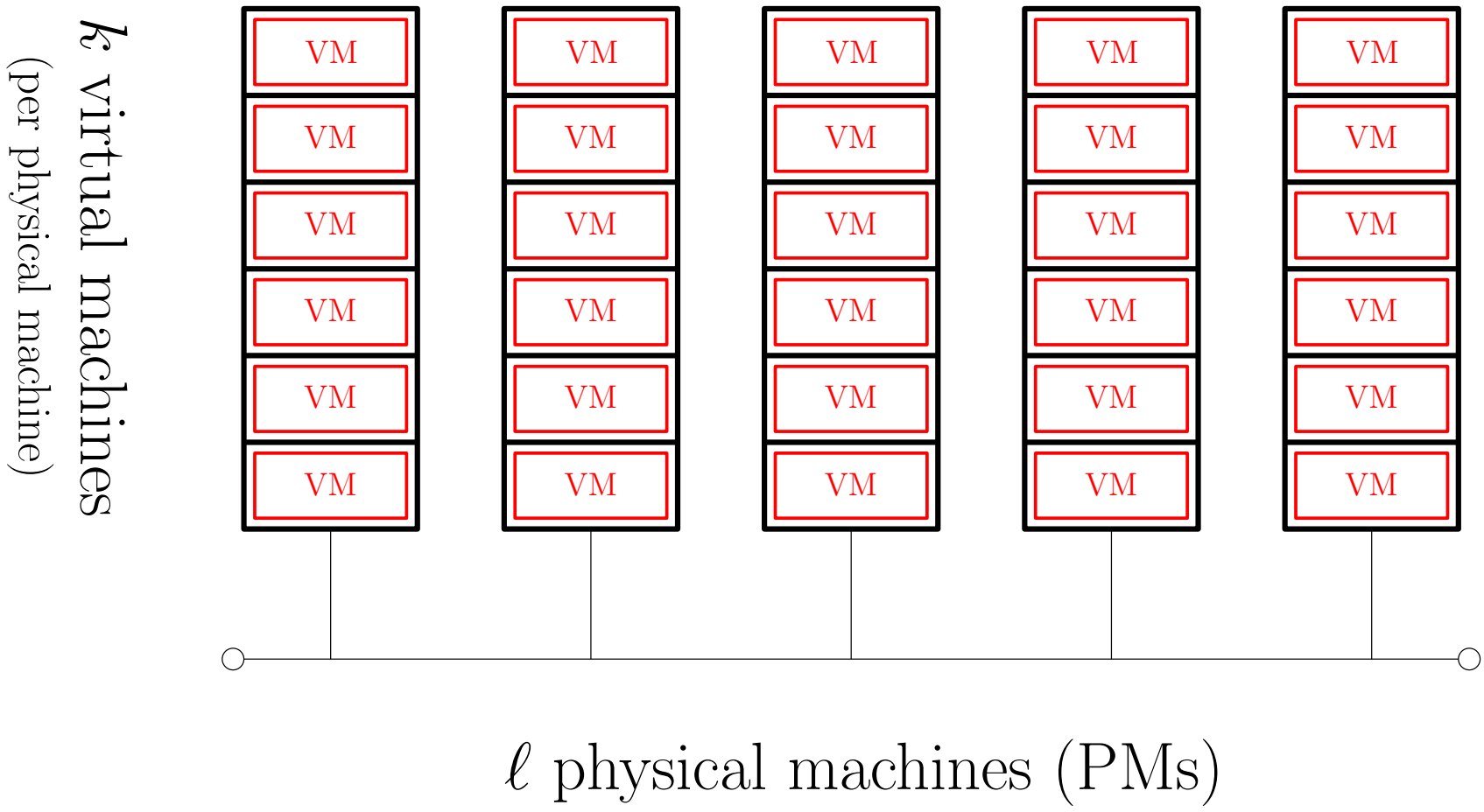
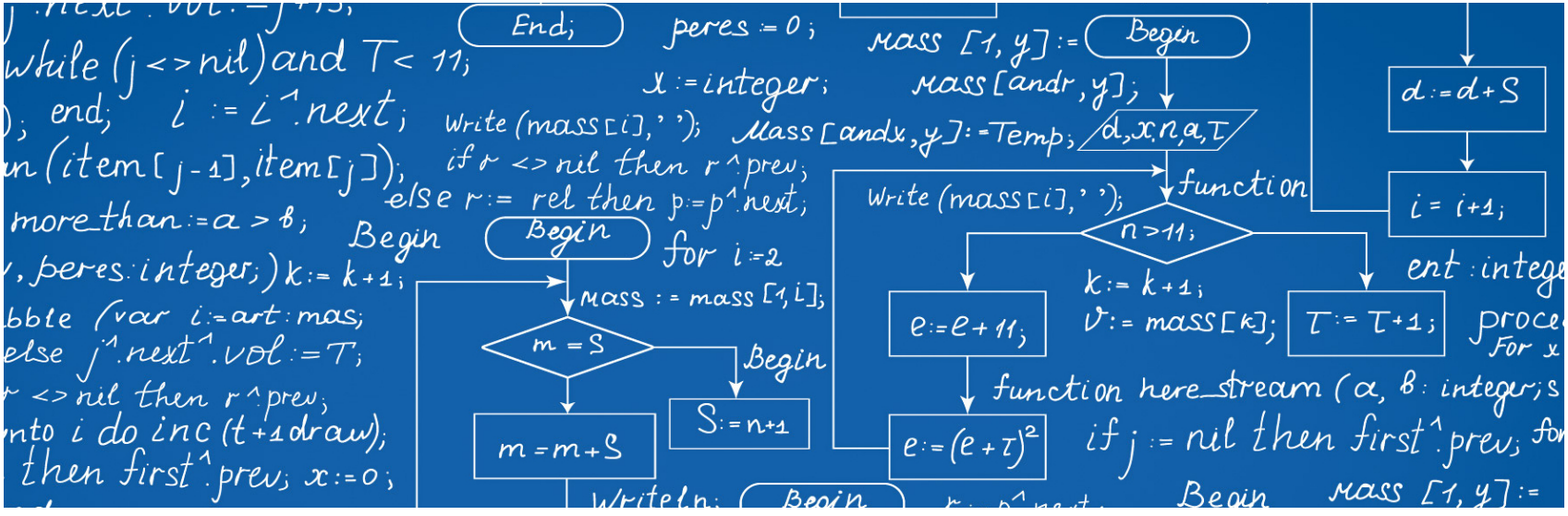
Data center architecture

Abstract view of physical machines and interconnecting network



Computational tasks in data centers

Client: I have *a* computational task to perform.

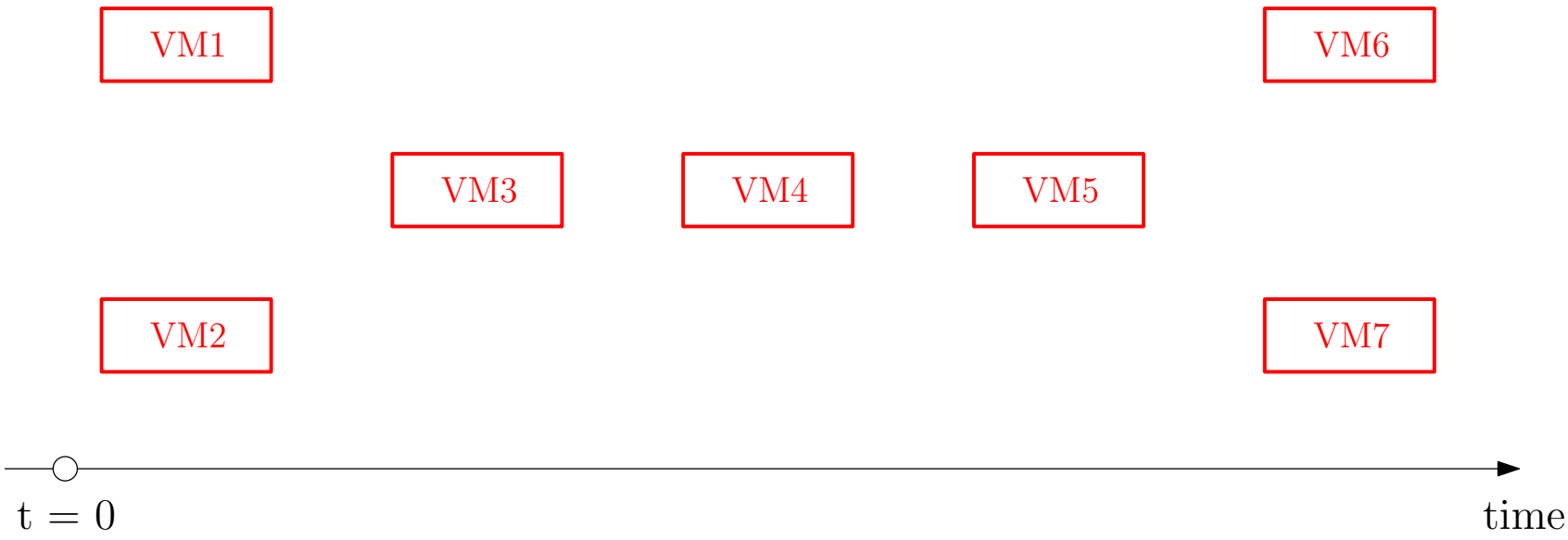


To finish in time, I need to run this task on 7 virtual machines!

VM1	VM2	VM3	VM4	VM5	VM6	VM7

Computational tasks in data centers

During runtime VMs communicate with each other.



Computational tasks in data centers

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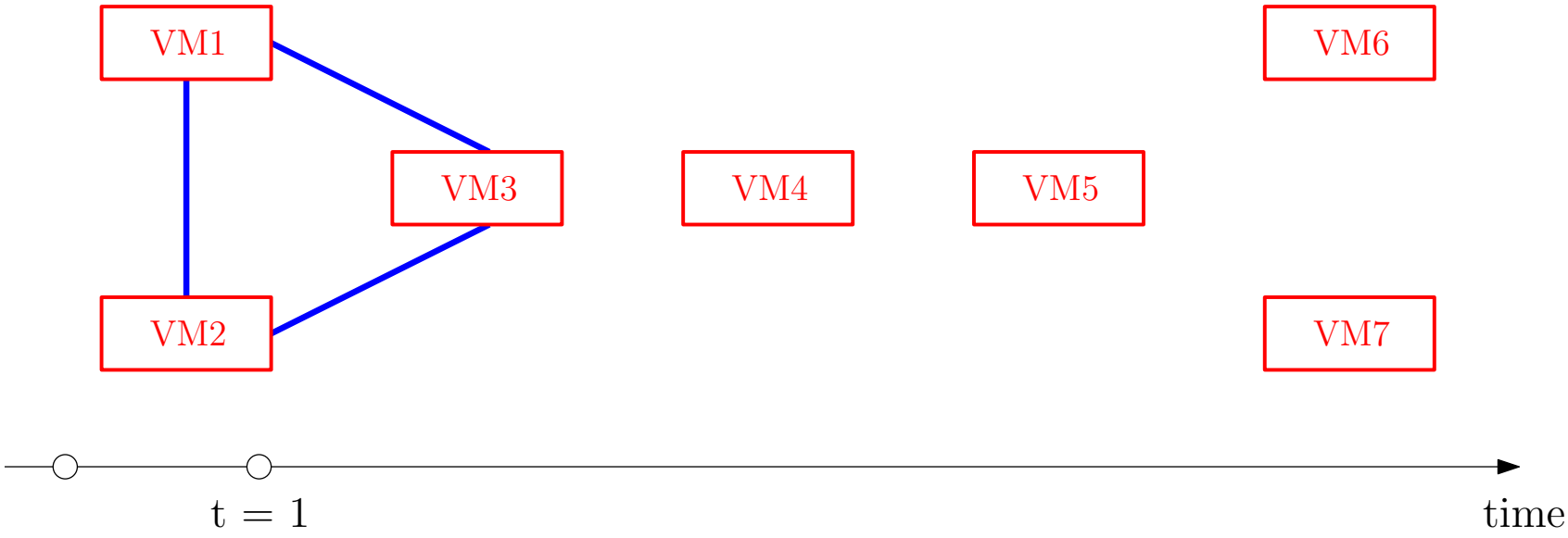

Computational tasks in data centers

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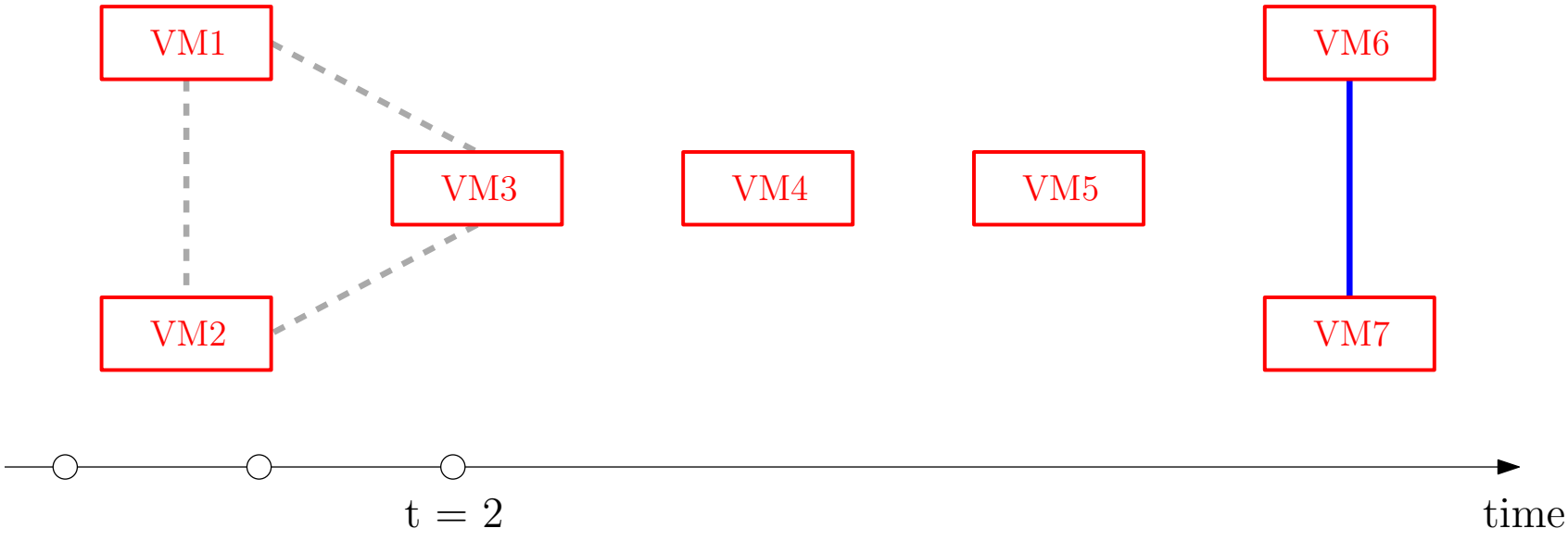

Computational tasks in data centers

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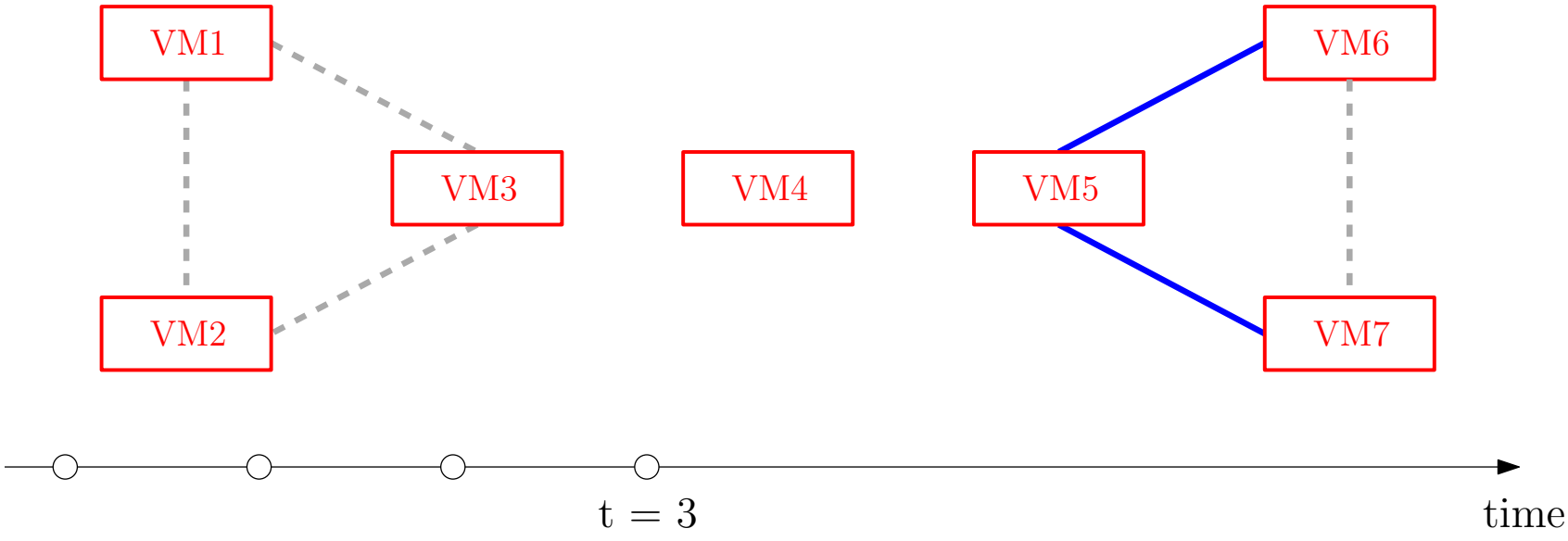

Computational tasks in data centers

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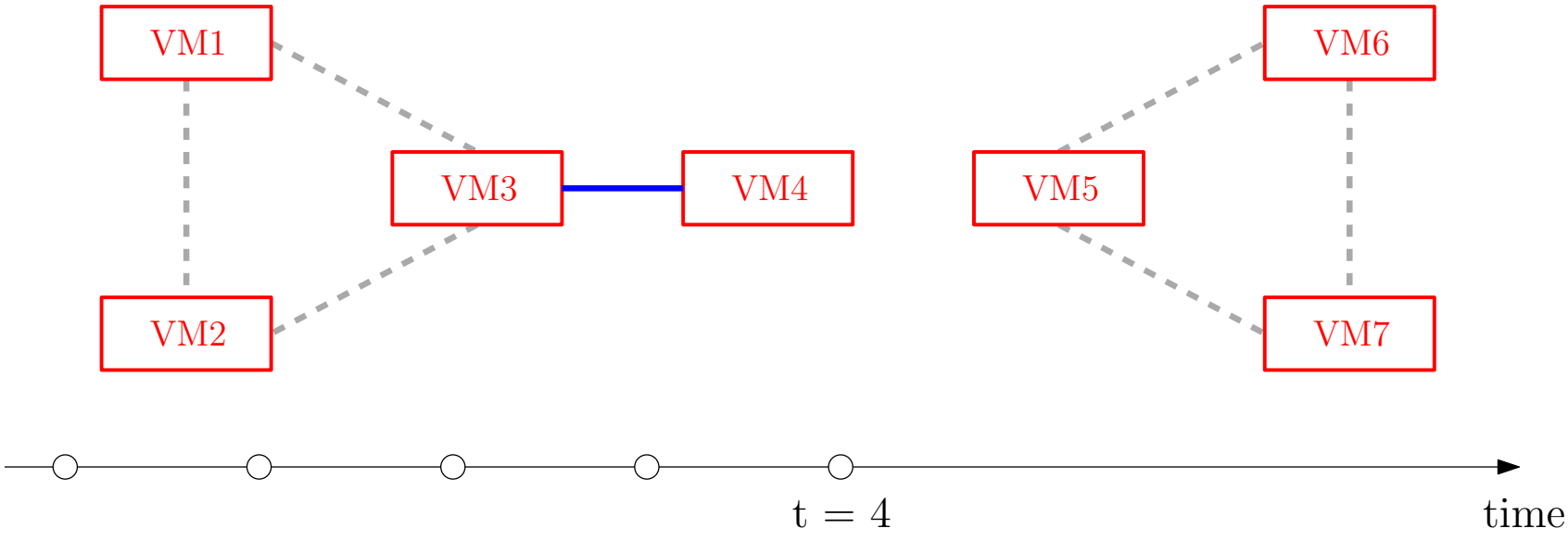

Computational tasks in data centers

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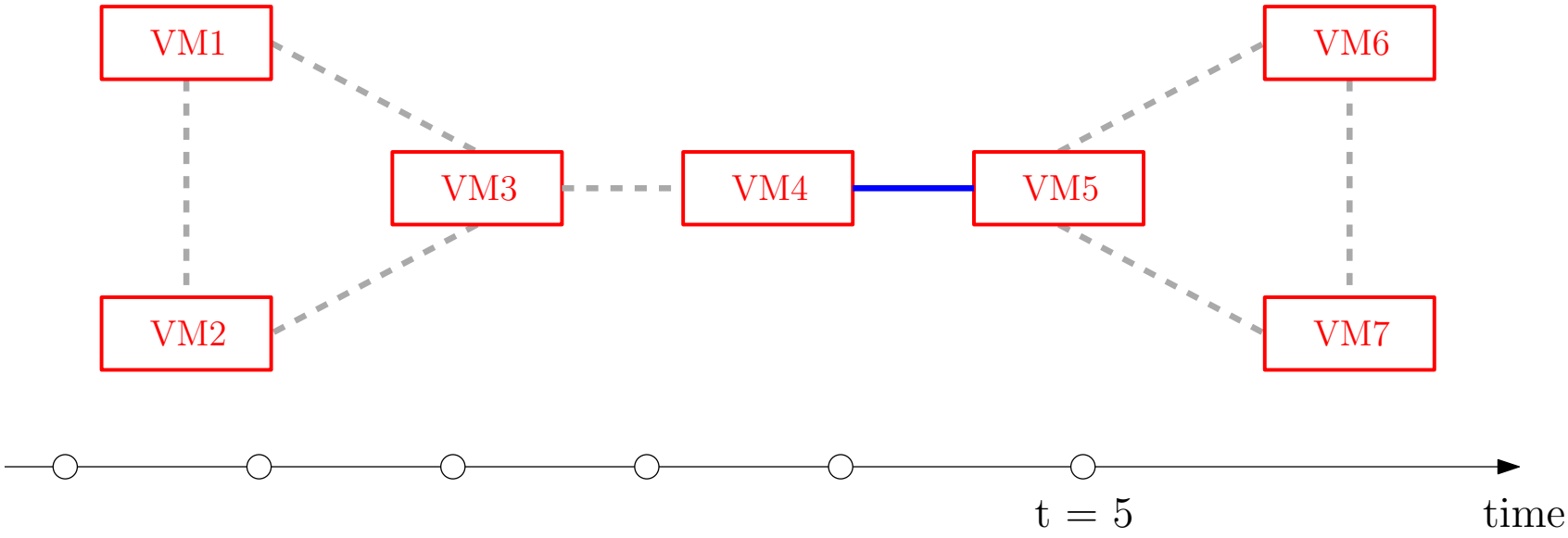
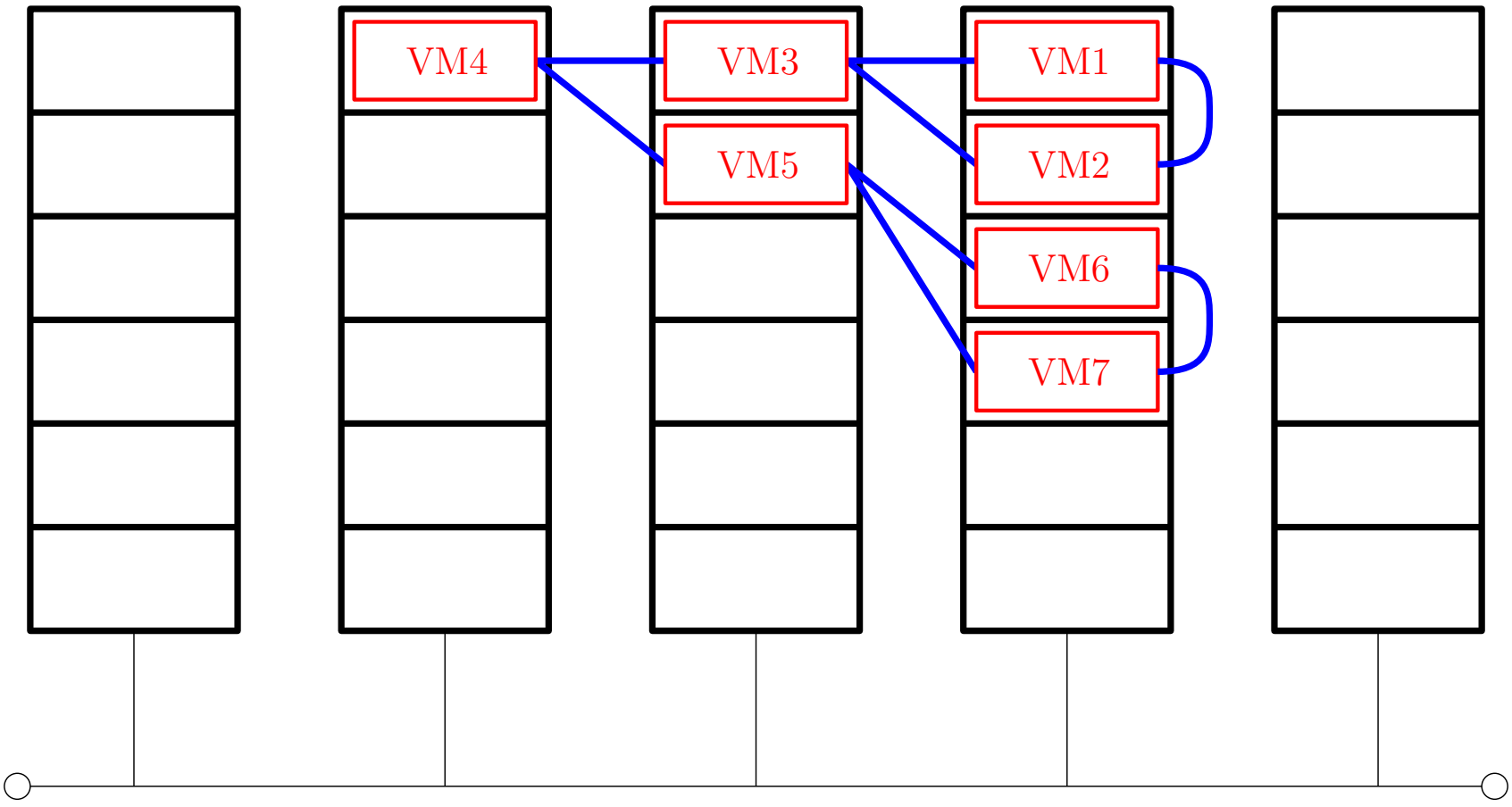


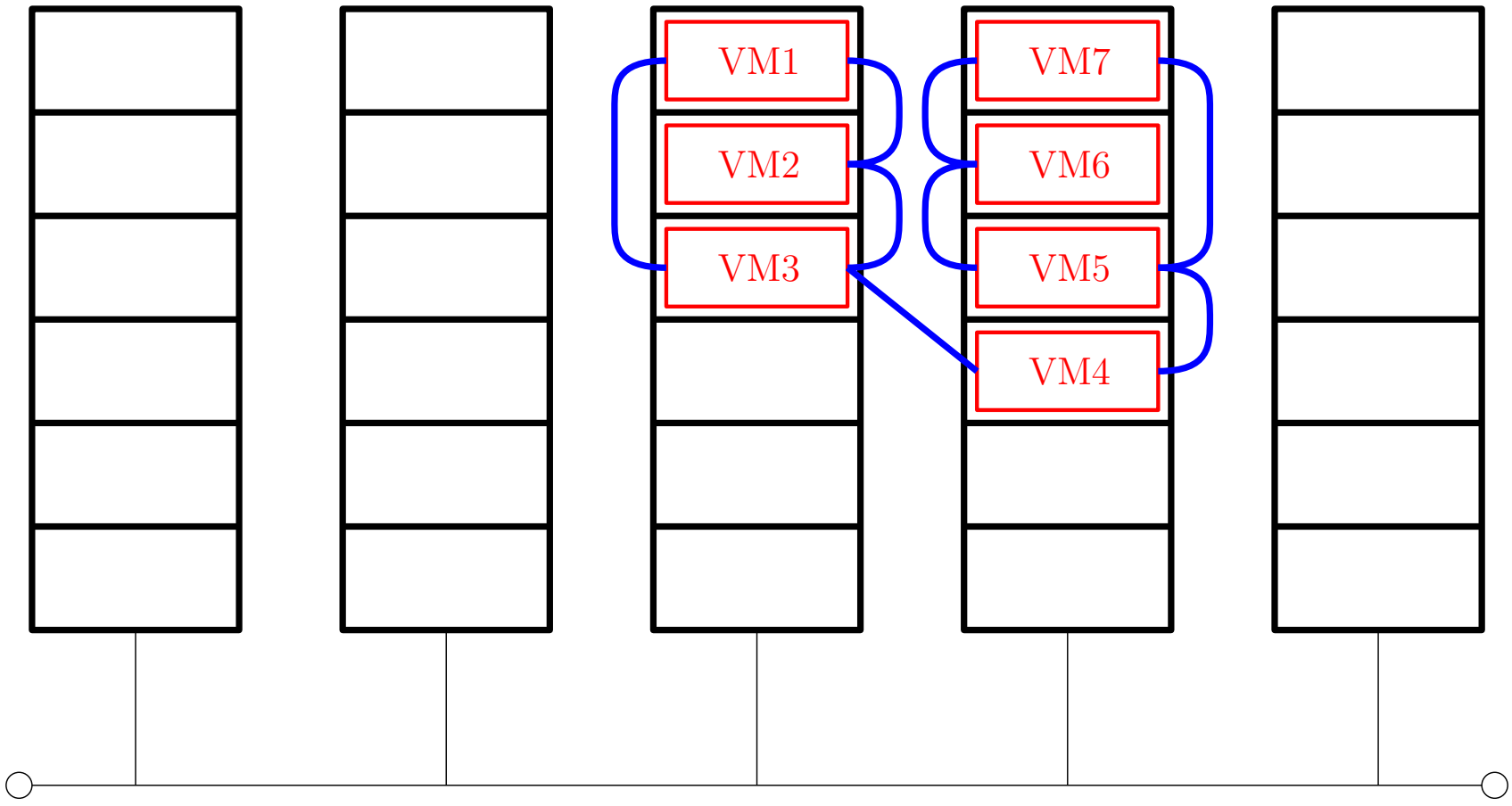
Network-efficient machine placement



Inefficient placement: total communication cost = 6

(internal communication is free)

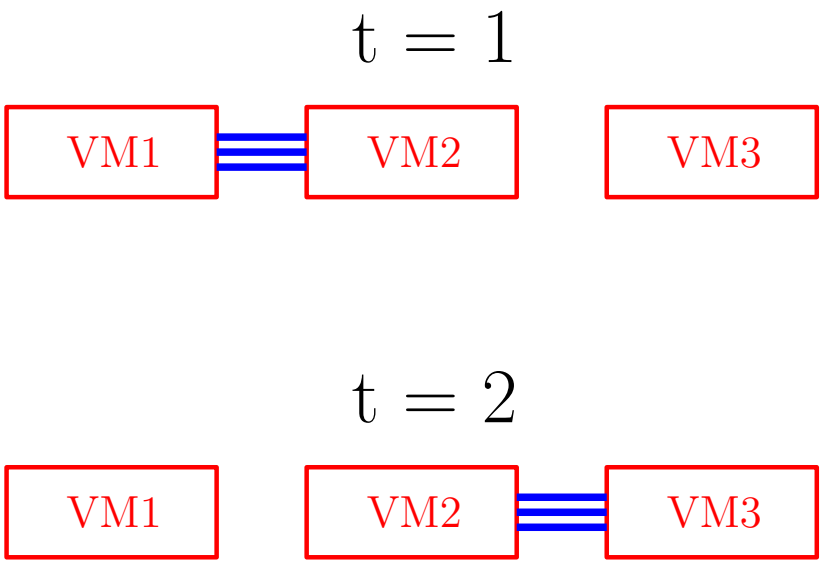
Network-efficient machine placement

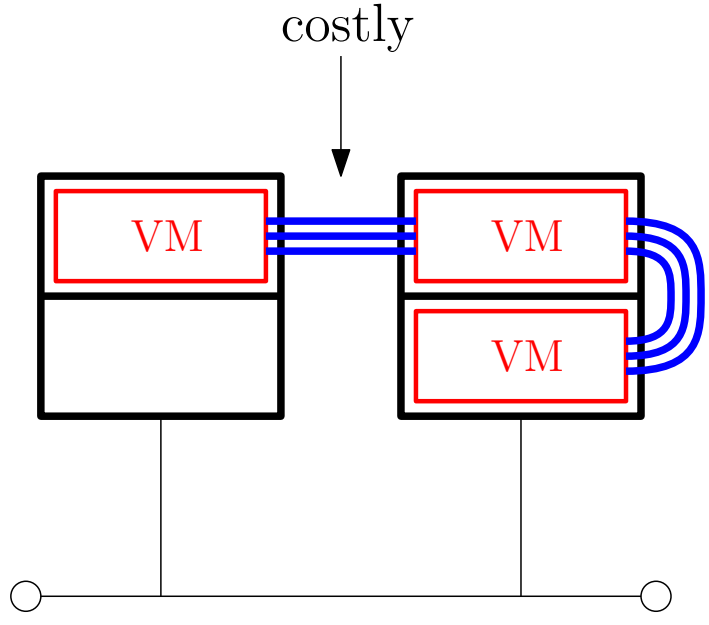


More efficient placement: total communication cost = 1

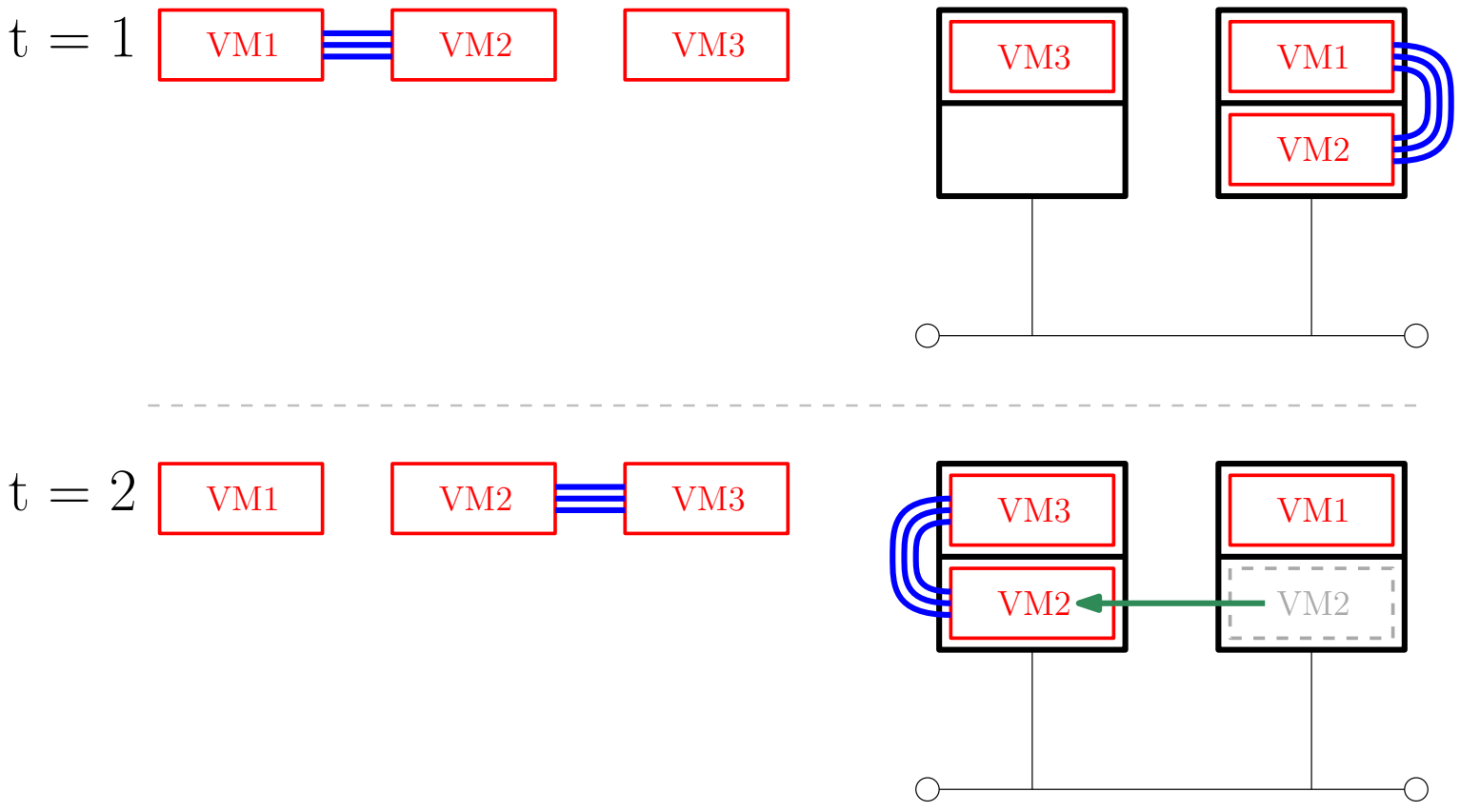
(internal communication is free)

Sometimes static placement is inherently inefficient





Virtual machine (VM) migration



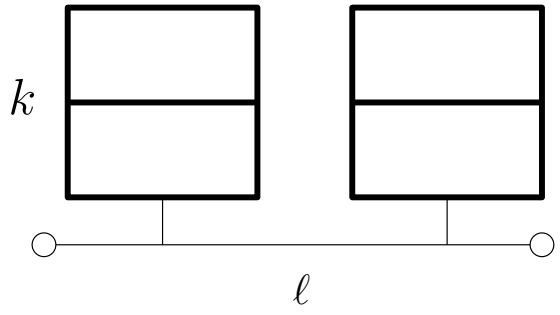
Fixed cost α for migrating a VM to another physical machine.

(migration is supported by major virtualization providers, inc. Xen, Hyper-V, VMware)

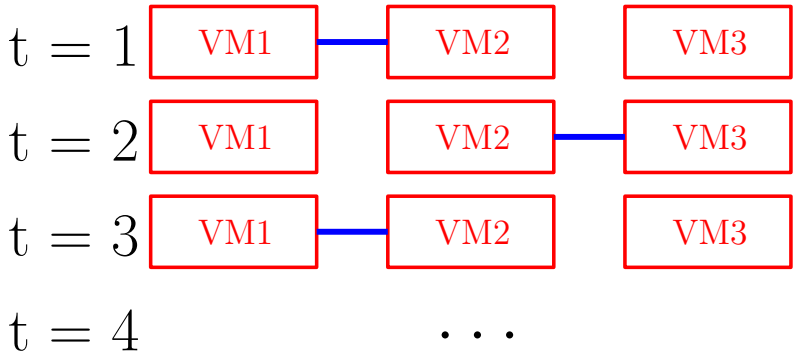
Balanced Re-partition Problem

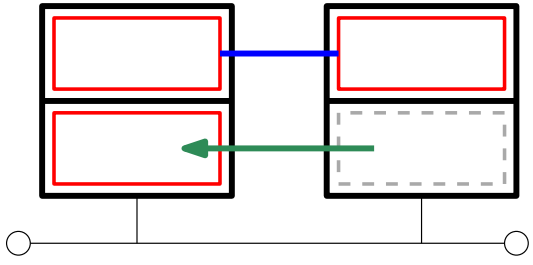
Input

Data center architecture:
ℓ physical machines with capacity k



Communication pattern:





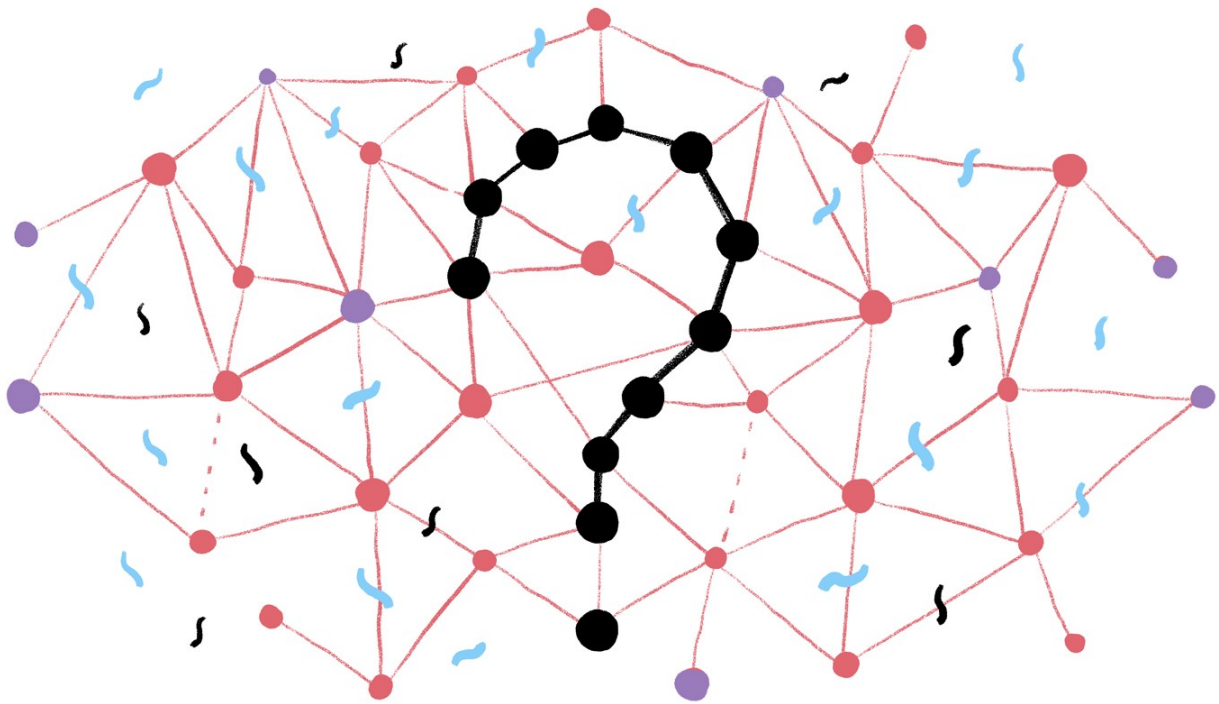
Costs:

External communication costs 1

Migration costs α

Objective: compute the migration schedule that minimizes the total cost of communication and migration

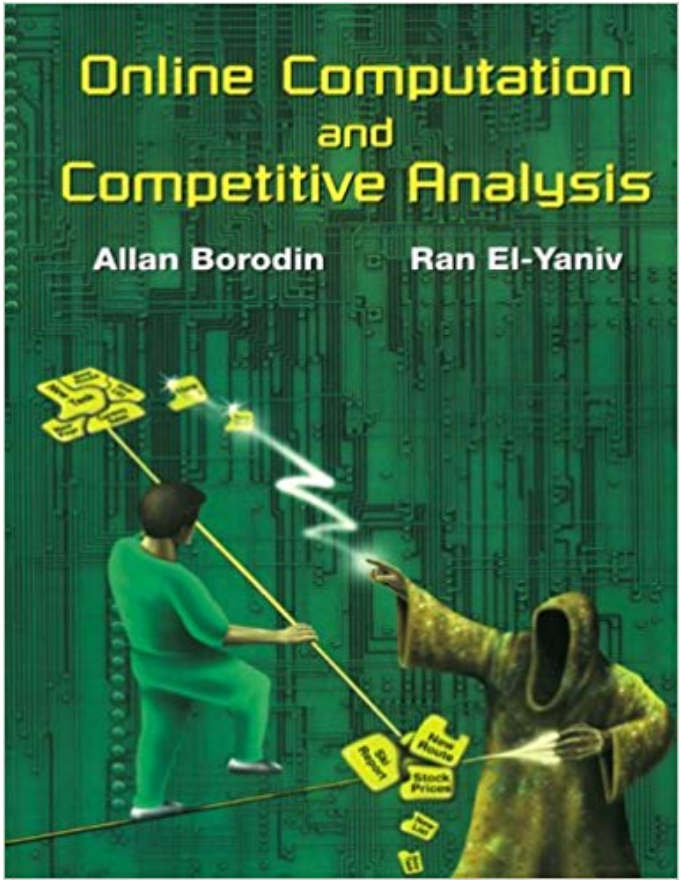
Problem: the communication pattern is unknown!



Communication requests appear on the fly.

Online algorithms and competitive analysis

- Input revealed piece by piece
- Irrevocable decisions
- Comparison to offline optimal algorithm



The competitive ratio:

$$ALG \leq c \cdot OPT$$

Offline Balanced Re-partition Problem

Input

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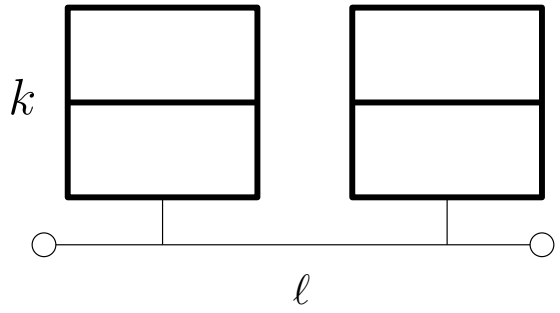
ℓ physical machines with capacity k



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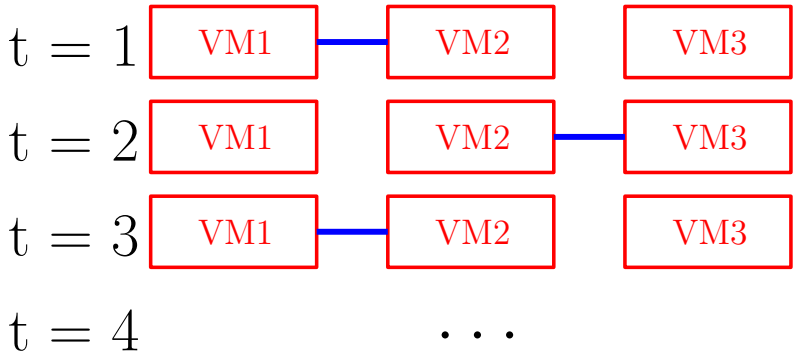

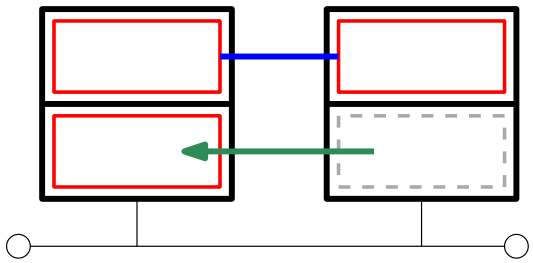

Costs:

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Migration costs α

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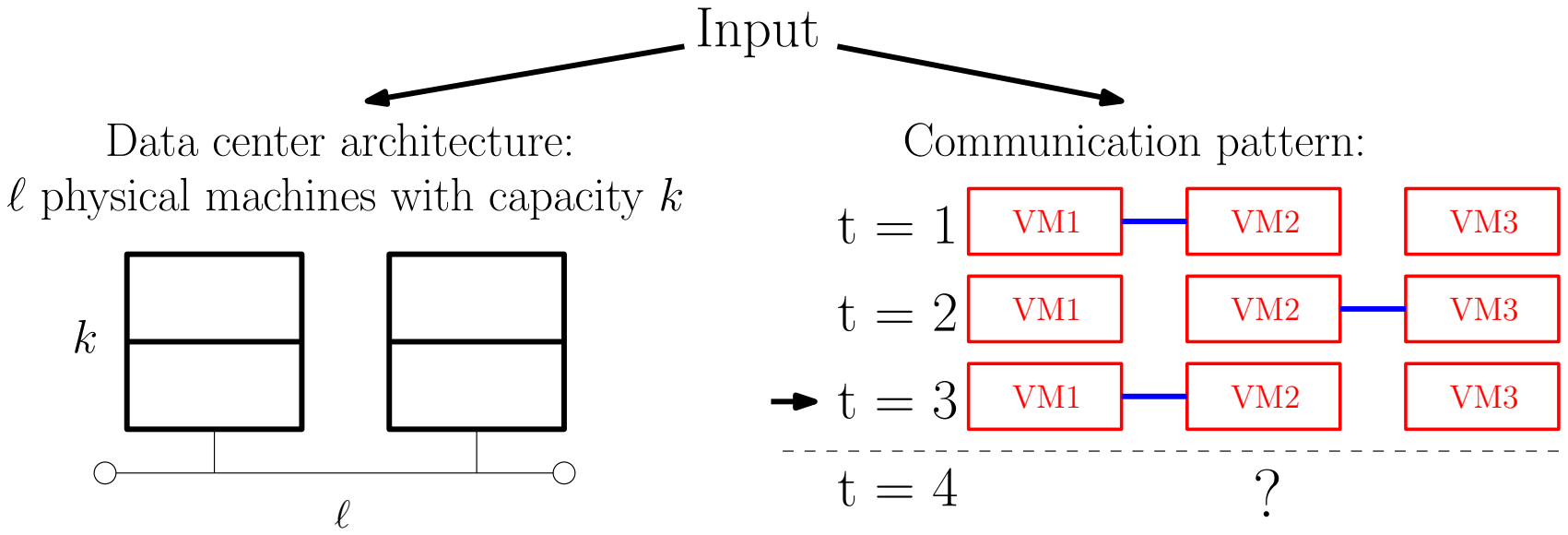
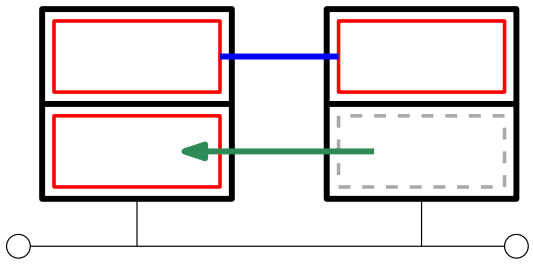
Online Balanced Re-partition Problem





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