flexible autonomous datacenter resource management

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i3S

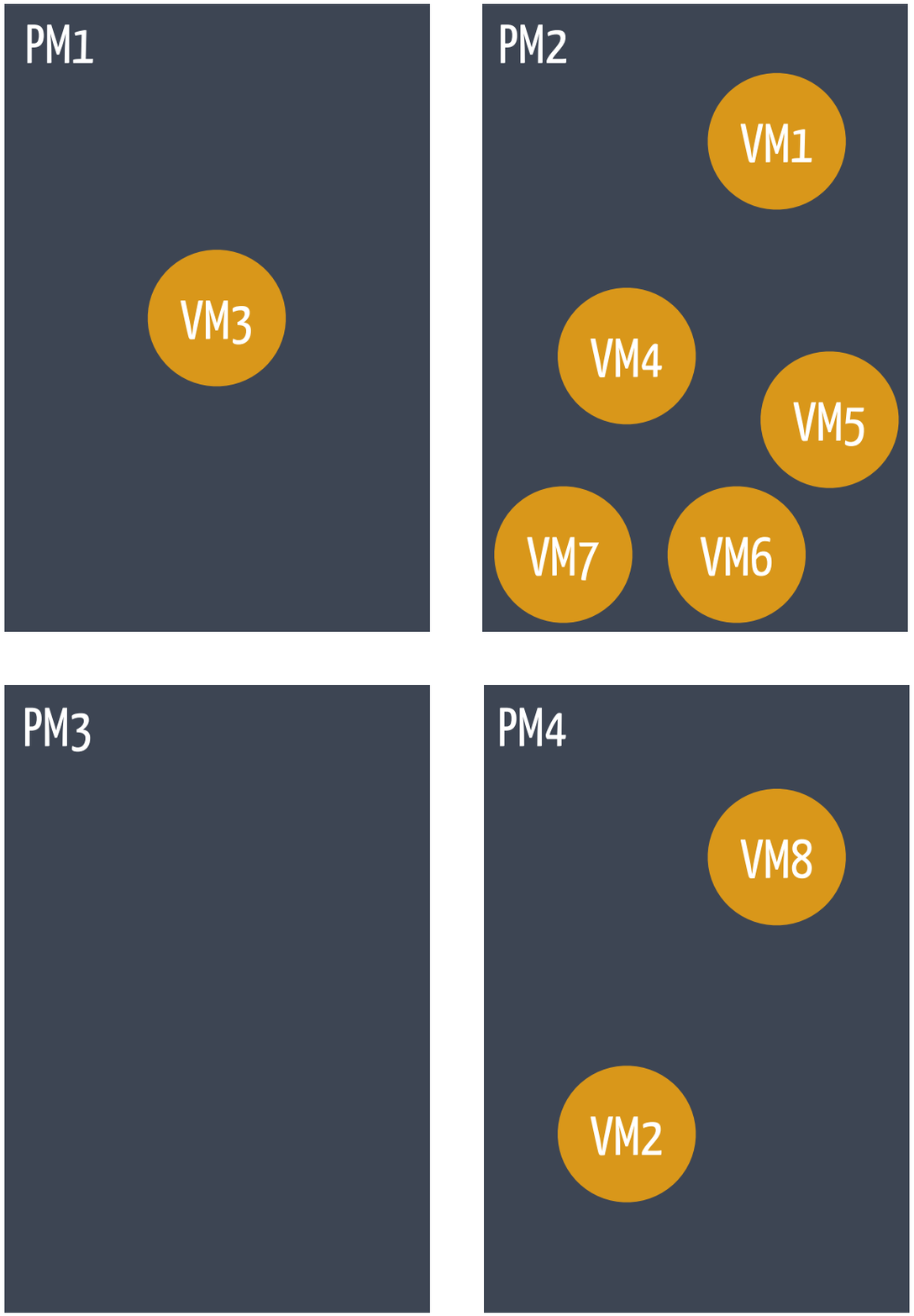
optimality

approximation

speed

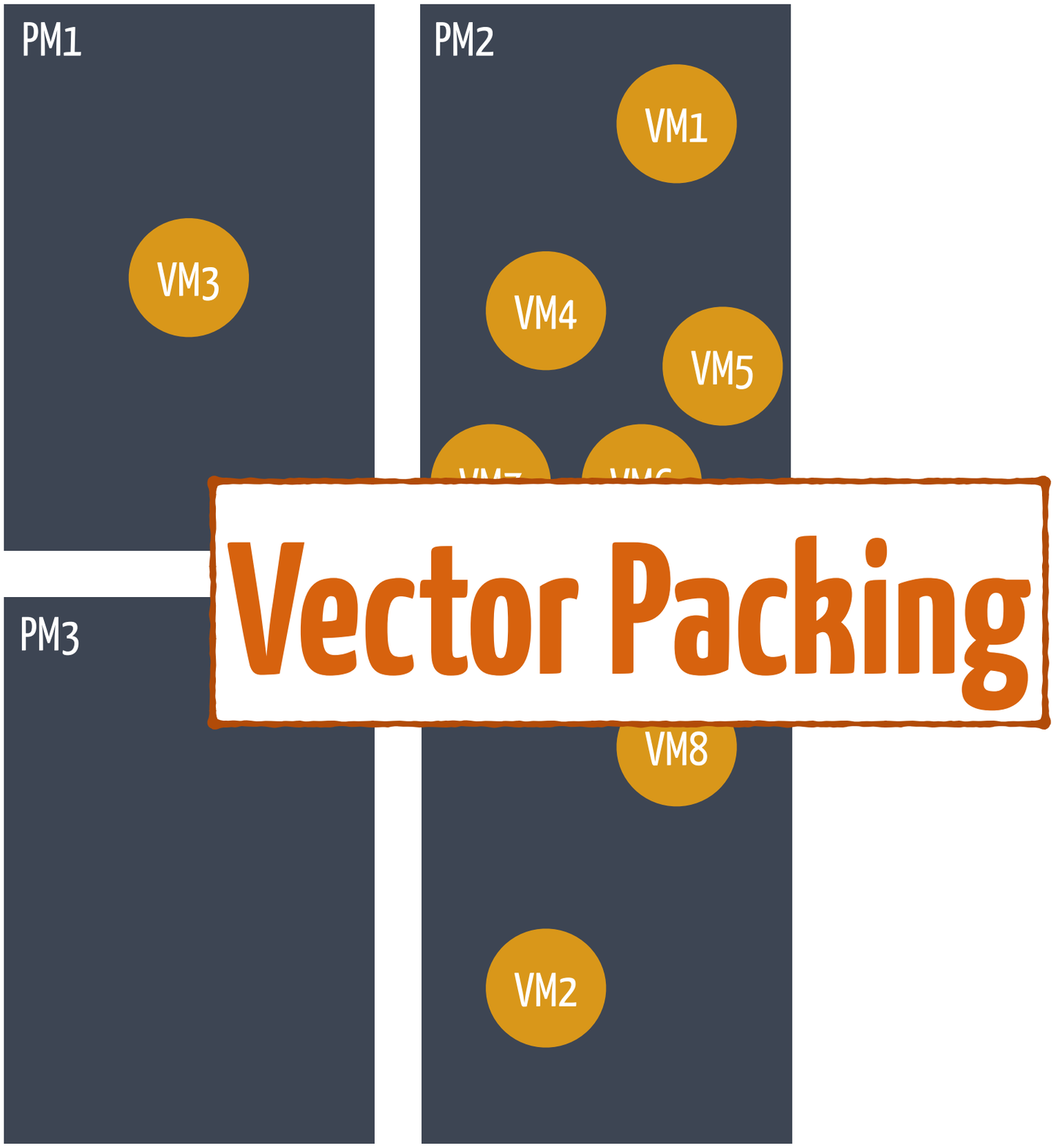
flexibility

datacenter resource management



Physical Machines (PM)

Virtual Machines (VM)

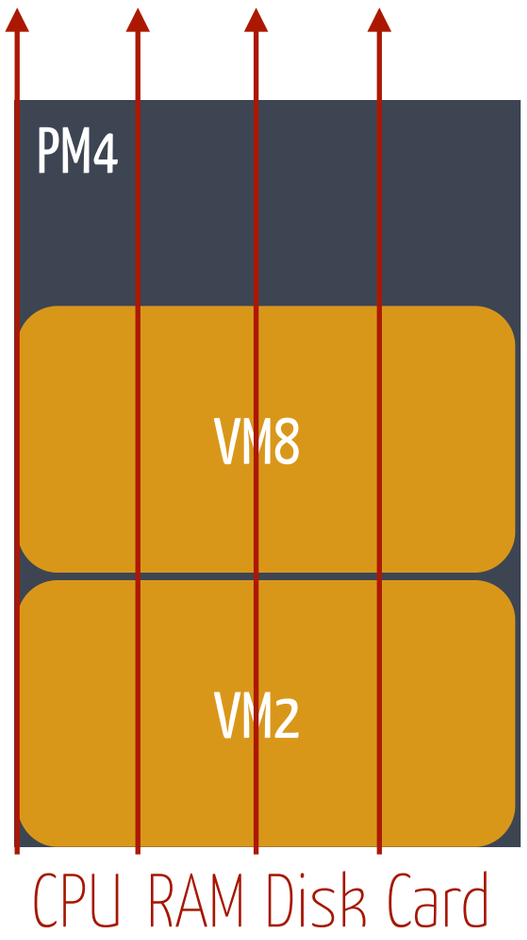


Vector Packing

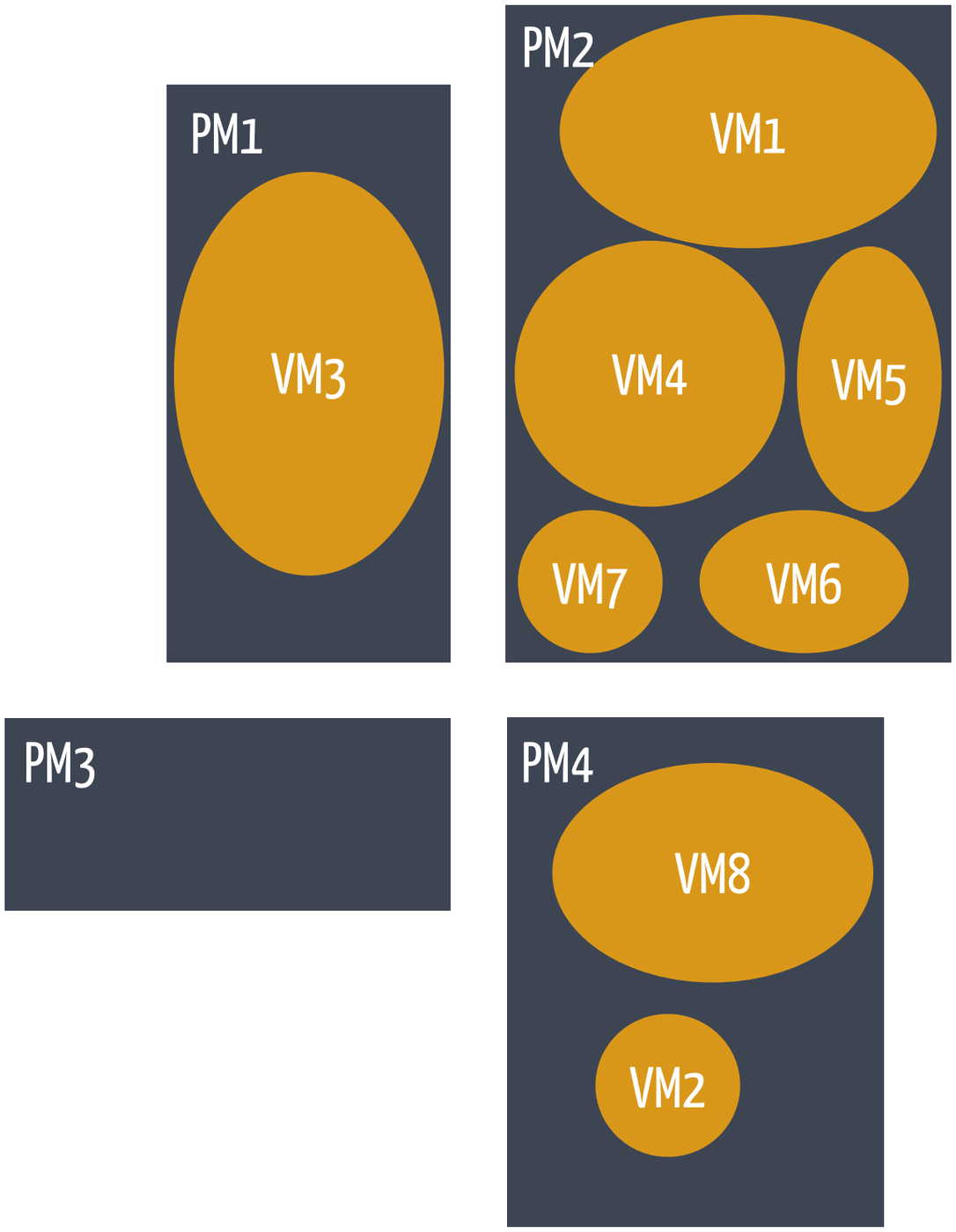
Physical Machines (PM)

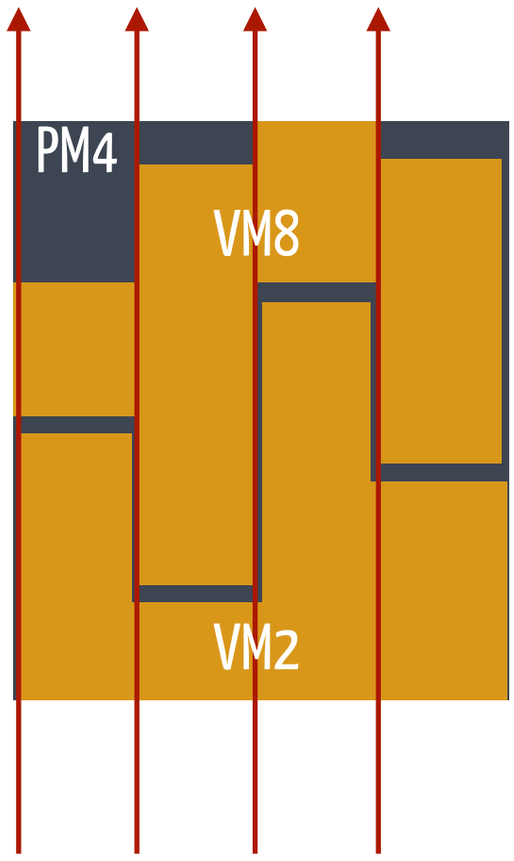
Virtual Machines (VM)

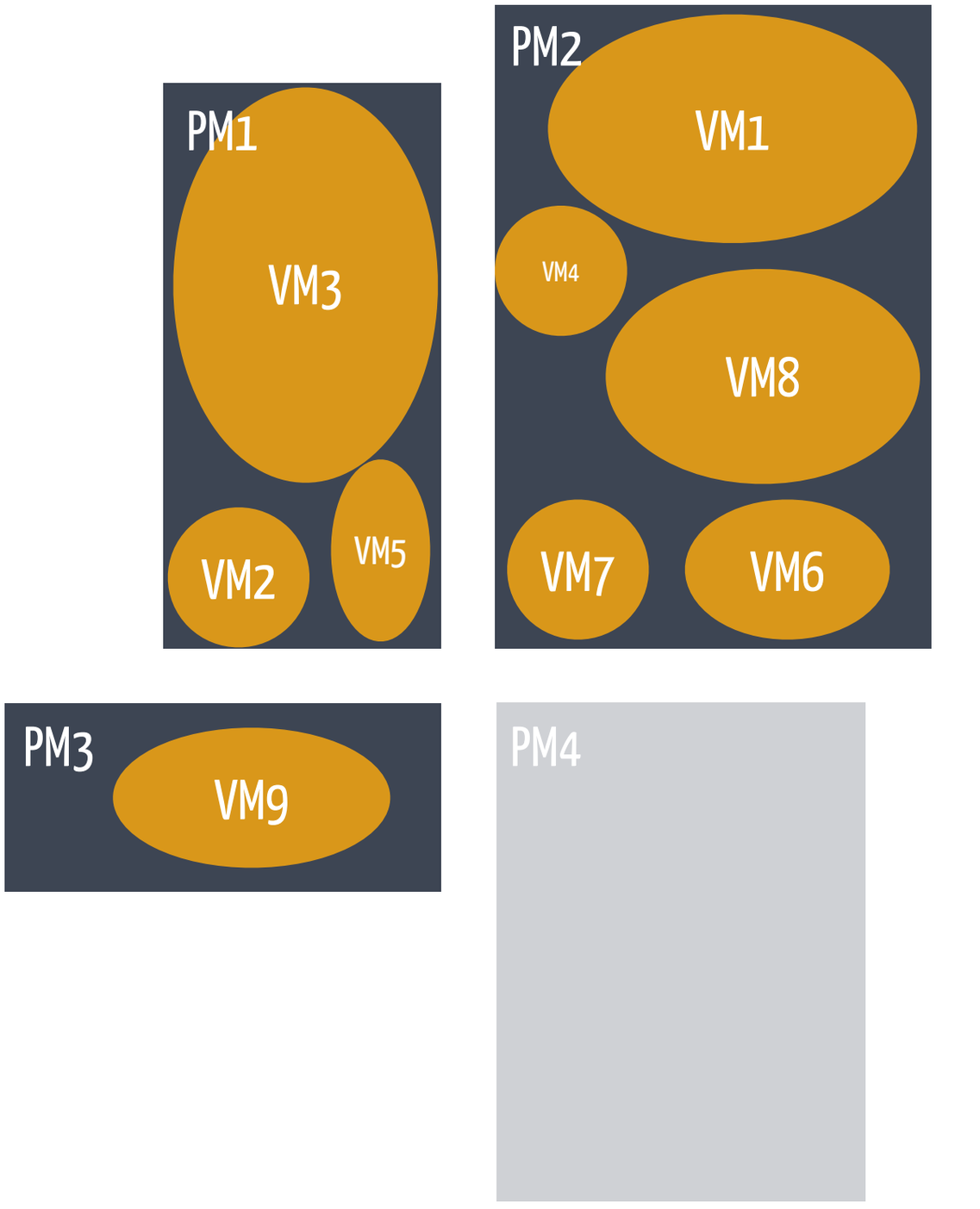
Resources



1 Heterogeneous







submissions
load change
failures

Dynamic?

launch
resize
stop
migrate off or live

reconfiguration actions

PM1

VM5

VM2

VM3

t

migrate

resize

relaunch

PM2

VM5

VM8

launch

PM3

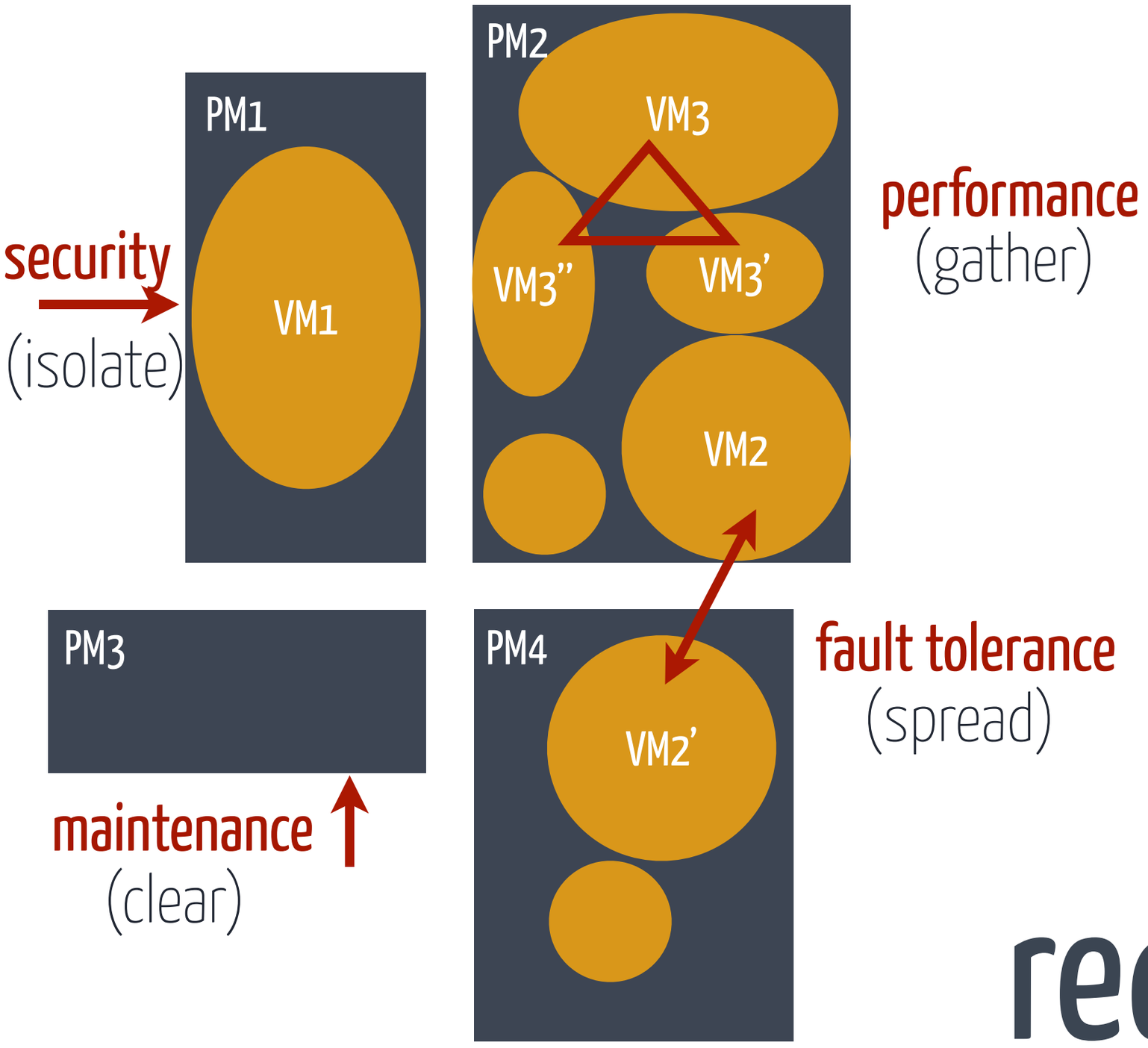
PM4

VM2

VM8

stop

Producer/Consumer Scheduling



3 User requirements

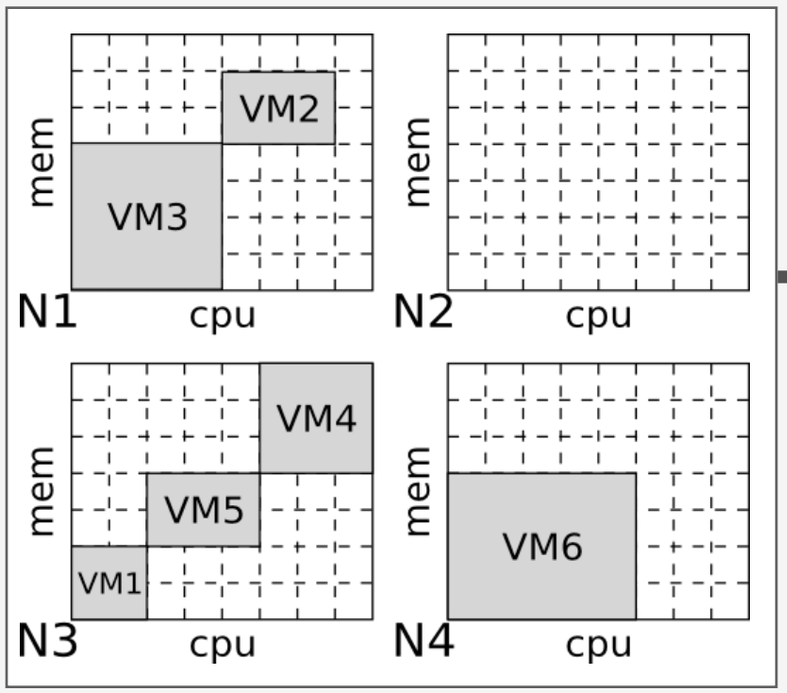
(heterogeneous & dynamic)

flexible

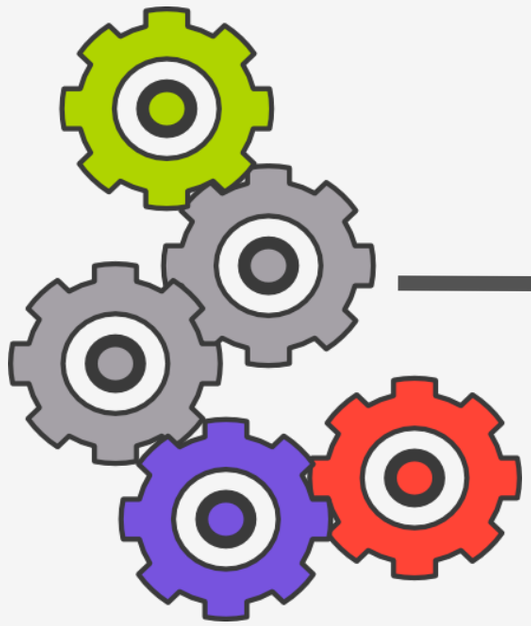
extensible (offline)

configurable (online)

An Open-Source flexible virtual machine scheduler



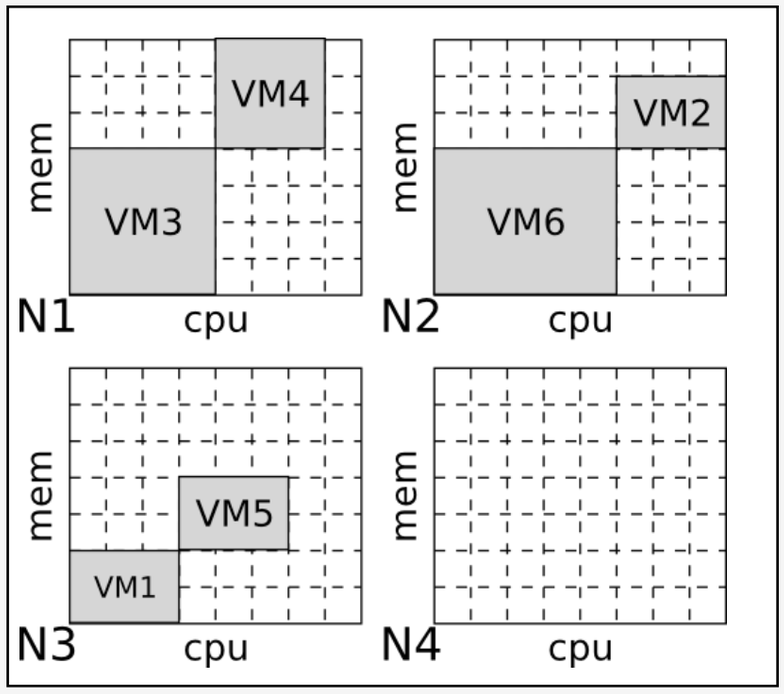

```
spread(VM[2..3]);
preserve({VM1},'ucpu', 3);
offline(@N4);
```



BtrPlace

The reconfiguration plan

```
0'00 to 0'02: relocate(VM2,N2)
0'00 to 0'04: relocate(VM6,N2)
0'02 to 0'05: relocate(VM4,N1)
0'04 to 0'08: shutdown(N4)
0'05 to 0'06: allocate(VM1,'cpu',3)
```

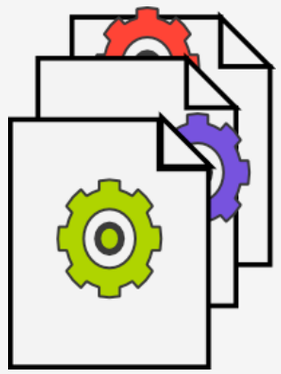


BtrPlace proposal

core reconfiguration algorithm

+

users scripts



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specialized reconfiguration algorithm

routines library

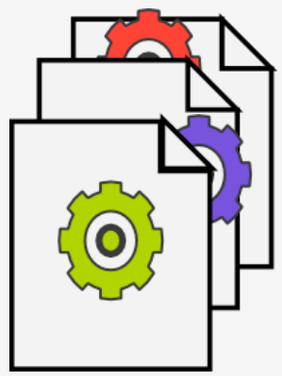
flexibility through constraint programming

packing + scheduling

core model

+

global constraints



Variables related to VM Management	
c^{host}	Current host of the VM (constant)
c^{mem}, c^{cpu}	Current amount of memory and uCPU resources allocated to the VM (constant)
c^{ed}	Time the VM may leave its current host
d^{host}	Next host of the VM
d^{mem}, d^{cpu}	Next amount of memory and uCPU resources to allocate to the VM
d^{st}	Time the VM arrives on its next host
Variables related to server management	
n^q	Next state of the server

`spread({VM1,VM2}):`

$$allDifferent(d_1^{host}, d_2^{host}) \wedge$$
$$d_1^{host} = c_2^{host} \rightarrow d_1^{st} \geq c_2^{ed} \wedge$$
$$d_2^{host} = c_1^{host} \rightarrow d_2^{st} \geq c_1^{ed}$$

constraint library

ban	unary
fence	unary
root	unary
quarantine	unary
spread	`alldifferent` (+ precedences)
lonely	`disjoint`
capacity	`gcc`
among	`element`
gather	`allequals`
mostly spread	`nvalue`
split	`disjointmultiple`
split among	`element + alldifferent`
max online	`weightedsum (cumulative)`

scalability through

light filtering packing in O(PMs)

local search fixing non-violations

partition split in subproblems

truncated B&B first solution

EVALUATION

PROTOCOL

5,000 PMs

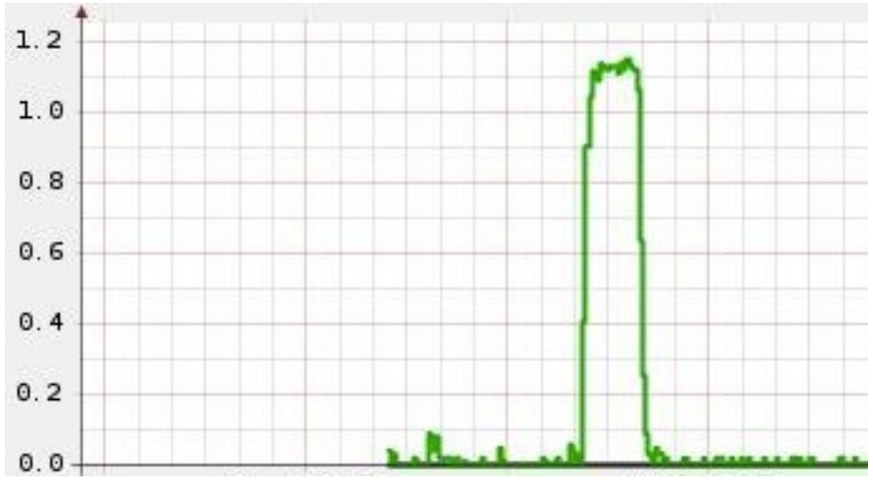
15,000 - 30,000 VMs

extra-large/high-memory EC2 instances

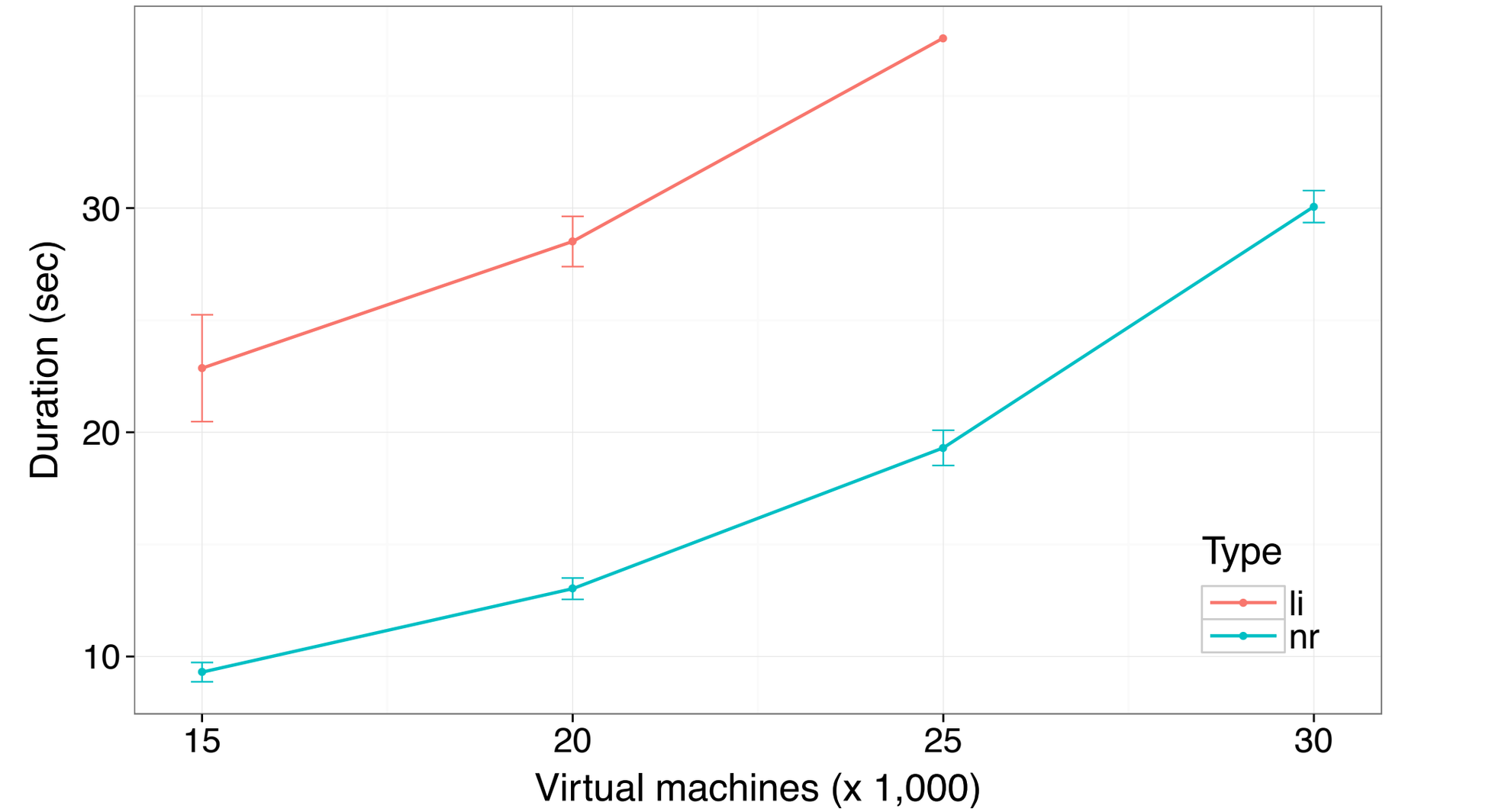
3-tiers HA web applications with replica

LI: 10% VM grow 30% uCPU

NR: 5% PM halt



solution time / **load**

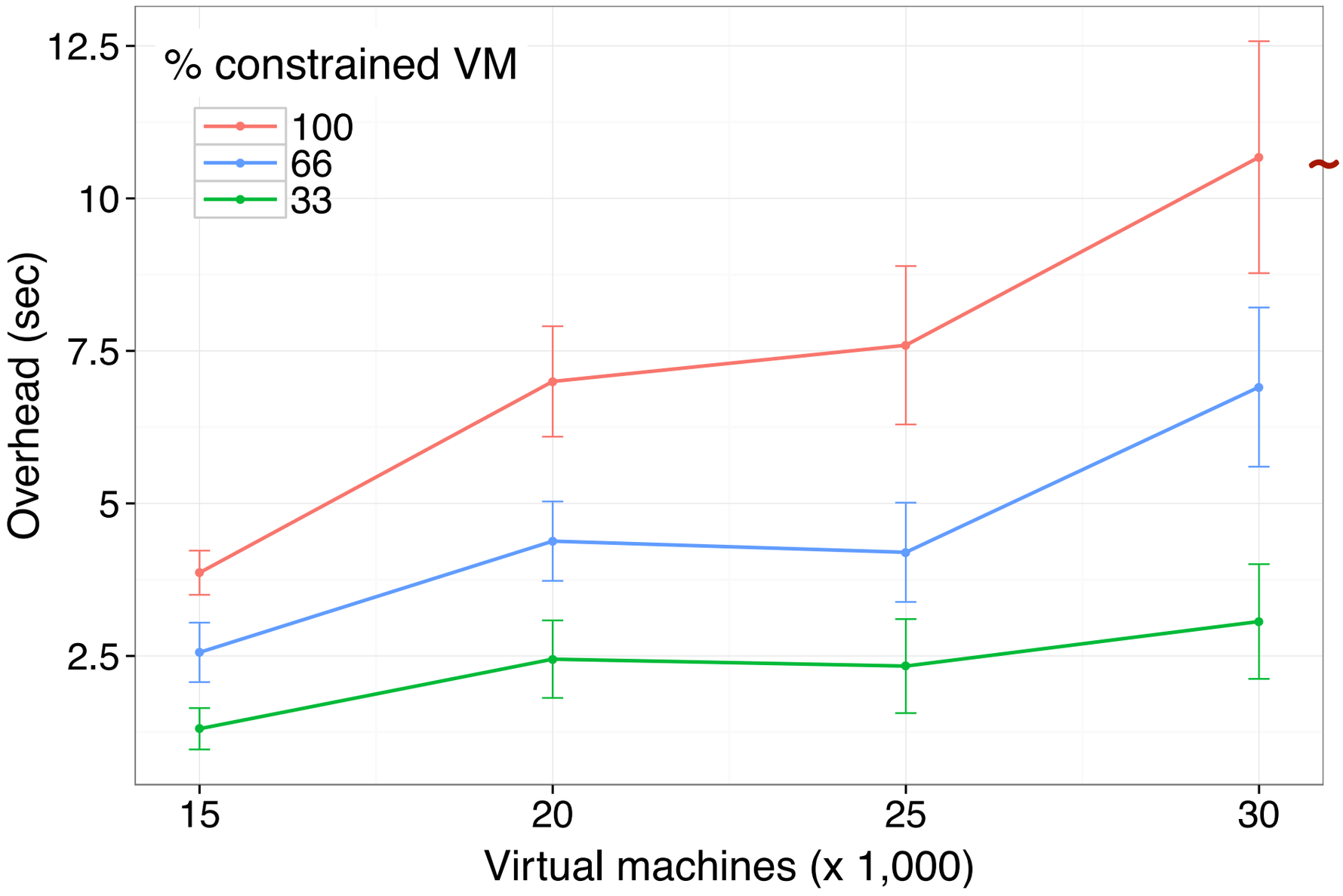


25%
EC2 average ?

70%
'ideal'

load

time overhead / user constraints



~ 30% in NR

CONCLUSION

flexibility as a key of automation

constraint programming as a solution

automated model composition

PERSPECTIVES

automated algorithm customisation
data and case studies

An Open-Source flexible virtual machine scheduler

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