



BonFIRE

Federating Clouds for Research and Experimentation

Juan A. Lorenzo del Castillo / July 3rd, 2013

About me

Juan A. Lorenzo del Castillo



Ph.D. in Computing Engineering from the University of Santiago de Compostela (Spain).

M.Sc. in Information Technologies. Inter-university Doctorate Program, USC-UDC (Spain).

M.Sc. in Telecom Engineering from the University of Valladolid (Spain).

B.Sc. in Telecom Engineering majoring Electronics from the University of Valladolid (Spain).



Research Engineer in the Cloud and Security Lab, HP Laboratories.

Performing Cloud building and integration tasks at the FP7 EU BonFIRE project.

Research interests:

- Virtualisation

- Performance monitoring

- Data Profiling

- Improvement of data locality on multiprocessor systems



Cloud 101



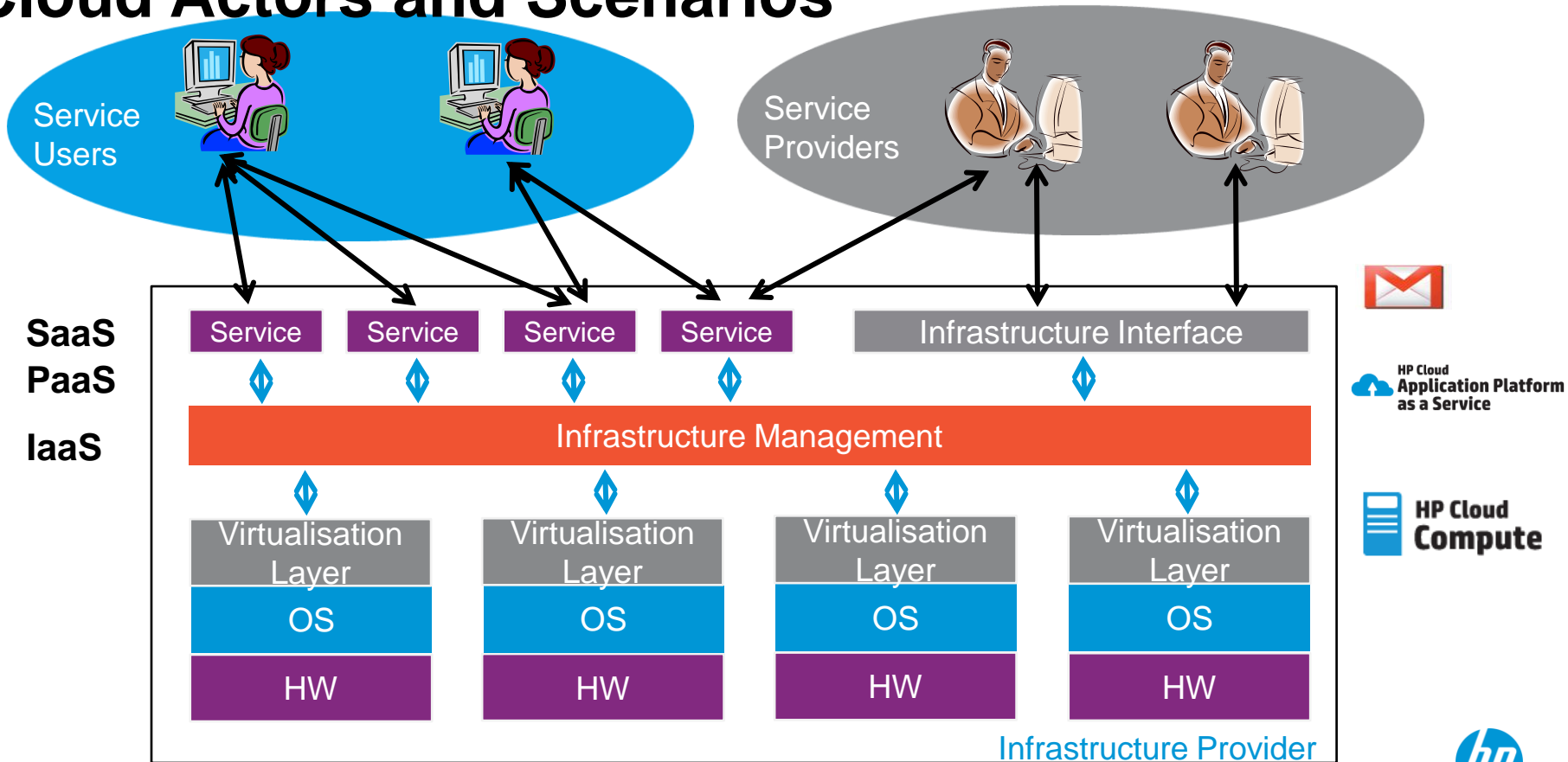
Cloud Computing

A Cloud is...

- A pool of computing resources (servers, storage, applications, etc.)
- Pay-per-use
- Eliminates the need for on-site equipment, maintenance, and management.
- Ubiquity
- Scalability and Elasticity
- SLAs



Cloud Actors and Scenarios



Cloud Computing for Experimentation



Testbeds for Services Experimentation

BonFIRE project

The BonFIRE project is designing, building and operating a multi-cloud facility to support research across applications, services and systems targeting the services research community on Future Internet.



Why BonFIRE

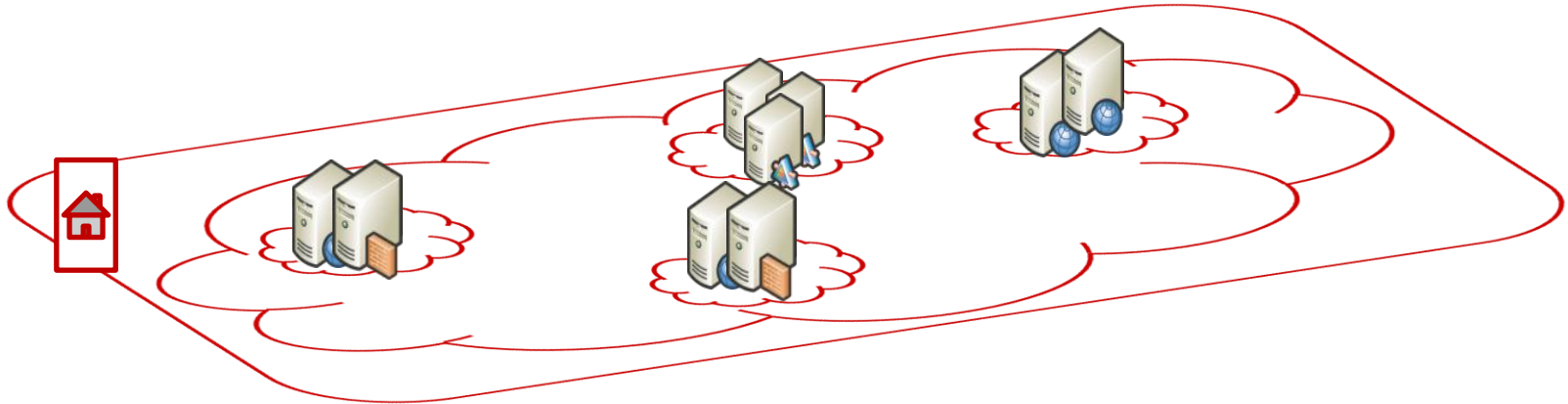
Traditional cloud facilities are not suitable for research and testing

- They do not provide low-level metrics at infrastructure level.
- They do not allow users to monitor the execution of their applications to a high degree.
- Users cannot control most of the many variables that affect performance (e.g. VM allocation).
- They provide a flat network, without possibility of controlling network QoS parameters (latency, packet loss, etc.).
- They do not provide testbed heterogeneity to test reproducibility of results.

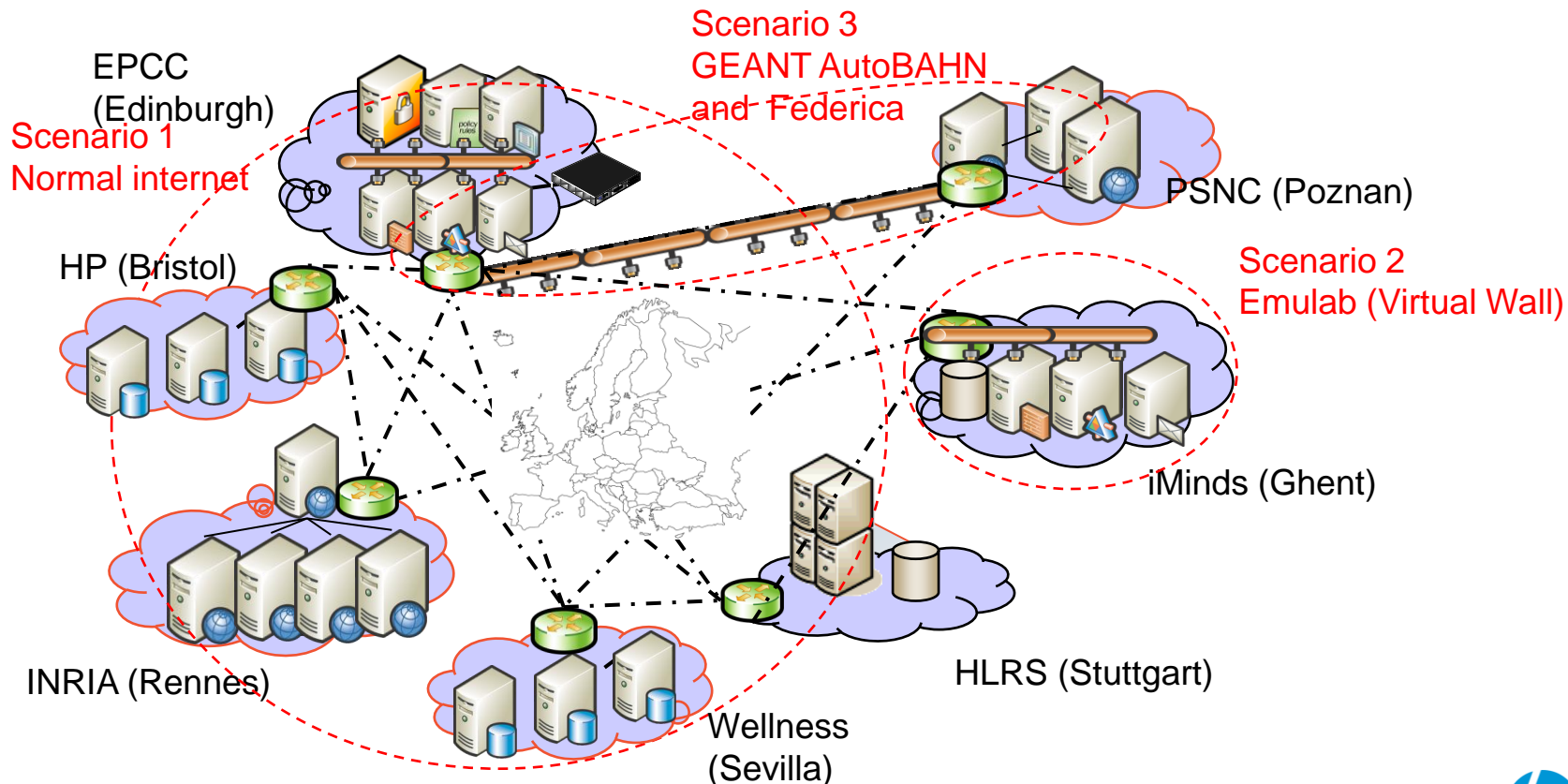
BonFIRE

Three scenarios

1. Multi-site clouds connected through normal internet
2. Cloud scenario with emulated network
3. Extended Cloud scenario with controlled network (federation with network facility)



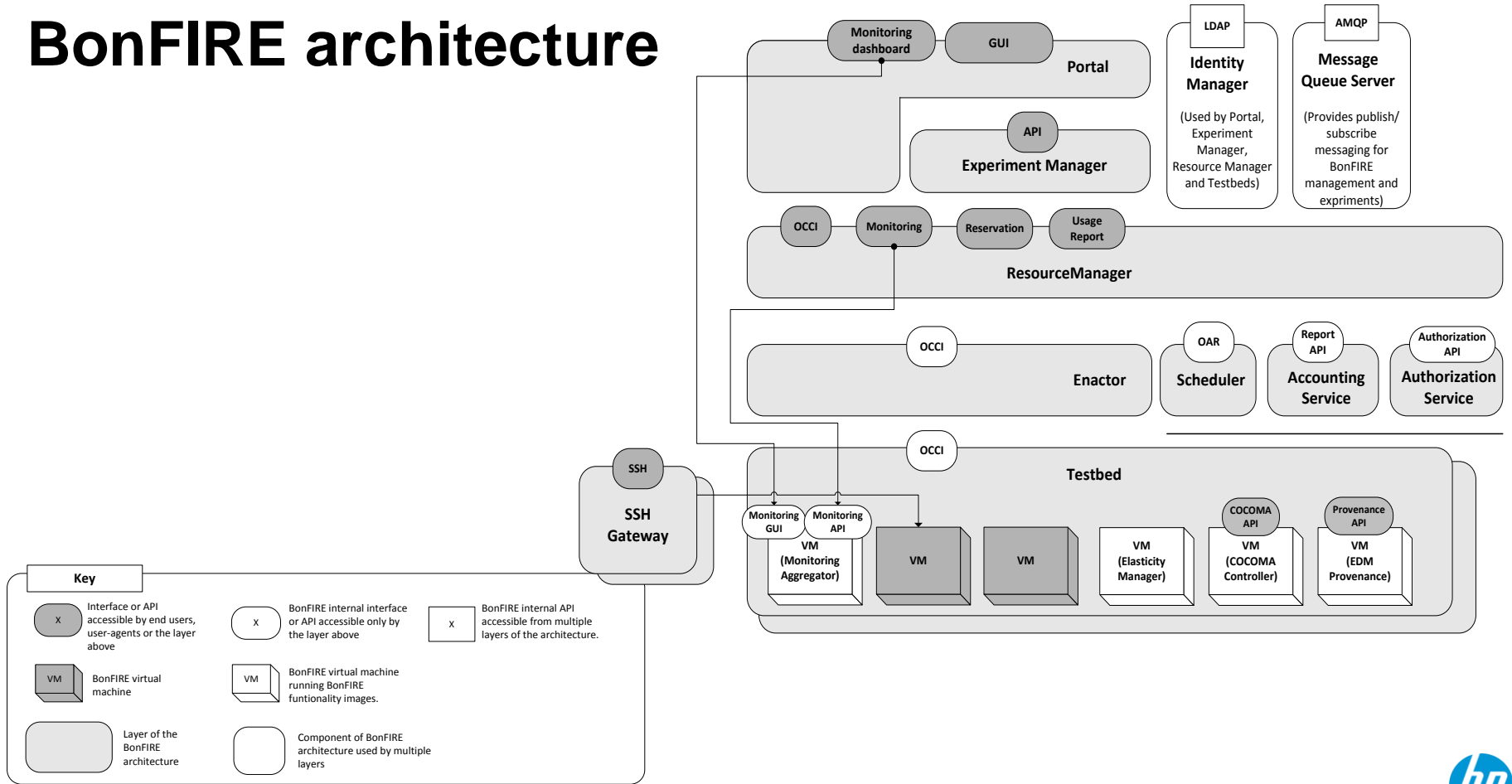
BonFIRE scenarios and sites



Permanent (>450cores / 45TB) & On-Request (+1,500 cores) infrastructures



BonFIRE architecture



Four pillars



Observability



Control



Advanced
Features



Ease of Use

Observability

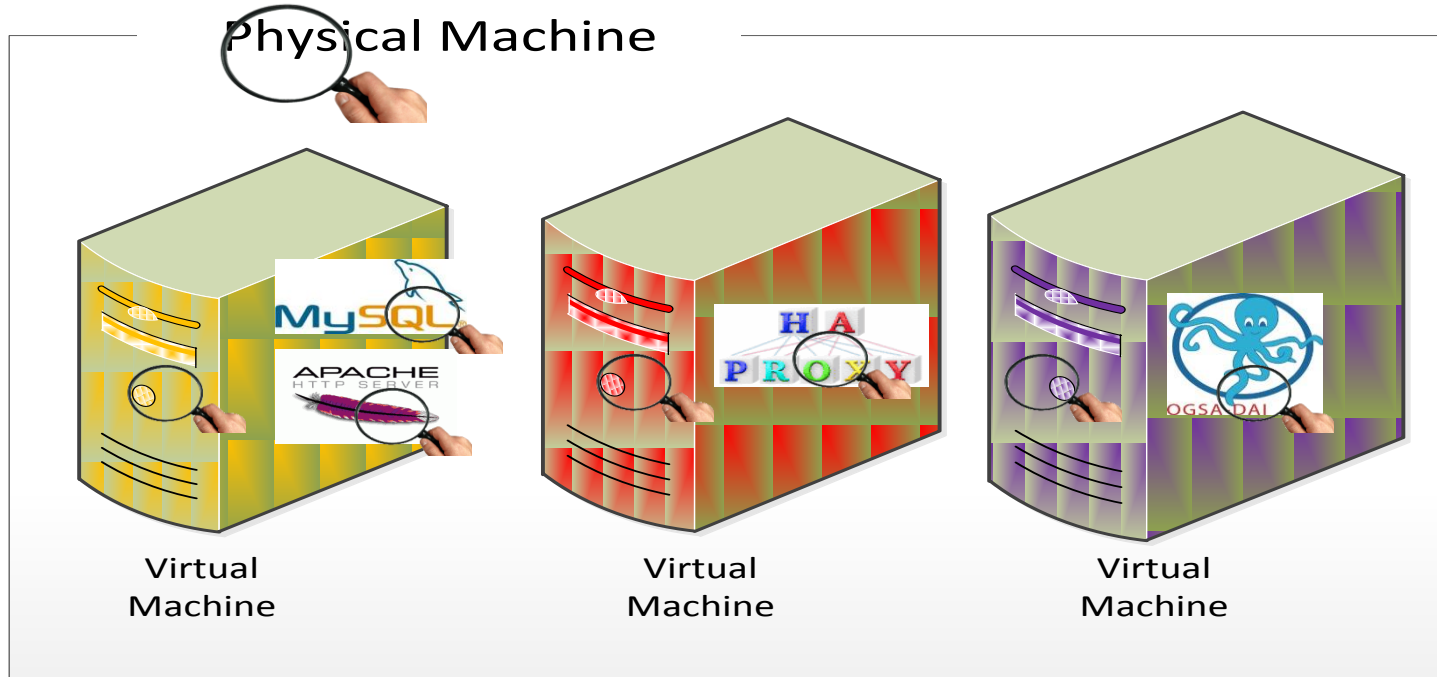
To understand the behaviour of the system you need to see inside the abstractions normally provided by clouds.



Observability



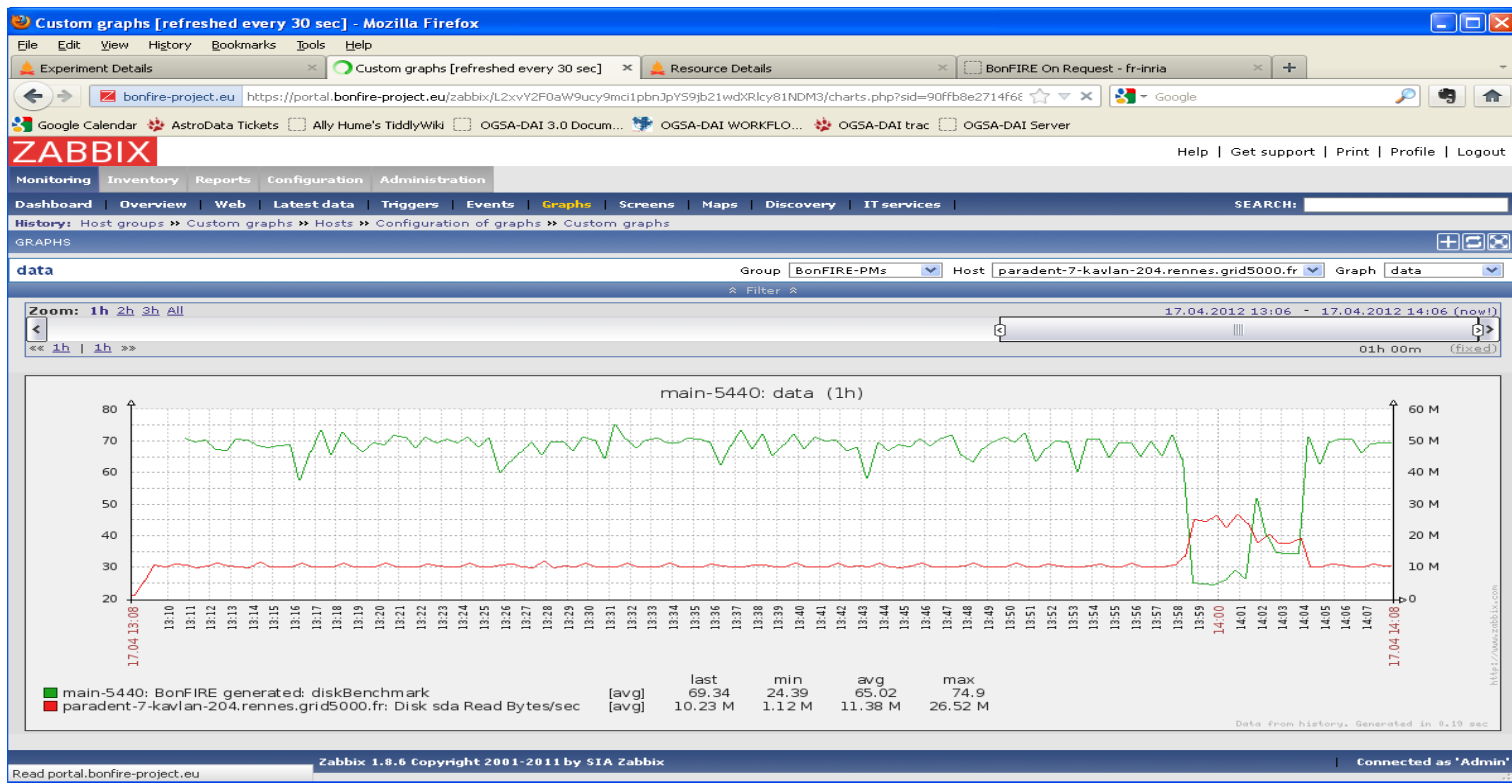
Application, VM and Physical machine metrics



Observability



Infrastructure metrics



Observability



Experiments supported

Passive use of infrastructure metrics

Understanding of contention and its impact on:

- Application performance
- General VM performance

Active use of infrastructure metrics

- By a cloud scheduler to **co-locate VMs** to minimise contention
 - e.g. by collecting statistics of the previous usage patterns of an image
- By a cloud application to **react** to the contention currently in the system



Observability



Control

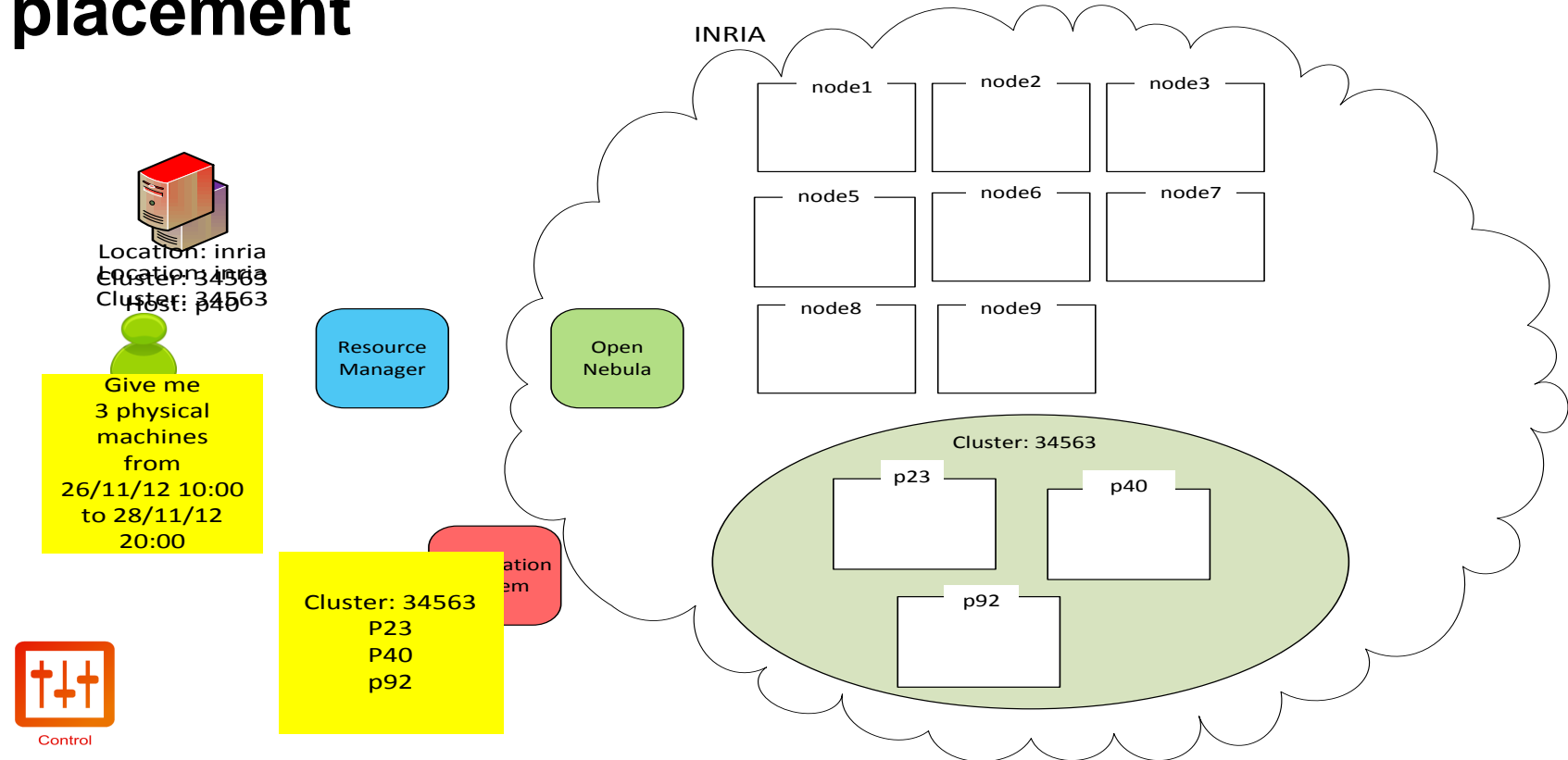
Observing is good but control is even better.



Control



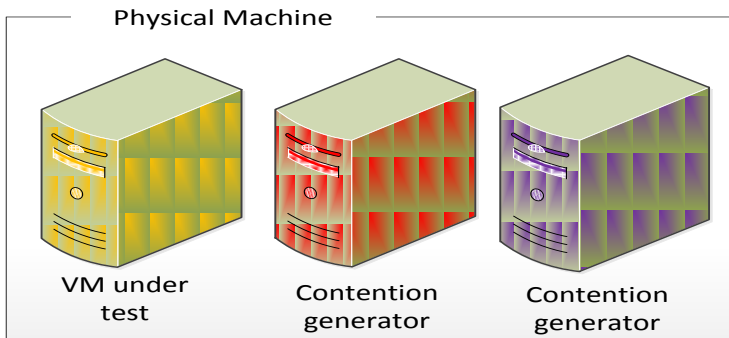
Exclusive physical machines and controlled placement



Supported Experiments

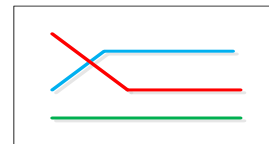
Exclusive use of physical machine and controlled placement

- Supports elimination of **unwanted contention**
- Increases experiment **repeatability**
- Supports the implementation of **controlled contention**
 - possible via common contention templates

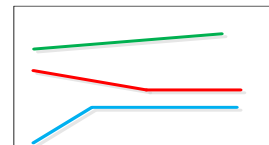


Control

Contention
Template 1

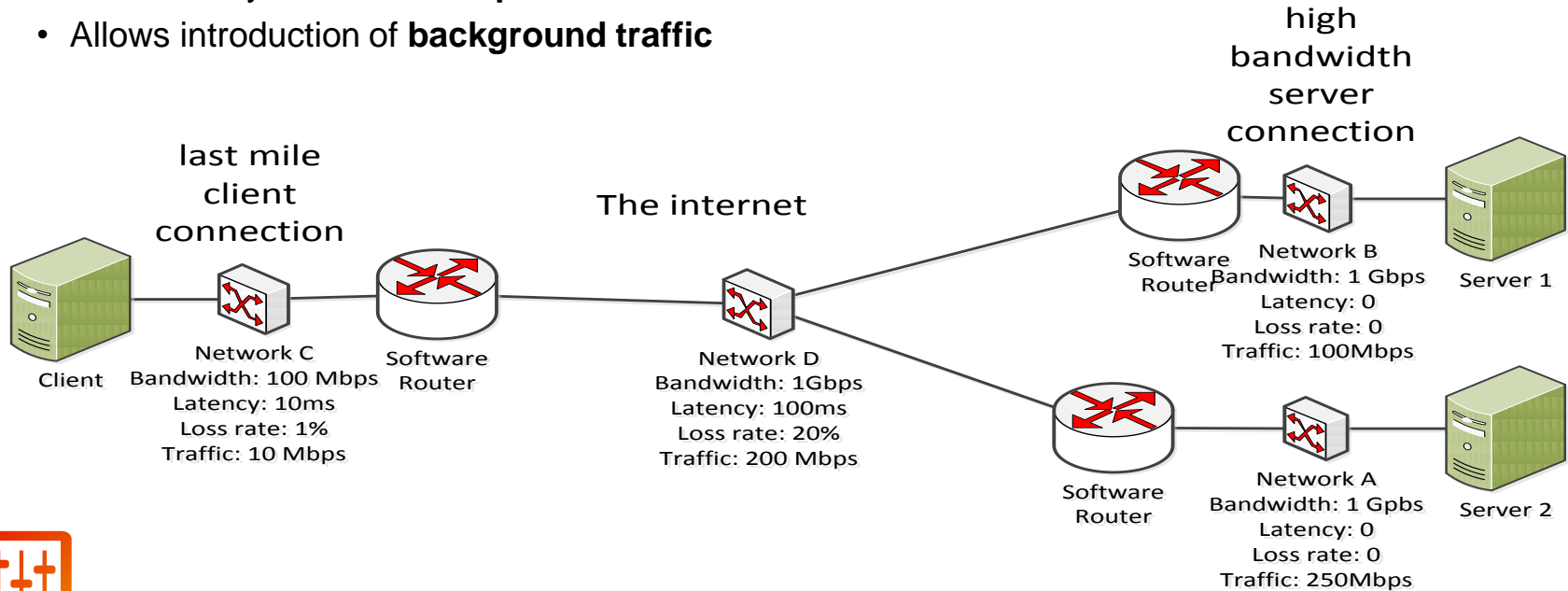


Contention
Template 2



Controlled networks with Virtual Wall

- Setup of any desired **network topology**
- Allows study of **network impairments**
- Allows introduction of **background traffic**



Control



Integration with AutoBAHN

Integrate BonFIRE with the GÉANT Bandwidth-on-Demand interfaces (AutoBAHN)

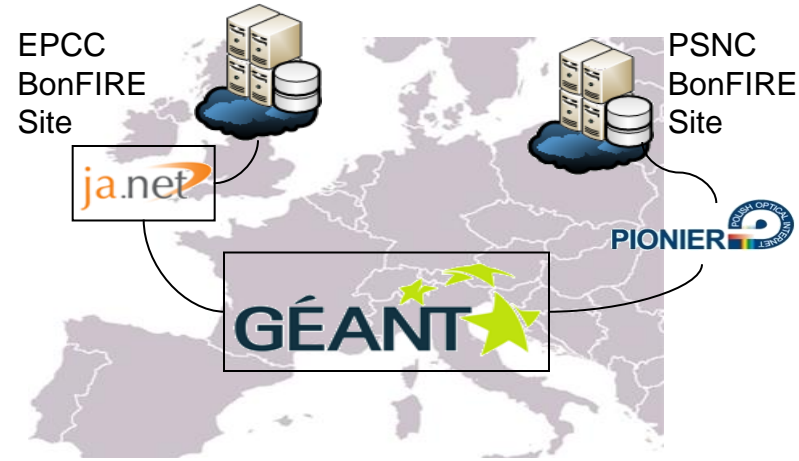
This allows network-aware experiments with requirements for guaranteed bandwidth

- Control

- Future service

Why AutoBAHN?

- Reference BoD system for European NRENs and GÉANT
- Most mature solution in terms of specification, implementation and deployment in the multi-domain environment interconnecting some of the sites
- Handles both on demand and advance requests

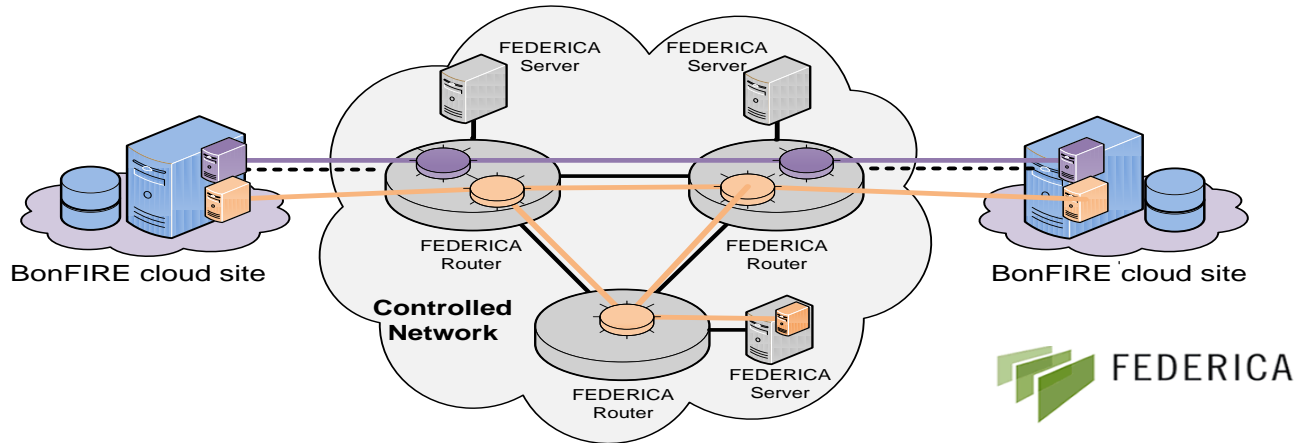


Control



FEDERICA offering

- FEDERICA is an e-Infrastructure based on virtualization of compute and network resources
- BonFIRE experimenters to request slices of network resources and be able to:
 - Select network topology
 - Configure static routes and dynamic routing protocols (OSPF, BGP)



Control



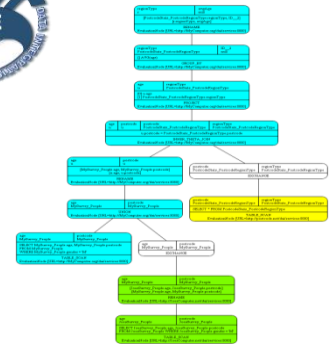
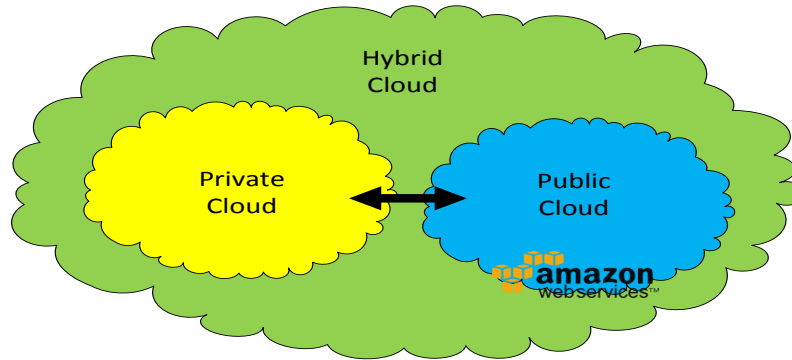
Supported Experiments

Controlled network quality of service

- Testing streaming applications
- Testing Services distributed applications
- Multi-cloud applications
- Experiments into how bandwidth on demand services could be used by cloud applications



Control



Advanced features



Advanced features

Intra-site VM migration

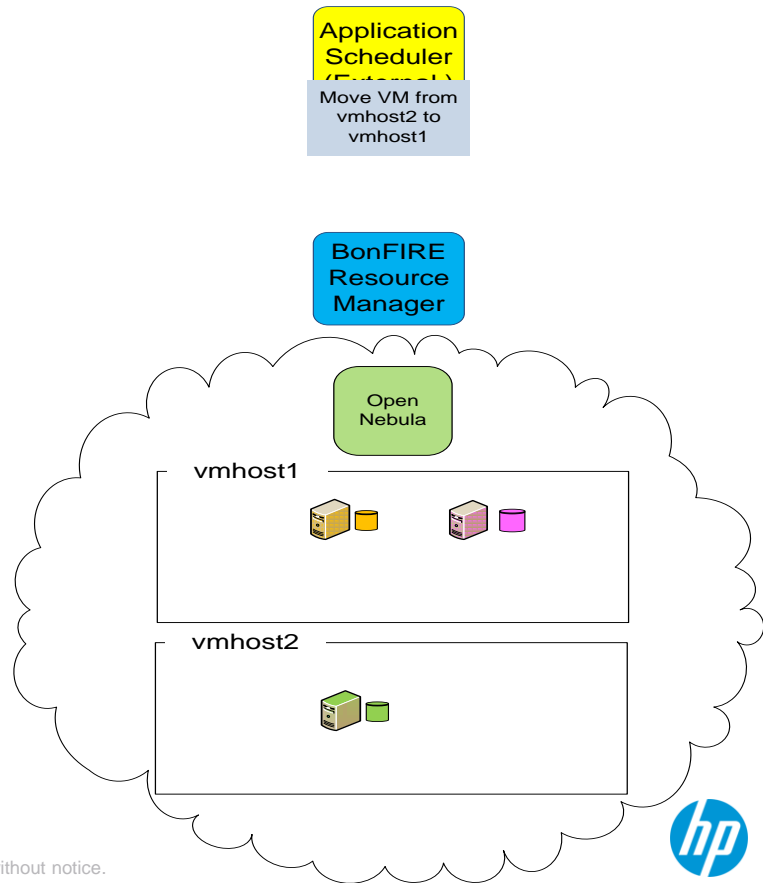
- Move VM from host to host
- Shut down physical hosts for energy saving

Bandwidth on demand services

- As well as being control tool, BoD services can also be used by network-aware applications

Connectivity to Amazon EC2

- Through the portal or our API.



Ease of Use

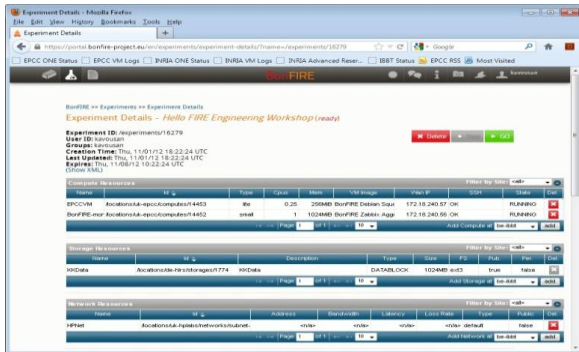


Ease of Use

If it's not easy, it won't be used

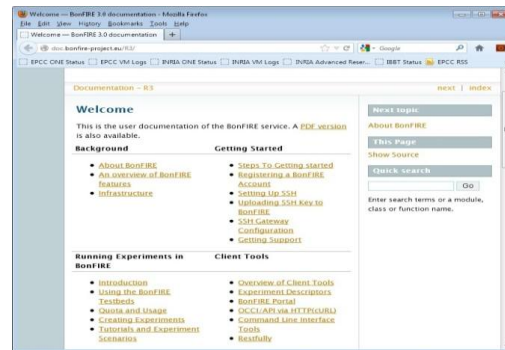
But what is easy?

BonFIRE interpretations:



The screenshot shows the BonFIRE web interface. The main content area displays 'Experiment Details' for an experiment named 'Hello FIRE Engineering Workshop (ready)'. It lists the experiment ID, user ID, creation time, and last update time. Below this, there are three sections: 'Compute Resources', 'Storage Resources', and 'Network Resources', each with a table of resource details.

```
"resources": [
  {
    "network": {
      "name": "myNetwork",
      "locations": ["be-ibbt"],
      "address": "192.168.0.0",
      "size": "C",
      "lossrate": 0,
      "bandwidth": 700,
      "latency": 0
    }
  },
  {
    "compute": {
      "name": "server",
      "locations": ["be-ibbt"],
      "instanceType": "Large-EN",
      "min": 1,
      "resources": [
        {
          "storage": "@lperf-demo2",
          "network": "@BonFIRE WAN",
          "network": "myNetwork"
        }
      ],
      "contexts": []
    }
  },
  {
    "compute": {
      "name": "client",
      "locations": ["be-ibbt"],
      "instanceType": "Large-EN",
      "min": 1,
      "resources": [
        {
          "storage": "@lperf-demo2",
          "network": "@BonFIRE WAN",
          "network": "myNetwork"
        }
      ],
      "contexts": [
        [{"IPERF_SERVER": ["server", "myNetwork"]} ]
      ]
    }
  }
]
```



The screenshot shows the BonFIRE documentation page. It features a navigation menu on the left with links for 'Documentation - ES', 'Welcome', 'Background', and 'Getting Started'. The main content area contains a 'Welcome' message and a list of links for 'About BonFIRE', 'Features', and 'Infrastructure'. There is also a search bar and a 'Quick Search' section.



BonFIRE Portal

Experiment Details - Mozilla Firefox
https://portal.bonfire-project.eu/en/experiments/experiment-details/?name=/experiments/16279

BonFIRE >> Experiments >> Experiment Details
Experiment Details - Hello FIRE Engineering Workshop (ready)

Experiment ID: /experiments/16279
User ID: kavousan
Groups: kavousan
Creation Time: Thu, 11/01/12 18:22:24 UTC
Last Updated: Thu, 11/01/12 18:22:24 UTC
Expires: Thu, 11/08/12 10:22:24 UTC
(Show XML)

Compute Resources Filter by Site: <all>

Name	Id	Type	Cpus	Mem	VM Image	Wan IP	SSH	State	Del.
EPCCVM	/locations/uk-epcc/computes/14453	lite	0.25	256MB	BonFIRE Debian Squ	172.18.240.57	OK	RUNNING	<input type="button" value="X"/>
BonFIRE-mor	/locations/uk-epcc/computes/14452	small	1	1024MB	BonFIRE Zabbix Aggr	172.18.240.56	OK	RUNNING	<input type="button" value="X"/>

Page 1 of 1 | Add Compute at be-ibbt | add

Storage Resources Filter by Site: <all>

Name	Id	Description	Type	Size	FS	Pub.	Per.	Del.
KKData	/locations/de-hirs/storages/1774	KKData	DATABLOCK	1024MB	ext3	true	false	<input type="button" value="X"/>

Page 1 of 1 | Add Storage at be-ibbt | add

Network Resources Filter by Site: <all>

Name	Id	Address	Bandwidth	Latency	Loss Rate	Type	Public	Del.
HPNet	/locations/uk-hplabs/networks/subnet-	<n/a>	<n/a>	<n/a>	<n/a>	default	false	<input type="button" value="X"/>

Page 1 of 1 | Add Network at be-ibbt | add

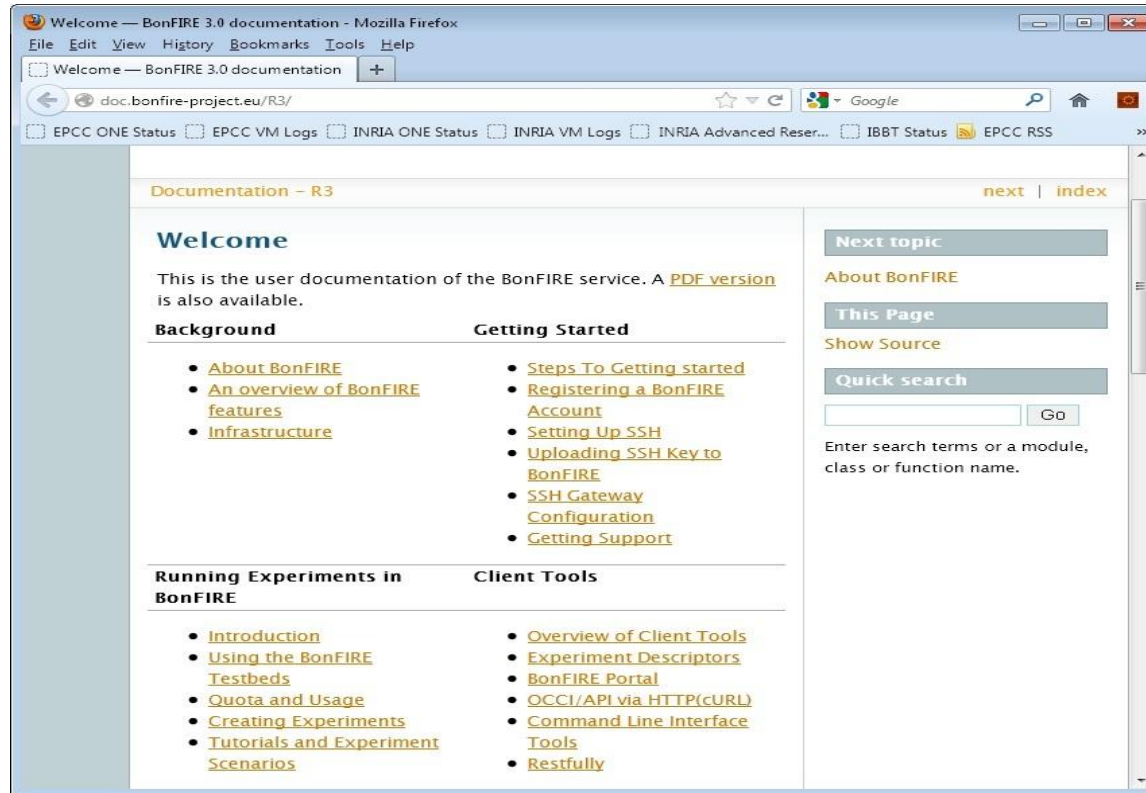


Experiment Descriptor

```
{
  "name": "myExperiment", "description": "Controlled Network", "duration": 60,
  "resources": [
    { "network": { "name": "myNetwork", "locations": ["be-ibbt"],
      "address": "192.168.0.0", "size": "C",
      "lossrate": 0, "bandwidth": 700, "latency": 0 }
    },
    { "compute": { "name": "server", "locations": ["be-ibbt"],
      "instanceType": "Large-EN", "min": 1,
      "resources": [
        {"storage": "@iperf-demo2"},
        {"network": "@BonFIRE WAN"},
        {"network": "myNetwork"}
      ],
      "contexts": [] }
    },
    { "compute": { "name": "client", "locations": ["be-ibbt"],
      "instanceType": "Large-EN", "min": 1,
      "resources": [
        {"storage": "@iperf-demo2"},
        {"network": "@BonFIRE WAN"},
        {"network": "myNetwork"}
      ],
      "contexts": [ {"IPERF_SERVER": ["server", "myNetwork"]} ] }
    }
  ]
}
```



295 pages of User Doc



The screenshot shows a Mozilla Firefox browser window displaying the BonFIRE 3.0 documentation. The address bar shows the URL `doc.bonfire-project.eu/R3/`. The page content includes a "Welcome" section with a link to a PDF version, and two columns of links under "Background" and "Getting Started".

Welcome

This is the user documentation of the BonFIRE service. A [PDF version](#) is also available.

Background

- [About BonFIRE](#)
- [An overview of BonFIRE features](#)
- [Infrastructure](#)

Getting Started

- [Steps To Getting started](#)
- [Registering a BonFIRE Account](#)
- [Setting Up SSH](#)
- [Uploading SSH Key to BonFIRE](#)
- [SSH Gateway Configuration](#)
- [Getting Support](#)

Running Experiments in BonFIRE

- [Introduction](#)
- [Using the BonFIRE Testbeds](#)
- [Quota and Usage](#)
- [Creating Experiments](#)
- [Tutorials and Experiment Scenarios](#)

Client Tools

- [Overview of Client Tools](#)
- [Experiment Descriptors](#)
- [BonFIRE Portal](#)
- [OCCI/API via HTTP\(cURL\)](#)
- [Command Line Interface Tools](#)
- [Restfully](#)

The right sidebar contains navigation links: "Next topic", "About BonFIRE", "This Page", "Show Source", and "Quick search". The search bar includes a text input field and a "Go" button.



Effectiveness

Several ways of interacting with BonFIRE:

- Portal
- Experiment descriptor
- Restfully: a client library for RESTful APIs
- Command Line Interface tools: *curl* and *bftools*

```
$ bfcompute create LittleComputeAtHLRS /locations/de-hlrs/storages/2090 21738 -I lite -G m30review
```

```
curl -ki --user ahume --header Content-Type:application/vnd.bonfire+xml  
https://api.bonfire-project.eu/experiments/21738/computes -X POST -d'<compute  
xmlns="http://api.bonfire-project.eu/doc/schemas/occi">  
<name>LittleComputeAtHLRS</name> <groups>m30review</groups>  
<instance_type>lite</instance_type> <disk> <storage href="/locations/de-  
hlrs/storages/2090"/> <type>OS</type> <target>hda</target> </disk> <nic> <network  
href="/locations/de-hlrs/networks/90"/> </nic> <link href="/locations/de-hlrs"  
rel="location"/> </compute>
```



Hands on BonFIRE!



Research on BonFIRE



Example experiment categories

Service applications experiments (non-cloud)

Including distributed peer to peer applications

Cloud (or multi-cloud) applications

e.g. cloud bursting scenarios with private and public clouds

Cloud infrastructure experiments

e.g. schedulers on top of BonFIRE, new live-migration strategies, contention minimisation

Application-and-network experiments

Experimenters configuring network to support applications

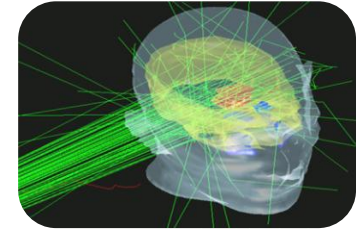
Bandwidth on demand

Application-specific routing



Impact of BonFIRE

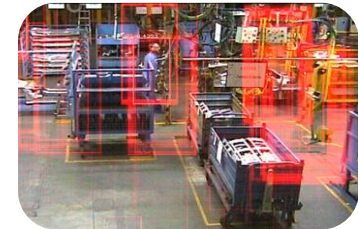
Tested radiotherapy cancer treatment service copes well with loss of compute cluster



SMEs validated network boundary conditions under which to market their video-streaming solution



Evaluating if QoS-oriented service management enables real-time computer vision in large-scale industrial environments



Impact of BonFIRE

3+4+5 funded experiments; one commercial Cloud

Two open calls; **50** proposals

Worthwhile research, powered by BonFIRE. E.g.:

- Media:** two **SMEs**; video-streaming system.
 - Identified the boundaries of their solution.
 - Know the conditions under which they can market it.
 - CityFlow STREP **builds** on these results.
- eHealth:** Supercomputing centre; service to improve radiotherapy **cancer** treatment.
 - Tested scaling as hospital demand increases
- Security:** Research centre; security results from **IoS** projects
 - Examine scalability of continuous security monitoring in a heterogeneous cloud infrastructure

Far reaching impact:

- Application Benchmarking, Service Engineering & Optimisation, QoS, Home Automation, Anti-plagiarism, P2P protocols



Free access to BonFIRE

Get free access to the BonFIRE resources

Three simple steps:

1. Visit www.bonfire-project.eu/involved
2. Spend 15 minutes to specify your needs
3. Apply to the BonFIRE Open Access

What you get:

- Cloud resources
 - Up to 50 virtual cores
 - Up to 250 Gb storage
- Advanced emulated network functionality
- BonFIRE's unique monitoring and control features

A promotional poster for the BonFIRE project. The top section has a yellow background with the word 'BonFIRE' in large, stylized red and orange letters. Below it, the text 'Testbeds for systems and services experimentation' is written in a smaller font. A blue starburst graphic contains the text 'Now Open for Access'. The middle section features a network diagram with orange human figures connected by lines on a dark background. The bottom section has a dark background with white and orange text. It lists three categories: 'Cloud and Service Technologies' with the question 'Do you need to test your innovative ideas?', 'Infrastructure Resources' with 'Do you need them?', and 'Open Access' with 'Do you want it?'. Below these is a bulleted list of features: 'A multi-site cloud facility for applications, services and systems experimentation', 'Large-scale, heterogeneous and virtualised compute, storage and networking resources', 'Full control of your resource deployment', 'In-depth monitoring and logging', 'Advanced cloud and network features', and 'Ease of use for experimentation'. At the bottom, it says 'Apply for free, open access' and provides contact information: 'Contact bonfire@bonfire-project.eu or visit www.bonfire-project.eu/involved'.

Summary

Multi-cloud experimentation facility for services community

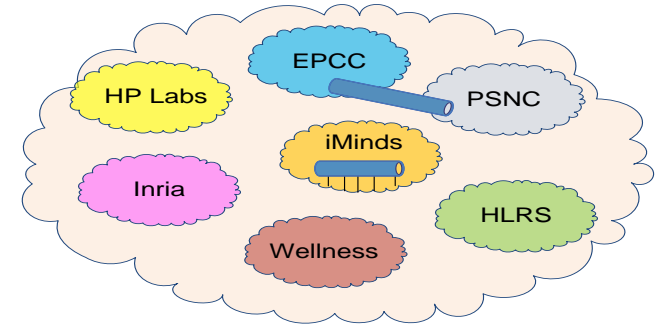
Founded on:

Observability

Control

Advanced Features

Usability



Supports a wide range of experimentation

Open call experiments delivering impact



Open for general use



Acknowledgements

Copyright © 2012, Hewlett-Packard Laboratories, on behalf of the BonFIRE Consortium.

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www.bonfire-project.eu



Thank you

