

# Automatic Run-time Adaptation in Virtual Execution Environments

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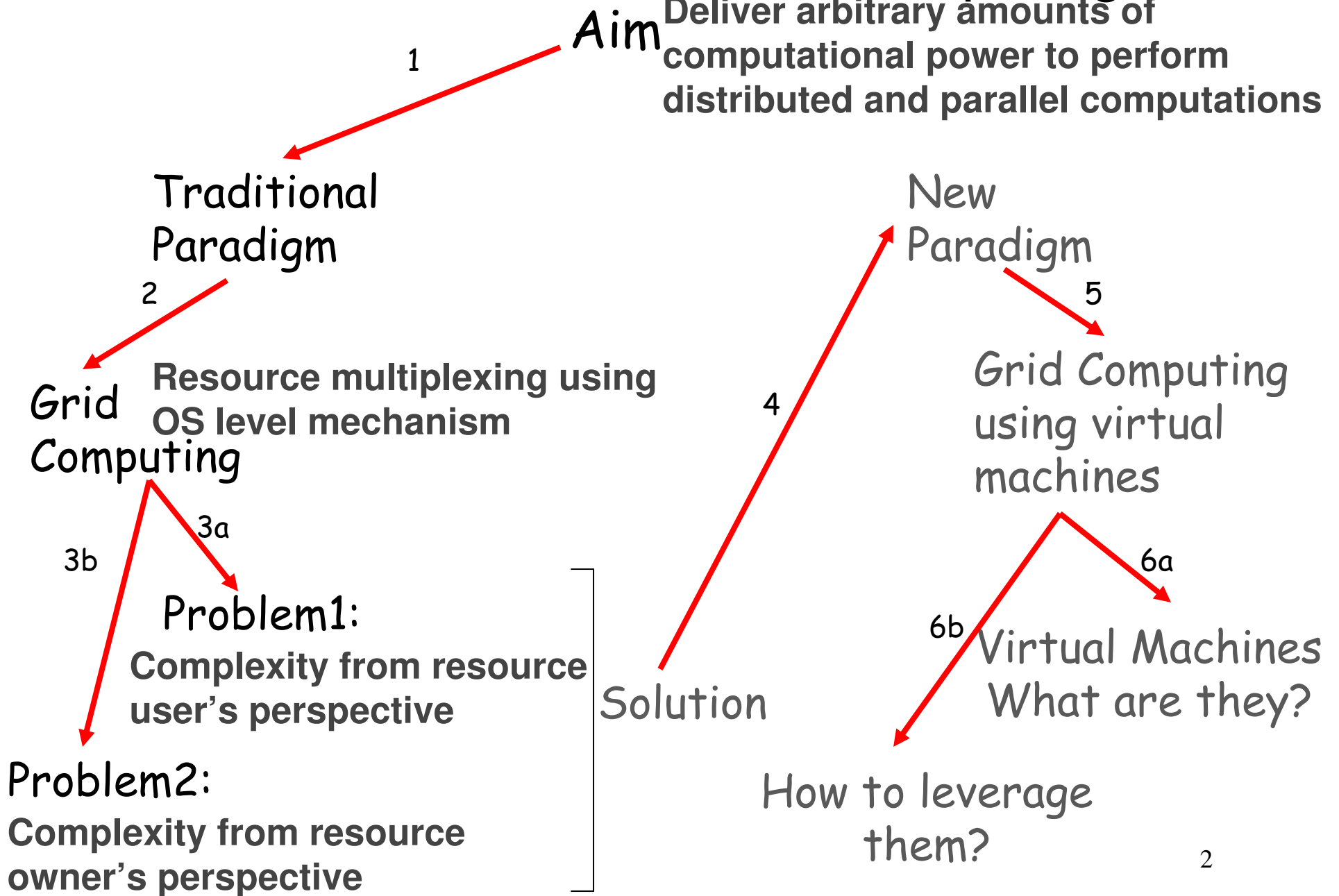
Northwestern University

<http://virtuoso.cs.northwestern.edu>




# Virtual Machine Grid Computing

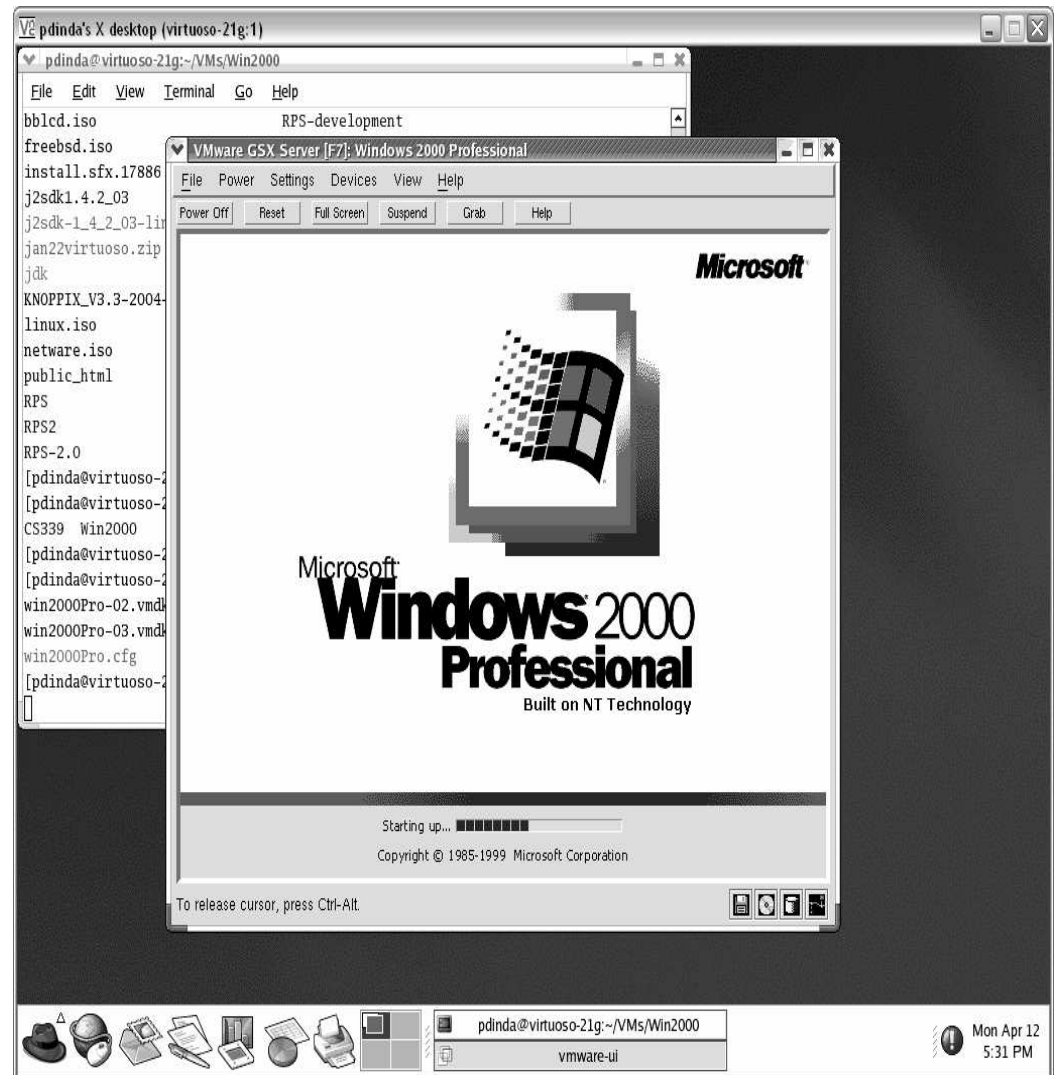
**Aim** Deliver arbitrary amounts of computational power to perform distributed and parallel computations



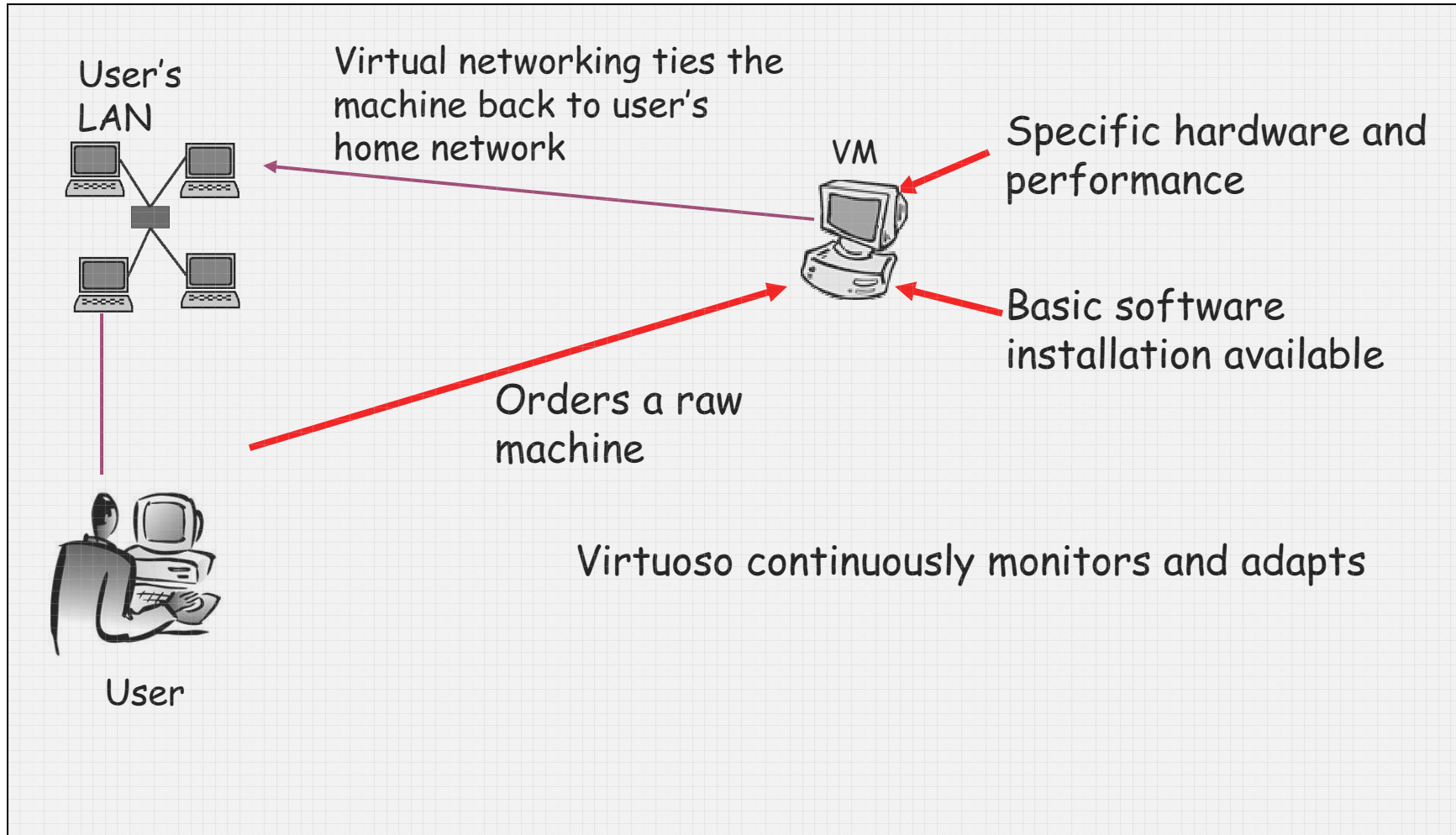
# Virtual Machines

## Virtual machine monitors (VMMs)

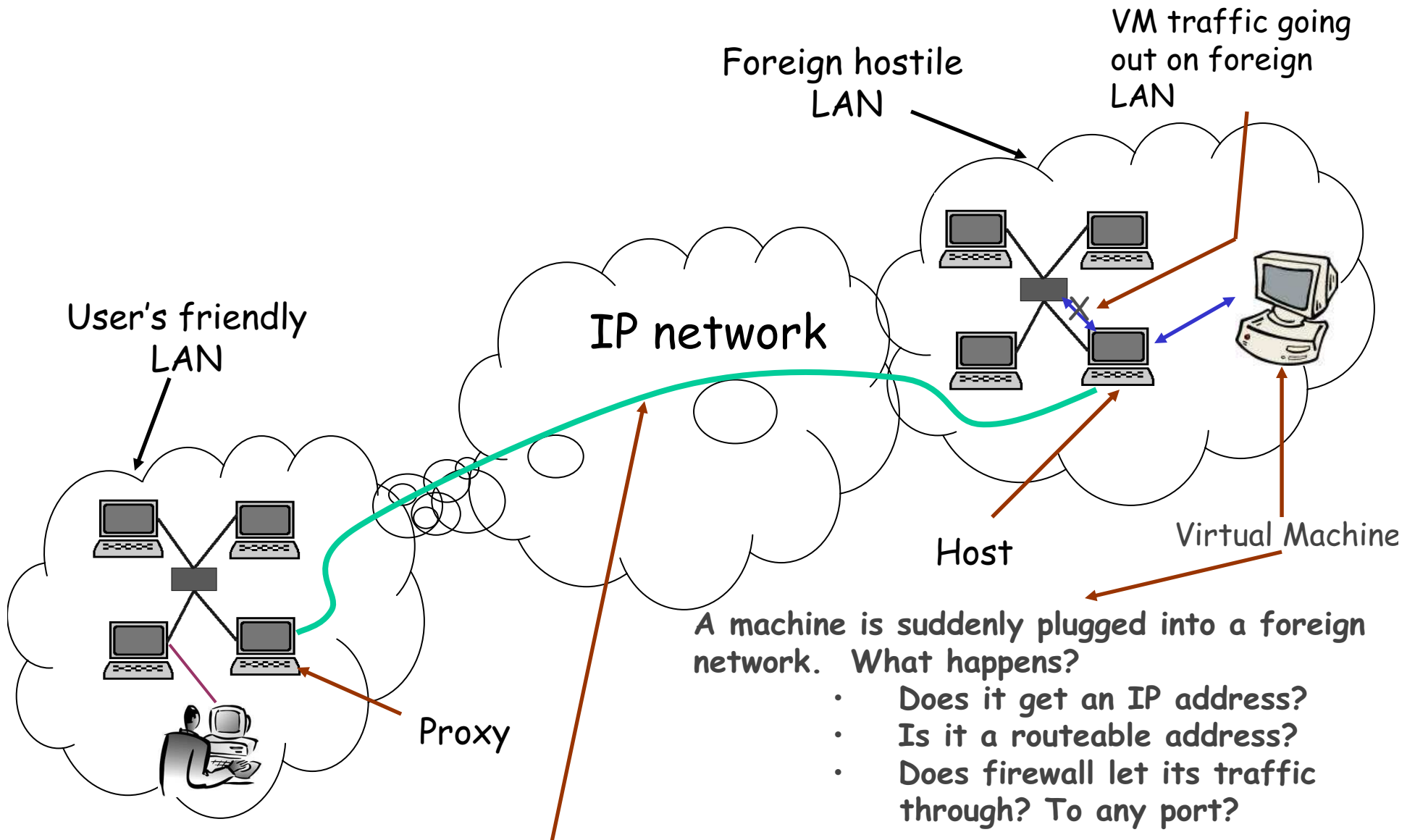
- Raw machine is the abstraction
- VM represented by a single image
- VMware GSX Server 



# The Simplified Virtuoso Model



# Virtual Networks



A machine is suddenly plugged into a foreign network. What happens?

- Does it get an IP address?
- Is it a routeable address?
- Does firewall let its traffic through? To any port?

VNET: A bridge with long wires

# Measurement and Inference

## Underlying network

- Topology
- Bandwidth
- Latency

[Gupta et al. In submission]

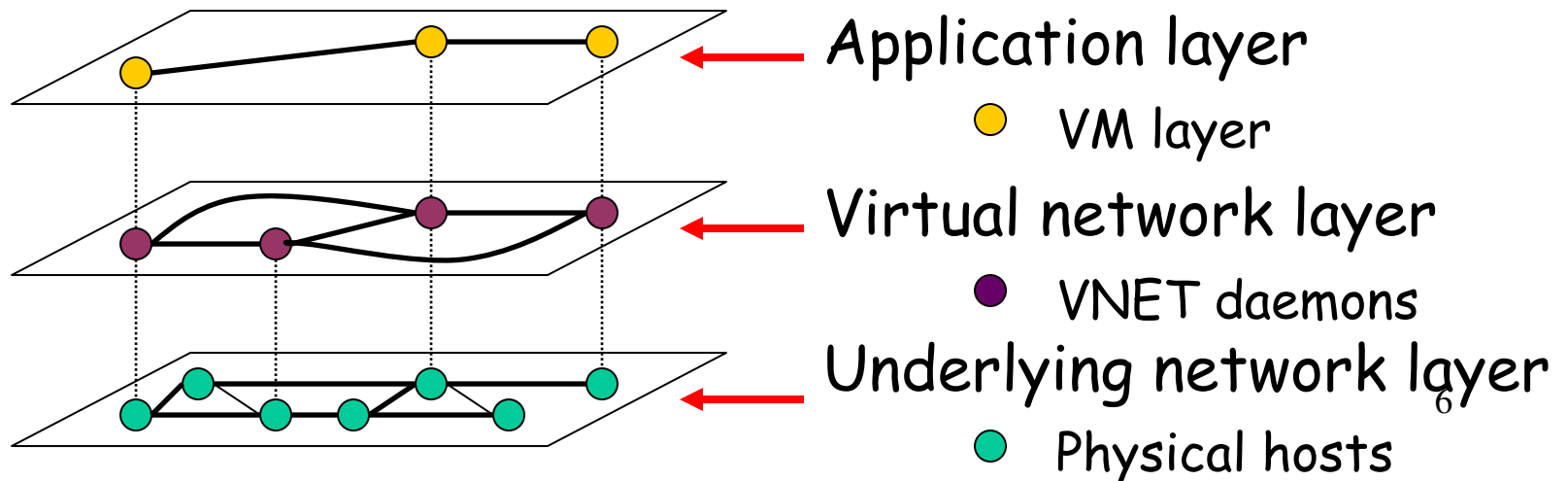
## Host and VM

- Size and compute capacities
- Size and compute demands

## Application (VTTIF)

- Topology
- Traffic load

[Gupta et al. LNCS 05]



# Adaptation Mechanisms

## VM Migration

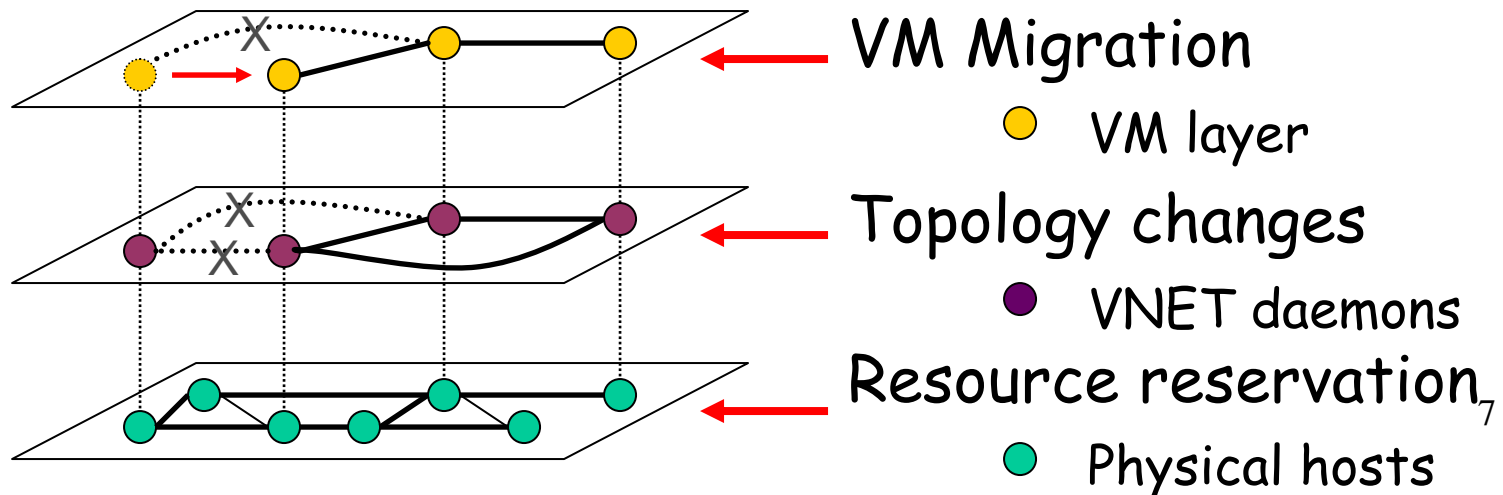
- Third party migration schemes

## Topology changes

- Overlay links
  - Overlay forwarding rules
- [Sundararaj et al. LCR 04, HPDC 05]

## Resource reservation

- Network [Lange et al. HPDC 05]
- CPU [Lin et al. GRID 2004]



# Generic Adaptation Problem In Virtual Execution Environments

- Goal:
  - VMs to Hosts mapping
  - Path to each 4-tuple
  - Meeting all demands within constraints
  - Such that
    - Sum of residual bottleneck bandwidth over each mapped path is maximized

# Optimizing Objective functions

- Many possibilities
- Maximizing sum of residual bottleneck bandwidths over each mapped path
  - Intuition:
    - Leave the most room for application to increase performance
- Minimizing the residual bottleneck capacity
  - Intuition:
    - Increase room for other applications to enter system

# Claim

- Wide spectrum of possibilities
  - Adaptation transparent to application
  - Application directed adaptation
- Claim
  - Adaptation using a single metric for a wide range of applications is possible and feasible



- For More Information
  - Prescience Lab (Northwestern University)
    - <http://plab.cs.northwestern.edu>
  - Virtuoso: Resource Management and Prediction for Distributed Computing using Virtual Machines
    - <http://virtuoso.cs.northwestern.edu>
- VNET is publicly available from
  - <http://virtuoso.cs.northwestern.edu>