contrail

open computing infrastructures for elastic services

ConPaaS: A Cloud Platform for Hosting Elastic Applications

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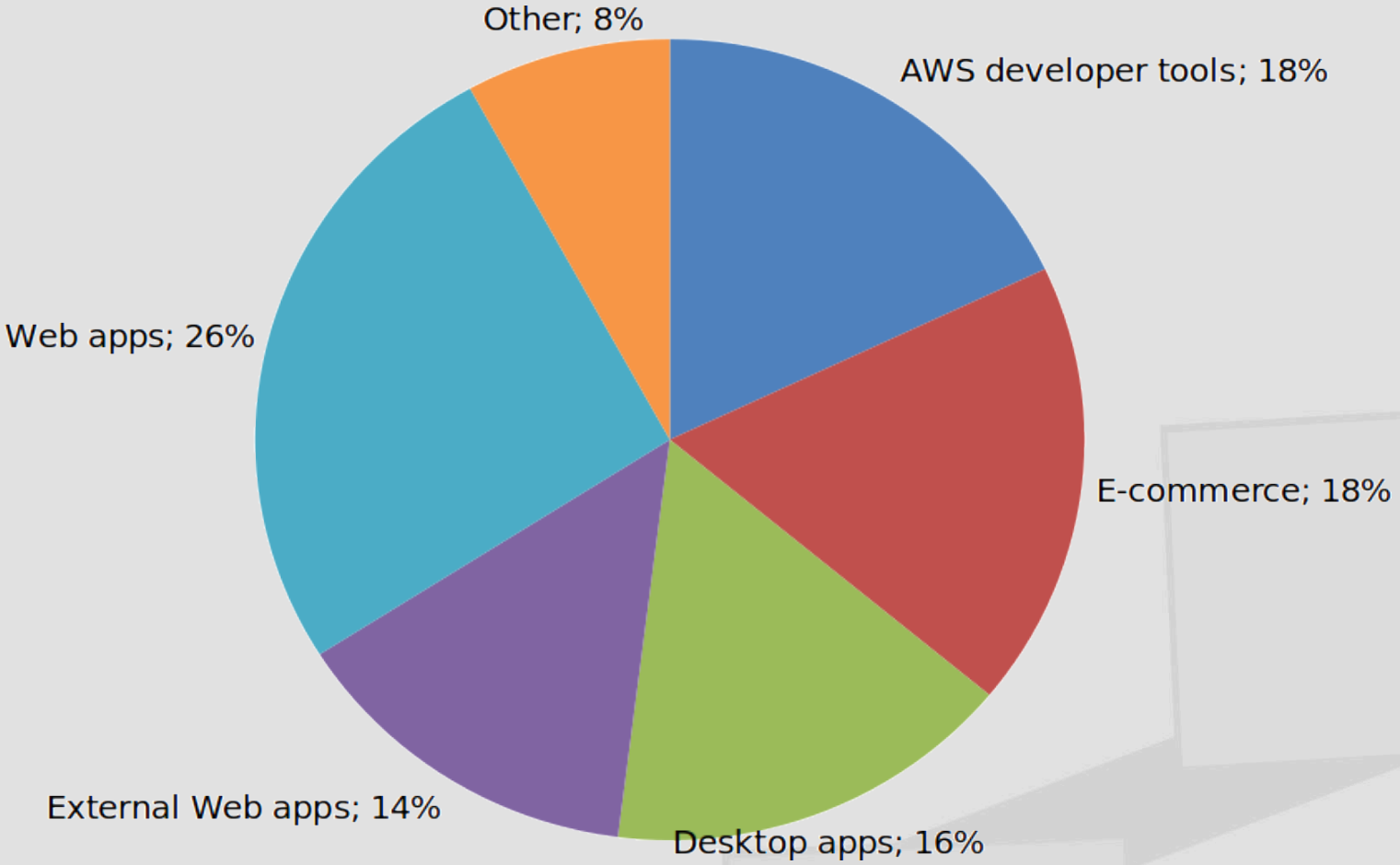
Typical Cloud Applications (according to AWS)

- Application Hosting
- Backup and Storage
- Content Delivery
- E-Commerce
- High Performance Computing
- Media Hosting
- On-Demand Workforce
- Search Engines
- Web Hosting

Applications running at Amazon Web Services



Sample: 50 applications from the AWS Customer App Catalog.

Many Cloud applications are alike

- Web servers
- Application servers
- Database servers
- High-performance frameworks (MapReduce, MPI, Workflows)
- . . . and a few percents of miscellaneous programs

Cloud application developers often rebuild
the same types of frameworks again and again and again. . .

Can the Cloud help support common types of applications?

- Infrastructure-as-a-Service provides basic computing resources
  - Absolute flexibility: you can build anything you want
  - But it can be very complex and time consuming
    - Deployment
    - Software upgrades
    - Fault-tolerance
    - Performance monitoring
    - Resource provisioning
    - Dynamic reconfiguration orchestration
    - etc.

- Platform-as-a-Service provides high-level services
  - Each PaaS service targets a specific family of applications
  - Provide a simple deployment environment for applications
  - Provide high-level guarantees for applications using these services

What is ConPaaS ?

ConPaaS is an open-source runtime environment for hosting applications in Cloud environments.

- Broad range of functionalities
  - Application servers, databases, high-performance computing, miscellaneous
- Fully integrated
  - Applications can compose any set of services together
- Easy to use but also very powerful
  - Simple Web GUI + powerful command-line tool
  - Services are highly customizable
- Cutting-edge SLA enforcement technologies
  - Elasticity and resource provisioning techniques to guarantee performance at the lowest possible cost
- Support for deployment on multiple-clouds
  - OpenNebula, AmazonEC2, OpenStack (soon)

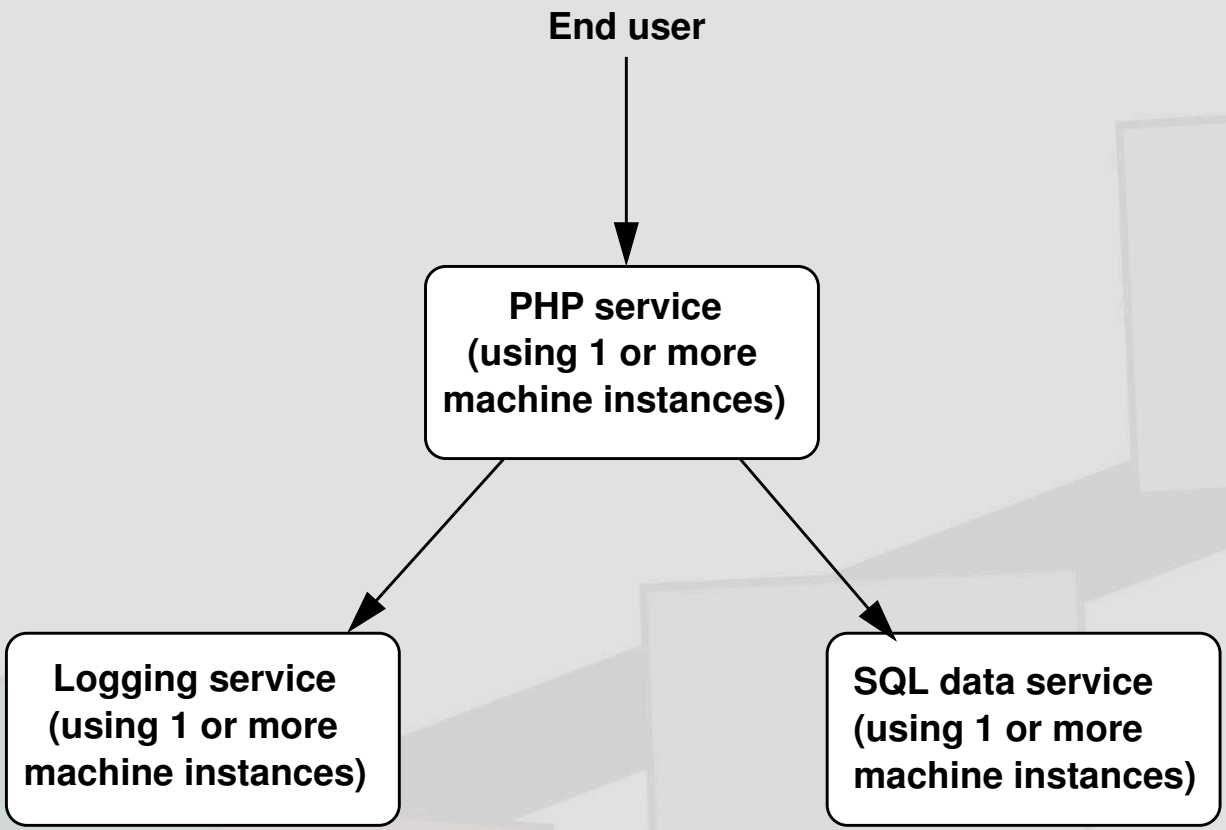
ConPaaS hosting Cloud Applications

- Fully support for the following services:
  - Web servers — static content and dynamic web applications (PhP, JSP)
  - MapReduce — for data-intensive computing
  - TaskFarming — for scientific applications
  - Databases (SQL and NoSQL) — for everybody
  - More services coming: CDN, functional testing, XtreemFS, etc.
- **BUT:** You can easily build your own ConPaaS service.

ConPaaS Applications

A ConPaaS application is defined as a composition of multiple service instances

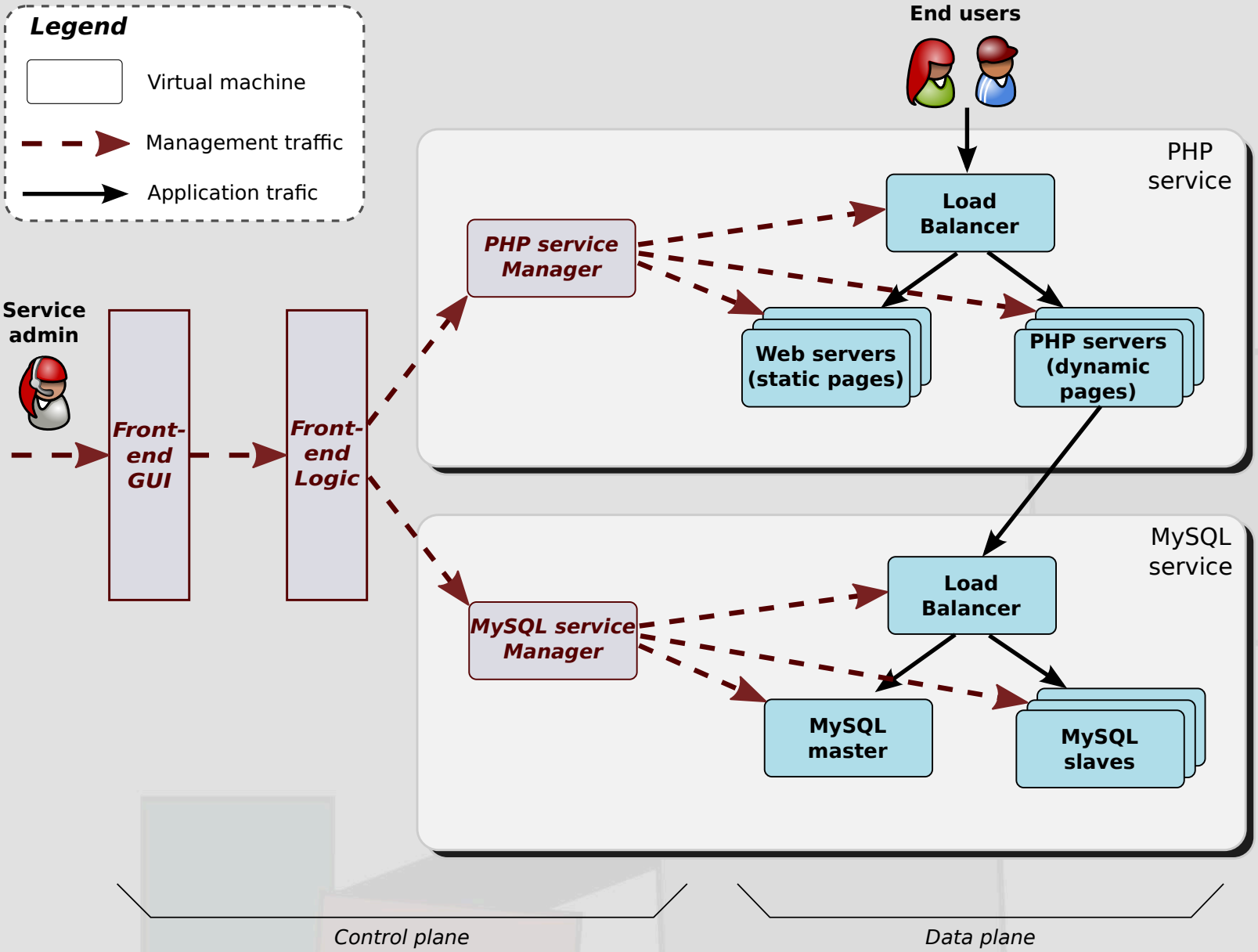
- For example: web hosting service + MySQL database + logging service (to store access logs)



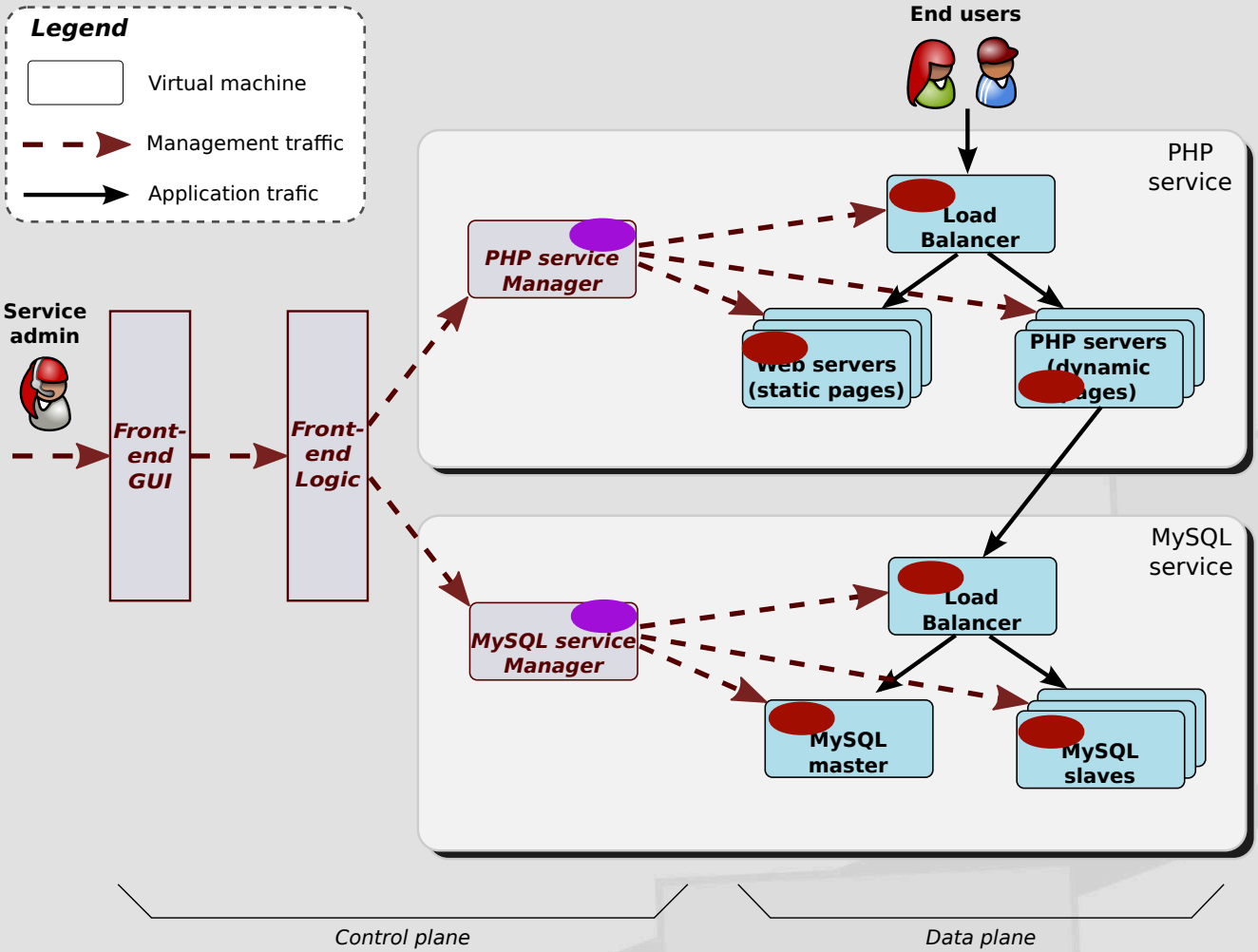
Architecture of a ConPaaS service

- A ConPaaS service is implemented as one or more virtual machine instances dedicated to a single user
  - Single-tenant: each VM belongs to a single user
  - No VM sharing between services (even for the same user)
- ConPaaS services are elastic: we can grow/shrink their capacity at runtime with no service disruption
  - Horizontal provisioning: add/remove virtual machines
- ConPaaS services will support dynamic resource provisioning: automatic capacity adjustment to support performance guarantees at minimum cost

ConPaaS Organization

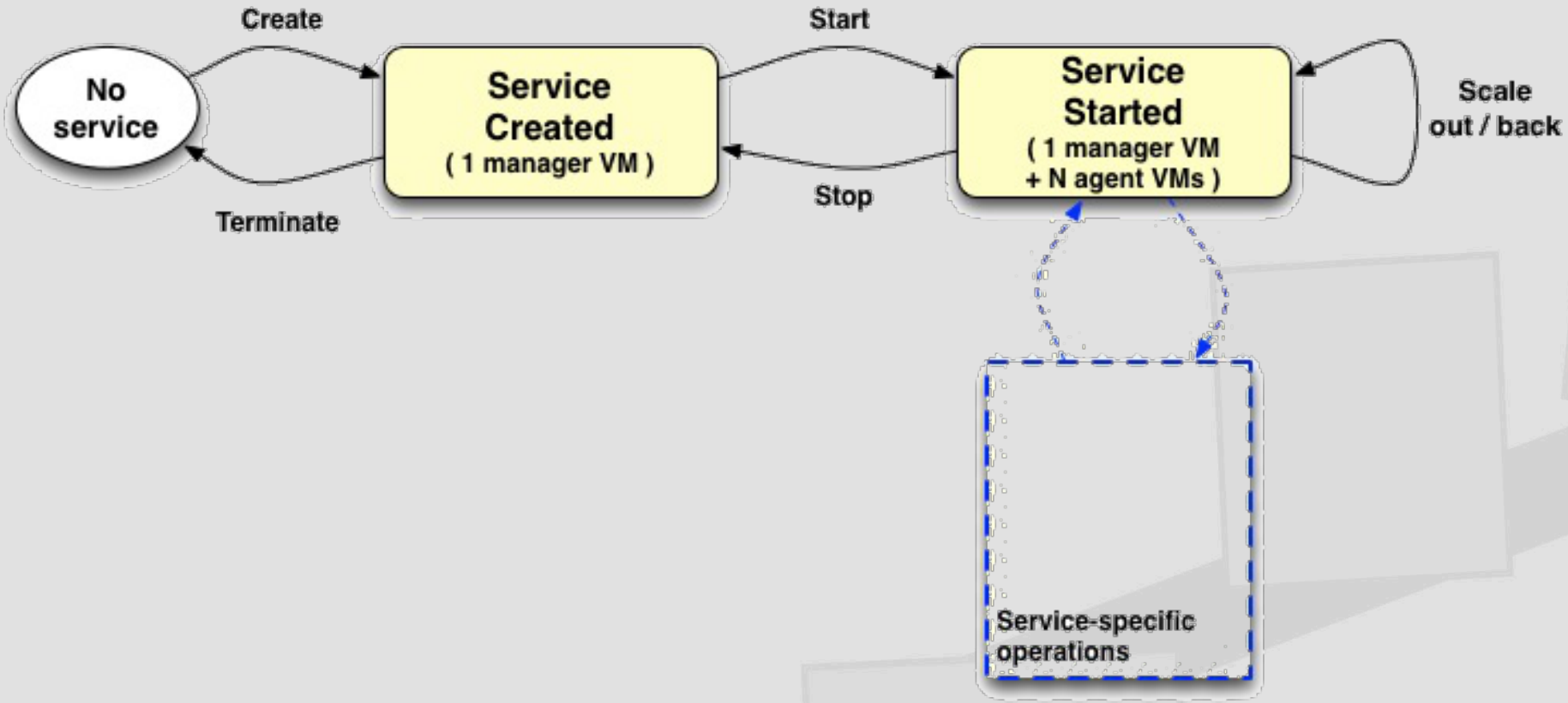


ConPaaS Organization

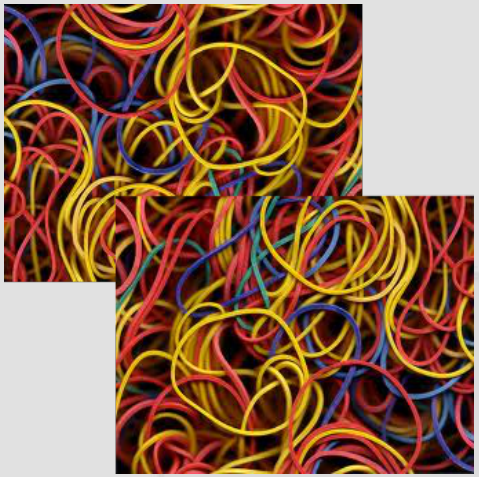


- Each manager VM contains a manager process
- Each agent VM contains an agent process

Lifecycle of a ConPaaS service

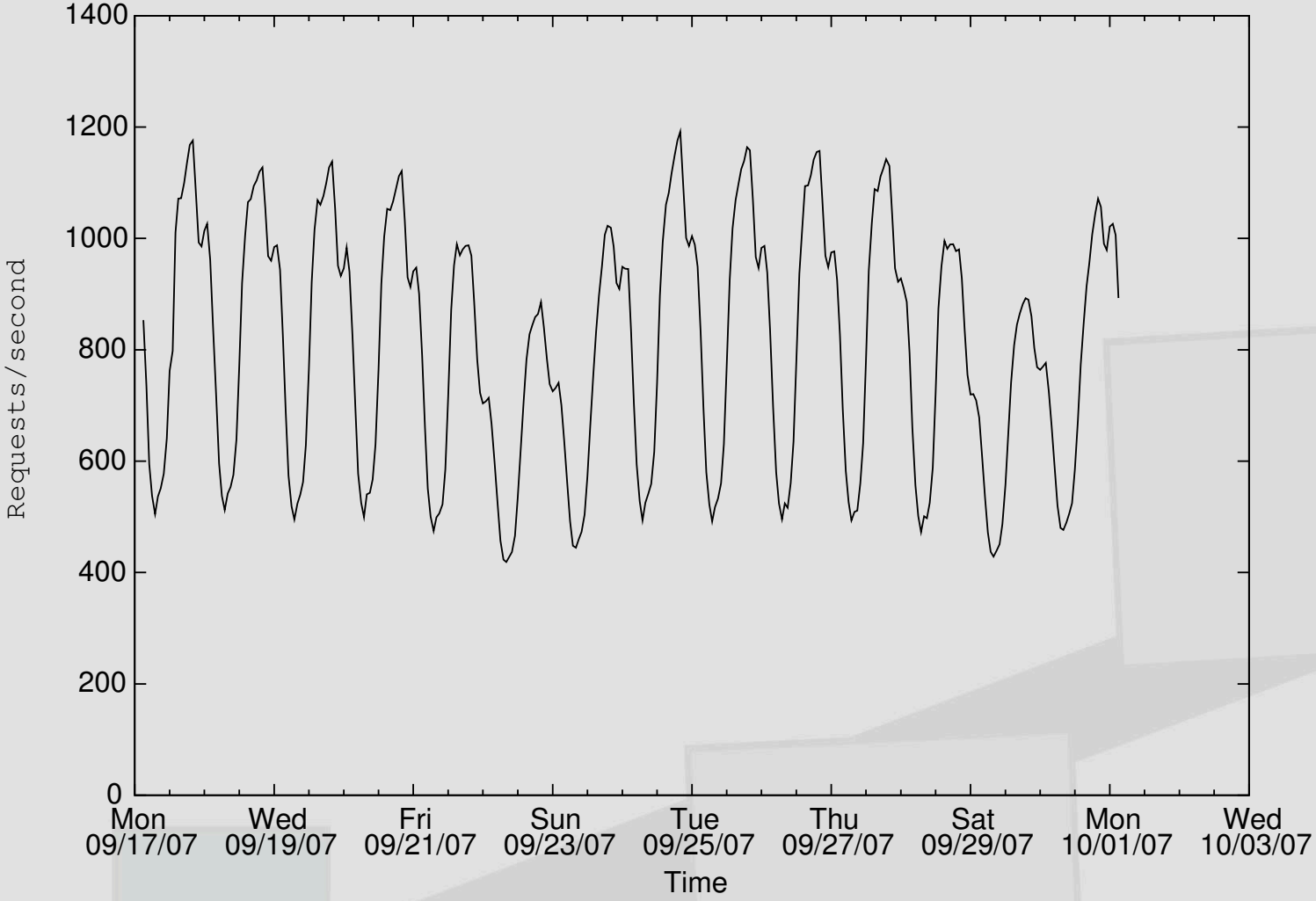


Elastic Cloud Applications



– Web applications

The varying capacity problem



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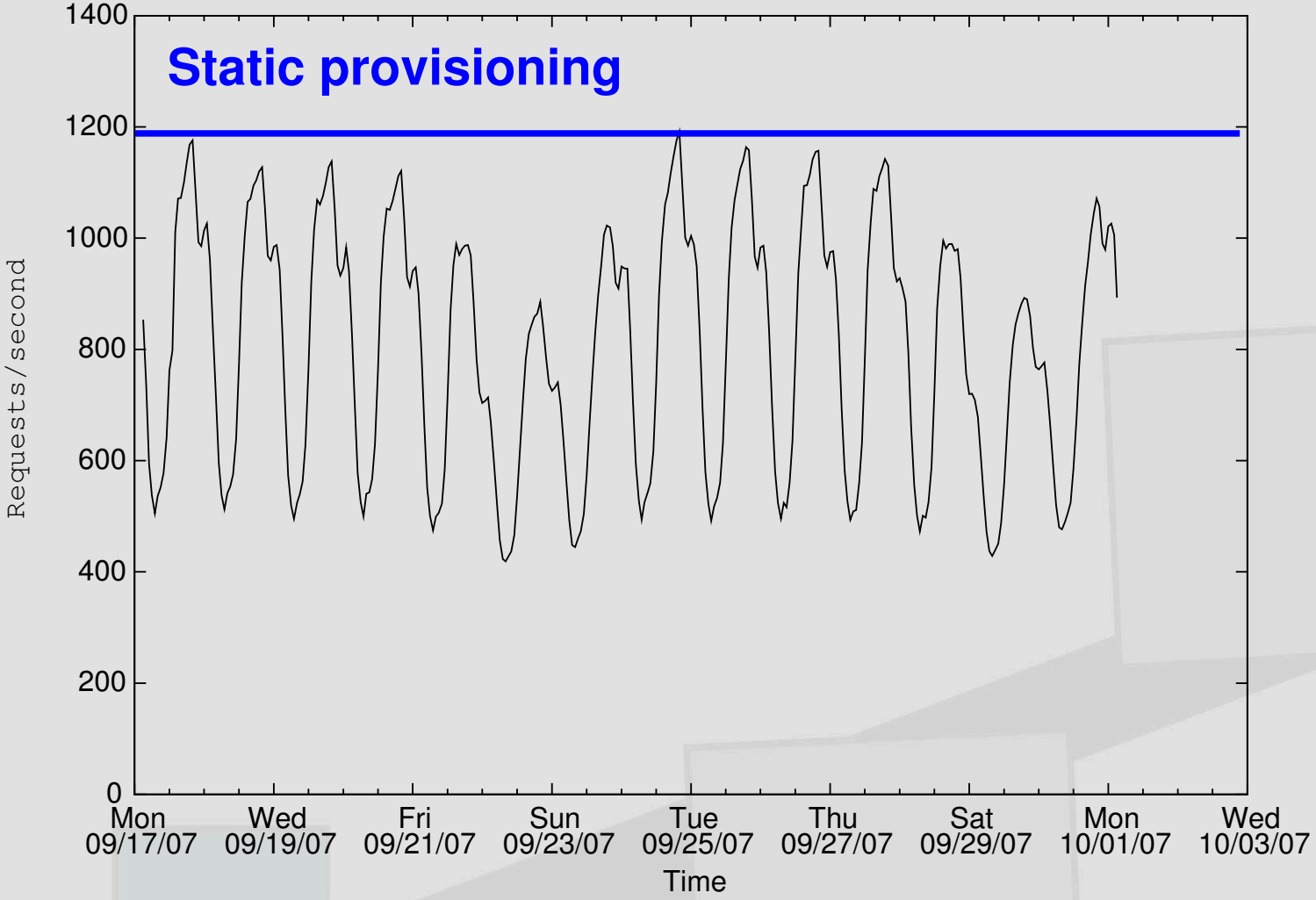

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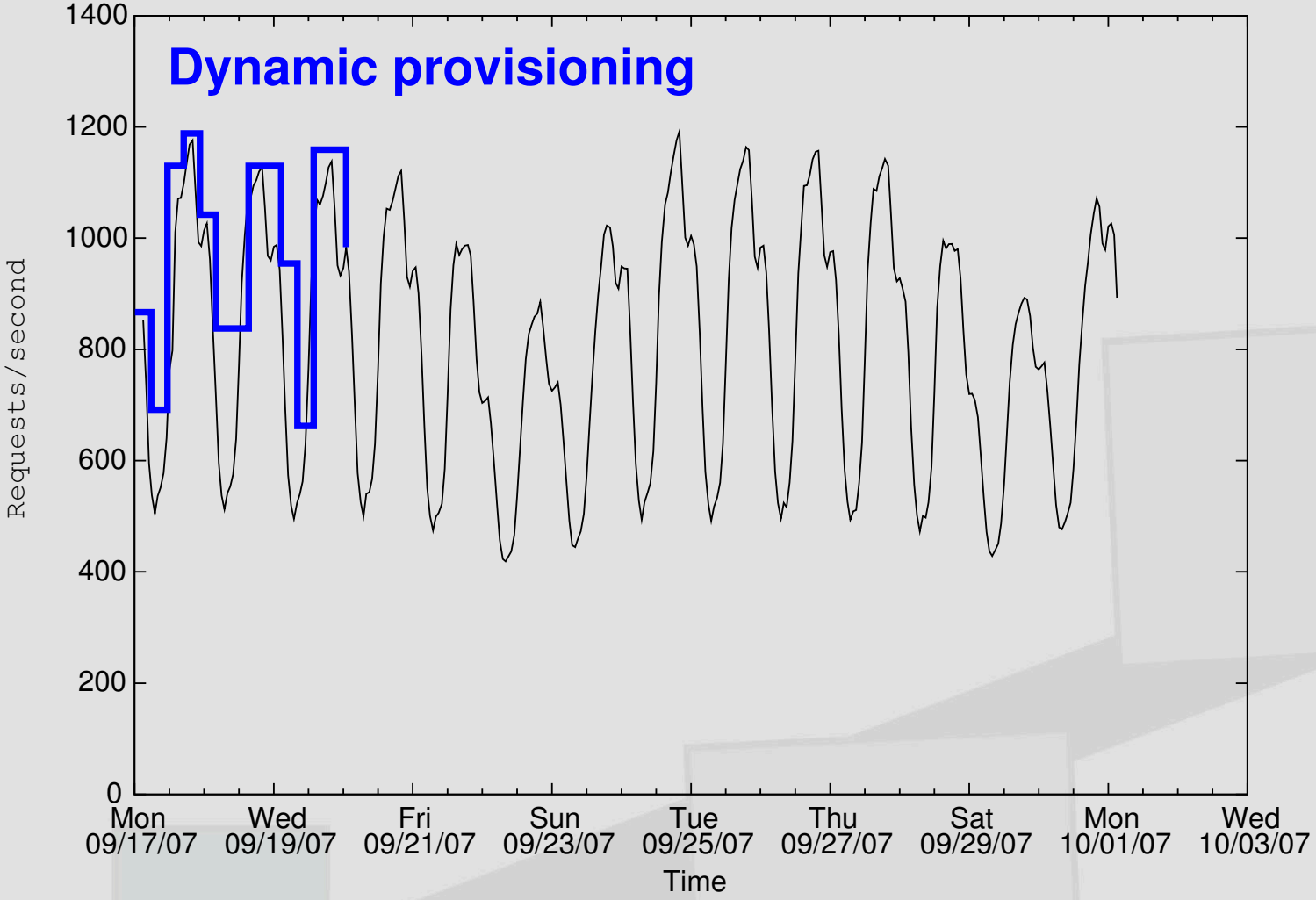
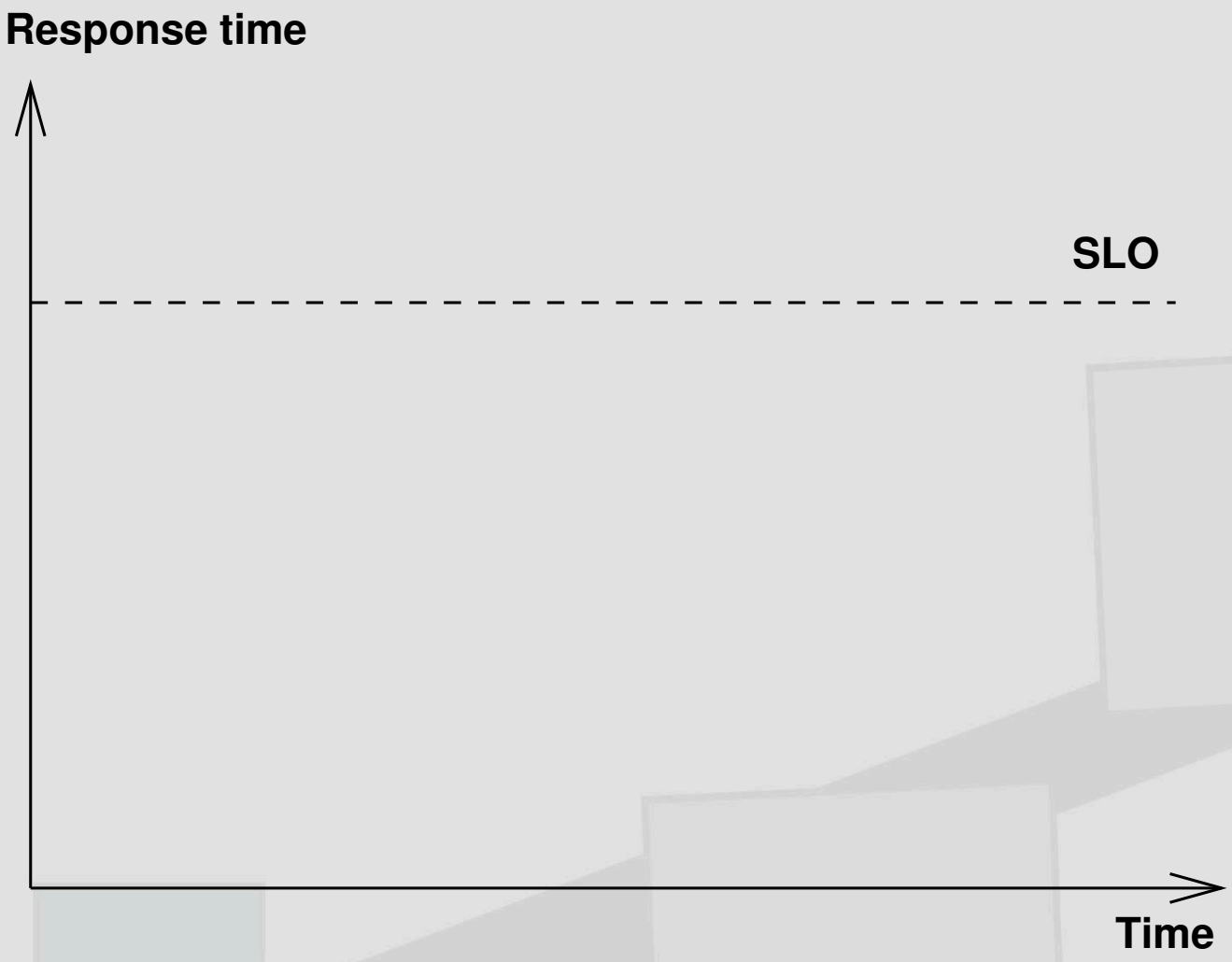


Dynamic resource provisioning



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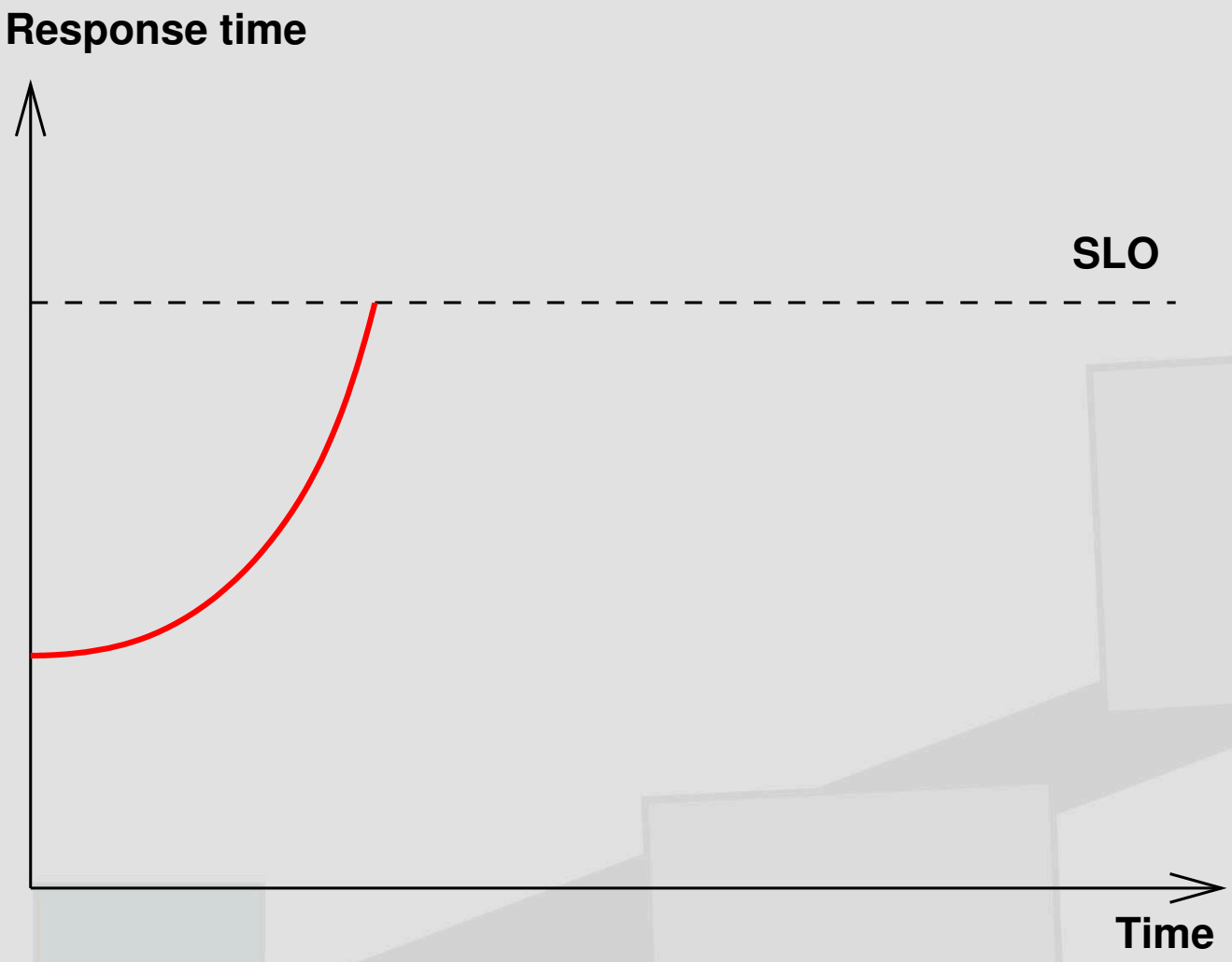

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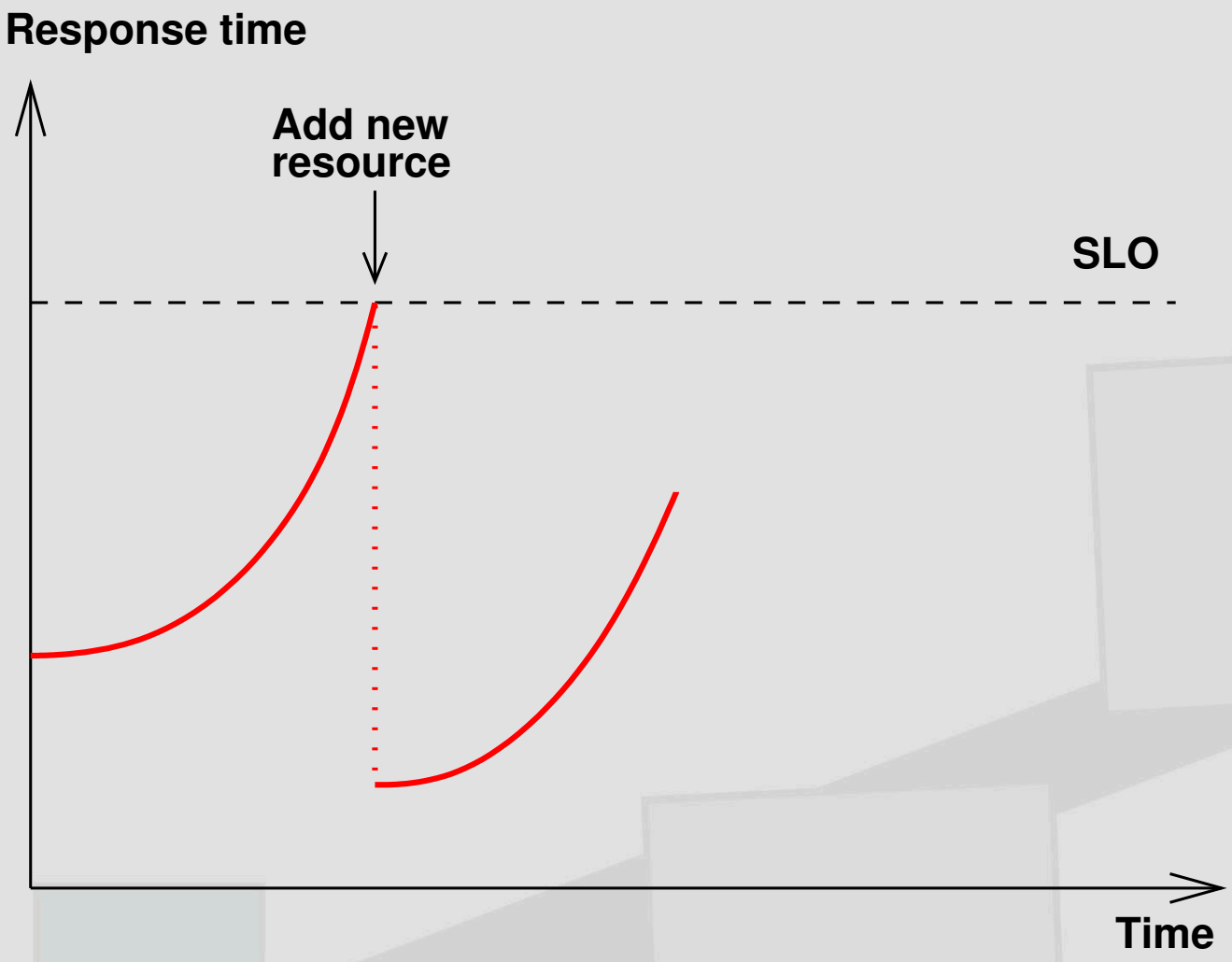

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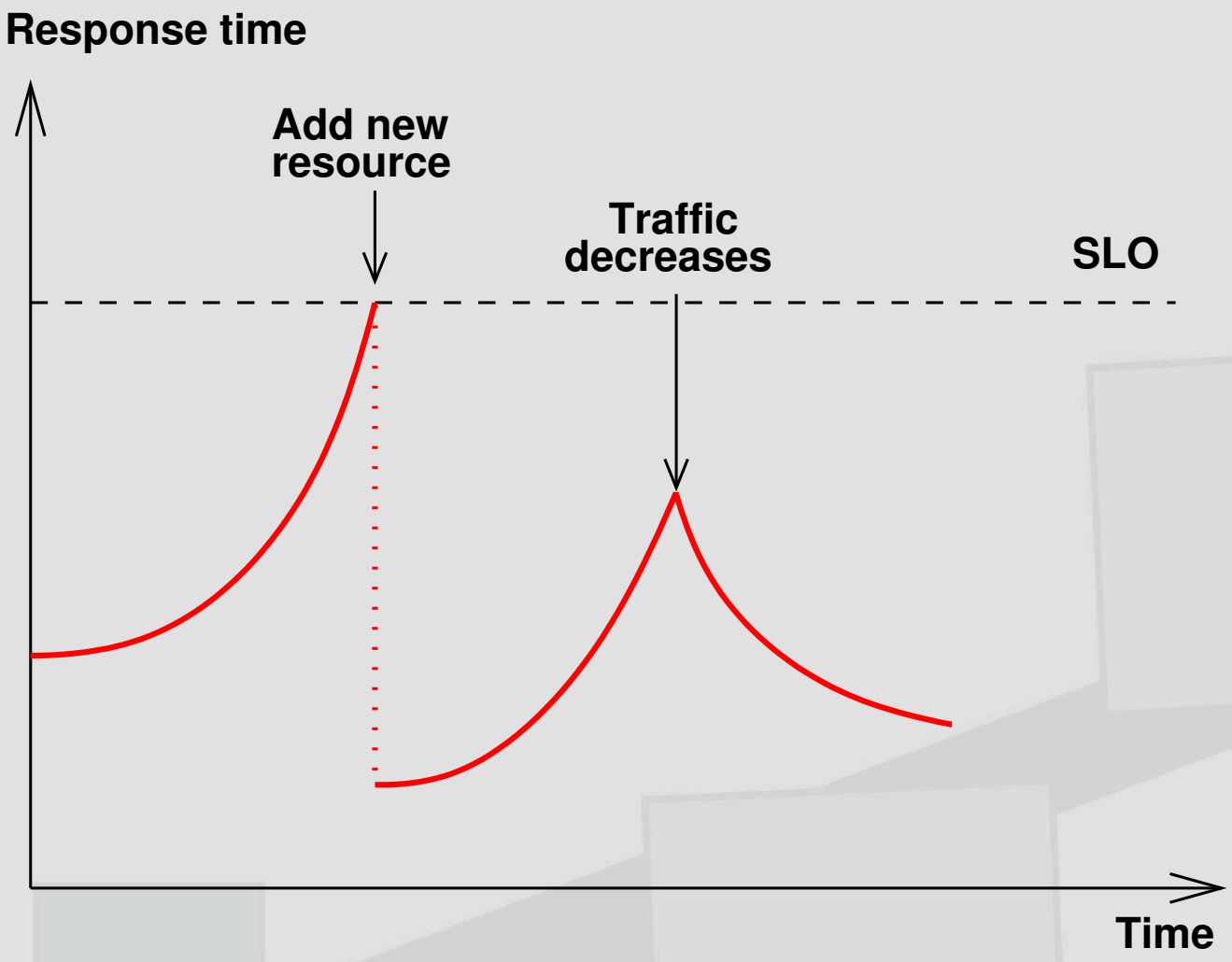

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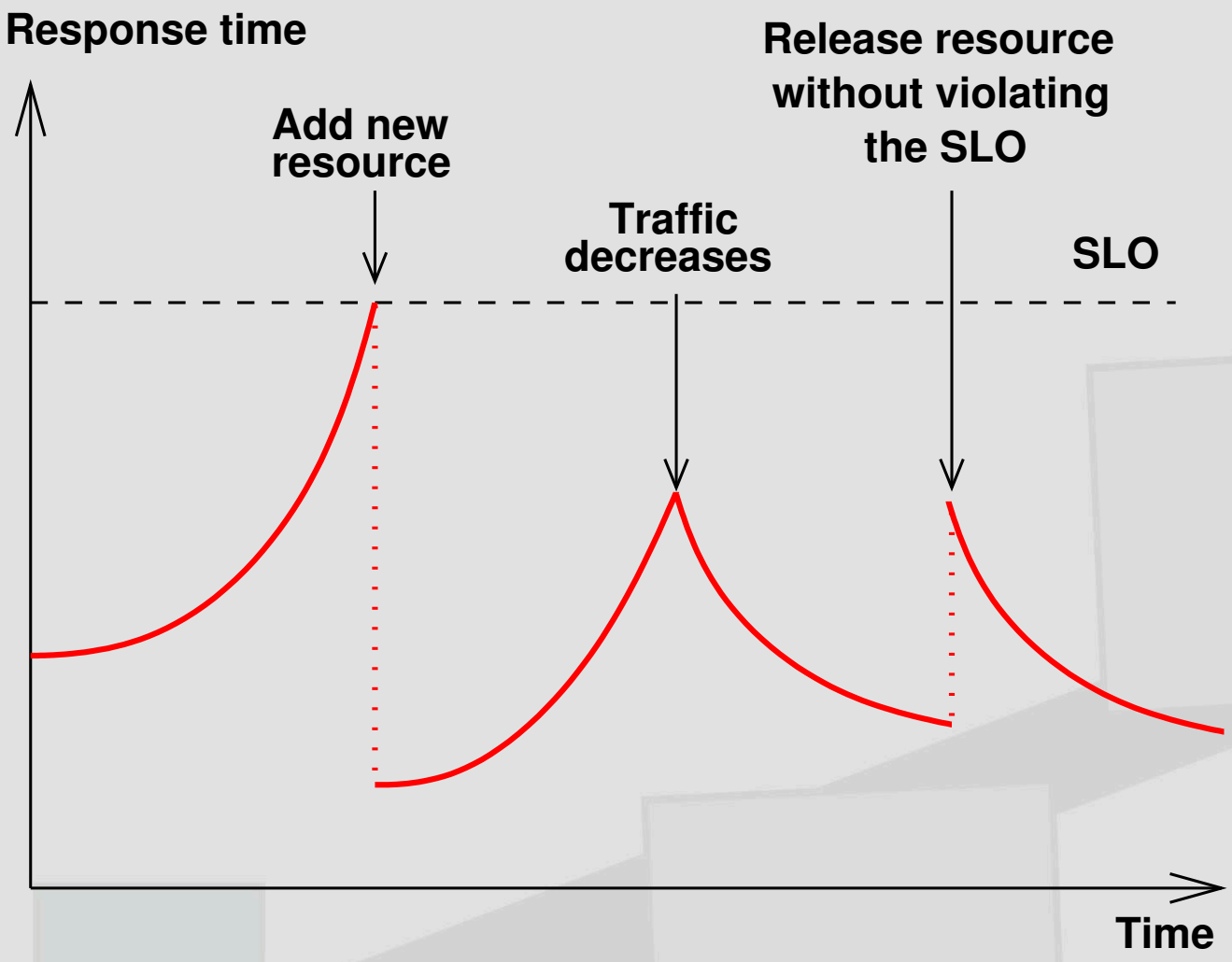
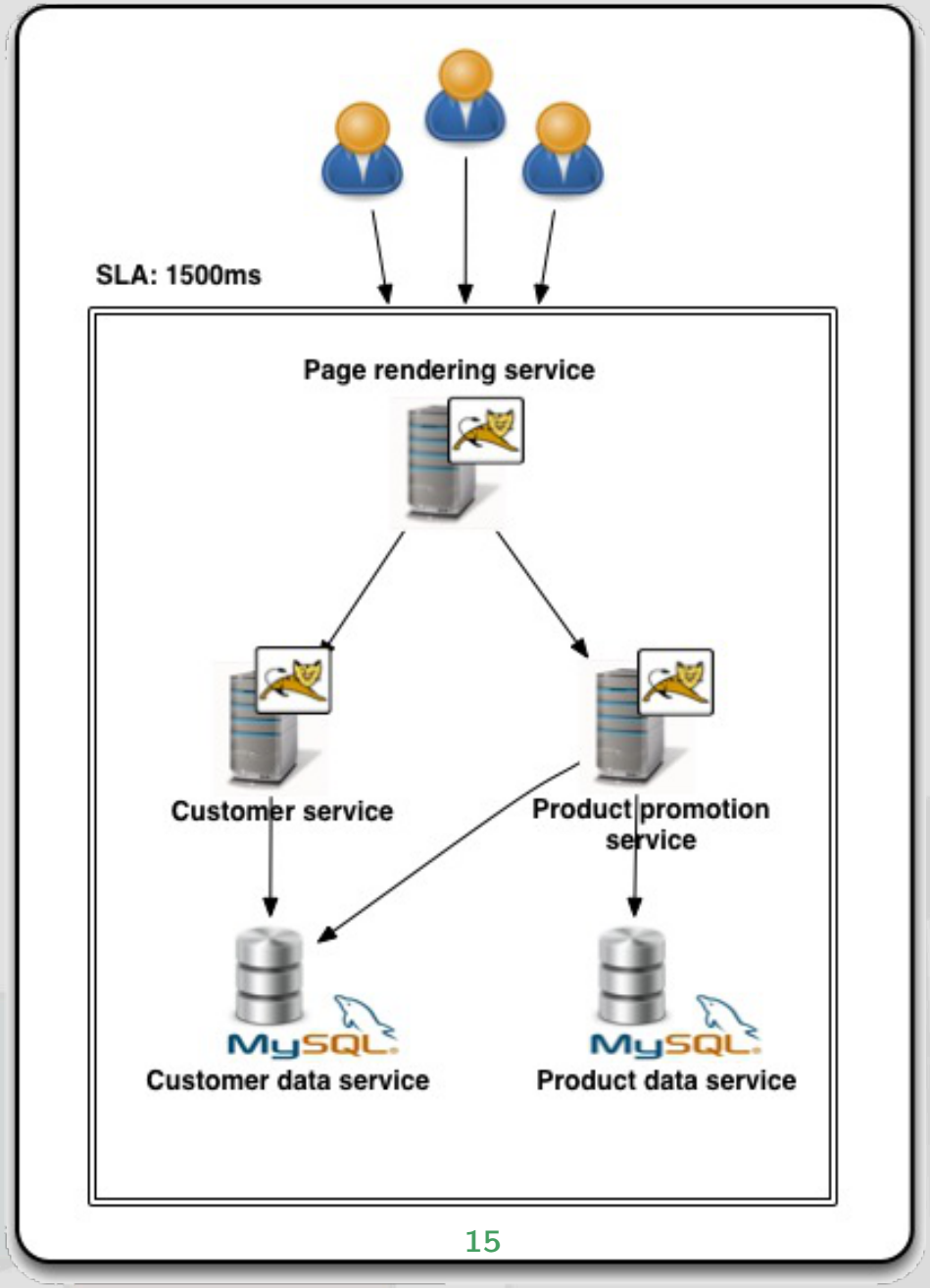


Provisioning in a multi-service Web application



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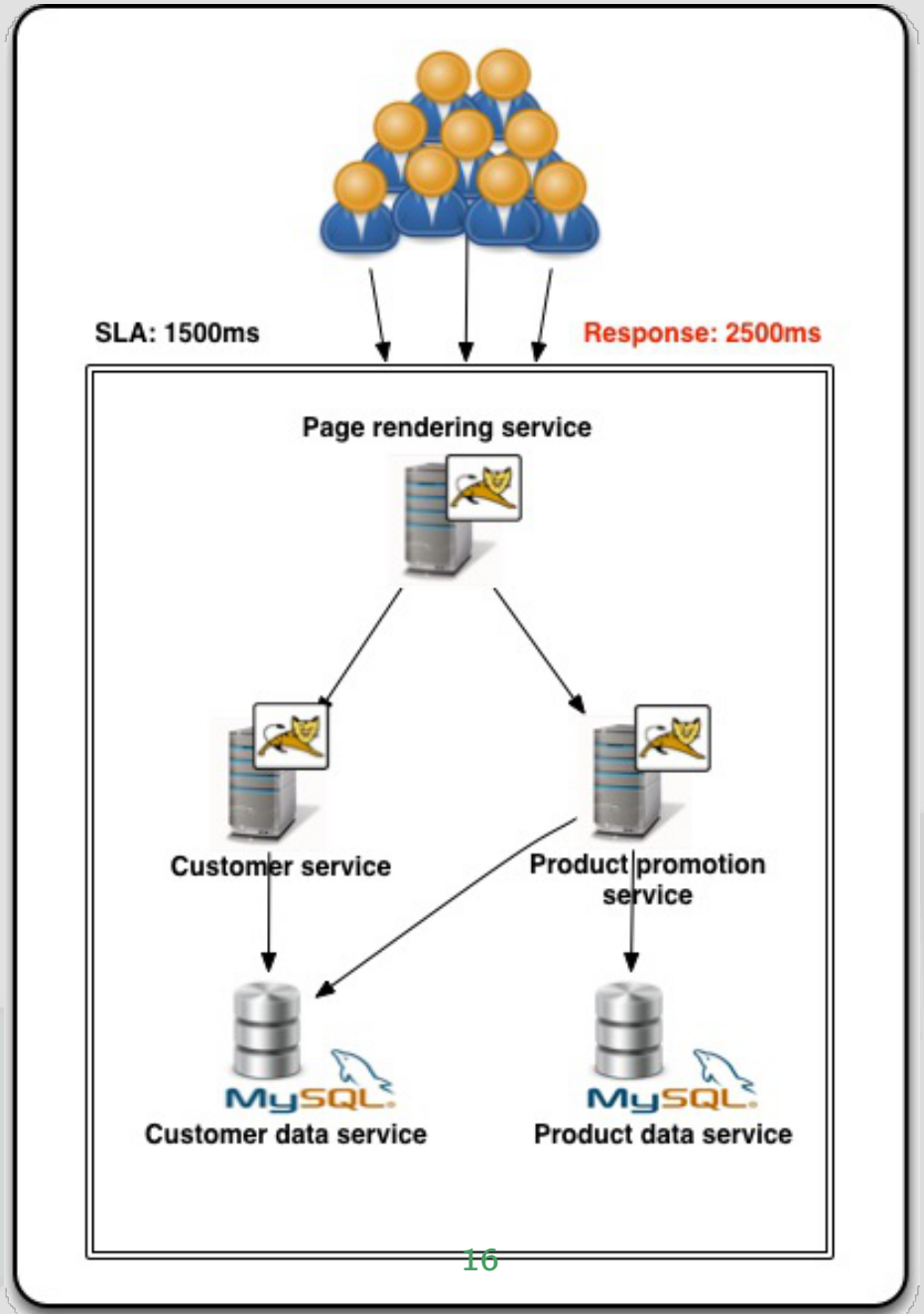

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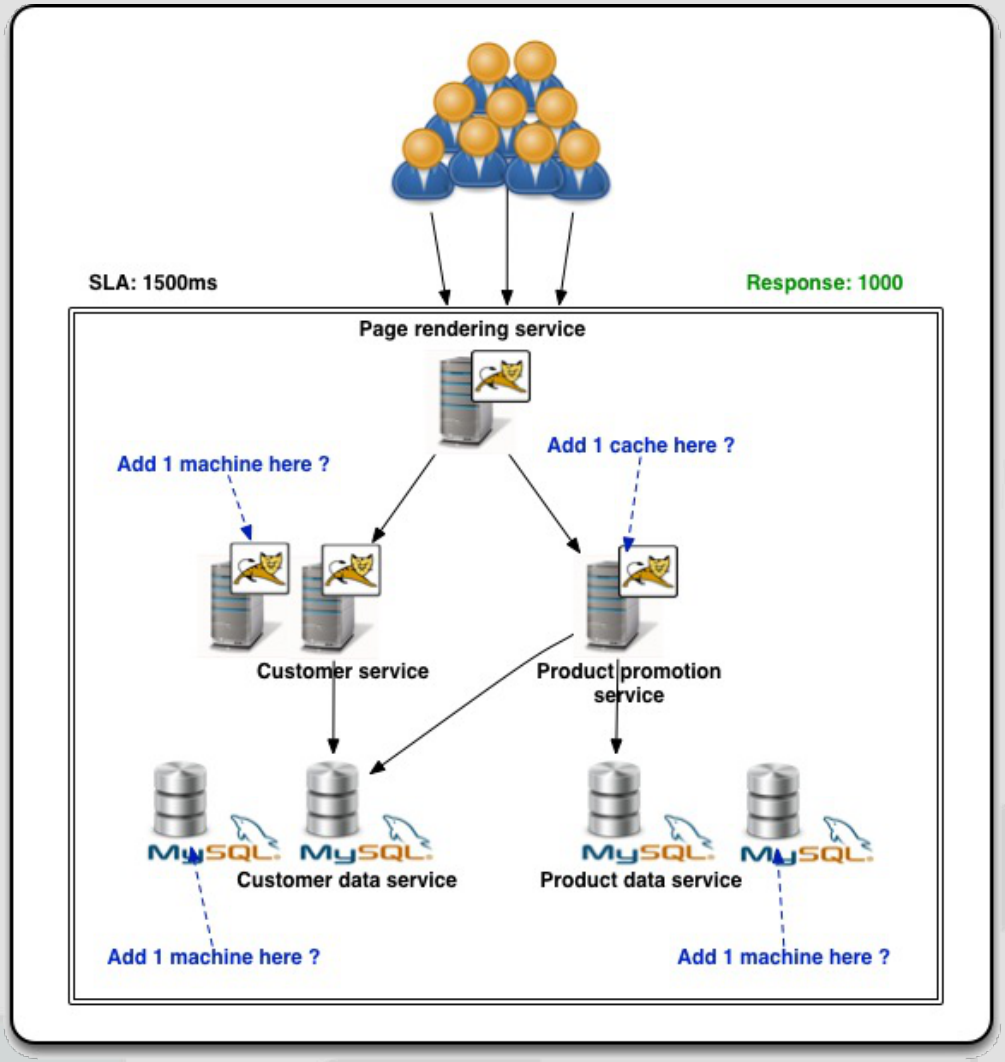
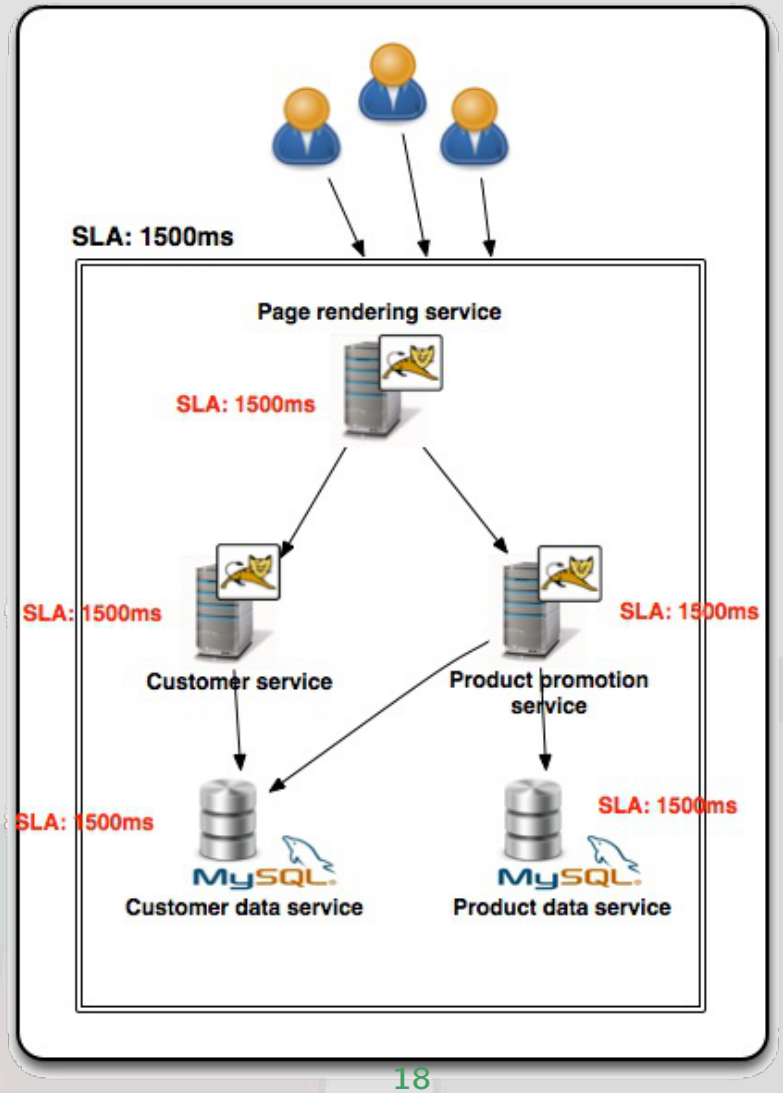


When the application needs more capacity, where should I place extra resources?

Classical solutions

- Threshold rules-based resource provisioning systems
  - Impose an SLO to each service individually



Classical solutions

- Threshold rules-based resource provisioning systems
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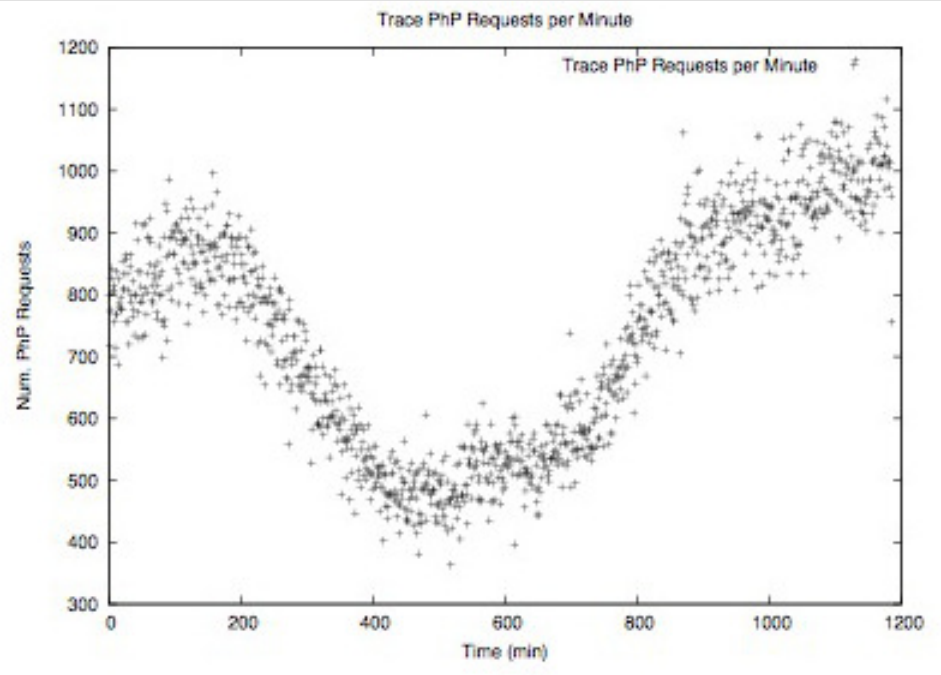

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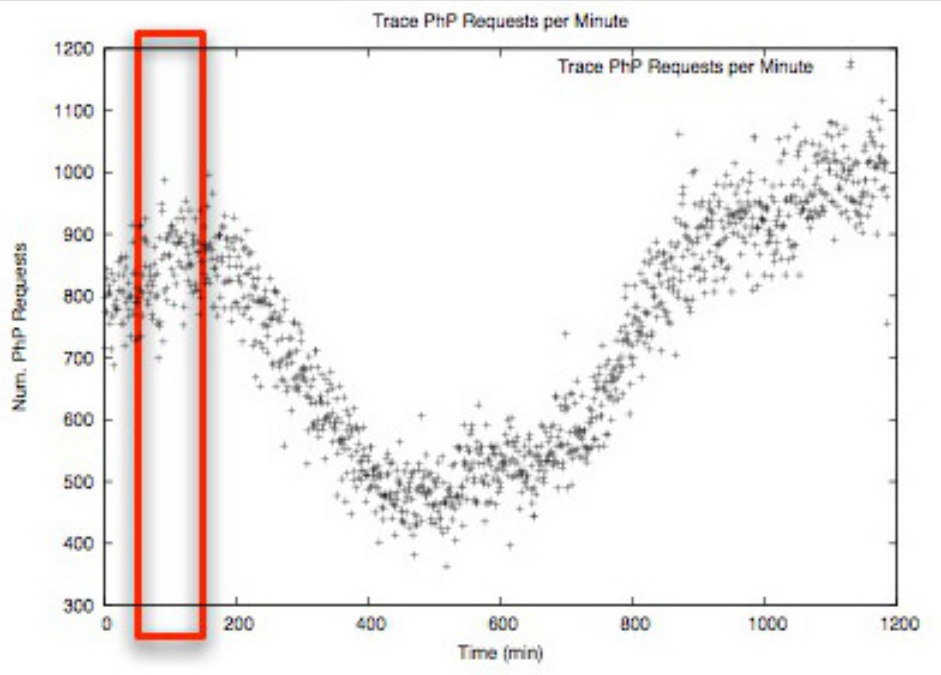

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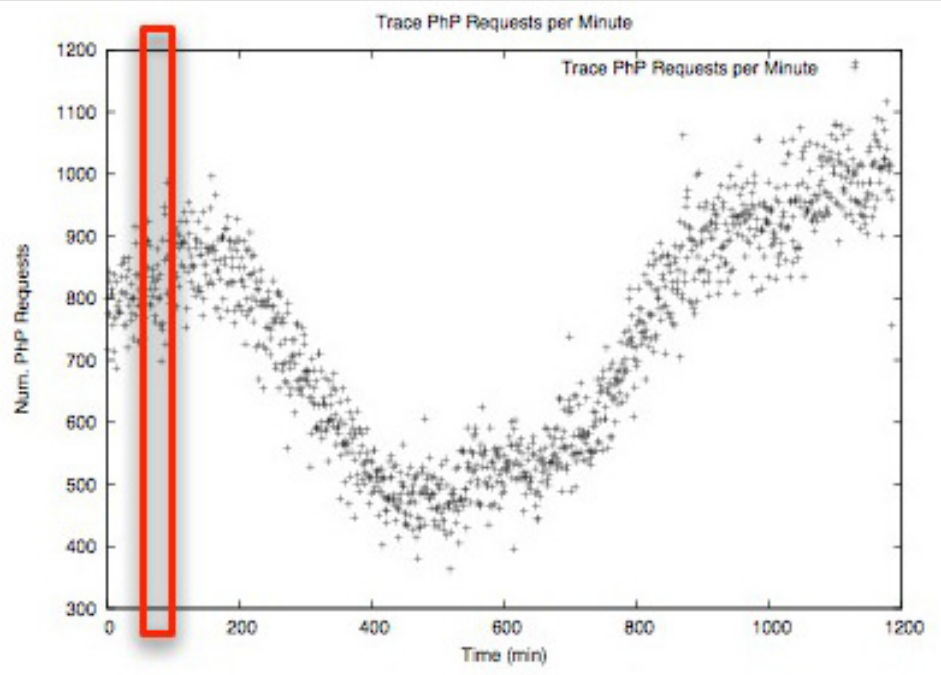

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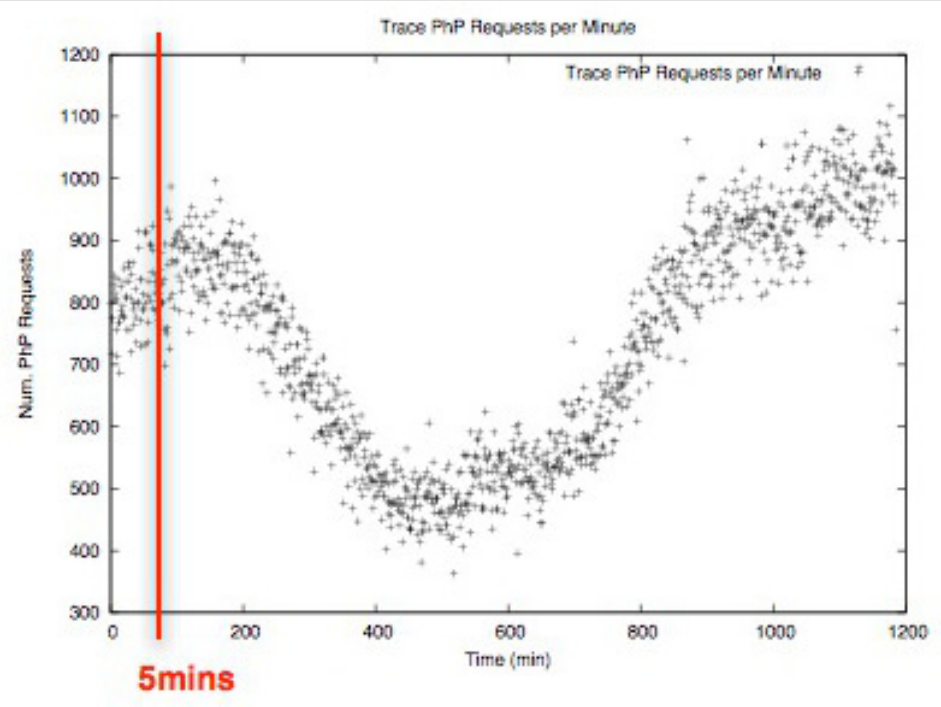


Classical solutions

- Threshold rules-based resource provisioning systems
  - Impose an SLO to each service individually
  - Scaling decisions are based on the actual workload burst
  - Examples: RightScale, OpenShift, Auto Scaling Amazon, etc ...

- Advantages
  - Each service can be scaled in isolation
  - Easily interpreted by non specialists
- Disadvantages
  - Only system-level performance constraints (CPU usage and Resp. time)
  - Easy target to temporal bursty variations in the workload
  - VM performance heterogeneity
  - Overall performance is suboptimal: SLO for backend services

ConPaaS: Auto-scaling System

- Profiling-based resource provisioning system
  - Extend the threshold rules-based system using profiling techniques
    - VM performance profiling
  - Impose an SLO to the front-end service only
  - Scaling decisions are based on the most recent workload history
- Advantages
  - Services collaborate to maintain the SLO at min. cost
  - VM performance heterogeneity
  - Application-specific performance constraints
  - Avoid flash crowds and slashdot effects
- Disadvantages
  - Best-effort in terms of SLA fulfillment

VM performance profiling

Purpose: To estimate the application response time that a certain VM will provide under a given workload.

Online profiling:

- Idea: while the application is in use, we direct a number of specified request workloads to the tested VMs and measure the response time
- Usage:
  - to dynamically adjust the load balancing weights of the provisioned VM's
  - to refine the conditions for scaling out/back
- Implementation: through a customized web load balancer

VM performance profiling

Purpose: To estimate the application response time that a certain VM will provide under a given workload.

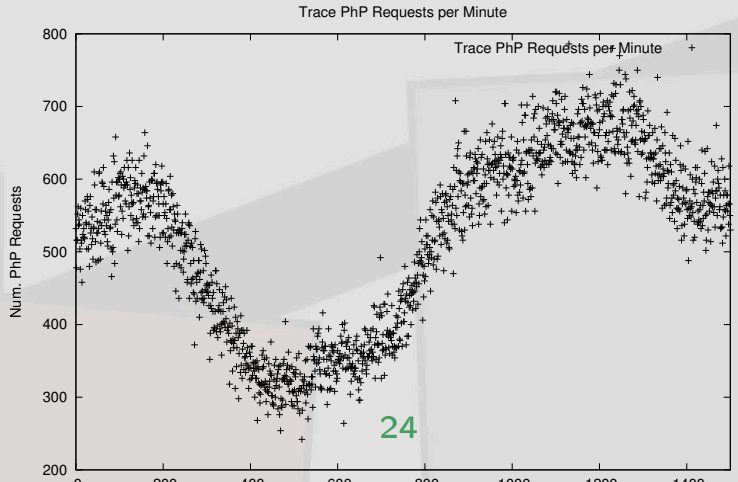
Offline profiling:

- Idea: to gather information about VM instances to have an initial assessment of their throughput.
- Usage:
  - to select the suitable set of VMs for an initial configuration
  - to define the flexible threshold ranges for each VM's instance
- Implementation: through training

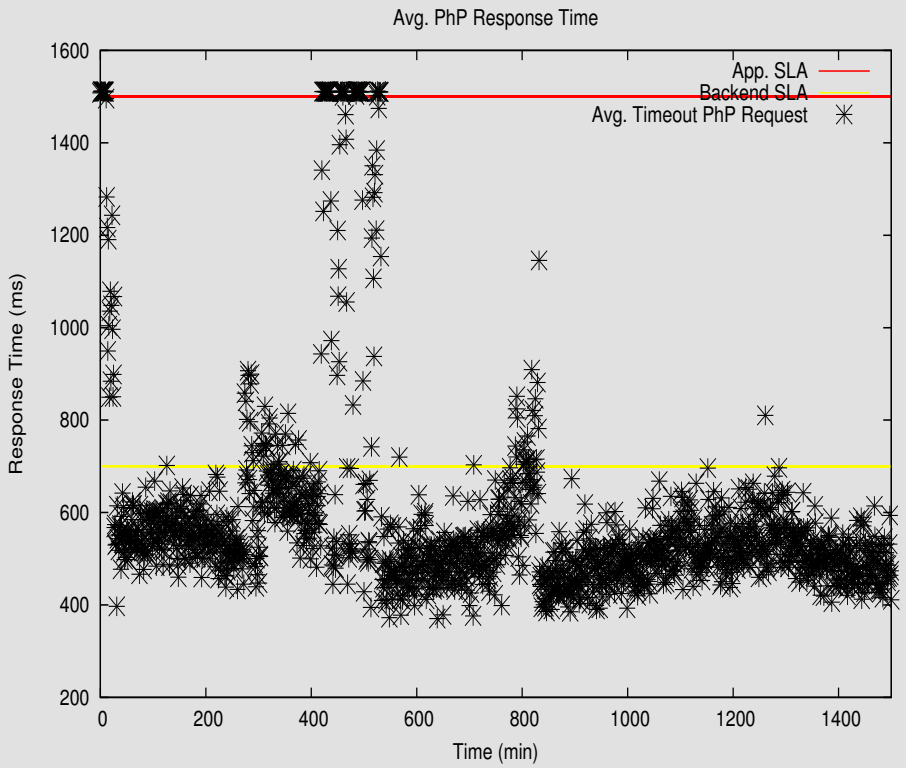
Preliminary Experimental Results

Purpose: Compare the behavioral pattern between the threshold-based and profiling-based (using the PhP web hosting service)

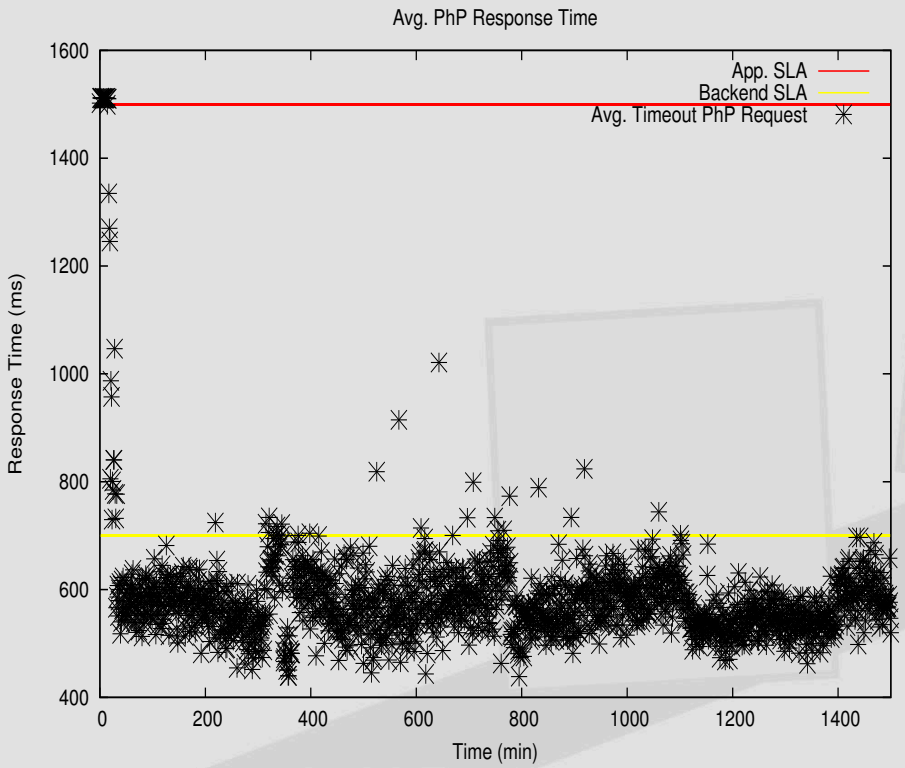
- Application: Wikipedia services - Mediawiki
  - English Wikipedia articles data (approx. 20Gb)
- Monitoring:
  - Ganglia (http://ganglia.sourceforge.net/)
  - Modules to monitor web-specific metrics
- Testing: Wikibench, a Wikipedia-based benchmark
  - Real access traces
- Enviroment: Amazon Elastic Cloud Compute



SLA Fulfillment (only PhP requests)

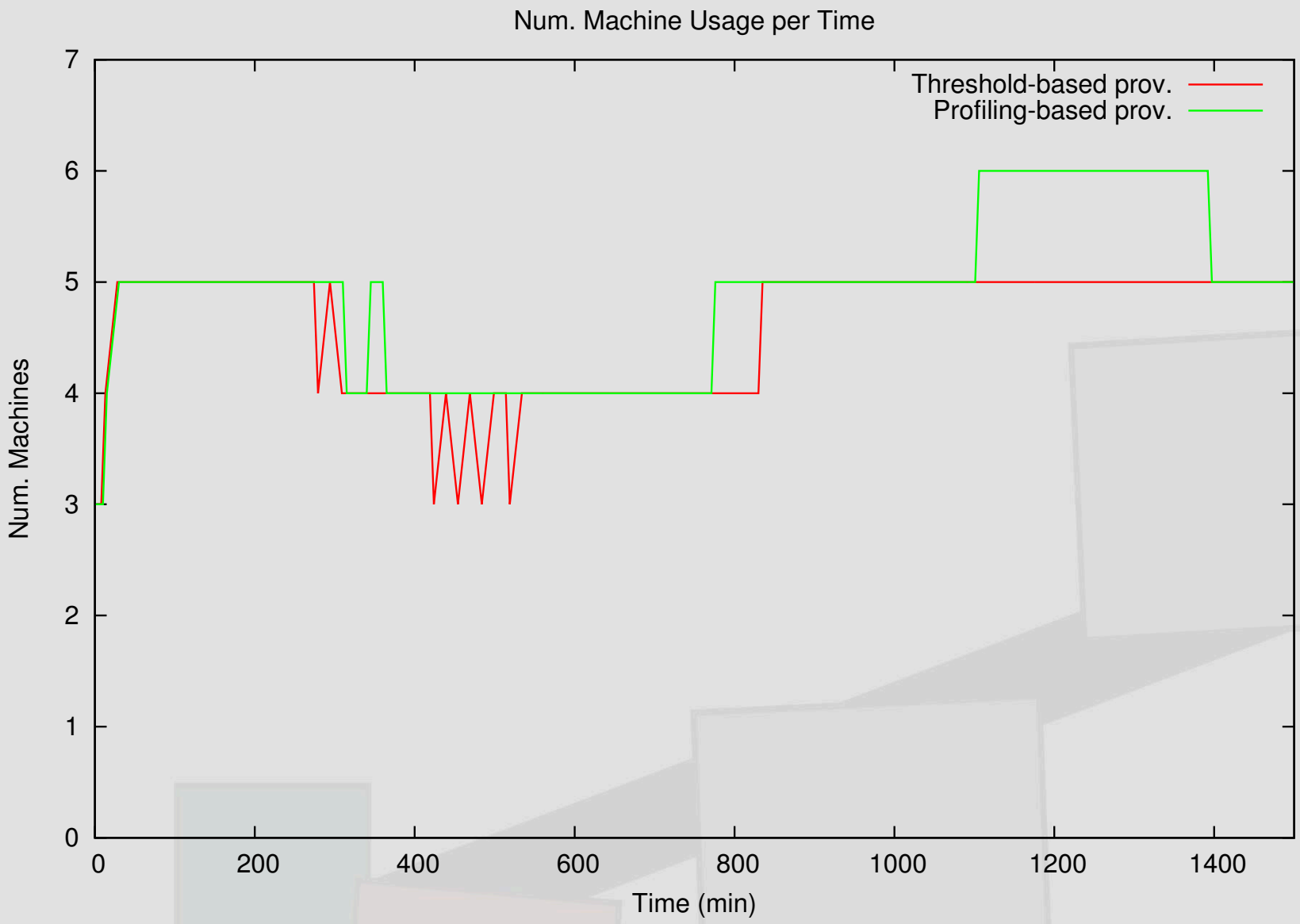


Threshold rules-based



Profiling-based

Resource Consumption



Conclusion

- ConPaaS is a platform-as-a-service environment
  - Designed to facilitate elastic application hosting in the cloud
    - Auto scaling system: Trade-off between SLA fulfillment and resource consumption
  - Designed to be easily extensible

- ConPaaS addresses two major classes of applications:
  - Web applications
  - Scientific applications
  - Combinations of both

- **ONGOING WORK**:
  - Online profiling when adding/removing VMs
  - Offline profiling to establish flexible threshold ranges
  - Vertical scaling (up/down)
  - Cost-aware resource provisioning

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EC 7th Framework Programme

Funded under: FP7 (Seventh Framework Programme)
Area: Internet of Services, Software & Virtualization (ICT-2009.1.2)
Project reference: FP7-IST-257438
Total cost: 11.29 million euro
EU contribution: 8.3 million euro
Execution: From 2010-10-01 till 2013-09-30
Duration: 36 months
Contract type: Collaborative project (generic)

The ConPaaS Front-End

ConPaaS - management in

10.100.0.97:9999/login.php

ConPaaS

ConPaaS is the Platform-as-a-Service component of the Contrail E.U. project.

ConPaaS aims at facilitating the deployment of applications in the cloud. It provides a number of services to address common developer needs. Each service is self-managed and elastic:

- it can deploy itself on the cloud
- it monitors its own performance
- it can increase or decrease its processing capacity by dynamically (de-)provisioning instances of itself in the cloud

Login

username

password

login register

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Register

username

email

password

retype password

first name

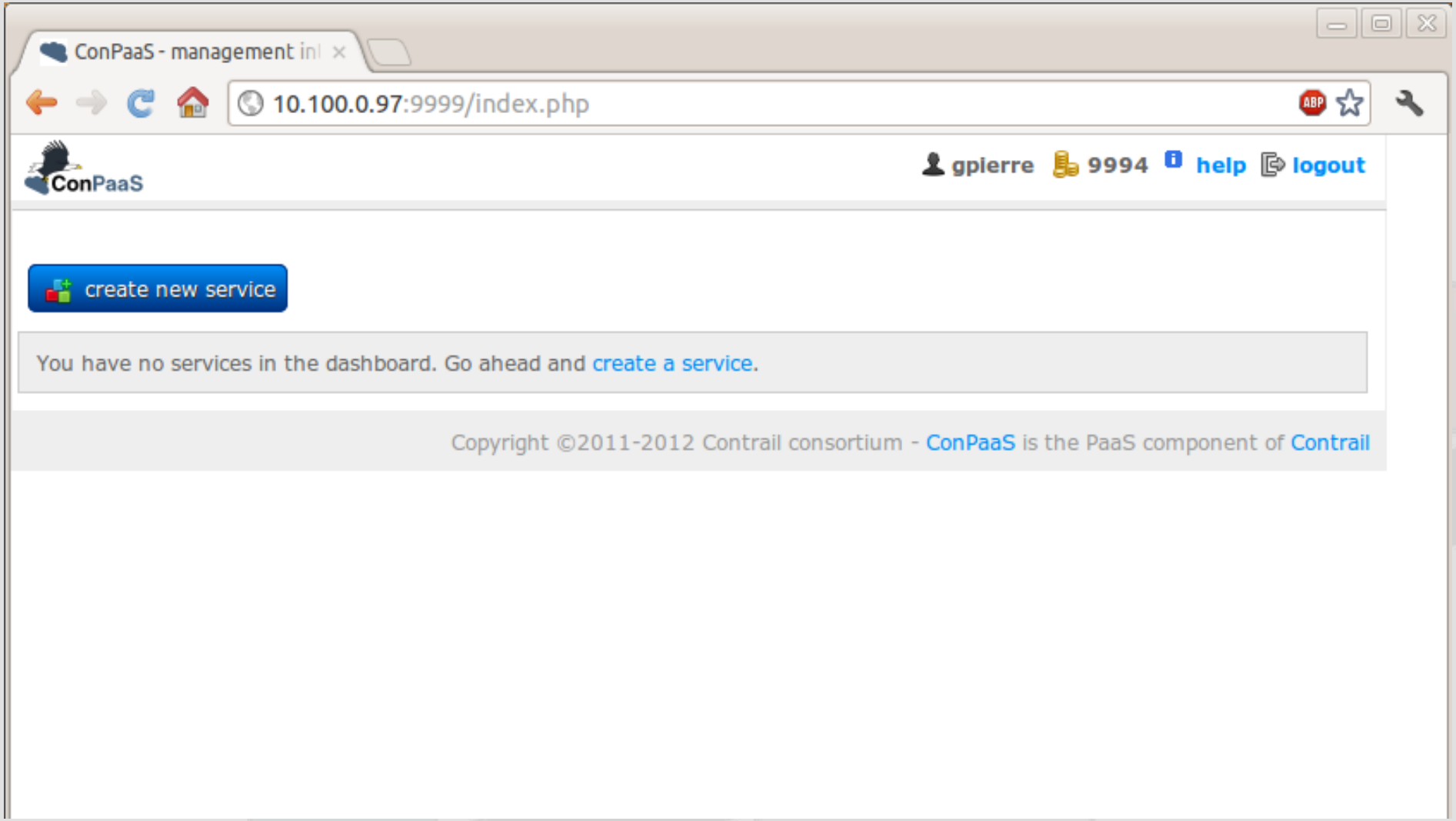
last name

affiliation

Type the two words:

reCAPTCHA™ stop spam. read books.

The ConPaaS Front-End



The ConPaaS Front-End

ConPaaS - create new serv

10.100.0.97:9999/create.php

ConPaaS

gpierre 9999 help logout

please select one of the services below

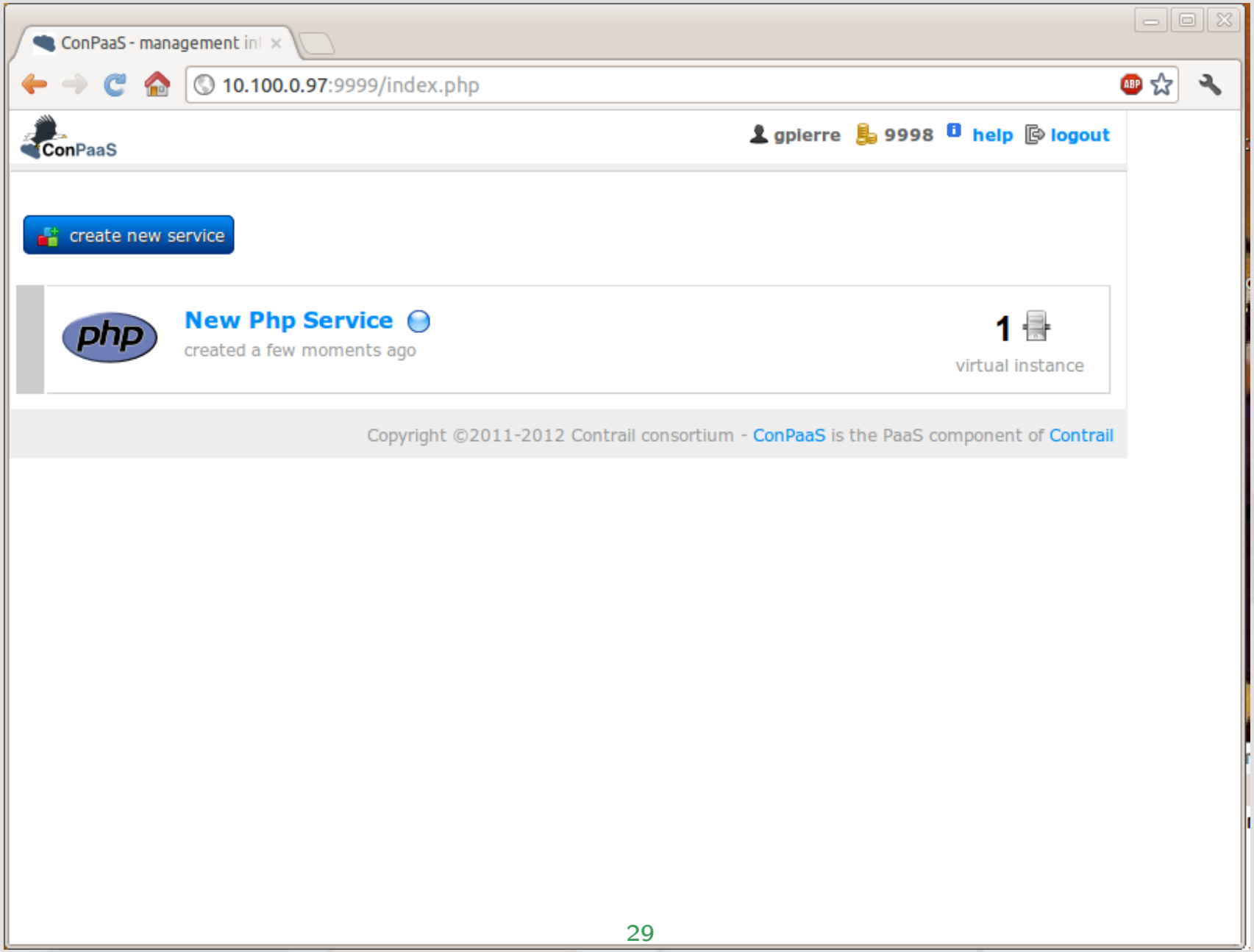
php	**php**	PHP version 5.2 under Nginx
	java	Java Servlet container using Apache Tomcat 7.2
MySQL	**mysql**	MySQL 5.2 Database
Scalarix	**scalarix**	in-memory key-value store
	map-reduce	Hadoop MapReduce cluster
	task farm	Service for running bags of tasks
Se	**selenium**	Selenium functional testing service

cloud provider OpenNebula / Amazon EC2 — Only OpenNebula is enabled on this deployment

create service

javascript: void(0);

The ConPaaS Front-End



The ConPaaS Front-End

ConPaaS - management ini

10.100.0.97:9999/service.php?sid=6

ConPaaS

gpierre 9998 help logout

back to Dashboard

New Php Service start terminate

manager log

initialized · init a few moments ago

1 instance running on OpenNebula

Instance 15751 manager 10.100.0.20

running

Code management

you may update the stage by

uploading archive

or by

checking out repository

Choose File No file chosen

example: .zip, .tar of your source tree

available code versions

code-default code-default.tar • **active** • download a few moments ago

Settings

Software Version 5.3

Maximum script execution time 30 seconds

Memory limit 128M

The ConPaaS Front-End

ConPaaS - management ini

10.100.0.97:9999/service.php?sid=6

ConPaaS

gpierre 9997 help logout

back to Dashboard

New Php Service stop

access application · manager log

running · started a few moments ago

2 instances running on OpenNebula

Instance 15751 manager 10.100.0.20
running

Instance 15752 proxy web php 10.100.0.21
running

add or remove instances to your deployment

0 proxy 0 web 0 php submit

Code management access application

you may update the stage by
uploading archive
or by
checking out repository

Choose File No file chosen
example: .zip, .tar of your source tree

available code versions

code-default code-default.tar · **active** · download a few moments ago

Settings

The ConPaaS Front-End

ConPaaS - management in

10.100.0.97:9999/service.php?sid=6

ConPaaS

gpierre 9997 help logout

back to Dashboard

New Php Service stop

access application · manager log

running · started a few moments ago

2 instances running on OpenNebula

Instance 15751 manager 10.100.0.20
running

Instance 15752 proxy web php 10.100.0.21
running

add or remove instances to your deployment

0 proxy +2 web 0 php submit

The page at 10.100.0.97:9999

no. of instances (e.g. +1, -2)

+2

Cancel OK

Code management

ss application

you may update the stage by
uploading archive
or by
checking out repository

Choose File No file cho

example: .zip, .tar of your source tree

available code versions

code-default code-default.tar · **active** · download a few moments ago

Settings

Software Version 5.3

Maximum script execution time 30 seconds

Memory limit 128M

save

The ConPaaS Front-End

ConPaaS - management in

10.100.0.97:9999/service.php?sid=6

ConPaaS

gpierre 9994 help logout

back to Dashboard

New Php Service stop

access application · manager log

running · started a few moments ago

5 instances running on OpenNebula

Instance 15751 running	manager	10.100.0.20
Instance 15752 running	proxy	10.100.0.21
web		
Instance 15753 *running*		10.100.0.22
Instance 15754 *running*		10.100.0.23
Instance 15755 running	php	10.100.0.24

add or remove instances to your deployment

0 proxy 0 web 0 php submit

Code management access application

you may update the stage by

uploading archive

or by

checking out repository

Choose File No file chosen

example: .zip, .tar of your source tree

available code versions

code-default code-default.tar · **active** · download a few moments ago

Settings

The ConPaaS Front-End

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ConPaaS

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Instance 15752 proxy running		10.100.0.21
web		
Instance 15753 *running*		10.100.0.22
Instance 15754 *running*		10.100.0.23
Instance 15755 php running		10.100.0.24

add or remove instances to your deployment

0 proxy 0 web 0 php submit

Code management access application

you may update the stage by

uploading archive

or by

checking out repository

Choose File No file chosen

example: .zip, .tar of your source tree

available code versions

code-y3gOfl wbas.tar · set active · download	a few moments ago
code-default code-default.tar · **active** · download	a few moments ago

The ConPaaS Front-End