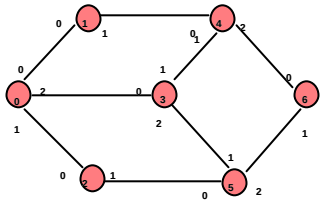
NVE Communication Architectures



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Lecture Overview

NVE Communication Architectures

- Broadcast
- Server
- Multi-server
- Peering
- Multicast for scalable NVE

Impact of NVE Communication Architecture

- Processor workload => cost and/or feasibility
- Network requirements => cost and/or feasibility
- Latency => human user acceptance
  - without this, you don't have a VE!

Components of Latency

- total time from input by one station to user stimulus at all stations
  - sensor delay at source
  - processing at source
  - transmit time at source
  - propagation time in all media
  - queueing/forwarding time in network
  - queueing/processing/transmit time at server
  - processing time on receipt
  - display time on receipt

Simple NVE Architecture

- Simplest case: two stations on a LAN
  - all actions from each station sent to the other
  - minimal contention for LAN
  - DIS traffic: 144 bytes + overhead per frame
    - overhead bytes UDP: 8 IP: 40 802.3: 26
    - total 218 bytes = 1744 bits
    - 30 frames per second?

NPSNET-IV Performance with DIS

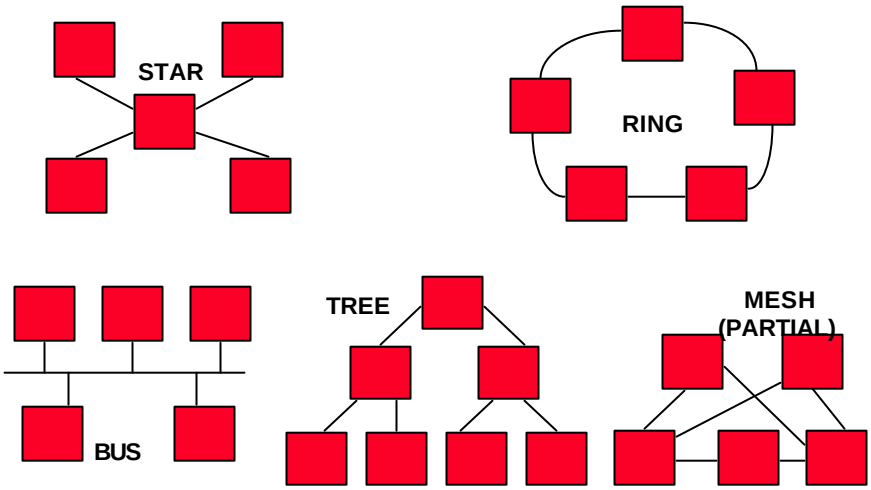
- Aircraft 12 PDUs per second
- Ground vehicles 5 PDUs per second
- Weapon firing 3 PDUs per second
- Fully articulated humans 30 PDUs per second (frame rate)
- Heartbeat PDU every 5 seconds.

Some Network Parameters

How many players can we support assuming 5 PDU/s and broadcast mode and no other traffic?

- V.90 “56K” modems - effective rate about 40 kb/s
  - 4 players
- 1.5 Mbps T-1 line
  - 172 players
- 10 Mb/s Ethernet LAN - effective rate about 4 Mb/s
  - 458 players

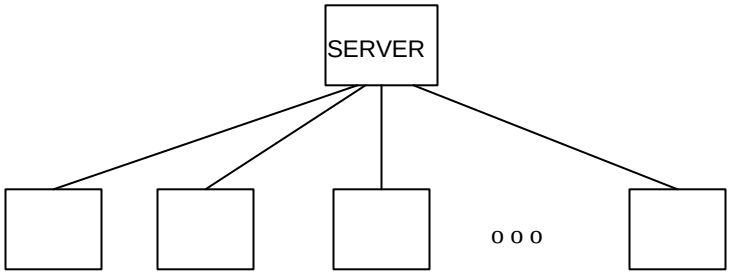
Underlying Network Topologies



Can make a big difference in latency!

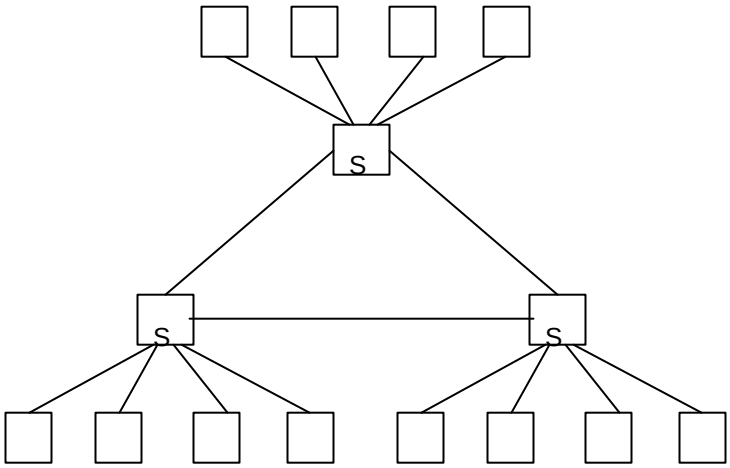
Multi-Player Client Server

Logical Architecture



- Servers are bottlenecks
  - But useful for compression & admin tasks

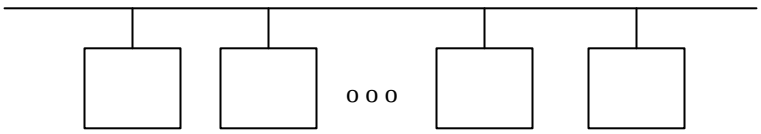
Multi-Server System



Peering System

Broadcast NVE Architecture

- all actions from each station sent to all others
- contention is proportional to number of transmissions
- application multicast: scales as N * (N-1)
- Ethernet broadcast: scales as N



Limitations of Broadcast

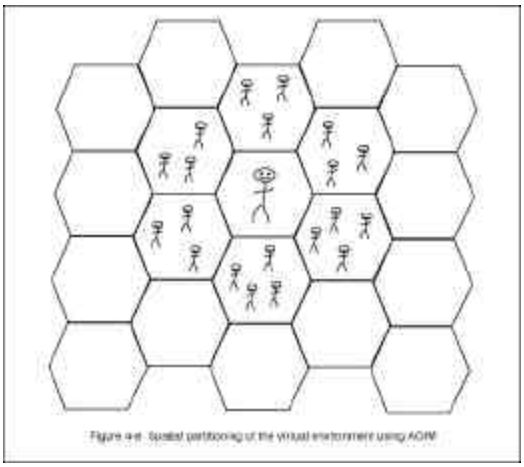
- Floods the network with packets
  - consumes network capacity
- All packets must be brought up through the kernel of the operating systems of all players on the net.
  - even if the packet is not for that machine
  - consumes processor capacity

Areas of Interest in the VE

- In the real world, which virtual environments emulate, entities have a limited “areas of interest”.
  - based on sensor range and/or user interest
- We can exploit this with multicast communications.
- Interactions are mediated by an AOIM software layer.

VE Software Scalability

- Virtual environment software architectures can exploit wide area multicast communications and entity relationships to partition the virtual world and enable the development of scalable VEs.
- In the HLA this is called “distributed data management”
  - each area of interest uses one multicast group
  - in theory it ought to reduce network load and processor load

Area of Interest Management

- Partitioning Classes
  - Spatial
  - Temporal
  - Functional