Model and Infrastructure for Peer-to-Peer Programming

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- Goals and Related Woks
1. **Peer-to-Peer Infrastructure**
2. **Programming Model and API**
- Experimentations
- Perspectives

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Goals

- Hosts are not available all time
- Dynamic Computational Peer-to-Peer (P2P):
  - Intranet & Internet
  - Proposing a High Level Model
    - Dynamic JVMs Network (computation nodes)
    - Not a Network's Protocol, Not DHT
    - P2P Programming Model for Branch and Bound (B&B) problems
- ProActive Context: no modification of Java language, of JVMs, …

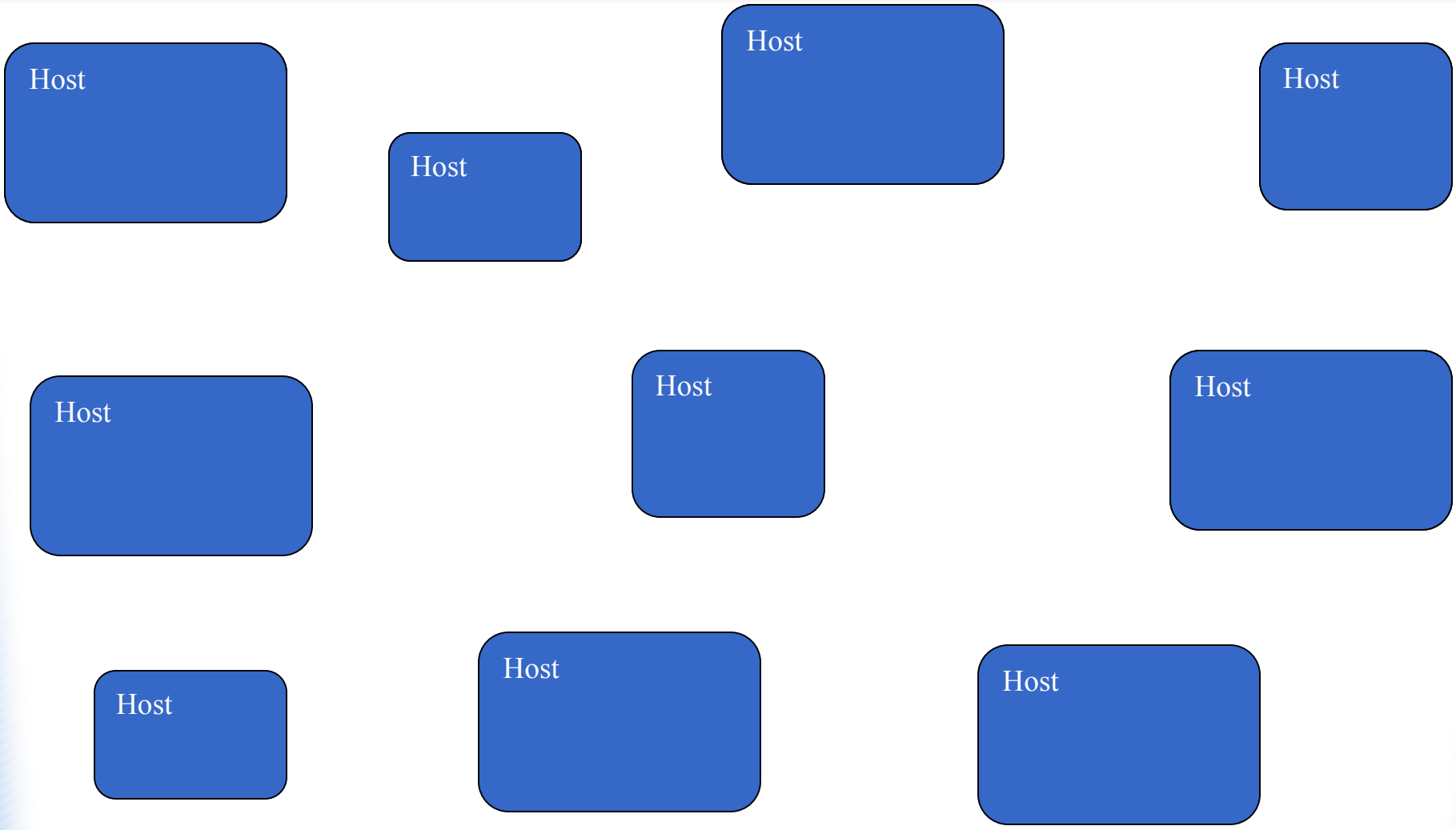
Related Works (Short)

- InteGrade :
  - Grid infrastructure for Intranet
  - Using desktop workstations
  - Master-slave, hierarchic
- XtremWeb :
  - Global Computing infrastructure
  - Large scale
  - No communication between tasks
- JXTA :
  - P2P library
  - Large scale, asynchrony and heterogeneity (languages & platforms)
  - Complete, low-level
- ProActive
  - Java library for Grid
  - Asynchrony, group's communications
  - Static deployment and heterogeneity (Java)

P2P Infrastructure

1st Part

Proposed Architecture



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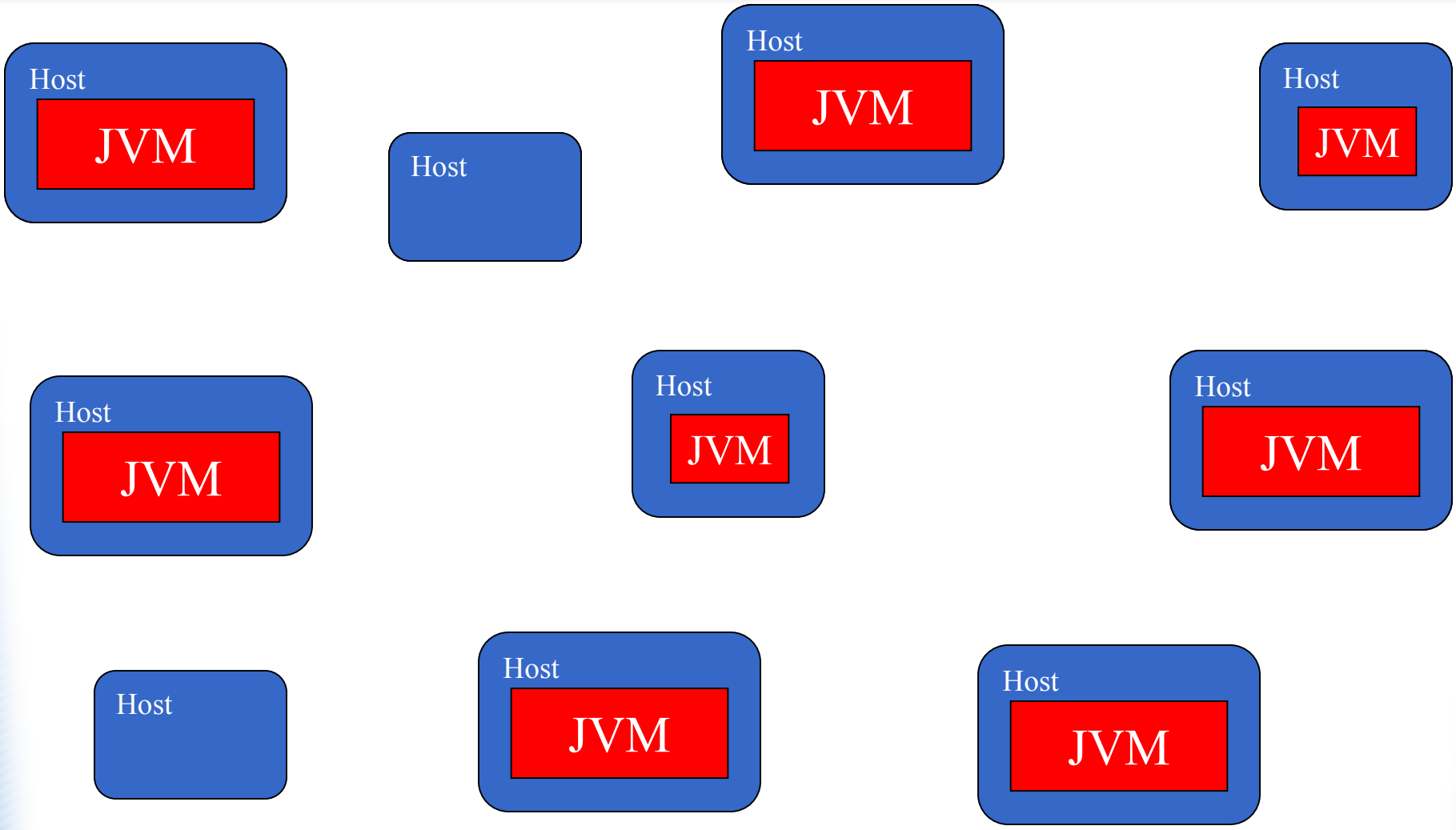

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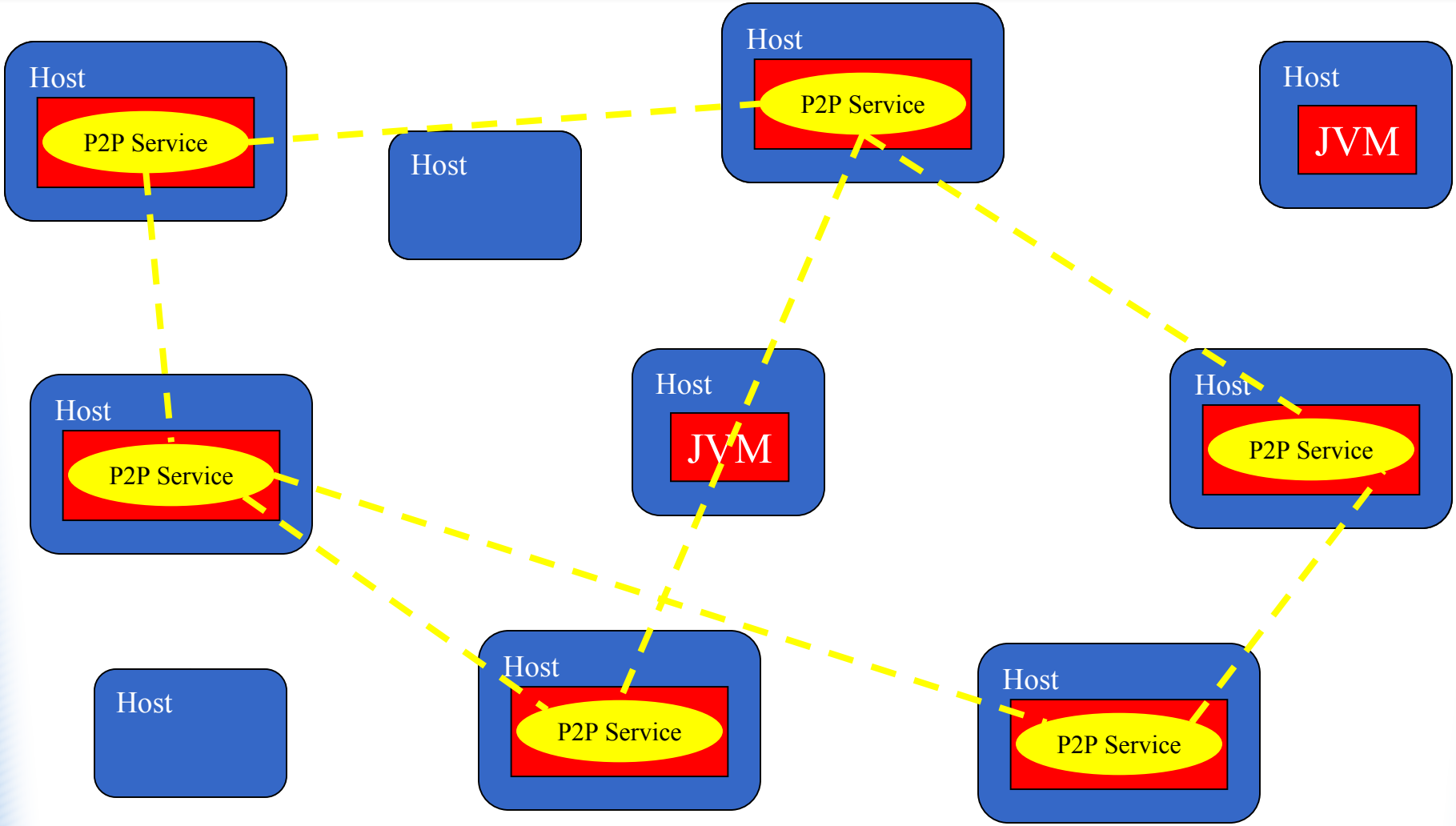
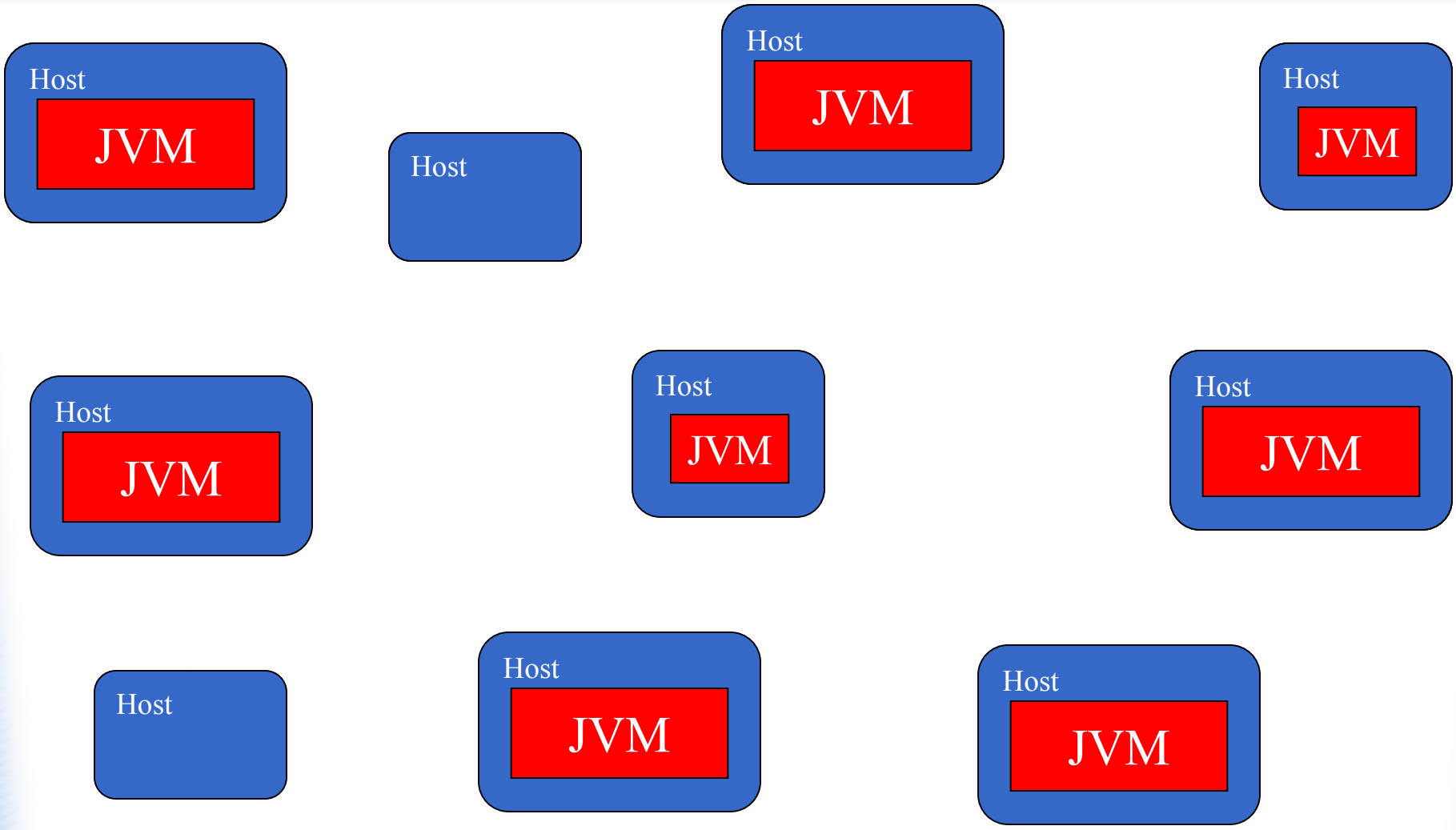


P2P Infrastructure

- Hosts Network ➔ JVMs Network
  - Overlay Network ≠ Indexed Search (DHT)
- Bootstrapping: many protocols (Jini, RmiRegistry, …)
- Dynamic environment :
  - Discovery : recording and un-recording
  - Resources (JVMs) acquisition
- Self-Organizing and Tunable Infrastructure :
  - Time To Update (TTU): peers (JVMs) availabilities
  - Number Of Acquaintances (NOA): keep up infrastructure
  - Time To Live (TTL): in hop for JVMS depth search, use for NOA
- Recursive Search of JVMs

P2P Infrastructure



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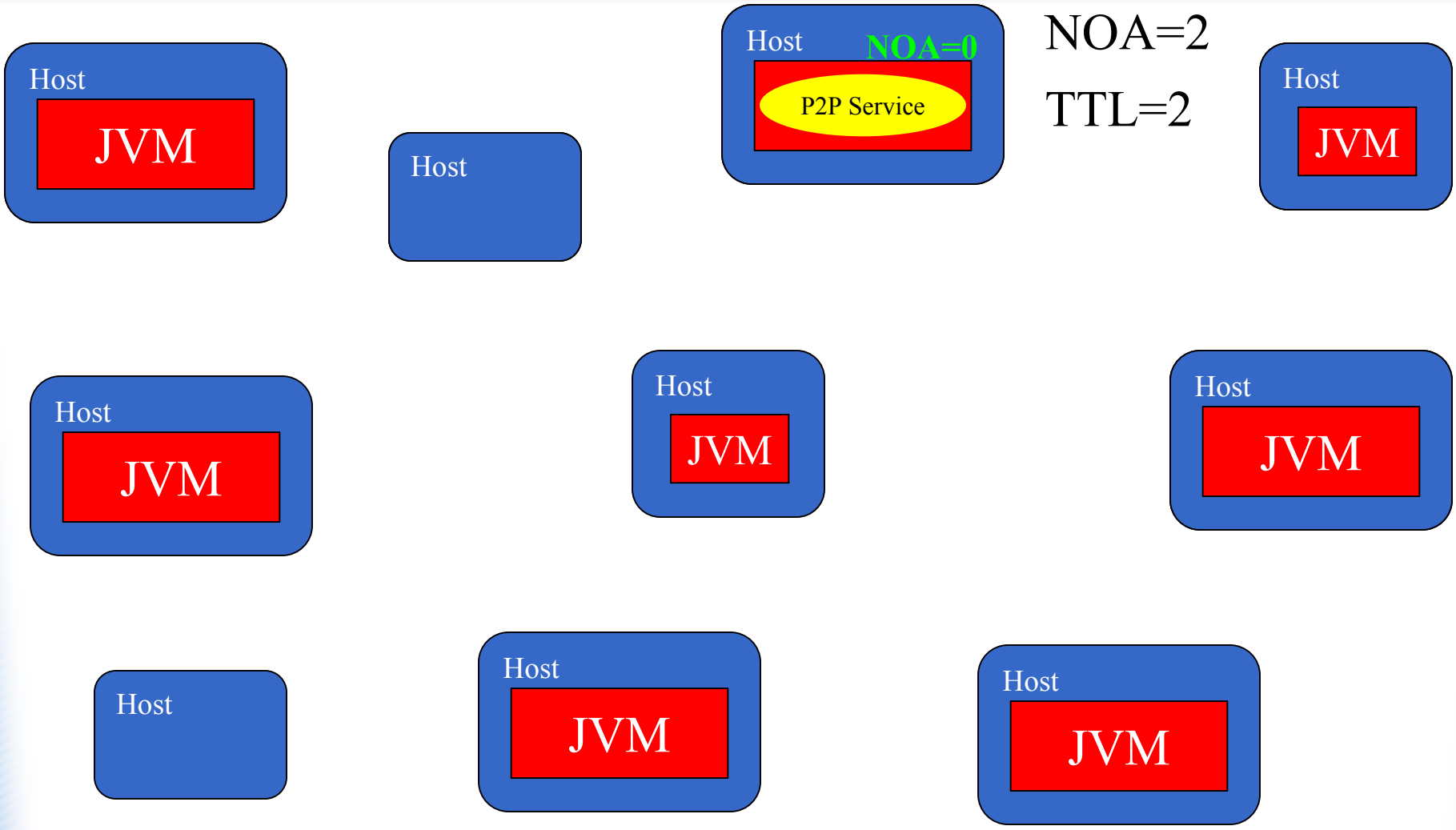

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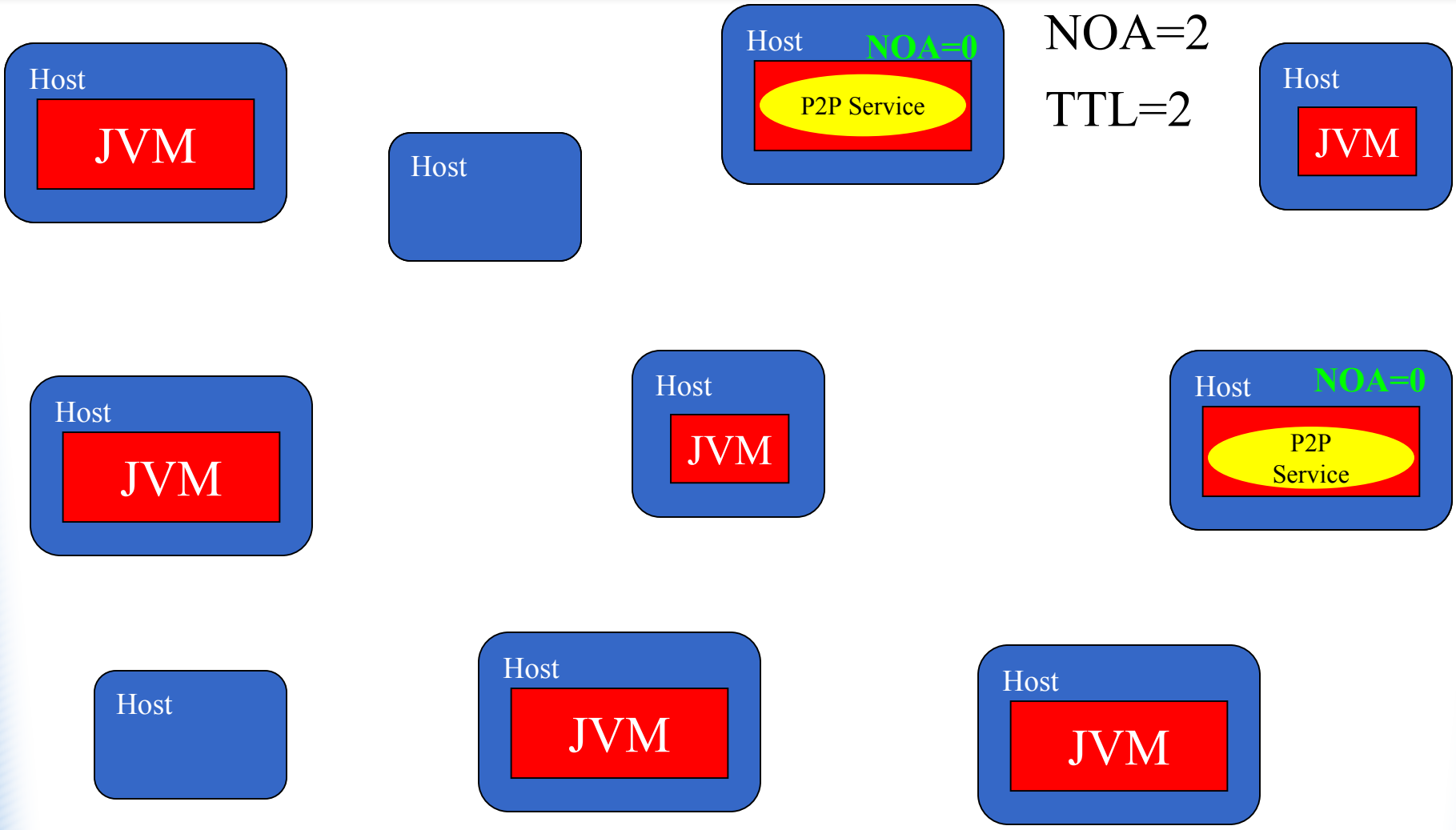

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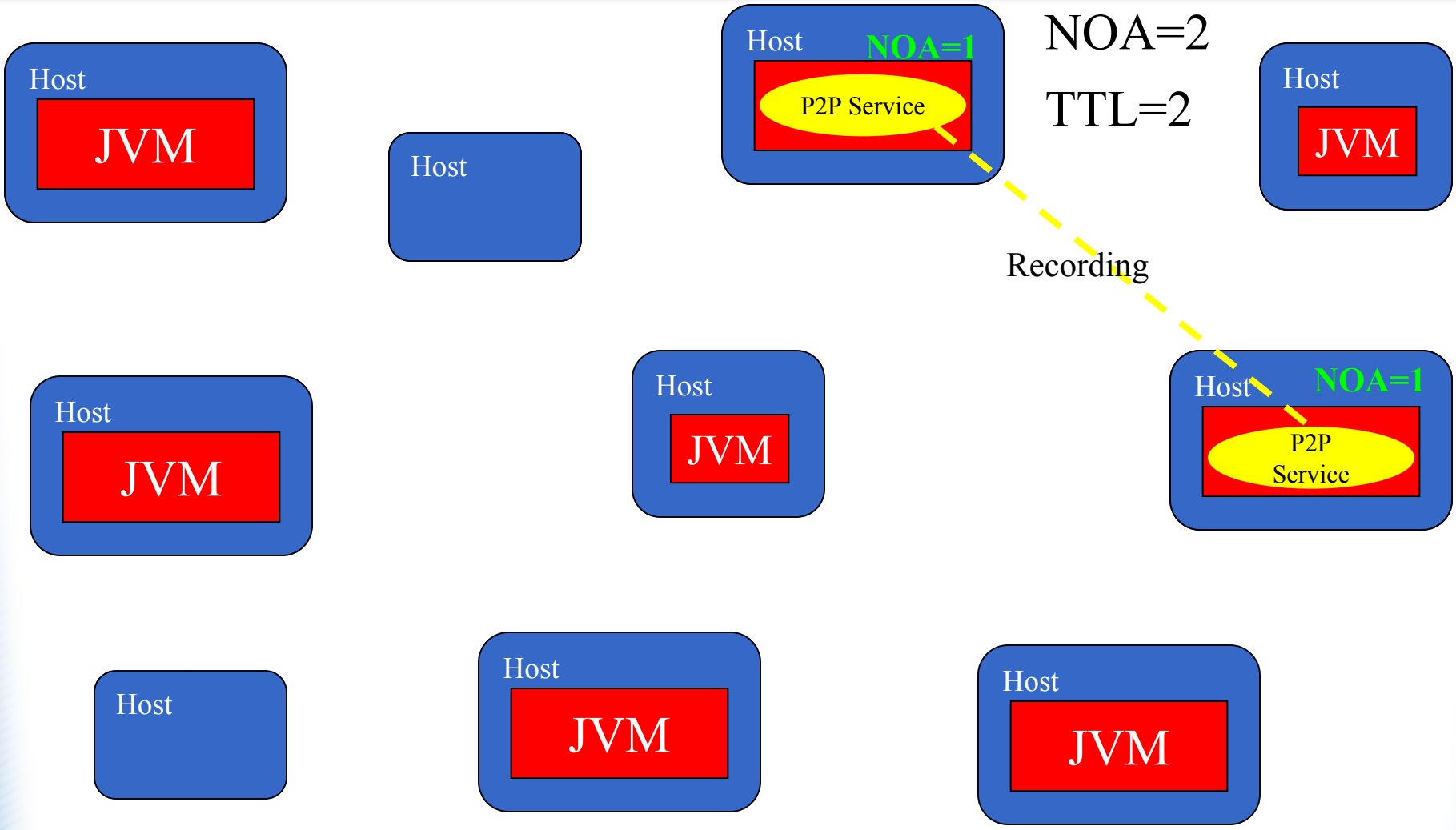

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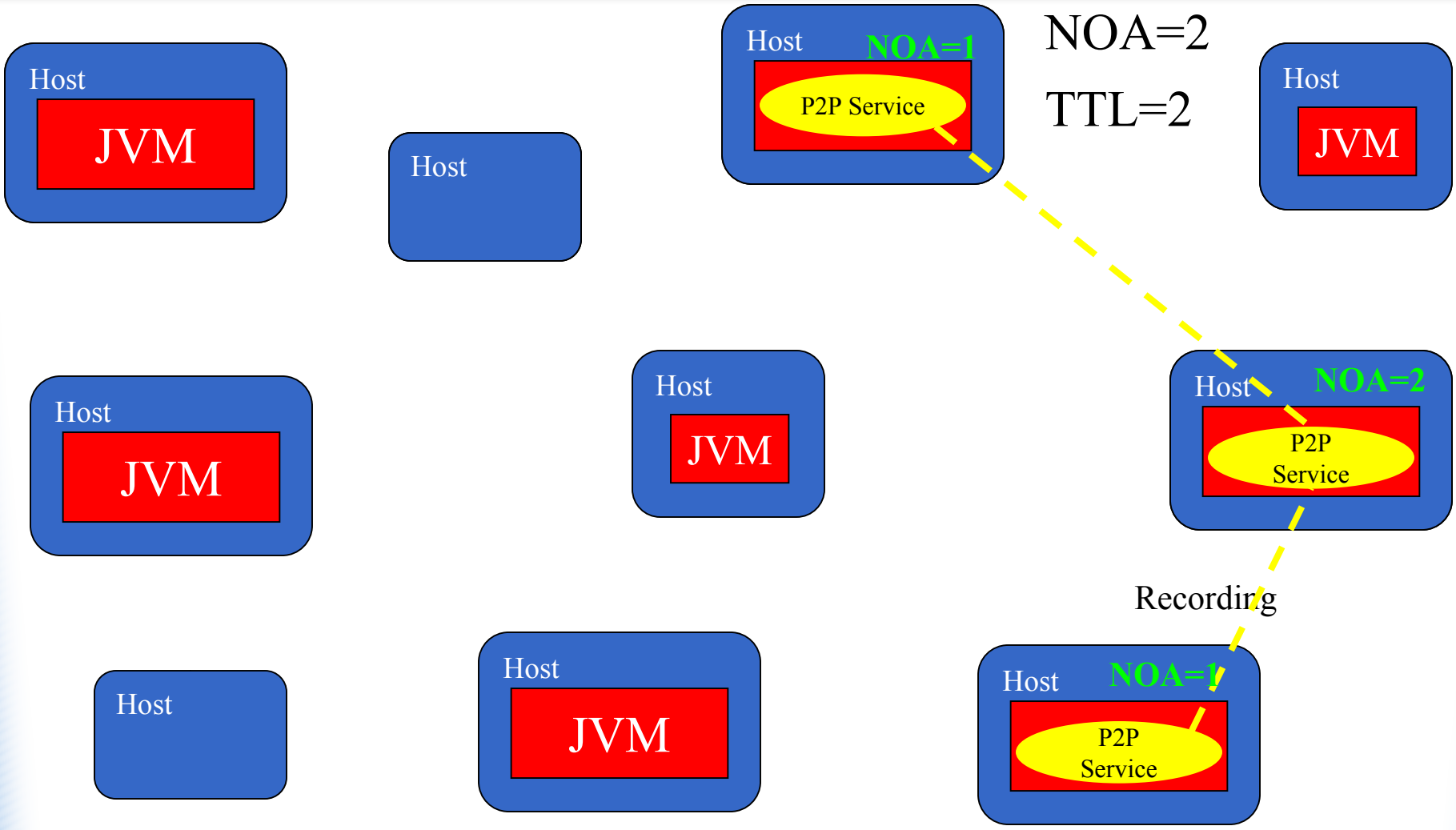

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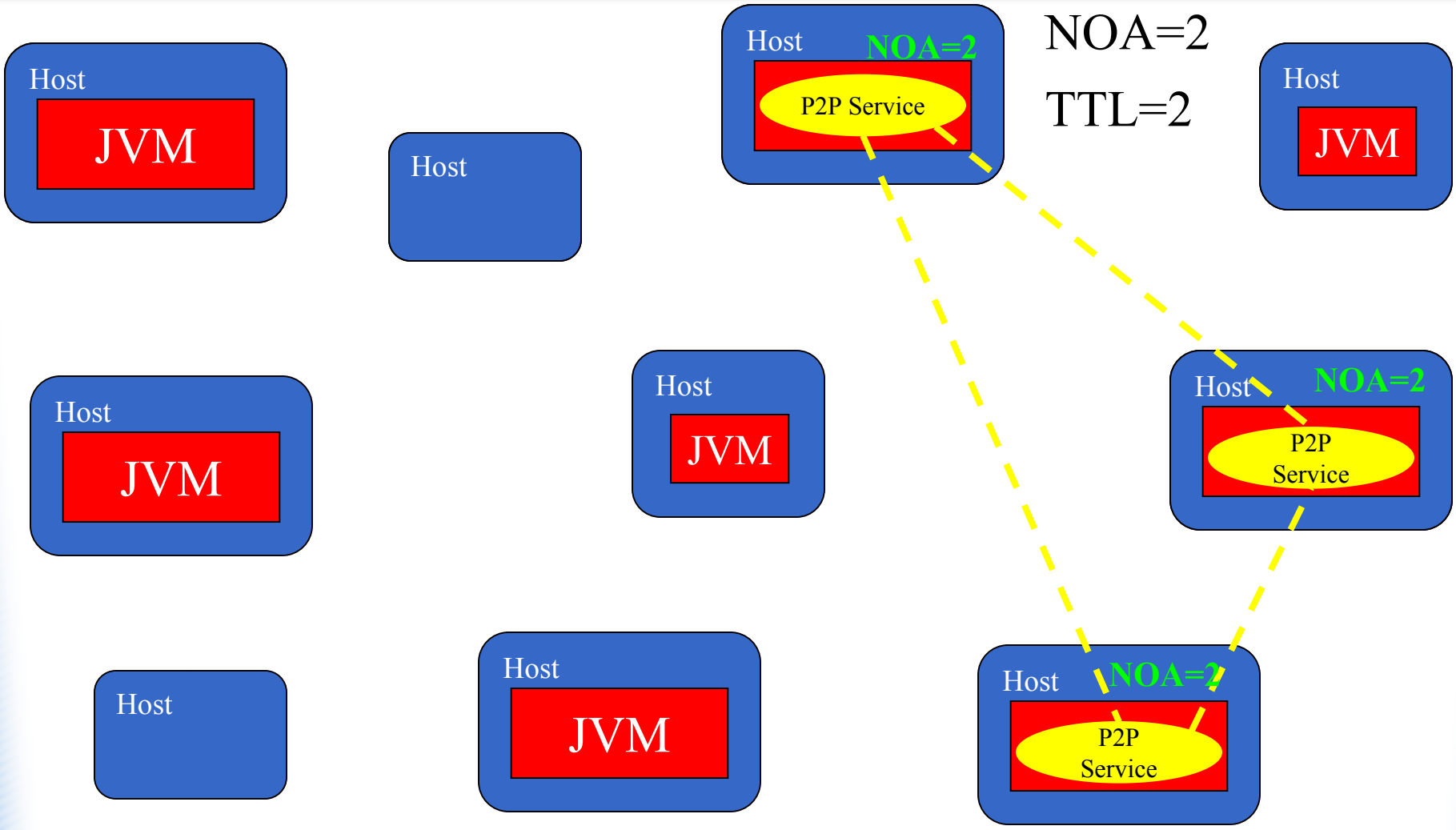

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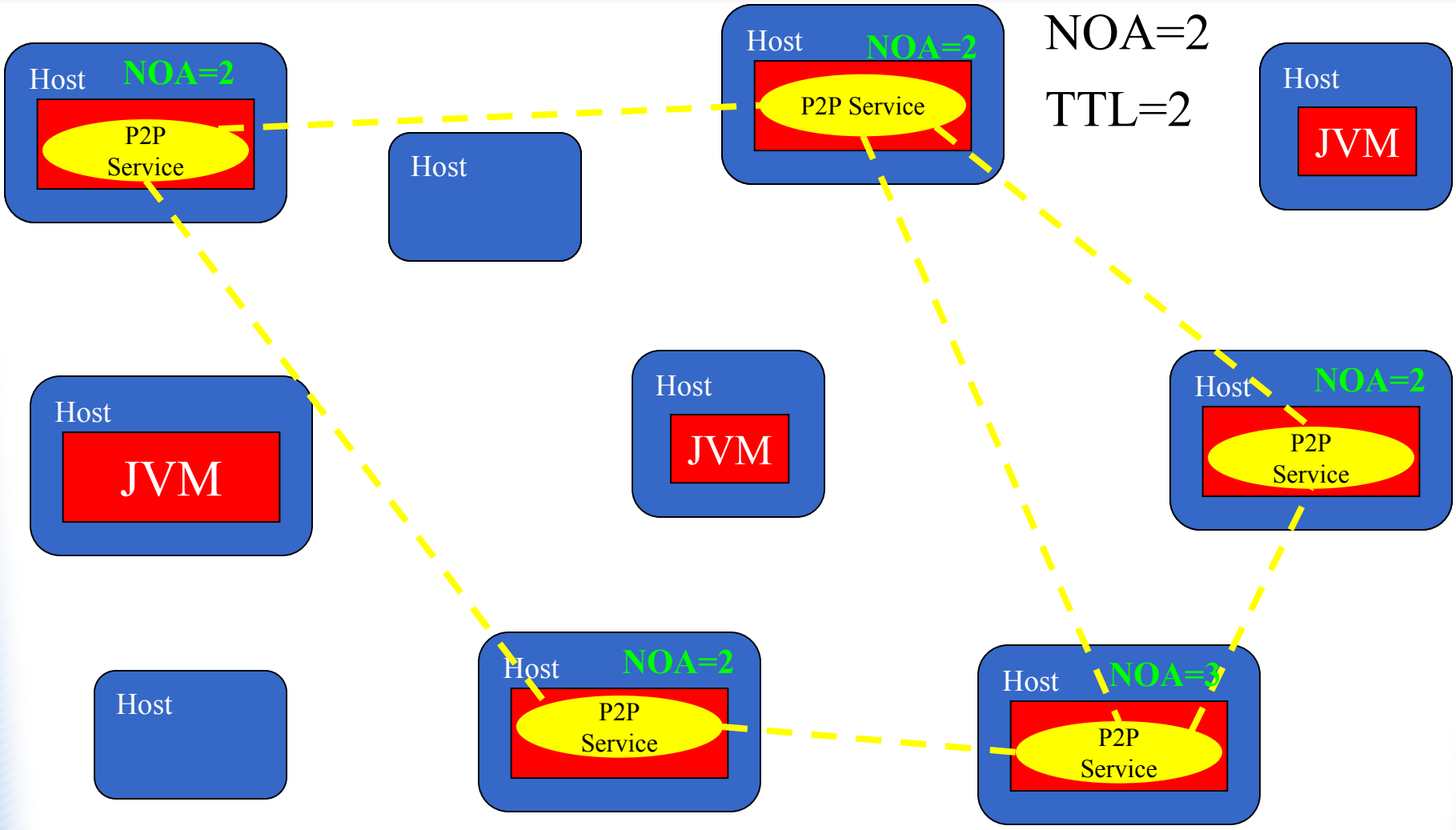

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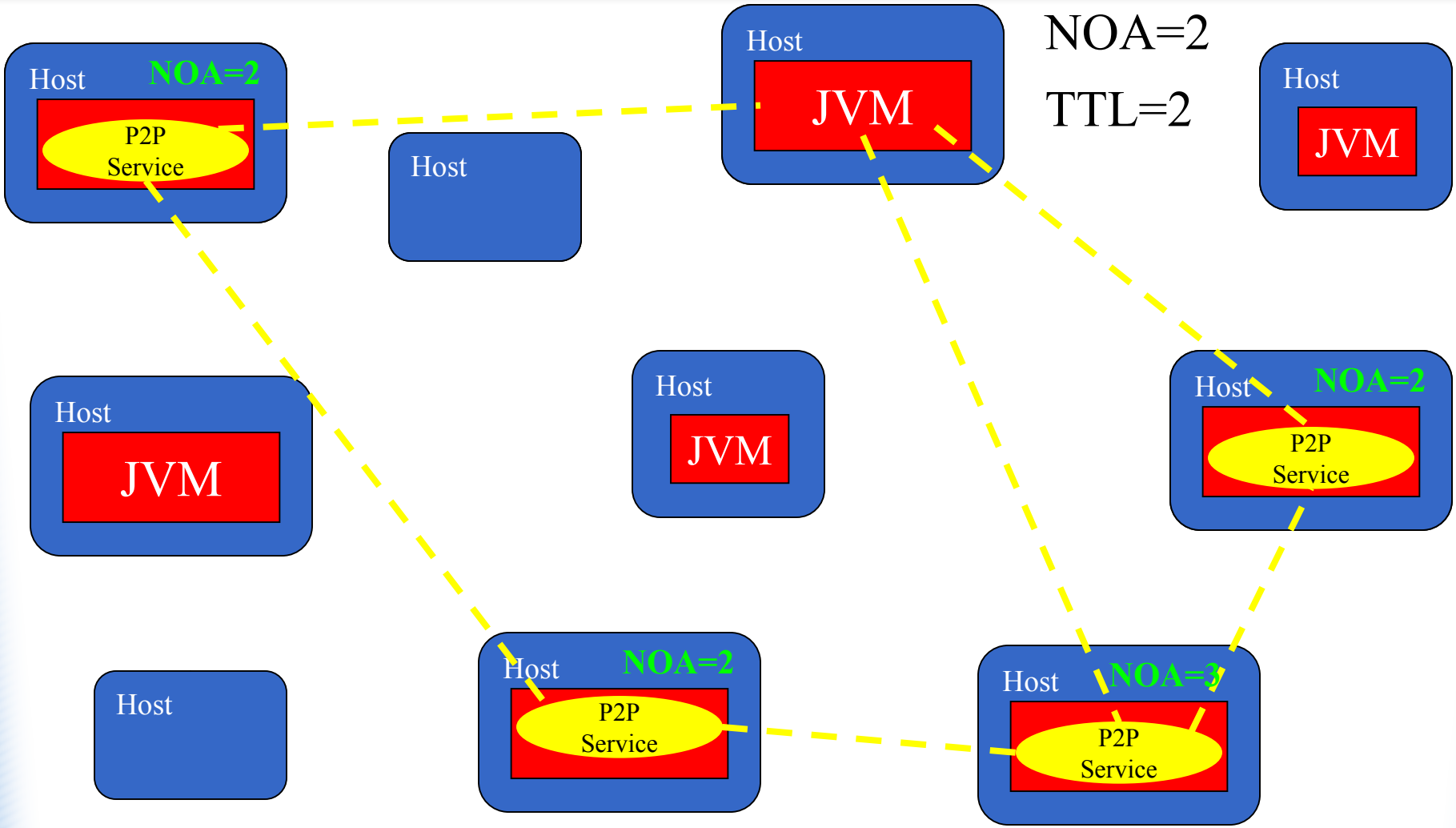

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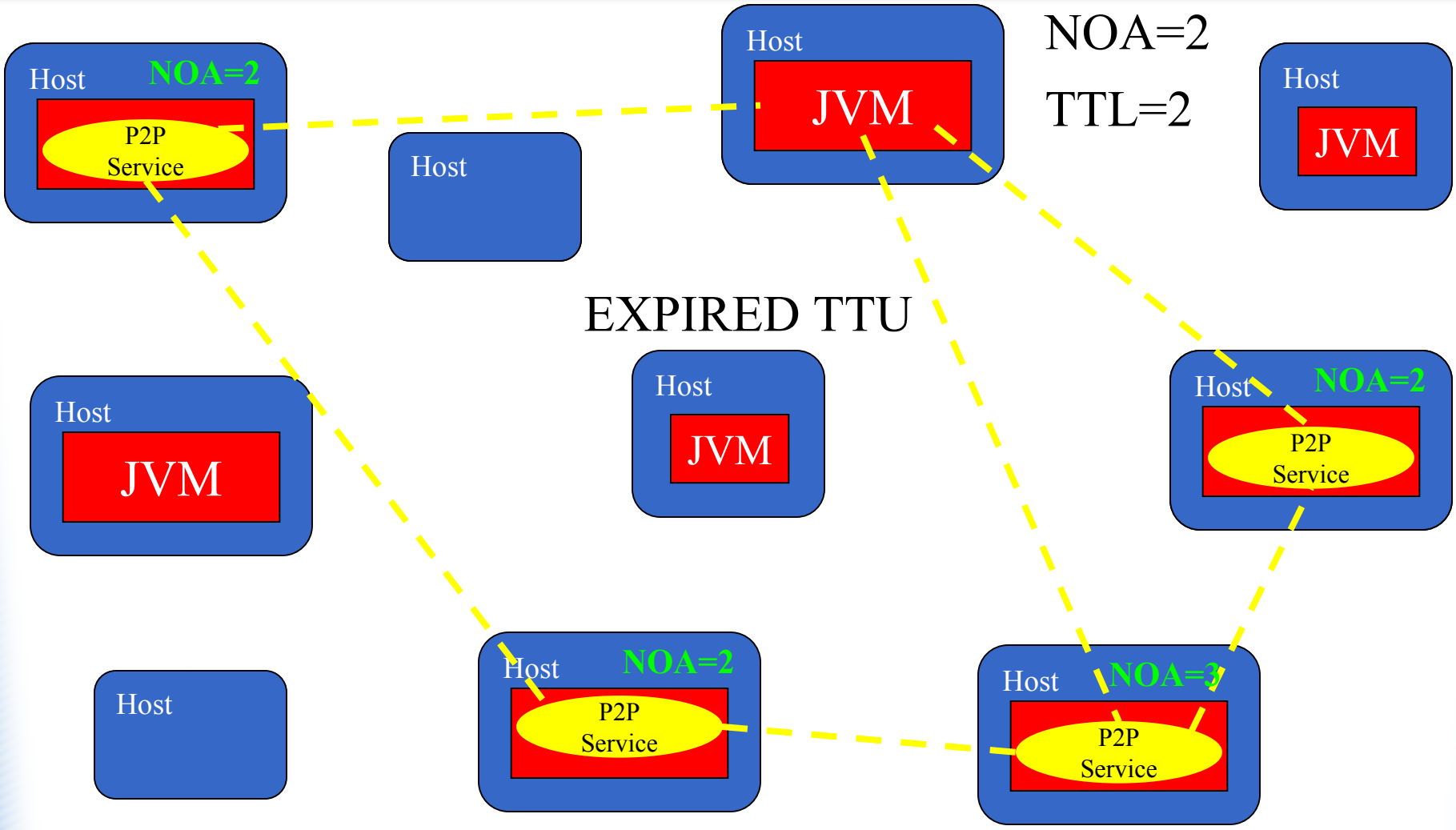

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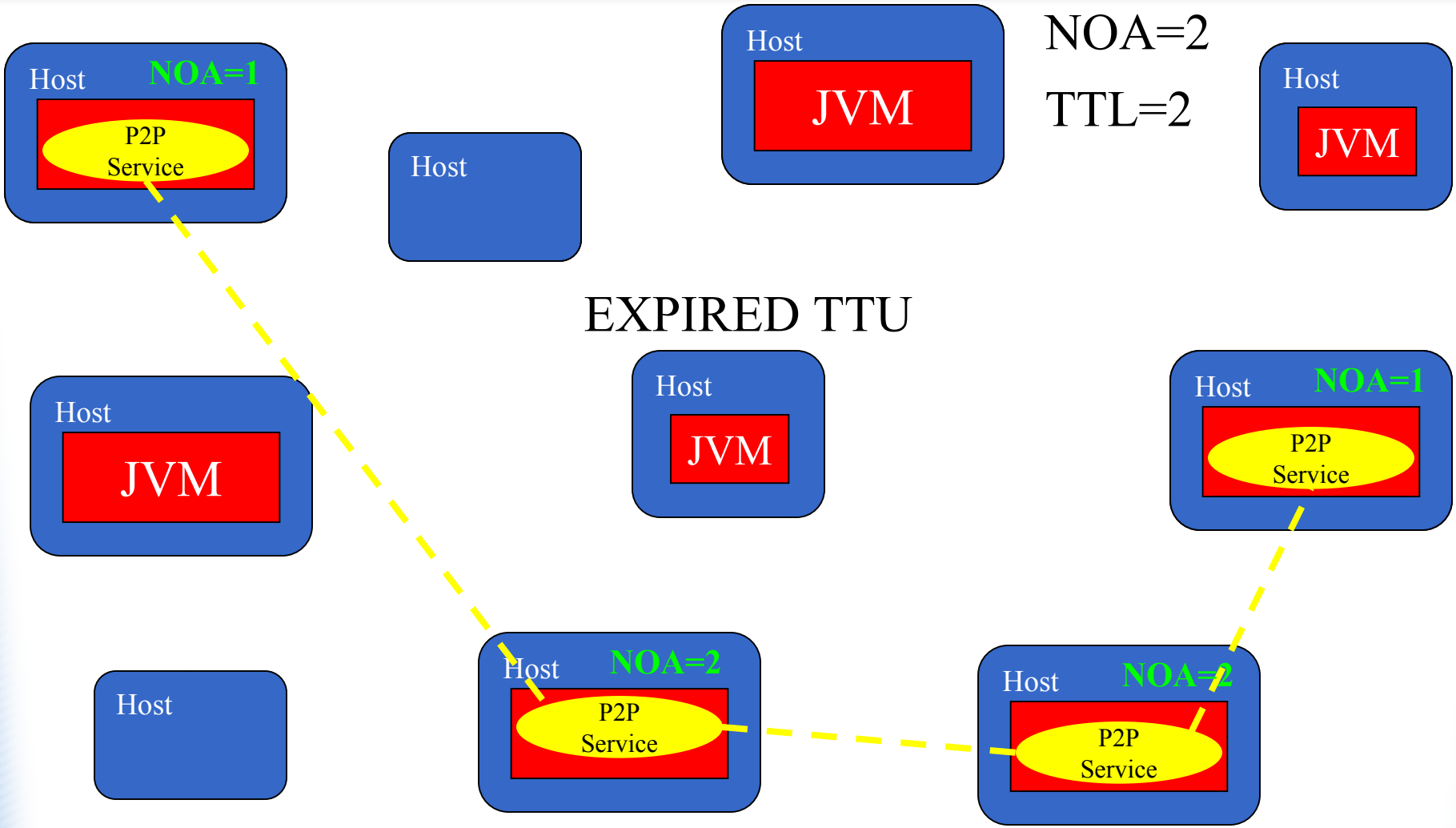

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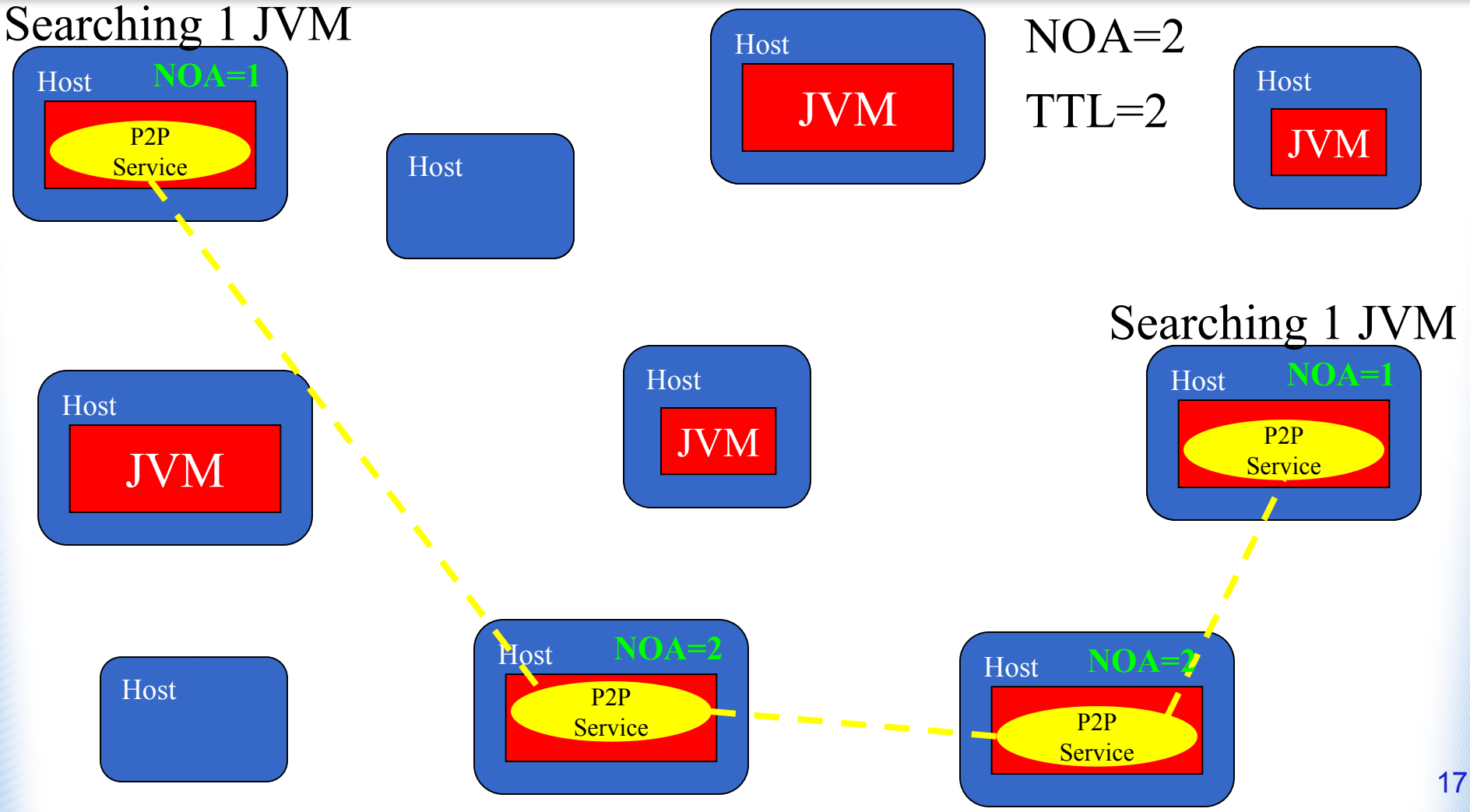

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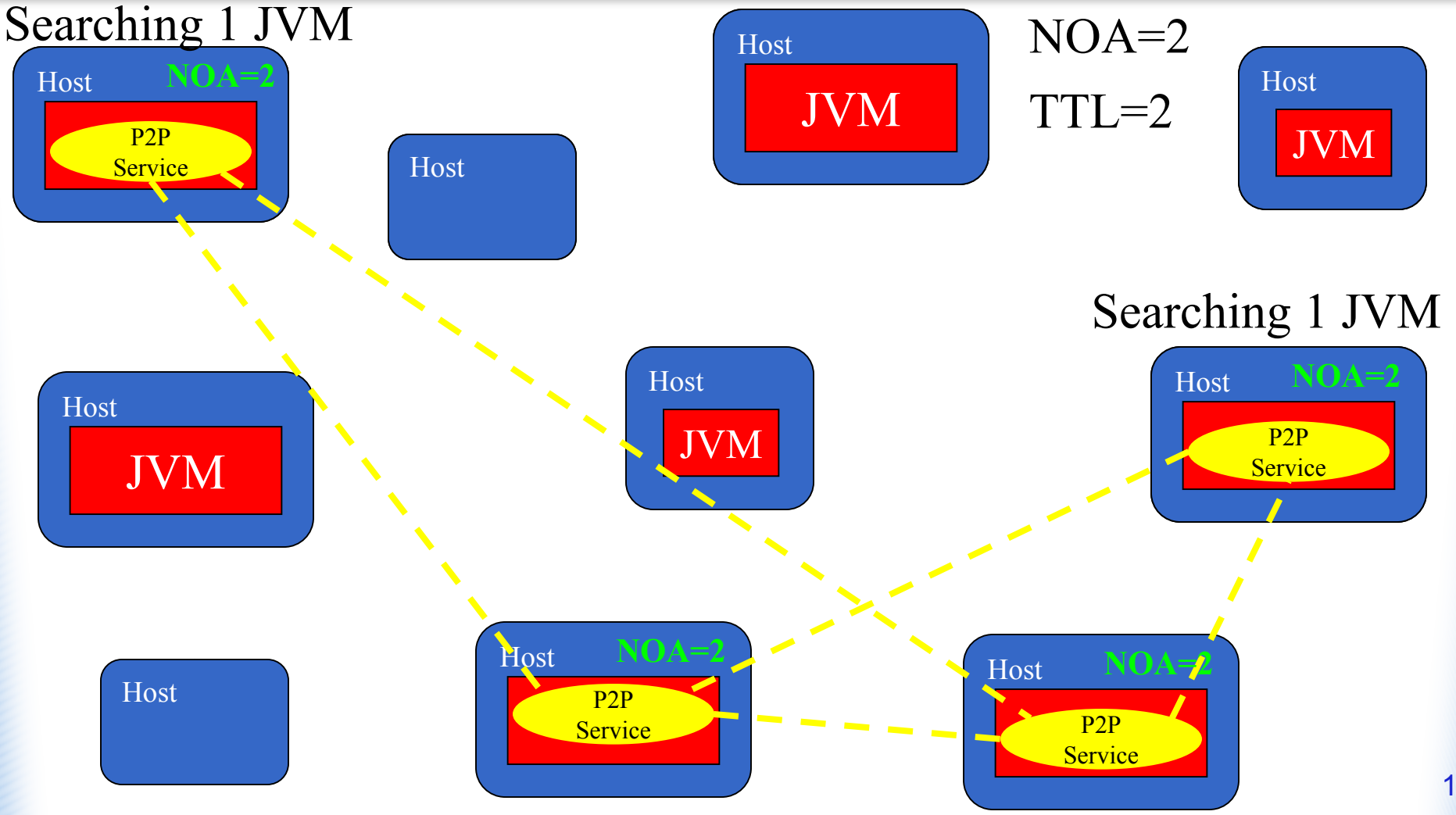
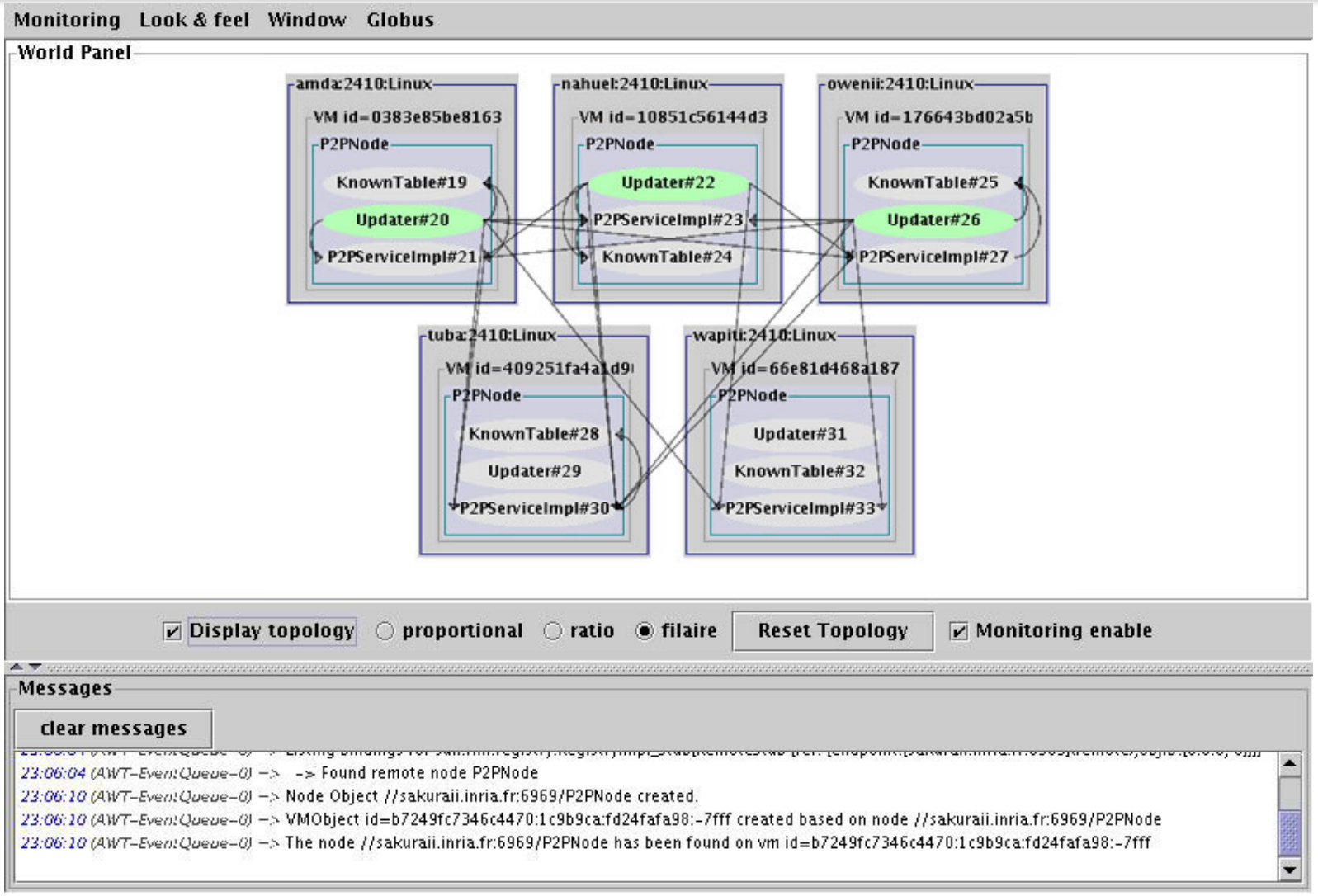


Implementation

- ProActive Runtimes: Standard JVMs
- Runtimes remote reaching and referencing to execute tasks:
  - Incompletes
  - Adding Active Objects:
    - **P2PService**: serves requests for recording and un-recording, accedes to Runtime's features and provides recursive search of JVMs
    - **Updater**: self-organizing and keeping up
    - **KnownTable**: list of acquaintances (peers)
  - Above communications protocols
    - Jini, RMI, Ibis and Web Services

Execution


Monitoring
Look & feel
Window
Globus
World Panel
amda:2410:Linux
VM id=0383e85be8163
P2PNode
KnownTable#19
Updater#20
P2PServiceImpl#21
nahuel:2410:Linux
VM id=10851c56144d3
P2PNode
Updater#22
P2PServiceImpl#23
KnownTable#24
owenii:2410:Linux
VM id=176643bd02a5b
P2PNode
KnownTable#25
Updater#26
P2PServiceImpl#27
tuba:2410:Linux
VM id=409251fa4a1d9
P2PNode
KnownTable#28
Updater#29
P2PServiceImpl#30
wapiti:2410:Linux
VM id=66e81d468a187
P2PNode
Updater#31
KnownTable#32
P2PServiceImpl#33
Display topology
proportional
ratio
filaire
Reset Topology
Monitoring enable
Messages
clear messages
23:06:04 (AWT-EventQueue-0) -> -> Found remote node P2PNode
23:06:10 (AWT-EventQueue-0) -> Node Object //sakuraii.inria.fr:6969/P2PNode created.
23:06:10 (AWT-EventQueue-0) -> VMObject id=b7249fc7346c4470:1c9b9ca:fd24fafa98:-7fff created based on node //sakuraii.inria.fr:6969/P2PNode
23:06:10 (AWT-EventQueue-0) -> The node //sakuraii.inria.fr:6969/P2PNode has been found on vm id=b7249fc7346c4470:1c9b9ca:fd24fafa98:-7fff

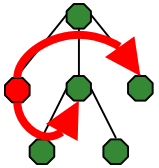
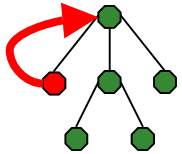
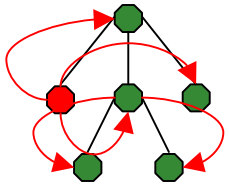
Programming Model

2nd Part

Programming Model

- Dynamic P2P Programming for B&B, etc.:
  - How to manage tasks, sub-tasks ?
  - Tasks communications: discovery tasks, volatility?
- Entities:
  - **Worker**: connects model with infrastructure
    - Task container
    - Getting new computational nodes
    - Tasks Communications
    - Managing dynamicity
  - **Solver**: Worker associate. Takes in input a problem creates sub-tasks (Problems) and found its best result
  - **Problem**: Worker associate
    - Dividing sub-problems
    - Merging results
    - Finding one solution
  - **Result**: solution abstraction

Programming Model

- Model is dynamic
- Communications between Workers :
  -  Brothers
  -  Father
  - All 
- Implementation built above ProActive Groups
  - Hierarchic organization
  - Communications between tasks
  - Tasks are parallels
- Troubles: volatility of Workers, comm.

Experimentations

P2P Infrastructure

-

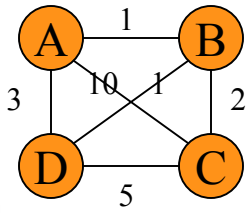
P2P Programming Model

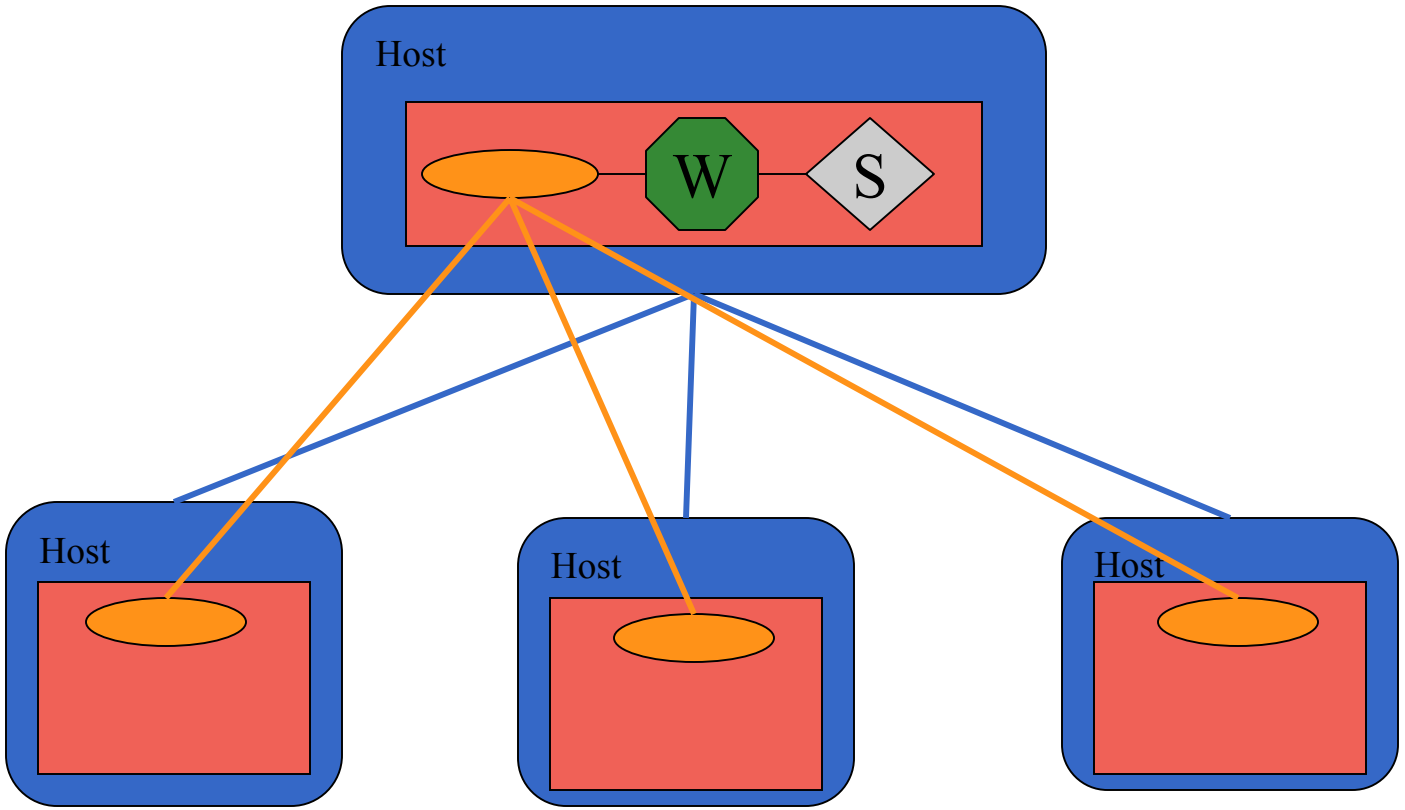
Infrastructure's Experimentation

- N-Queens:
  - Master-slave application with static deployment
  - Dynamic Workers Acquisition
  - Faults tolerant
  - TTU = 10 minutes ; TTL = 10 hops; NOA = 10 peers

20-Q	23 Peers	Tasks : 2482	Cumulated CPU time: 73h7'22 ''	Real time : 3h15'20''	Solutions : 39029188884
21-Q	23 Peers	3081	569h23'16''	24h59'44''	314666222712
23-Q	23 day 130 night	116/4203	-	Since June 20th	-

Model's Experimentation
Traveling Salesman Problem





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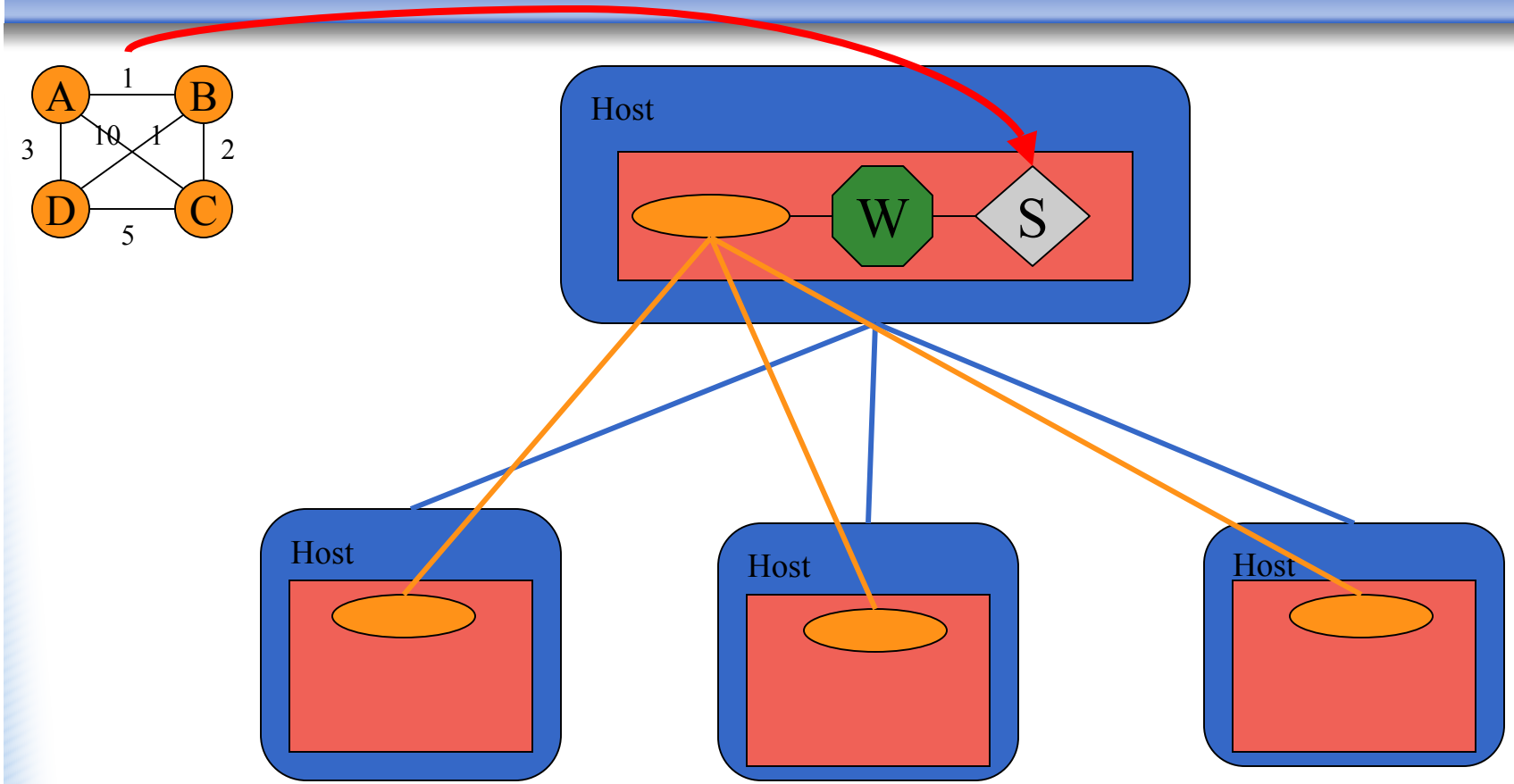

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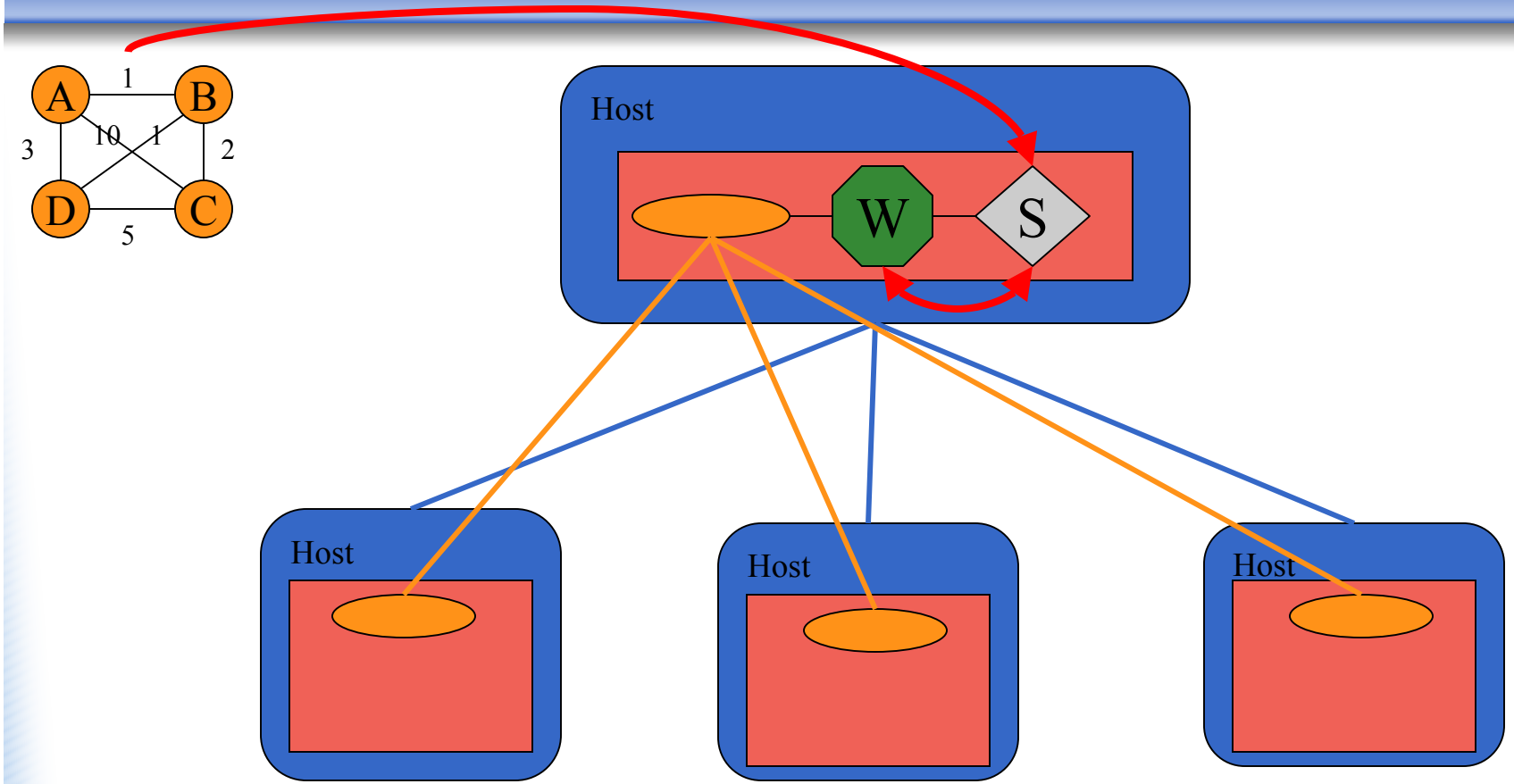

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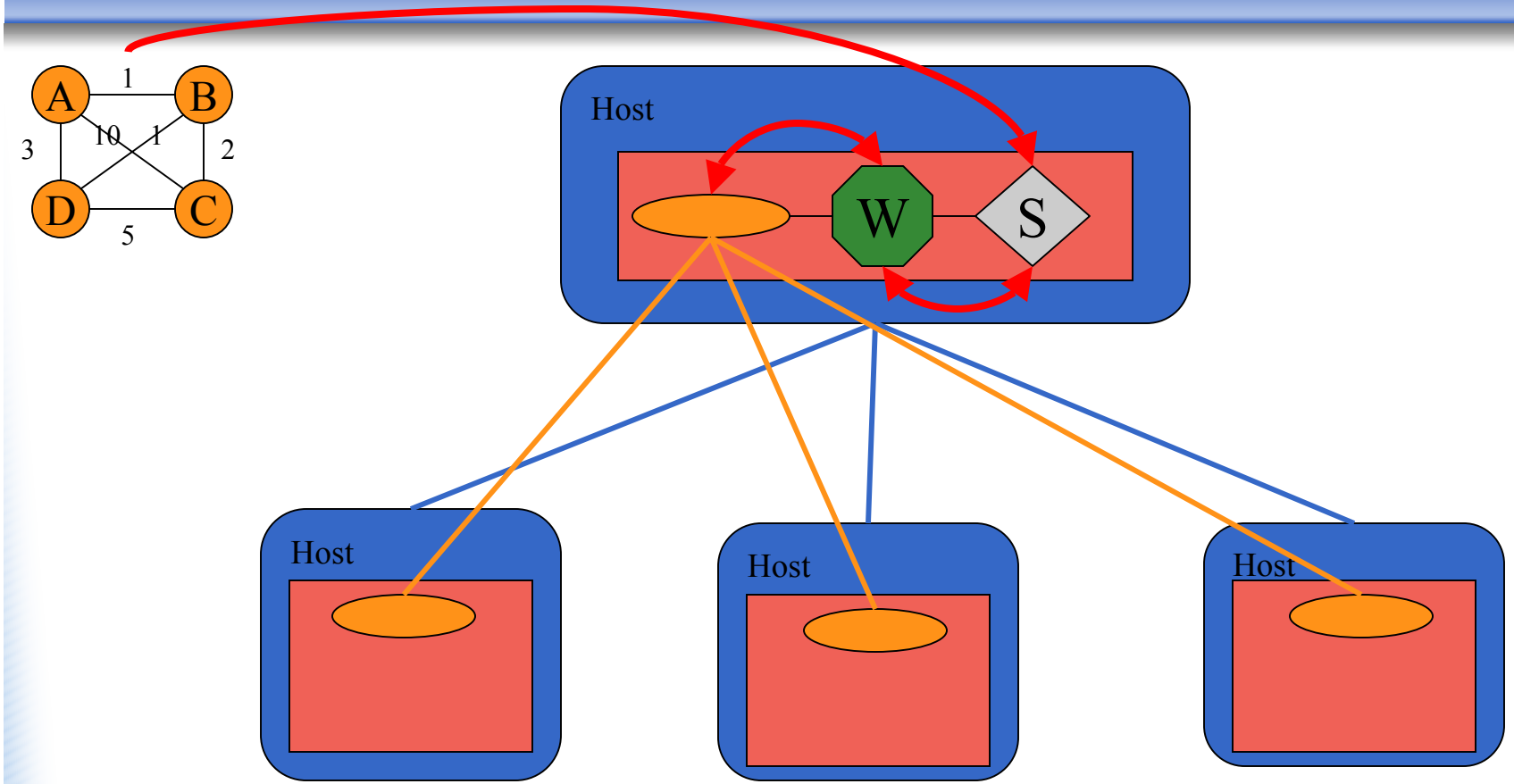
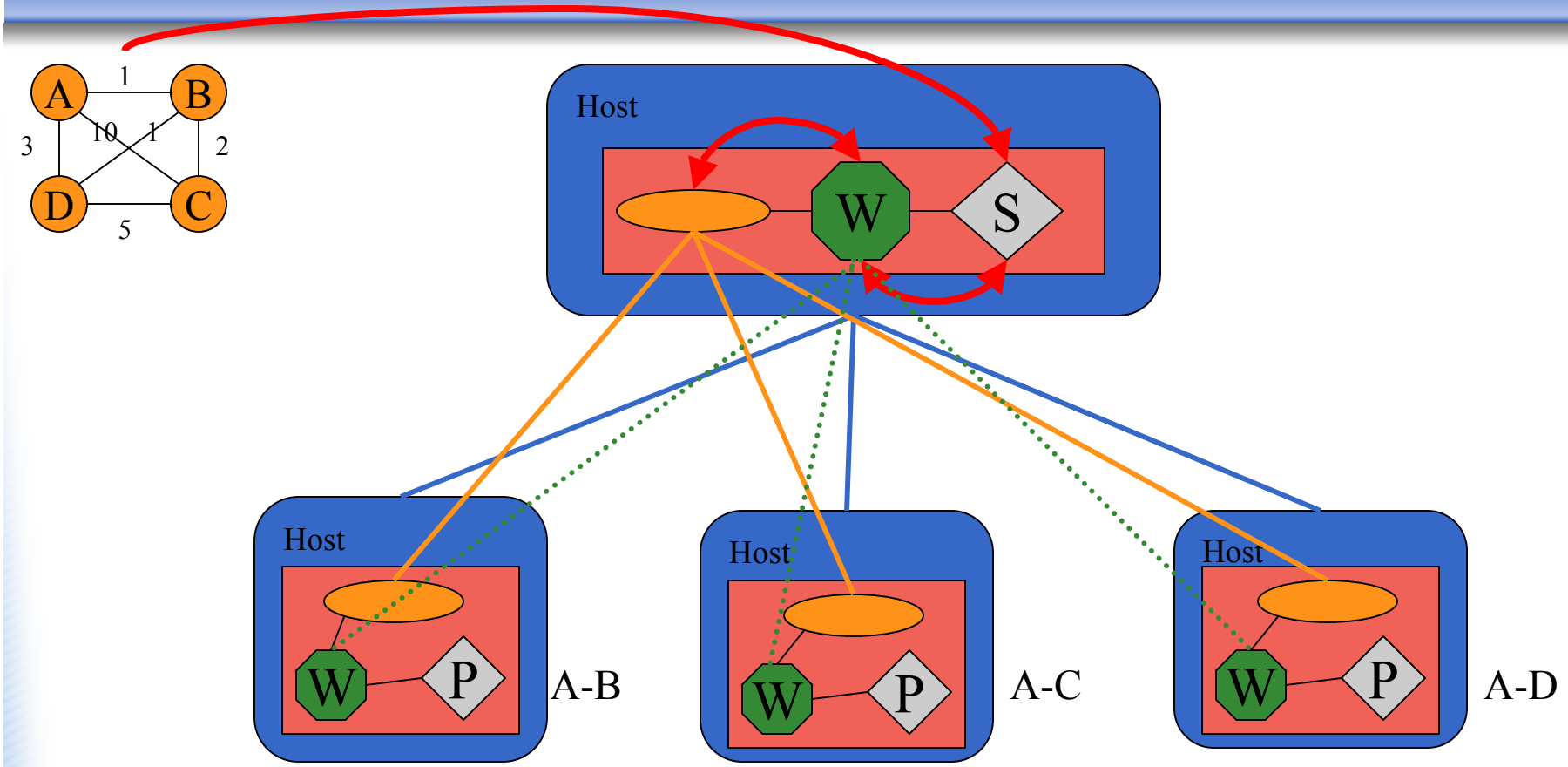


Model's Experimentation Traveling Salesman Problem



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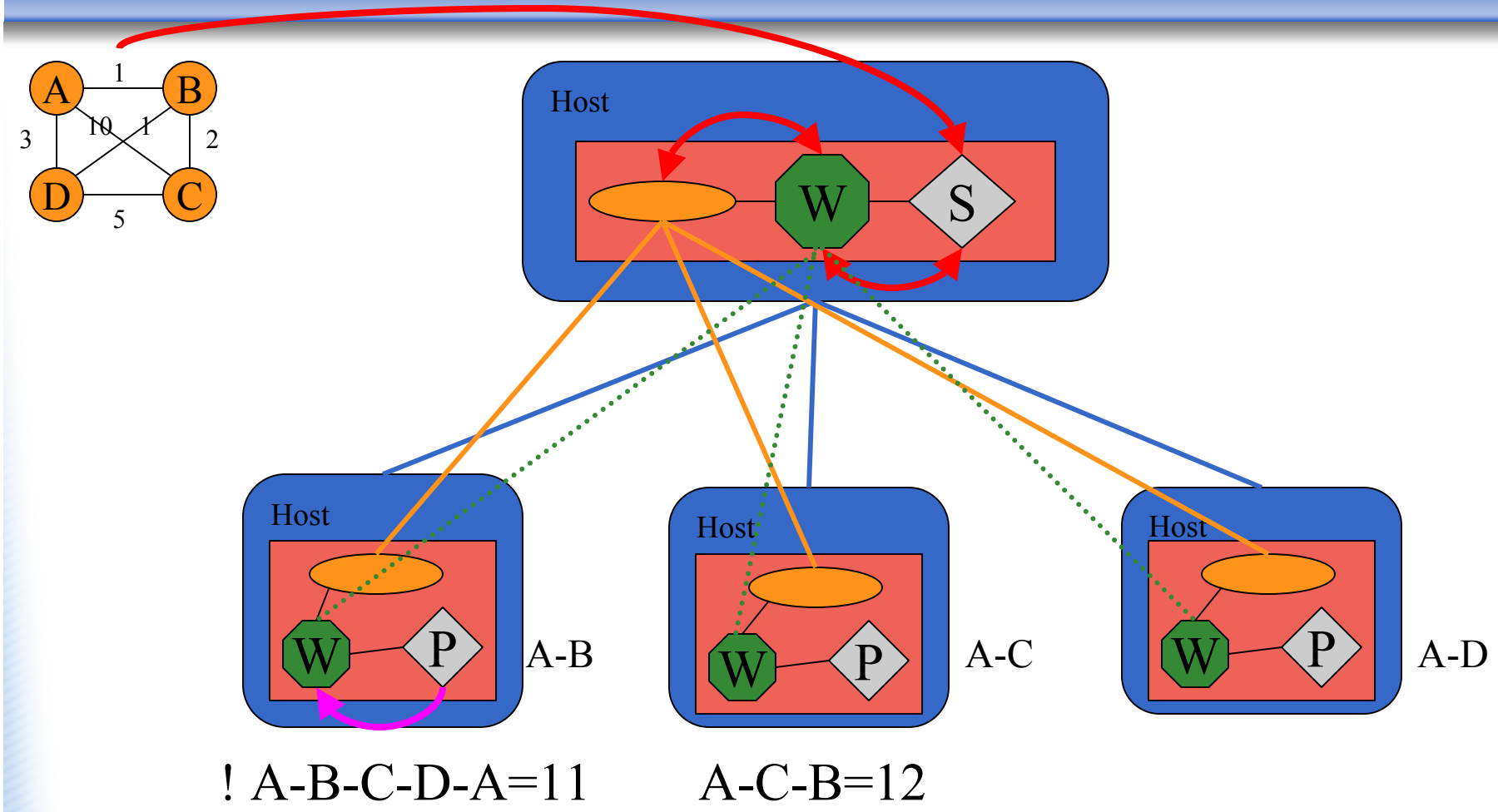

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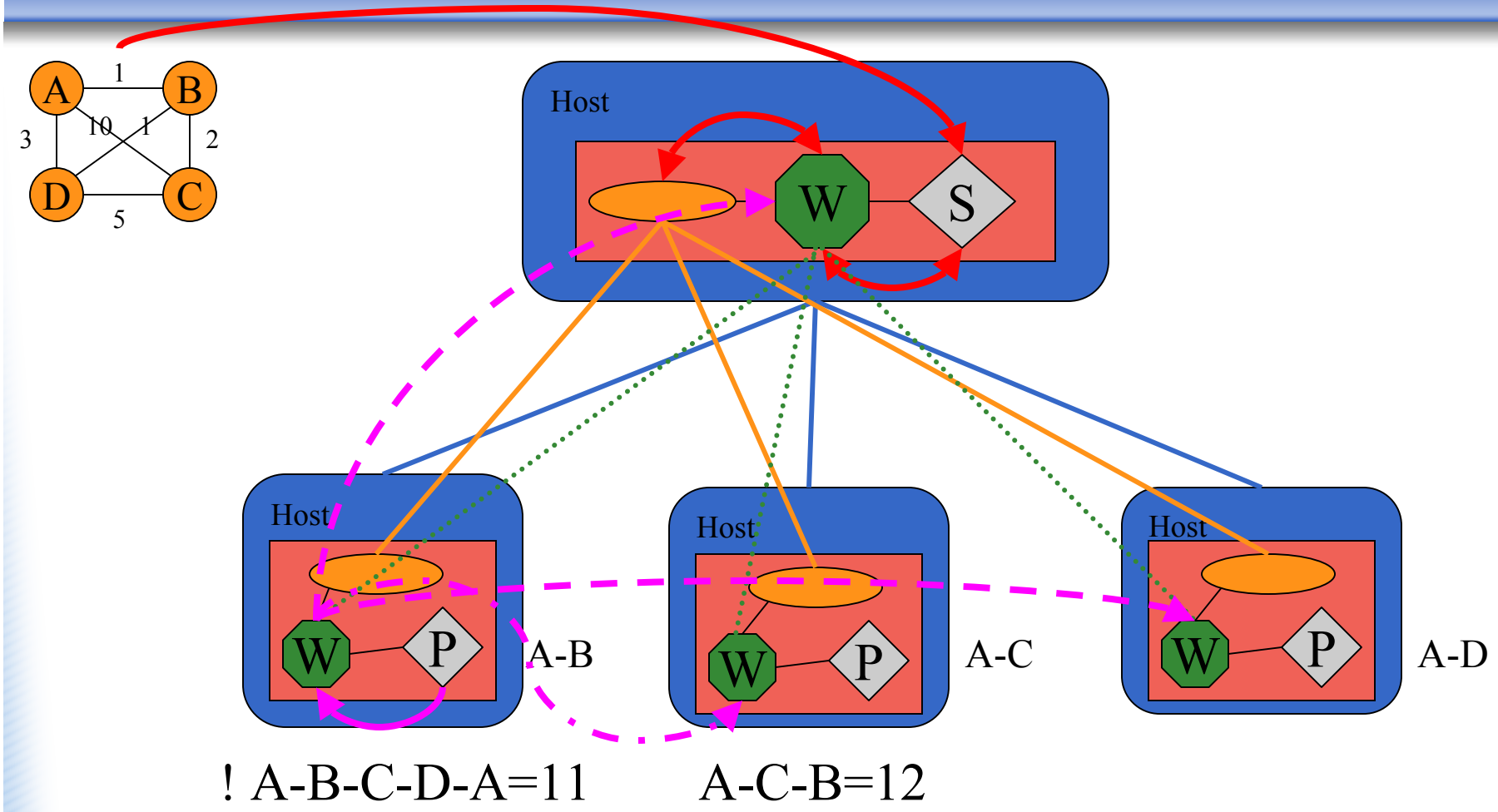

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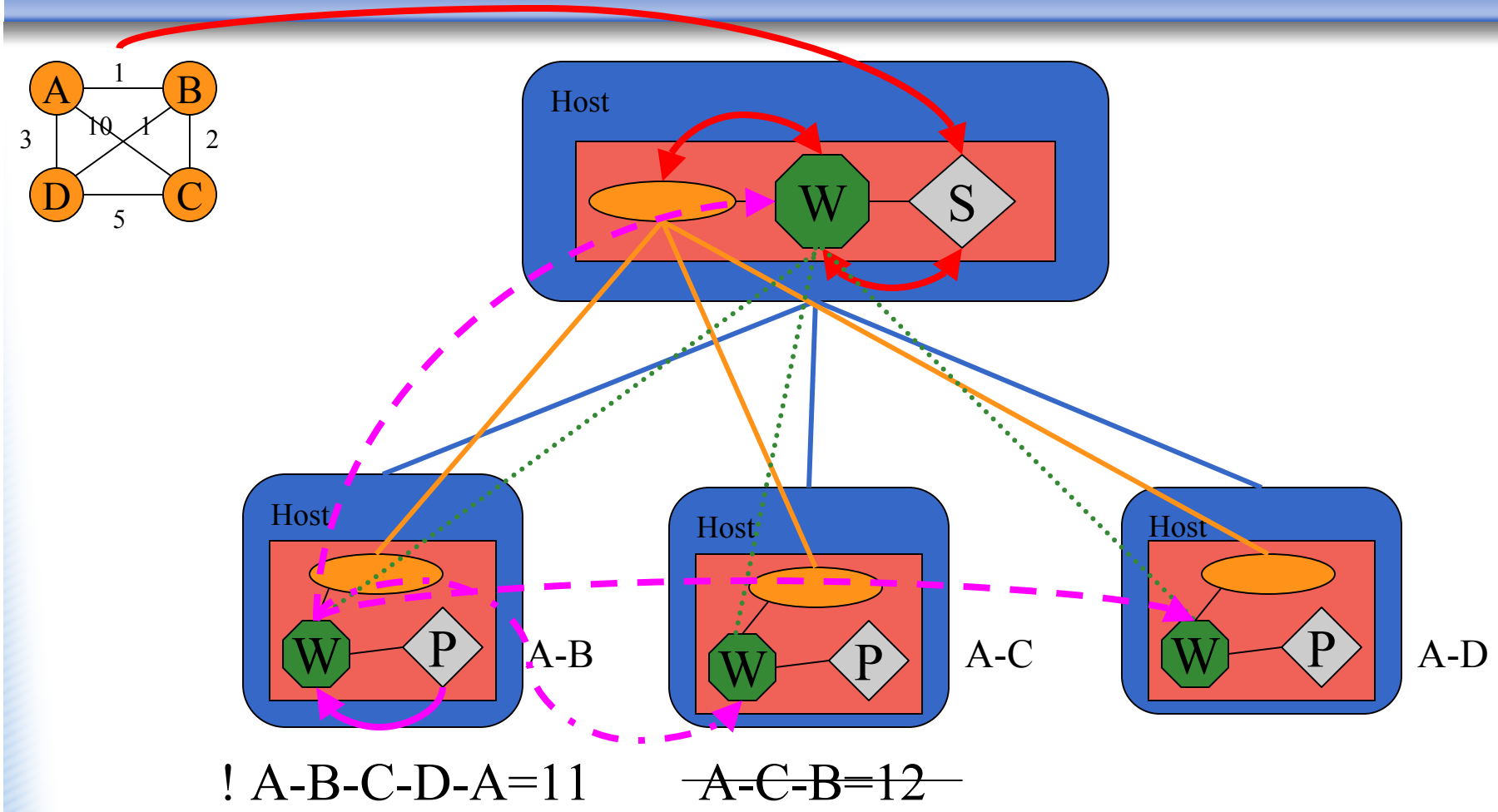

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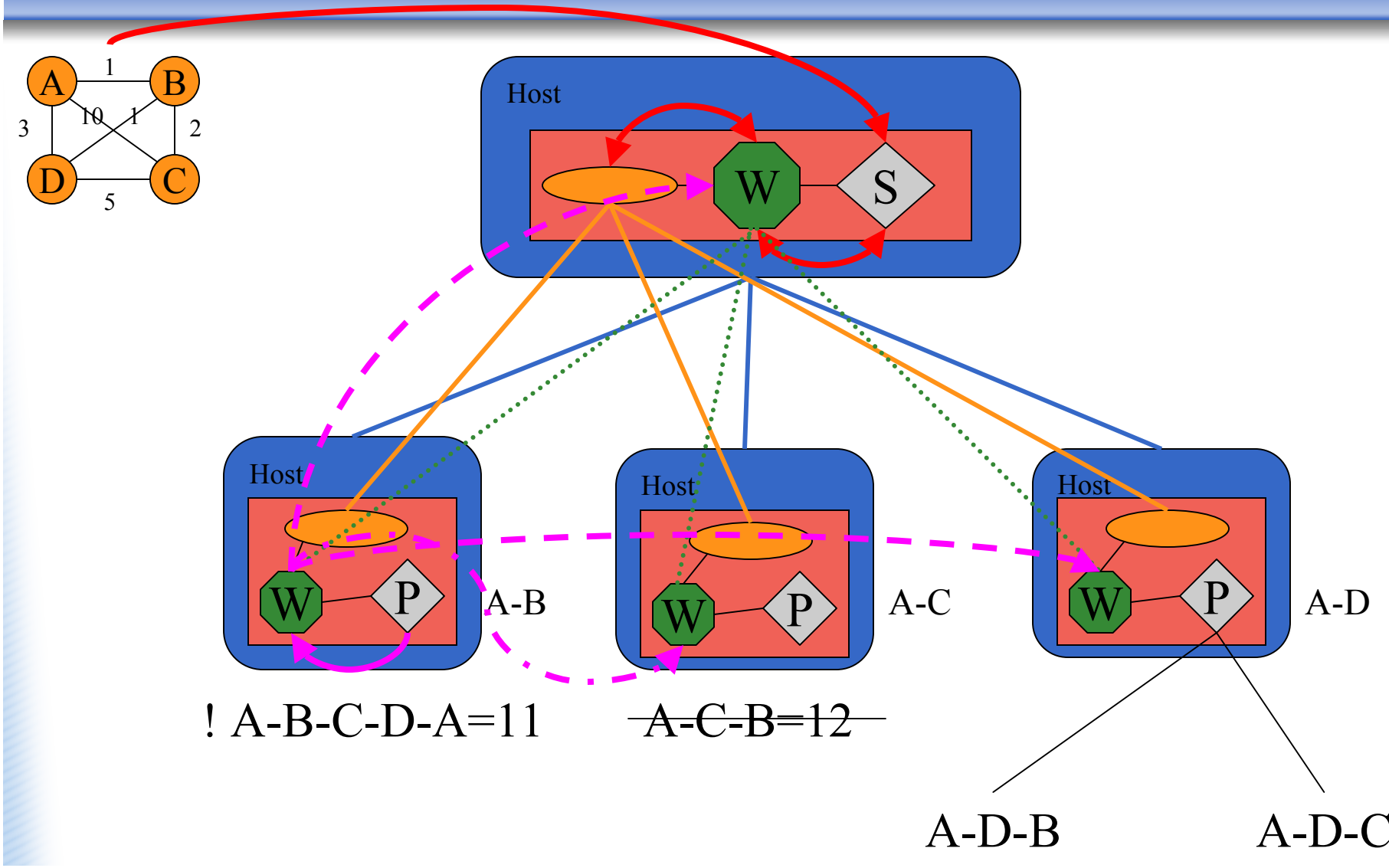

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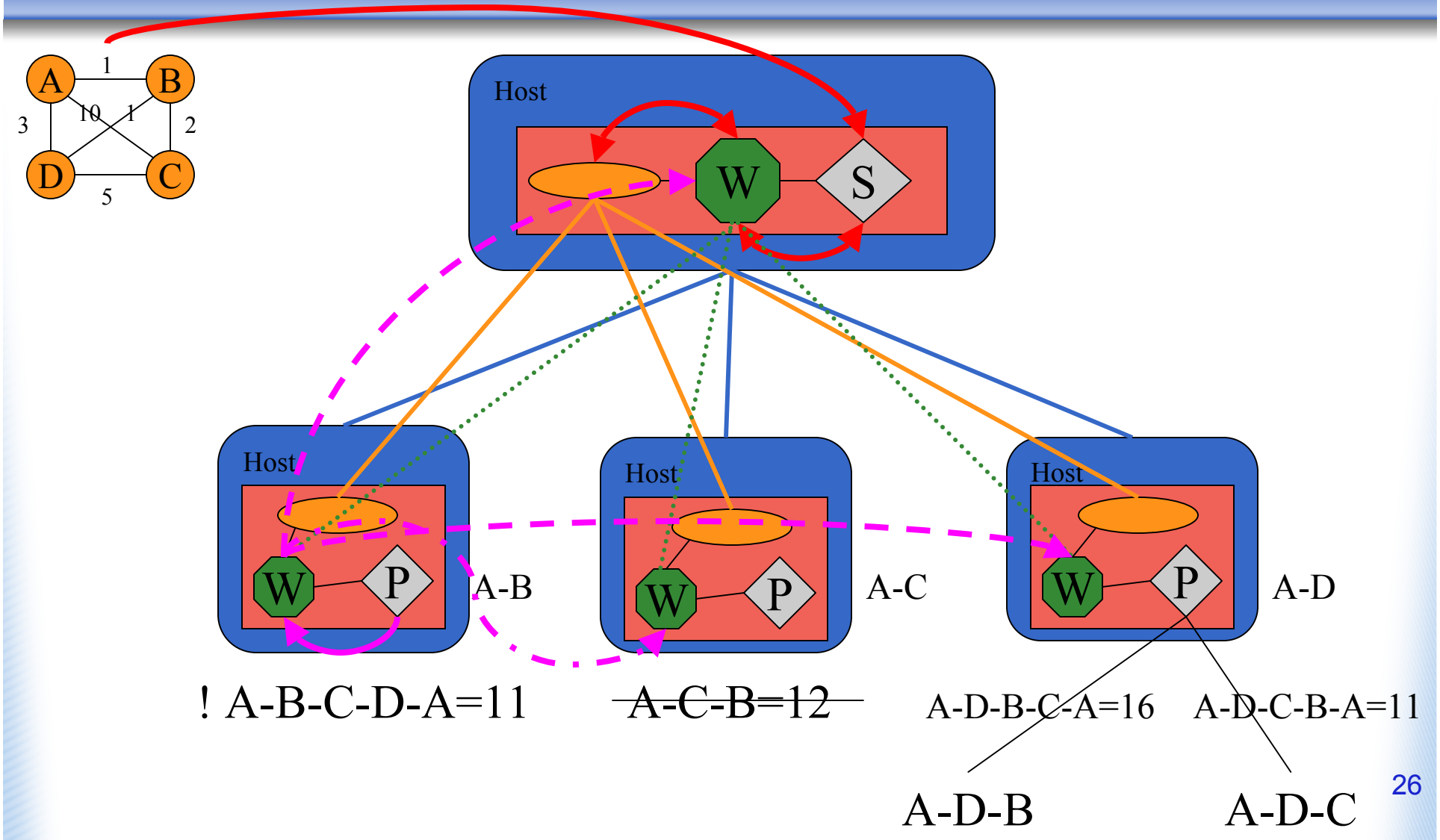

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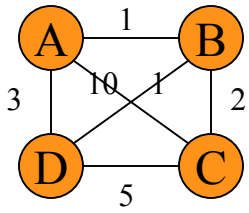

Host

W

S

Host

W

P

A-B

Host

W

P

A-C

Host

W

P

A-D

A-D-C-B-A=11

! A-B-C-D-A=11

~~A-C-B=12~~

A-D-B-C-A=16

A-D-C-B-A=11

A-D-B

A-D-C

Evaluation

- In relation to related works :
  - InteGrade
    - No static organization :

      Self-organizing
  - XtremWeb
    - Tasks communications
    - Synchronizations
  - JXTA
    - Infrastructure ready to use and
    - Model with programming API
  - ProActive
    - P2P dynamic deployment,
    - Computational and parallel P2P programming API

Conclusion

- Contributes :
  1. P2P Infrastructure of JVMs
     - Tunable (TTU, TTL et NOA)
     - Self organizing
     - 1st real P2P infrastructure for computational
  2. Model for P2P programming
     - Dynamic programming P2P (B&B)
     - 1st model with communications between tasks
  3. Implementations and Experimentations

- Perspectives :
  - Large scale tests (500, …, 5000)
  - Simulations or emulations
  - Modeling: Jackson's networks, Kelly's networks
  - Integrate some search methods : BFS, DFS