {'platform_name': 'SONoMA', 'hostname': 'ape.onelab.elte.hu', 'ip': '157.181.175.247'},
      {'platform_name': 'TDMI', 'hostname': 'planet2.elte.hu', 'ip': '157.181.175.248'}, ... ]}]
```

Live measurements and interconnection



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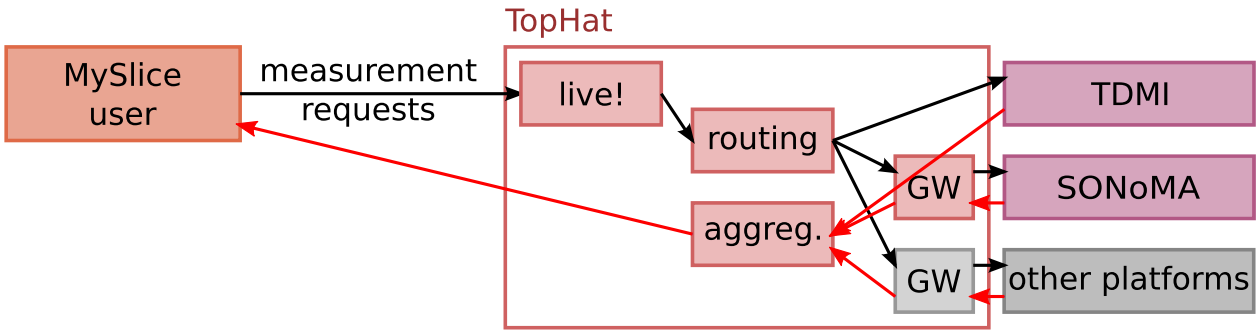

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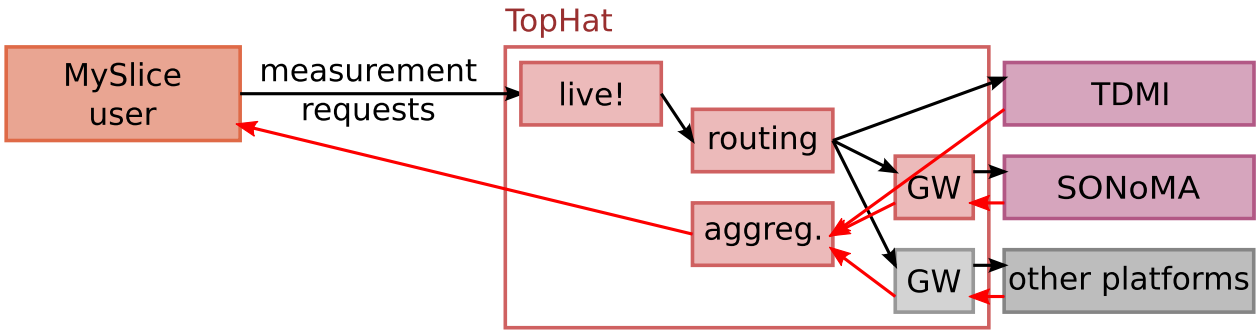

Sample query: traceroute on two different platforms:

```
path_list = [('planet2.elte.hu', 'planetlab-europe-02.ipv6.lip6.fr'),
             ('ape.onelab.elte.hu', 'planetlab-europe-02.ipv6.lip6.fr')]
Get(auth, 'now', 'traceroute', path_list,
    ['src_ip', 'dst_ip', 'hops.ttl', 'hops.ip', 'hops.hostname'])
```

Result:

```
[{'src_ip': '157.181.175.248',  'dst_ip': '132.227.62.19',
    'hops': [{'ttl': '1', 'ip': '157.181.175.254',  'hostname': None},
    {'ttl': '2', 'ip': '157.181.126.45',  'hostname': 'taurus.taurus-leo.elte.hu'}, ...]},
 {'src_ip': '157.181.175.247', 'dst_ip': '132.227.62.19', 'hops': [ ... ]}]
```

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Following up the interconnection

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- Ongoing work on the interconnection with several partners
  - some of them are here ! (DIMES, ETOMIC, SONoMA, Gulliver)
- Potential interconnection with perfSONAR ?
  - provides uniform access to the various measurements from the NREN networks
  - a large number of PlanetLab nodes belong to academic networks such as GEANT2 or Internet2
  - perfSONAR measurements would complement end-to-end measurements available in TopHat
- . . . and others ?

The challenges (1/2)

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Accounting

- Exhaustive usage monitoring of the system (experiments and measurements)
  - daily debugging and long-term engineering
  - reporting to website, sponsors and partners
  - users' behaviour dataset
- Interconnecting systems pushes the need for exchanging accounting information between platforms

Authentication

- Towards a common authentication framework...
- Some proposals in OneLab2 (NICTA, ELTE)

The challenges (2/2)

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Resource description

- hot issue in testbed interconnection : GENI, OMF, SFA
- PlanetLab RSpecs describe the TopHat architecture
- need extend these descriptions to measurements
  - tools, measurements, policies, etc.

Data formats

- for storage and communication with users and third-party services

Interoperability

- other experiment management facilities: e.g. NITOS in OneLab2
- our goal: interoperable bricks between the different systems
- flexibility for the user to keep its prefered front-end

Conclusion

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- measurement service for PlanetLab users (for setting up, running and analysing experiments)
- interconnection of various world class projects into a simple common API
- topological data made available to the user via MySlice

References

Thomas Bourgeau, Jordan Augé, Timur Friedman,
TopHat: A topology information service to support applications in a future-internet testbed,
accepted to TridentCom'2010, 18-20 May 2010, Berlin, Germany.

Contacts :
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- Jordan Augé,
- Thomas Bourgeau,
- Timur Friedman

Websites :

- TopHat: http://www.top-hat.info
- DIMES: http://www.netdimes.org
- ETOMIC: http://www.etomic.org
- MySlice: https://myslice.planet-lab.eu