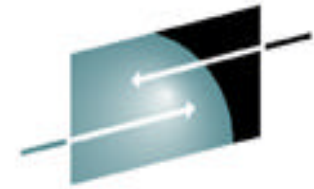


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# Session 3604

## Performance Modeling and Analysis of SNA and IP Application Workloads on S/390 and zSeries

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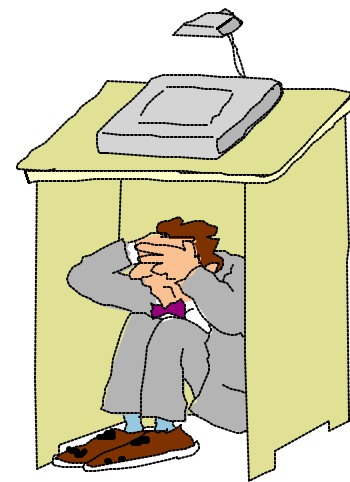
# Challenges with eBusiness Solutions

## ■ Dynamic Environment

- ▶ Changes must be deployed quickly
  - New applications, changes to existing applications, network infrastructure, workload levels
- ▶ Without adversely impacting existing application workloads
  - What is the impact on
    - Server platform requirements (CPU, storage, etc.)
    - Network infrastructure (network, routers, server connectivity, etc.)
  - SLA for new and changed workloads must be met
    - Degraded performance is often perceived as "down time"

## ■ Uncertainty often inhibits change

- ▶ For example, we're considering SSL to protect the communications of some key applications
  - What will be the impact of this change?
    - On end user response time?
    - On system resources (CPU, etc.)
    - On network traffic?



# Network Modeling and Simulation Tools

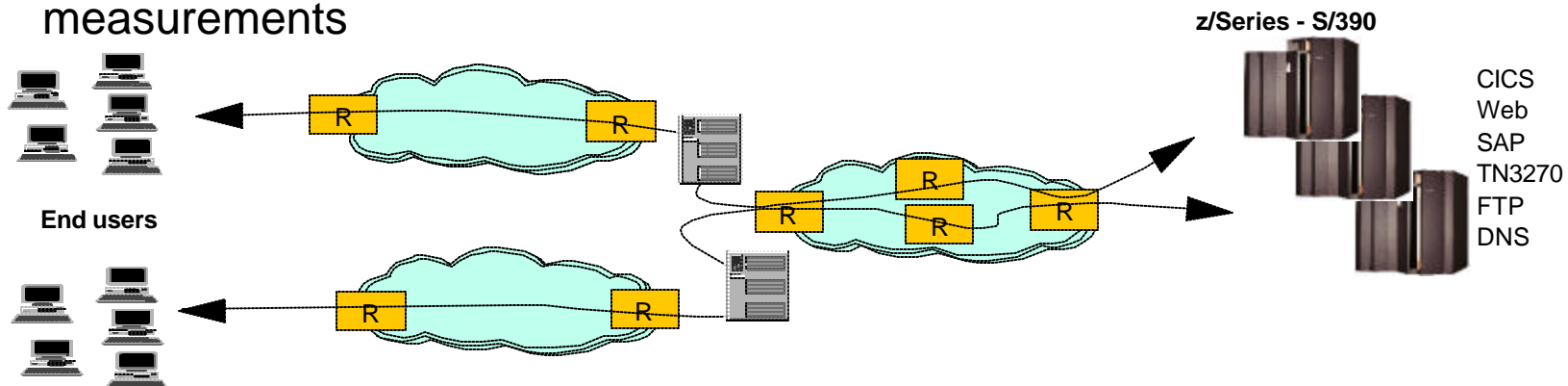
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- Network Modeling/Simulation tools provide an inexpensive solution
  - ▶ Changes can be evaluated before they are deployed
  - ▶ Detailed performance data for accurate capacity planning
  - ▶ Help answer what/if questions while still in the planning phase
- Several approaches to Modeling network performance
  - ▶ Simulation Modeling
    - Computer program that simulates network flows to predict future behavior
  - ▶ Analytic Modeling
    - Computer program that uses mathematical models to predict future network behavior
  - ▶ Modeling through Load Testing and Performance Measurements
    - Generate **real** network traffic that represents existing/new workload conditions
      - Measure results and provide detailed performance measurements

# Application Workload Modeler (AWM)

## ■ What is it?

- ▶ A application workload simulation tool for measuring and modeling the performance of the network infrastructure, end-to-end
  - Including the network, systems, and applications
  - Generates real network traffic and provides detailed performance measurements



## ■ Allows enterprise or service providers to model the impact of various types of workloads on servers and networks

- ▶ Users can evaluate the impact of a change **before** the change is deployed in production environment
  - *Do you need to upgrade network components to meet your performance objectives?*
  - *Is the existing network infrastructure sufficient?*
  - *Is this the right communications model for an application?*

# Questions, Questions, Questions....

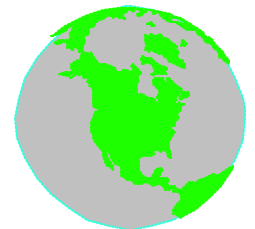
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- What is the impact on performance when making changes to the network infrastructure, systems, software and applications?
  - ▶ Network infrastructure changes
    - Enterprise Extender, Virtual Private Networks (VPN), Quality of Service (QoS) deployment
    - Network connectivity updates (Fast Ethernet to Gigabit Ethernet, Channel Attached Routers to OSA Express, router upgrades, network protocol updates, etc.)
  - ▶ Application Changes
    - New/changed TCP/IP application deployment
      - Using Secure Sockets Layer (SSL) for encryption
    - Changes in SNA applications, including migration to TCP/IP
  - ▶ System/Software changes
    - Upgrading hardware or software?
    - Considering a Load Balancing Solution?
    - Server Consolidation?
    - How can I measure the impact of deploying a TN3270E solution?
    - What kind of performance should I expect from FTP transfers?

# Application Workload Modeler (AWM)



- Application Workload Modeler for z/OS R1
  - ▶ New IBM product
  - ▶ Includes z/OS, Linux for zSeries and Linux/Intel versions of the product
  - ▶ Worldwide GA December 20, 2002
- Application Workload Modeler for Linux on zSeries Version 1.1
  - ▶ Linux for zSeries and Linux/Intel versions of the product
  - ▶ Worldwide GA January 17, 2003



# Key features

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- Generates real network traffic
  - ▶ Representative of real application network patterns
  - ▶ Simulates large numbers of end-users
    - Capable of generating high volume, stress load conditions
    - Eliminates the need for manual simulations
  - ▶ Multiple modes of operation
    - Client/Server Mode
    - Application Client Mode
- Application Workload Modeler provides detailed statistics to help evaluate the performance of these workloads
  - ▶ Per "session" as well as cumulative averages for Throughput, Response time, Transaction rate
  - ▶ Transient behavior of workloads



# Key Usage Scenarios

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## ■ Network Provisioning

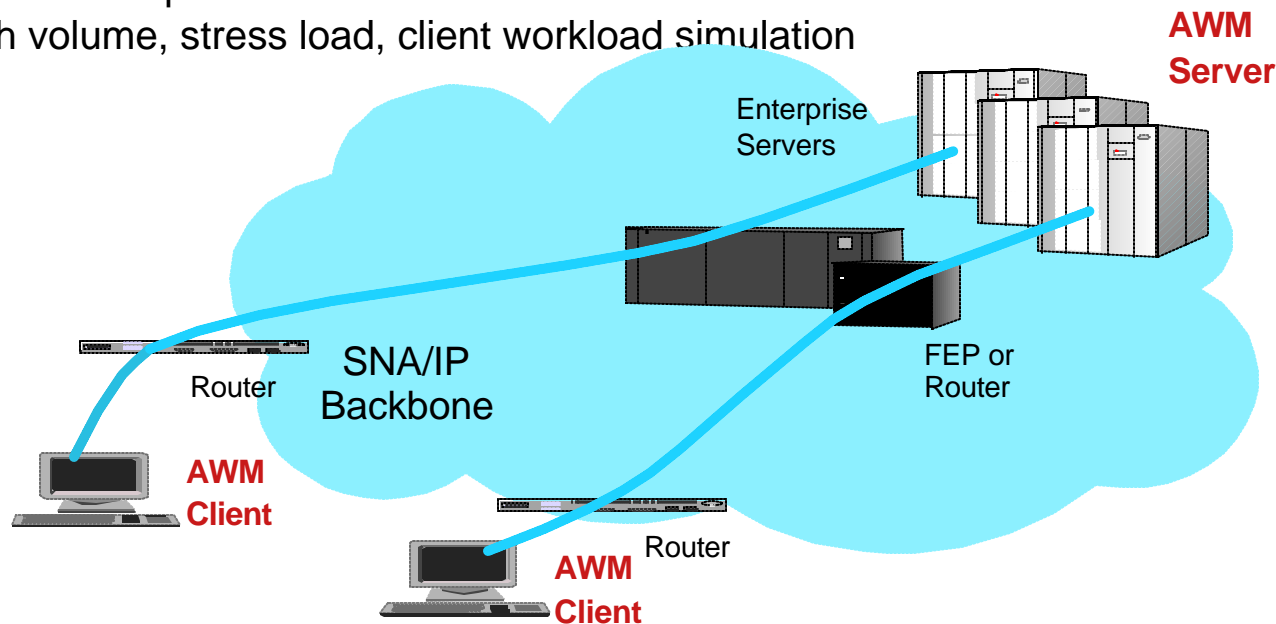
- ▶ Using application (client/server) traffic profiles
- ▶ Determine adequacy of network capacity and network-component of response times
  - What-if scenarios for traffic growth and traffic mixes
- ▶ Monitor performance of network

## ■ Application provisioning

- ▶ Configure AWM to generate traffic to typical application servers to validate performance for different workloads (Application Client Mode)
- ▶ Complementary to other modeling tools for capacity planning

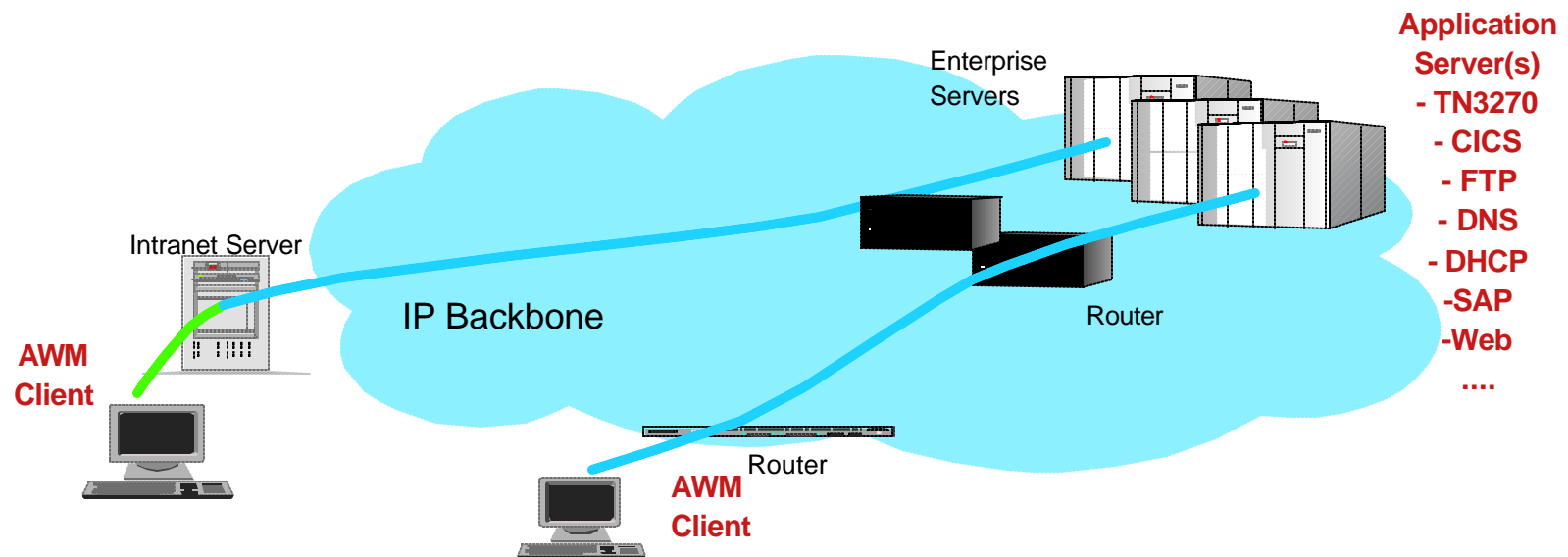
# Client/Server mode Benchmarks

- Application Workload Modeler generates **real** network traffic that simulates communications for both client and server applications (SNA and TCP/IP applications)
  - ▶ Focus on performance measurements of end-to-end network communication paths
  - ▶ Allows modeling of common application workload patterns
    - Transactional request/response workloads
    - Bulk data transfer workloads
  - ▶ Can be used to model new application "network behavior"
    - **Prior** to application development/deployment
  - ▶ Best/worst case scenarios
    - Application-specific bottlenecks eliminated
    - High volume, stress load, client workload simulation



# Application Client mode Benchmarks

- Application Workload Modeler generates **real** network traffic that simulates client network communications for well known, standard TCP/IP server applications
  - ▶ Focus on performance measurements of end-to-end network communication paths for key server applications
    - TN3270, FTP, Web Server, CICS sockets, DNS, DHCP, SAP R/3 ICL, SMTP
  - ▶ Customized stress load conditions
    - Number of clients, rates of requests, etc.
  - ▶ Helps answer what/if questions
    - What type of performance can I expect if my client request workload doubles?
    - Can a single server handle the anticipated workload?
    - What are the effects of QoS on specific workloads?



# Application Workload Modeler Statistics

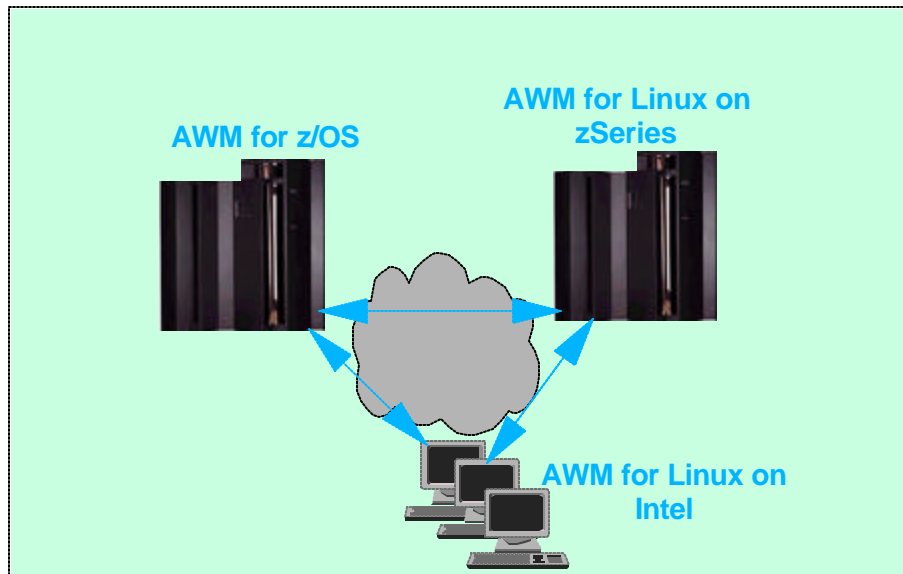
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- Key output of the Application Workload Modeler
  - ▶ Performance data collection can be customized by user
    - Multiple samples
    - Number of transactions per sample
    - Interim and Final reports
  - ▶ Detailed performance statistics reported for all workload simulation tests
    - Customized reports based on workload type (e.g. SAP vs FTP)
    - Response time metrics (mean, min, max, variances, etc.)
    - Throughput rates, average data transfer rate, etc.

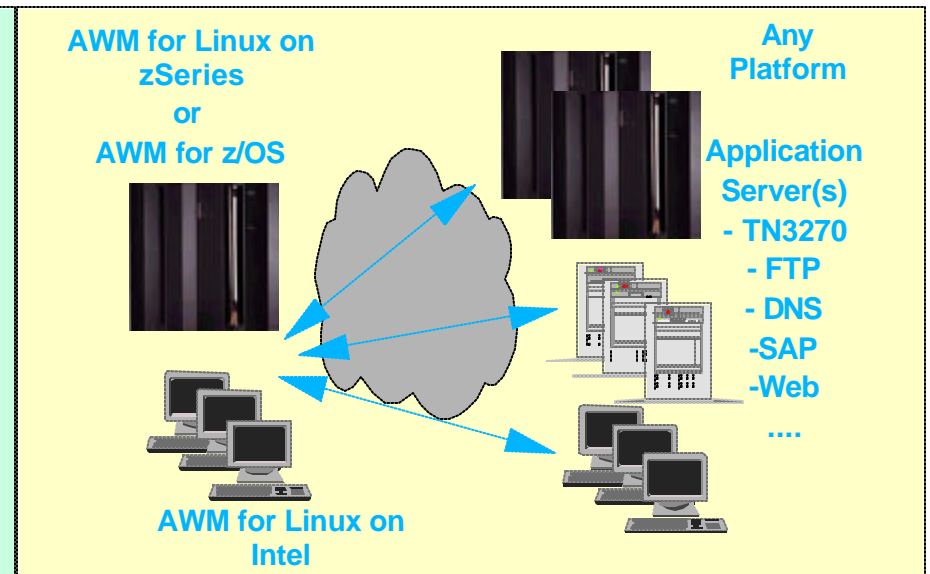
# Multi-platform Support

- Additional flexibility with support for multiple platforms
  - ▶ *Application Workload Modeler for z/OS*
    - Supports current z/OS platforms and OS/390 V2R10
  - ▶ *Application Workload Modeler for Linux on zSeries*, which supports the following:
    - Red Hat Linux for S/390, or later
    - SuSE Linux Enterprise Server 7 for S/390 and zSeries, or later
  - ▶ *Application Workload Modeler for Linux*, which supports the following Linux distributions on Intel platforms:
    - RedHat 7.1, 7.2, 7.3, SuSE 7.3
- Allows users to select best platform based on specific workload modeling/simulation needs

**AWM Client/Server Mode**

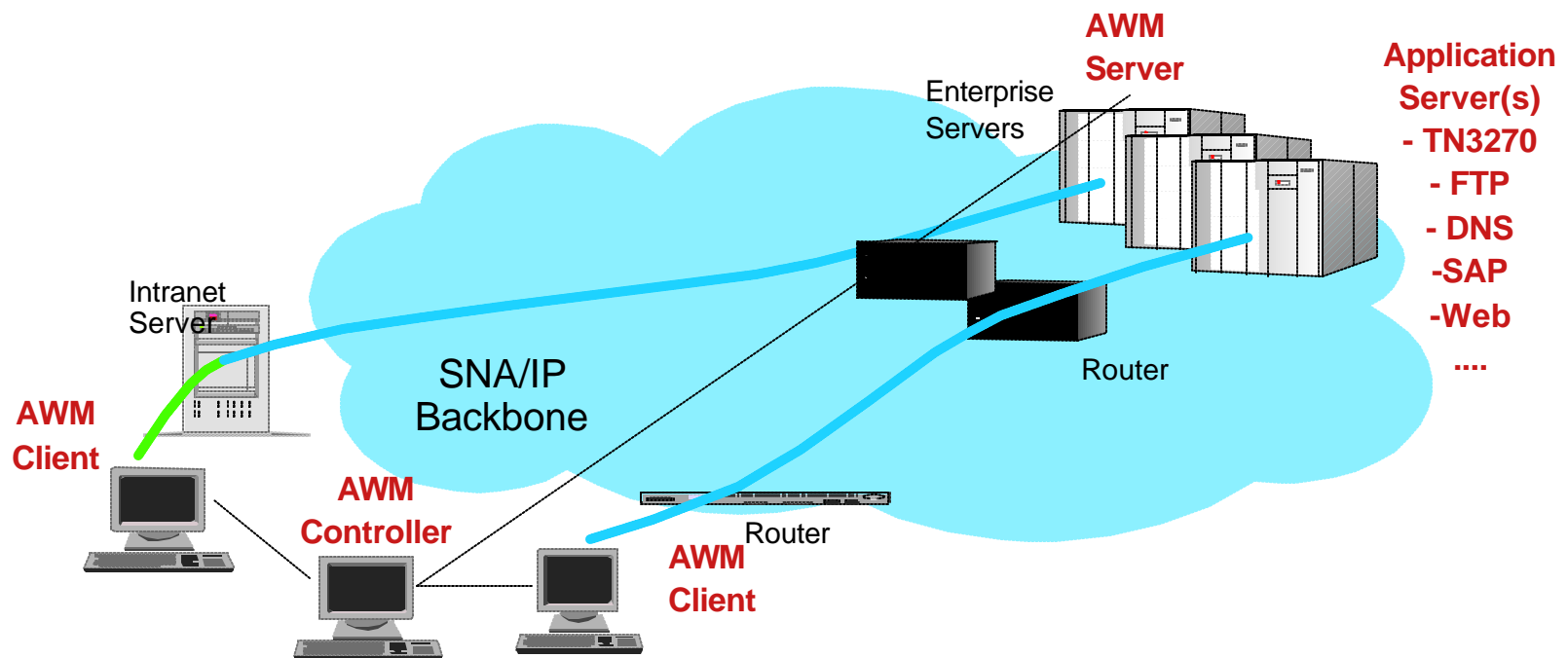


**AWM Application Client Mode**

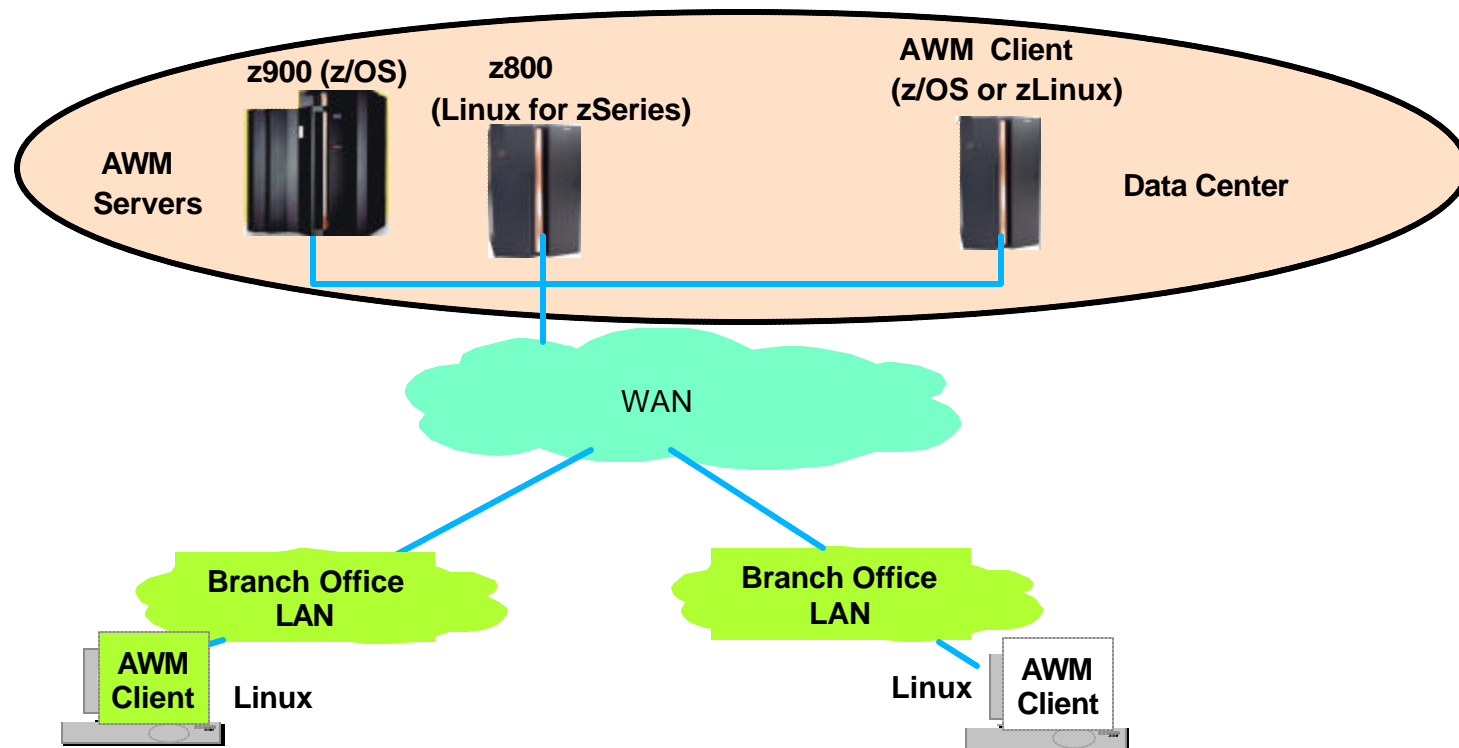


# Multi-instance Simulation Support

- A single Application Workload Modeler client instance can generate the network traffic equivalent of hundreds/thousands clients
  - ▶ Workload volume bounded only by host and network capacity
- Multiple AWM client instances can collaborate in a simulation test
  - ▶ Level of simulated workload virtually unconstrained
  - ▶ A single AWM instance can act as the *Controller* for the test
    - Single point of control for configuring, executing, monitoring a test across multiple AWM instances
    - Obtains performance statistics from all AWM client instances and provides individual and aggregated reports



# Measuring network performance end-to-end



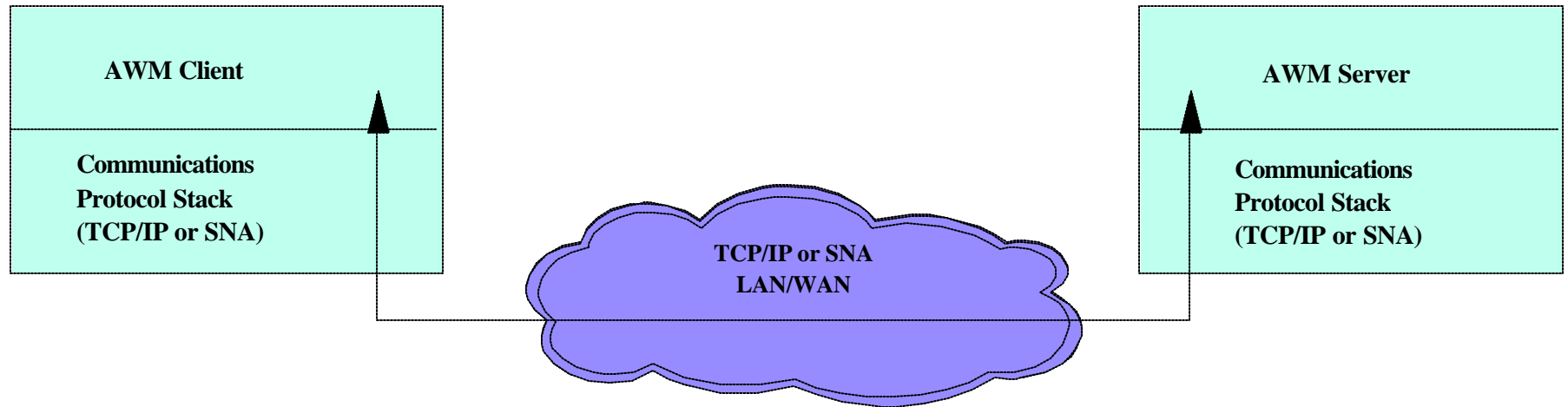
- Flexible Client/Server placement options
  - ▶ Within data center
  - ▶ Between data centers
  - ▶ Between remote users and data center
- Allows testing and measuring of distinct network paths
  - ▶ Comparison of network performance for different sets of users
    - Local and remote end users
    - End users in different branches



# Client/Server Benchmarks



# AWM Client/Server mode



- ▶ Application specific bottlenecks eliminated
  - Allows true measurement of end-to-end network infrastructure performance
- ▶ AWM simulates both client and server application using standard APIs
  - TCP/IP sockets
    - TCP, UDP sockets
      - Also supports Secure Sockets Layer (SSL)
    - IPv4 and IPv6 support
    - Multicast support
  - SNA APIs (on OS/390 or z/OS only)
    - VTAM RAPI, APPCCMD and HPDT APPCCMD
  - No complicated scripts required!

# AWM Client/Server mode...

## ■ Supported workload models

### ▶ Connection-Intensive Workload

- Connect/Request/Response (CRR)
- e.g. Web-like traffic

### ▶ Interactive workload

- Request/Response workload (RR)
- e.g. Telnet traffic pattern

### ▶ Streaming data

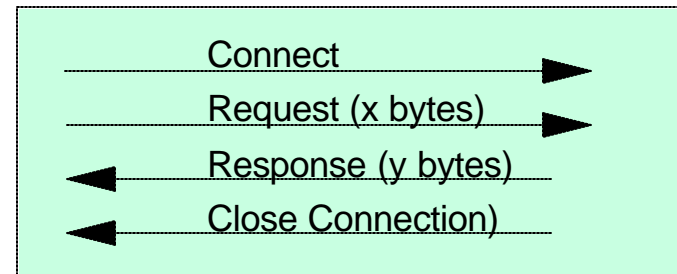
- Bulk data transfer (STREAMS)
- in either direction, e.g. FTP traffic

## ■ Configuration Options

- ▶ Number of clients to be simulated
- ▶ Transaction request rate
  - "think time" for transactional workloads
- ▶ Send/rcv data length

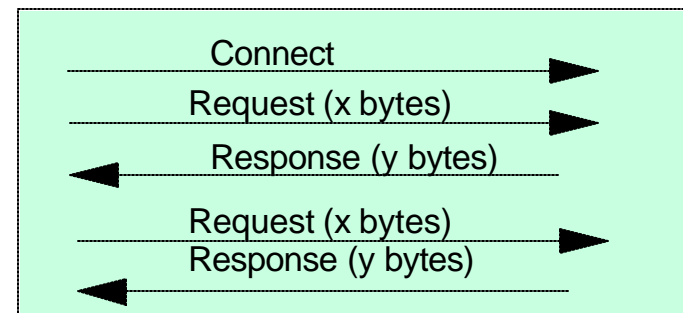
AWM  
Client

CRR

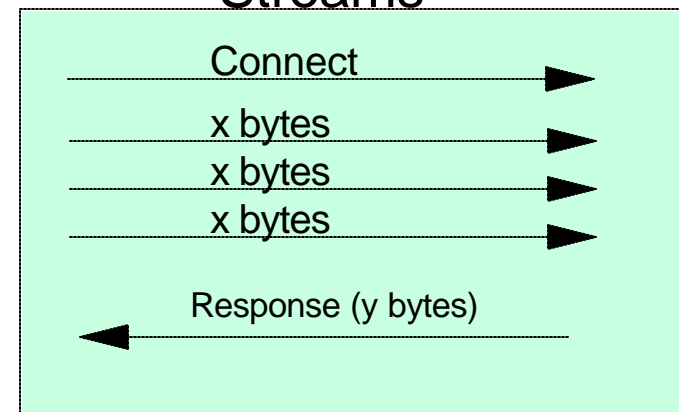


AWM  
Server

RR



Streams

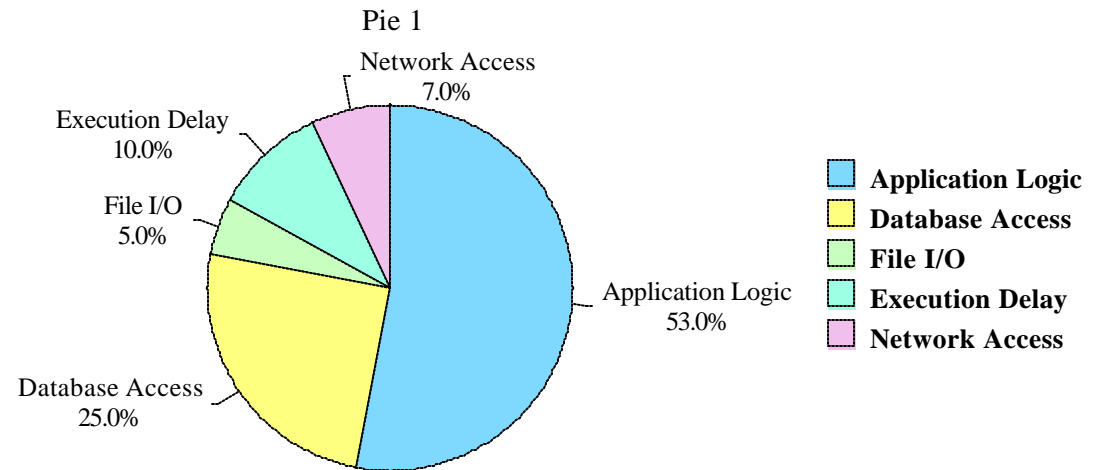


# Client/Server mode...

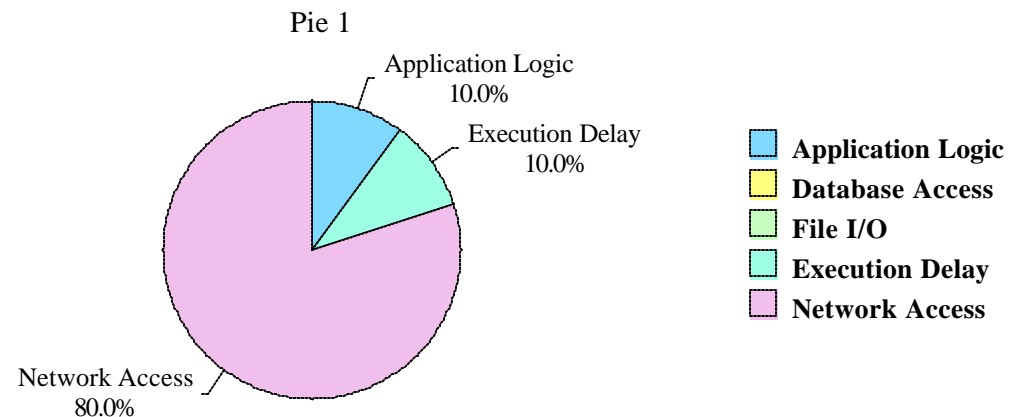
## ■ Allows measurement of true network infrastructure response time

- ▶ Best/Worst case scenarios:
  - What kind of end-to-end response time is the network capable of?
- ▶ Helps identify bottlenecks
  - Network vs other components (application, CPU, storage, I/O, database access, etc.)
- ▶ Is a network infrastructure upgrade needed?
- ▶ Will a network upgrade have a significant effect on application response time?

## Decomposition of application response time



## AWM Client/Server Benchmarks Response Time Decomposition



# Client/Server mode benchmark reports

## SUMMARY OF WORKLOAD PERFORMANCE DATA

Statistics in Time Range: 0 - 86400  
Number of samples: 196  
Overall Average Transaction Rate: 9911.867521 trans/sec  
Overall 95% C.I.of TPS: 9434.94 -10001.9  
Overall R.P.of TPS: 2.916977357 %  
Overall Maximum Transactions Rate: 10903.10766  
Overall Minimum Transactions Rate: 678.2357445  
Overall Average Throughput: 11894241.03 bytes/sec  
Overall 95% C.I.of Throughput: 1.13219e+07 -1.20023e+07  
Overall R.P.of Throughput: 2.916977357 %  
Overall Maximum Throughput: 13083729.19  
Overall Minimum Throughput: 813882.8934  
Overall Average Transaction Response Time: 0.0009984730076  
Overall 95% C.I.of TRT: 0.000979699 -0.00101725  
Overall R.P.of TRT: 1.880279681 %  
Overall Maximum Transaction Response Time: 0.001514039  
Overall Minimum Transaction Response Time: 0.000819191

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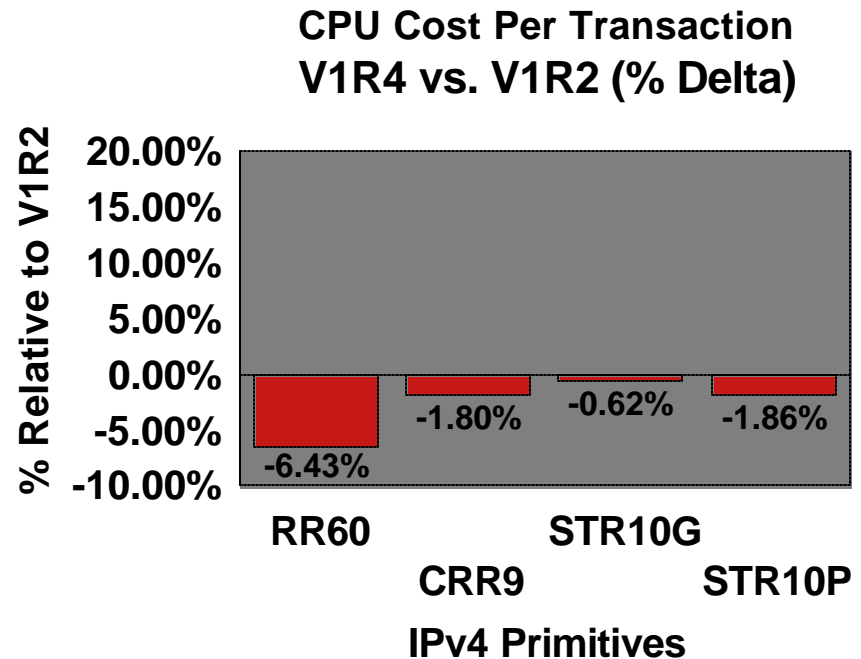
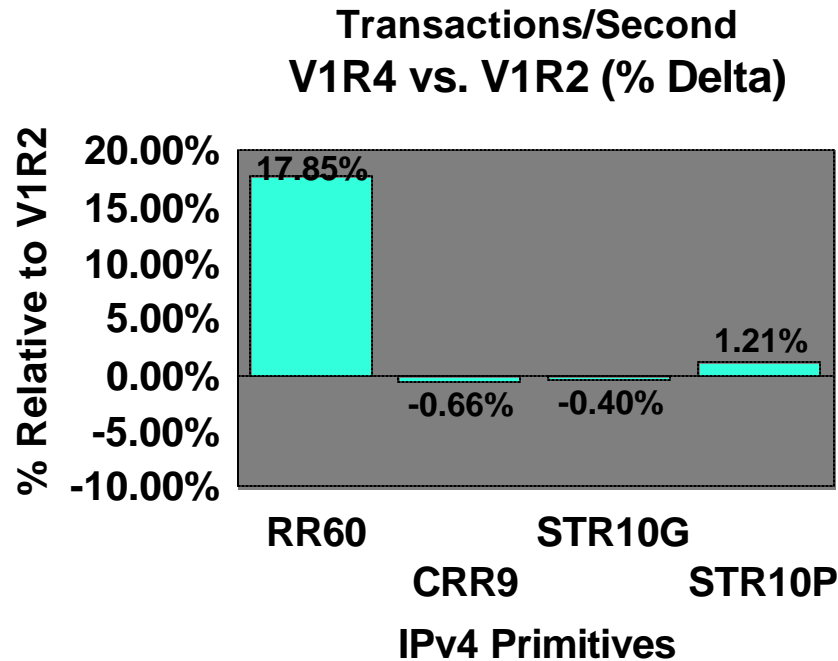
# Client/Server mode benchmark reports...

	Transactions per sec	Throughput bytes/sec	Response Time	Relative Precision	Confidence Interval
Overall	9911.87	1.18942e+07	0.000998473	1.88028	1.877409e-05
Session:00	1048.64	1.25836e+06	0.00095365	6.38787	6.091796e-05
Session:01	1034.76	1.24171e+06	0.00096643	3.79586	3.668428e-05
Session:02	1013.16	1.21579e+06	0.000987045	5.49161	5.420467e-05
Session:03	944.128	1.13295e+06	0.00105921	7.32882	7.762762e-05
Session:04	968.268	1.16192e+06	0.0010328	6.75297	6.974468e-05
Session:05	908.377	1.09005e+06	0.0011009	7.63488	8.405207e-05
Session:06	1101.59	1.3219e+06	0.000907825	5.76292	5.231723e-05
Session:07	1068.82	1.28259e+06	0.000935632	5.42444	5.075286e-05
Session:08	1042.79	1.25134e+06	0.000959001	6.16016	5.907593e-05
Session:09	997.592	1.19711e+06	0.00100246	7.75387	7.772938e-05

# AWM usage in z/OS measurements

## ■ Client/Server Benchmarks (TCP)

- ▶ z/OS V1R4 CS relative to V1R2
- ▶ Comparison - Trans/sec, CPU Cost Per Transaction

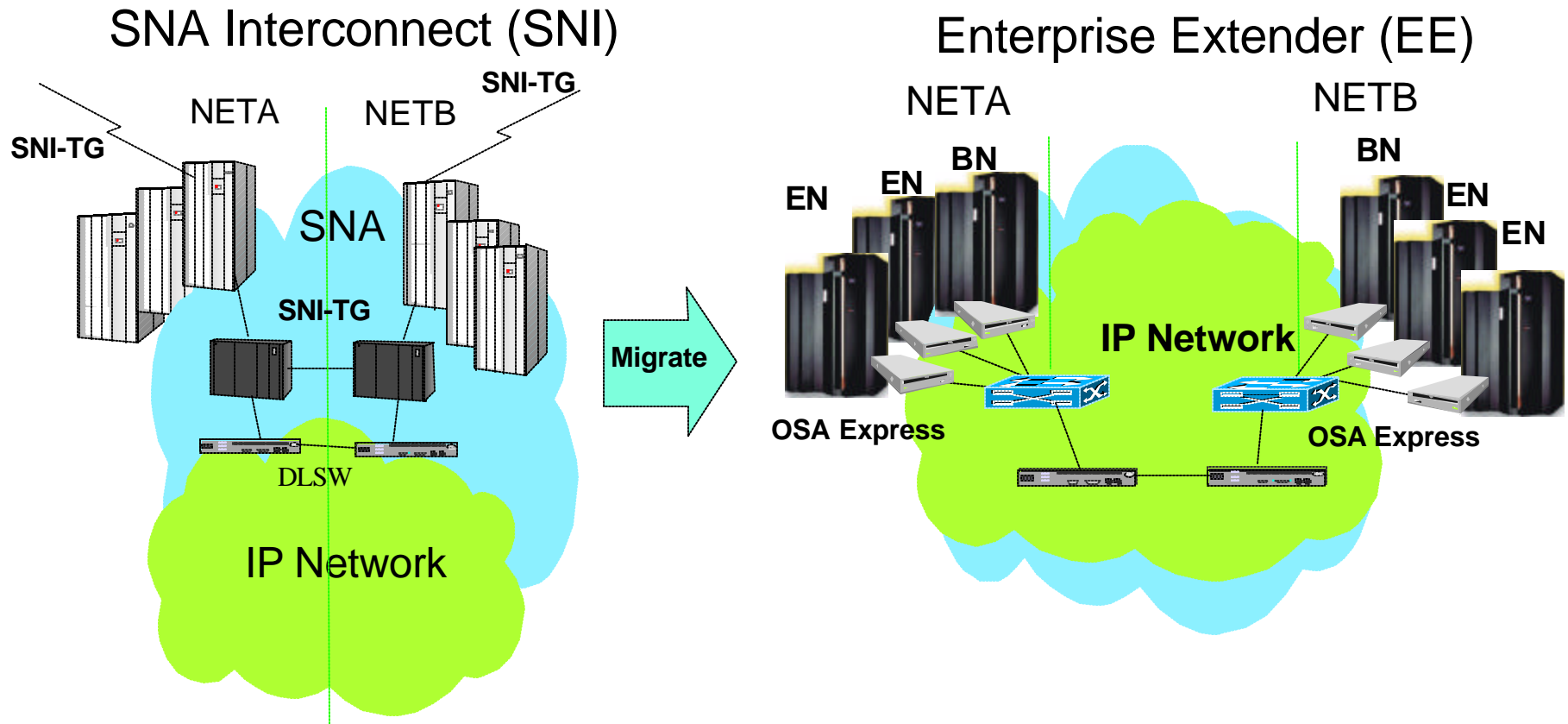


- V1R4 provides Transaction rates within -0.66% to 17.85 % of V1R2
- V1R4 provides lower CPU cost per transaction than V1R2 and the percentages are within (-0.62 to -6.43)

## ■ AWM used extensively internally for performance measurements

- ▶ For example, refer to the "z/OS V1R4 Communication Server Performance Summary", at:
  - <http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/PRS582>
- ▶ **Session 3919: TCP/IP for MVS Performance Tuning Tips and Capacity Planning**
  - Thursday, 3pm

# Enterprise Extender Modeling

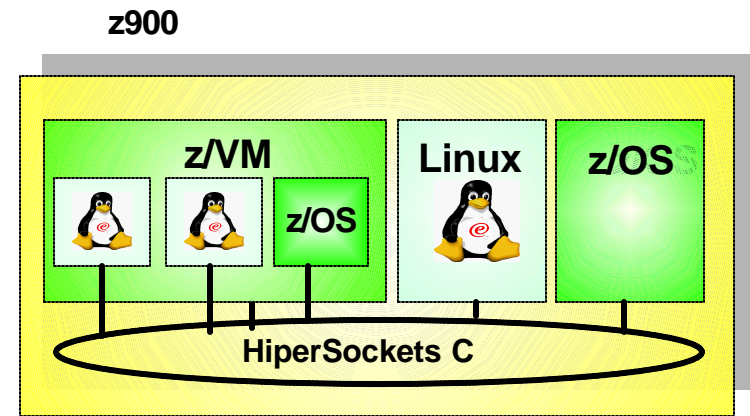


- **AWM can be used to model Enterprise Extender connectivity between data centers or business partners**
  - ▶ Withdrawal of 3745/6 as well as the high speed and reduced networking cost of OSA Express makes migration to Enterprise Extender very attractive
    - AWM can assist in network tuning, ensuring proper Quality of Service for SNA traffic across IP network, and capacity planning
- **Future feature of AWM will be the ability to model Enterprise Extender from the branch to the data center**

# Server Consolidation - HiperSockets Modeling

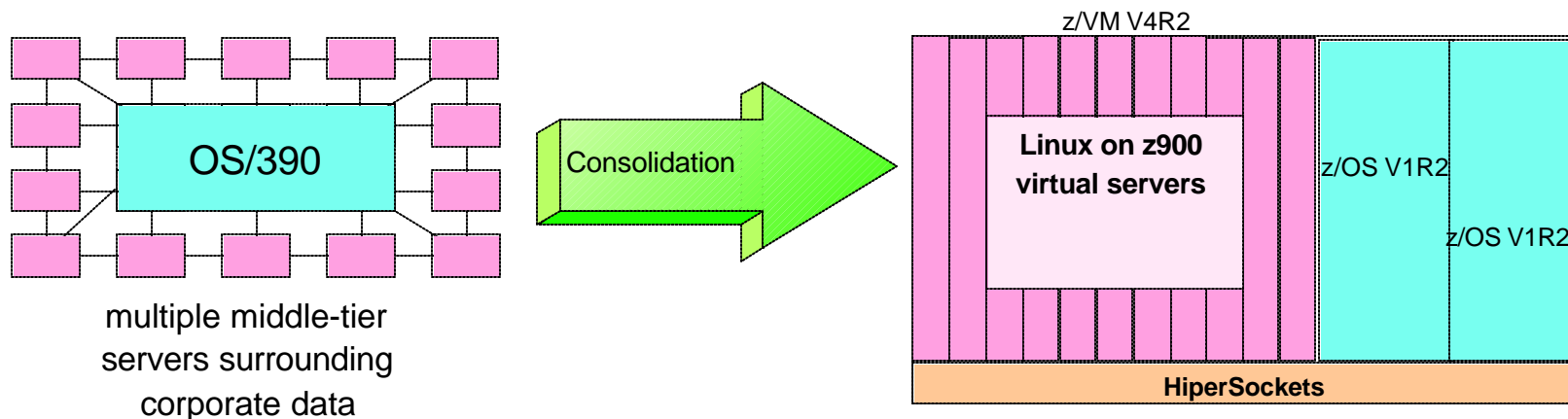
## ■ HiperSockets Overview

- ▶ High speed, low latency, any-to-any TCP/IP network within a z900 processor
- ▶ Among virtual servers and LPARs (z/OS, Linux and z/VM)
- ▶ Cost savings - no adapters, network boxes, or cabling
- ▶ Transparent to applications



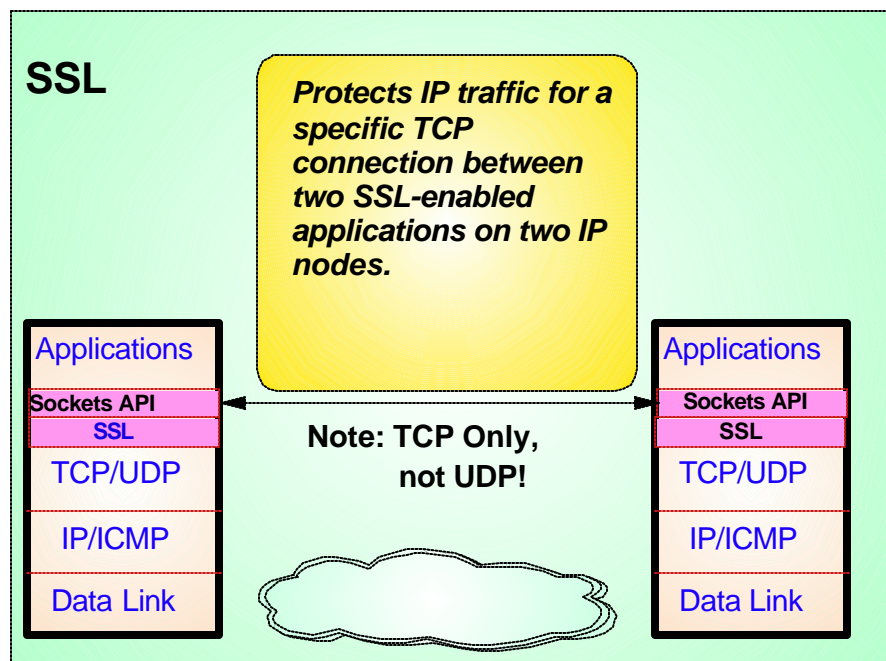
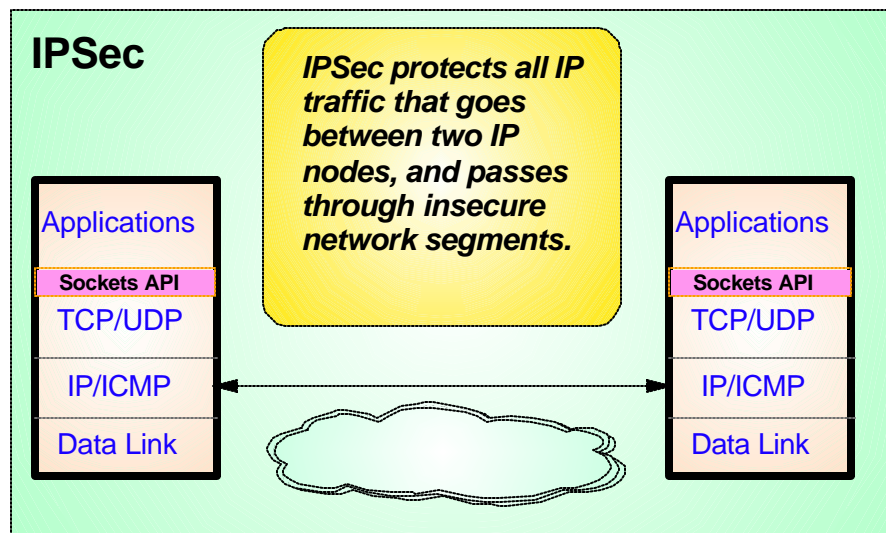
## ■ AWM can be used to model and measure the performance characteristics of various workloads over HiperSockets

- ▶ Host to host communications within a zSeries processor
- ▶ Server Consolidation Scenarios
  - Multiple Linux for zSeries middle tier servers accessing z/OS enterprise data



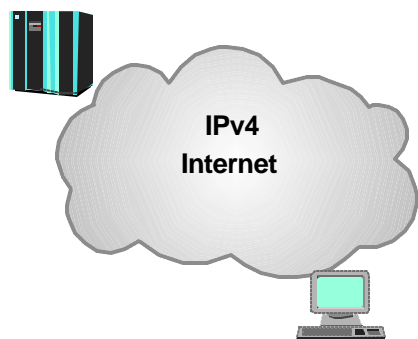


# Performance Evaluation of IPSec/SSL

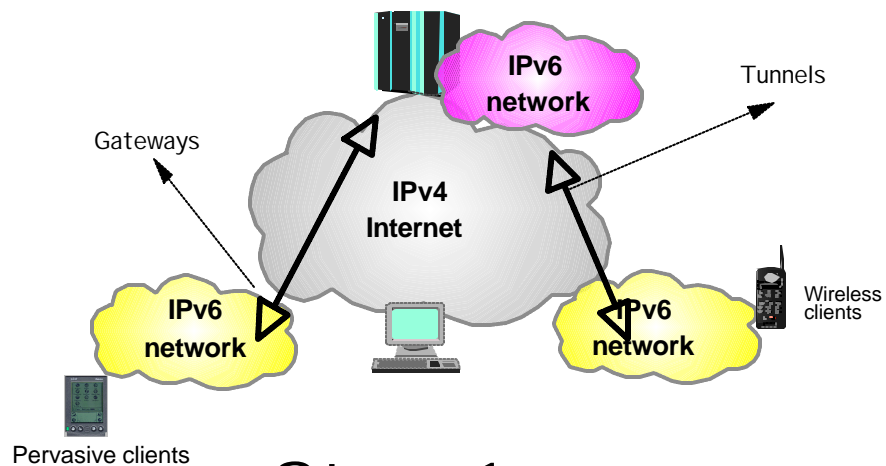


- AWM can be used to model and measure the effect of IPSec/SSL prior to production deployment
  - ▶ Generate predictable workload
    - through a VPN (Tunnel or Transport mode)
      - Client/Server or Application Client mode
    - Using SSL
      - Client/Server mode
      - GSSKIT and OPENSSL support (Linux)
      - System SSL support (OS/390 and z/OS)
  - ▶ Measure effects of IPSec/SSL on
    - End user response time
    - Throughput
    - Host Requirements (i.e. CPU)
    - Router utilization

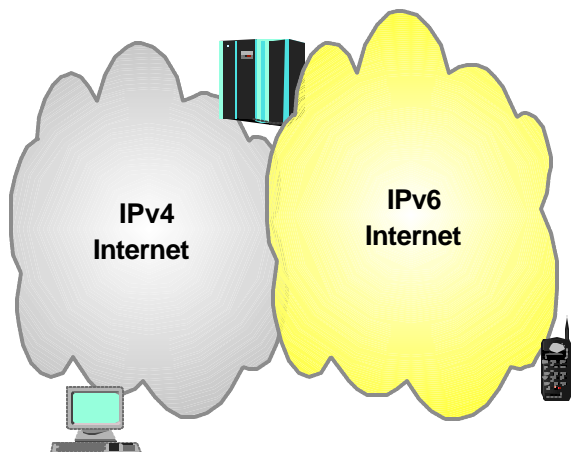
# IPv4 to IPv6 Internet Evolution



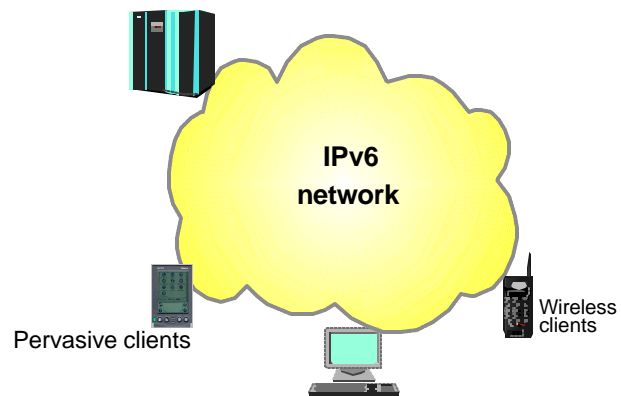
Today



Stage 1

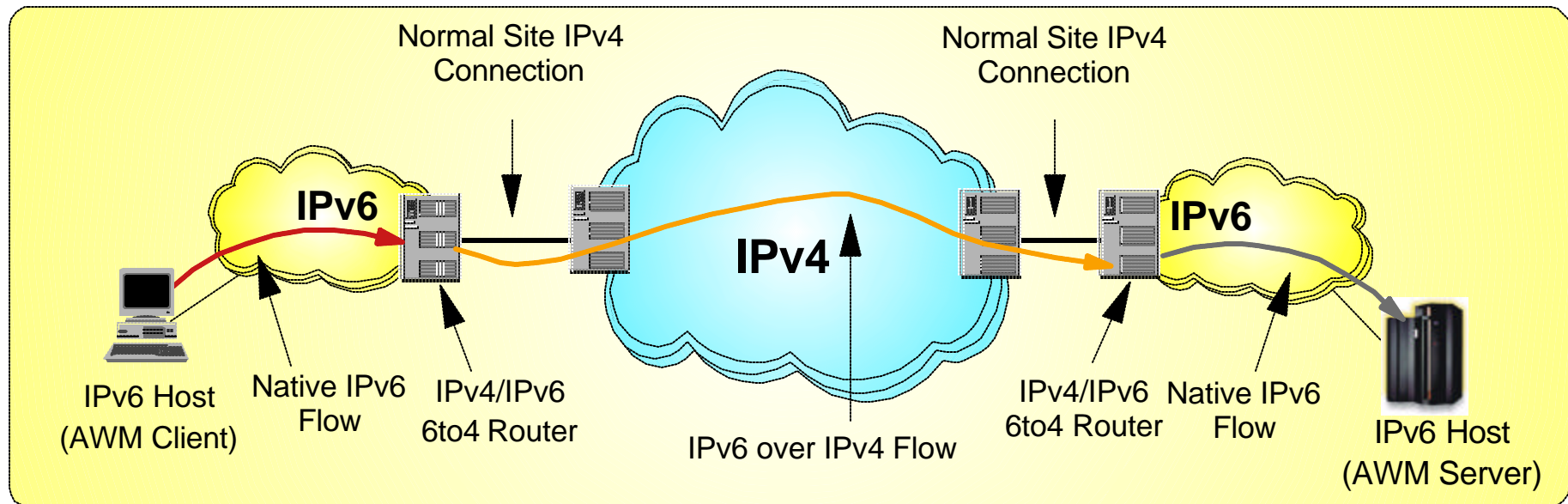


Stage 2



Stage 3

# IPv6 - Modeling the performance impact

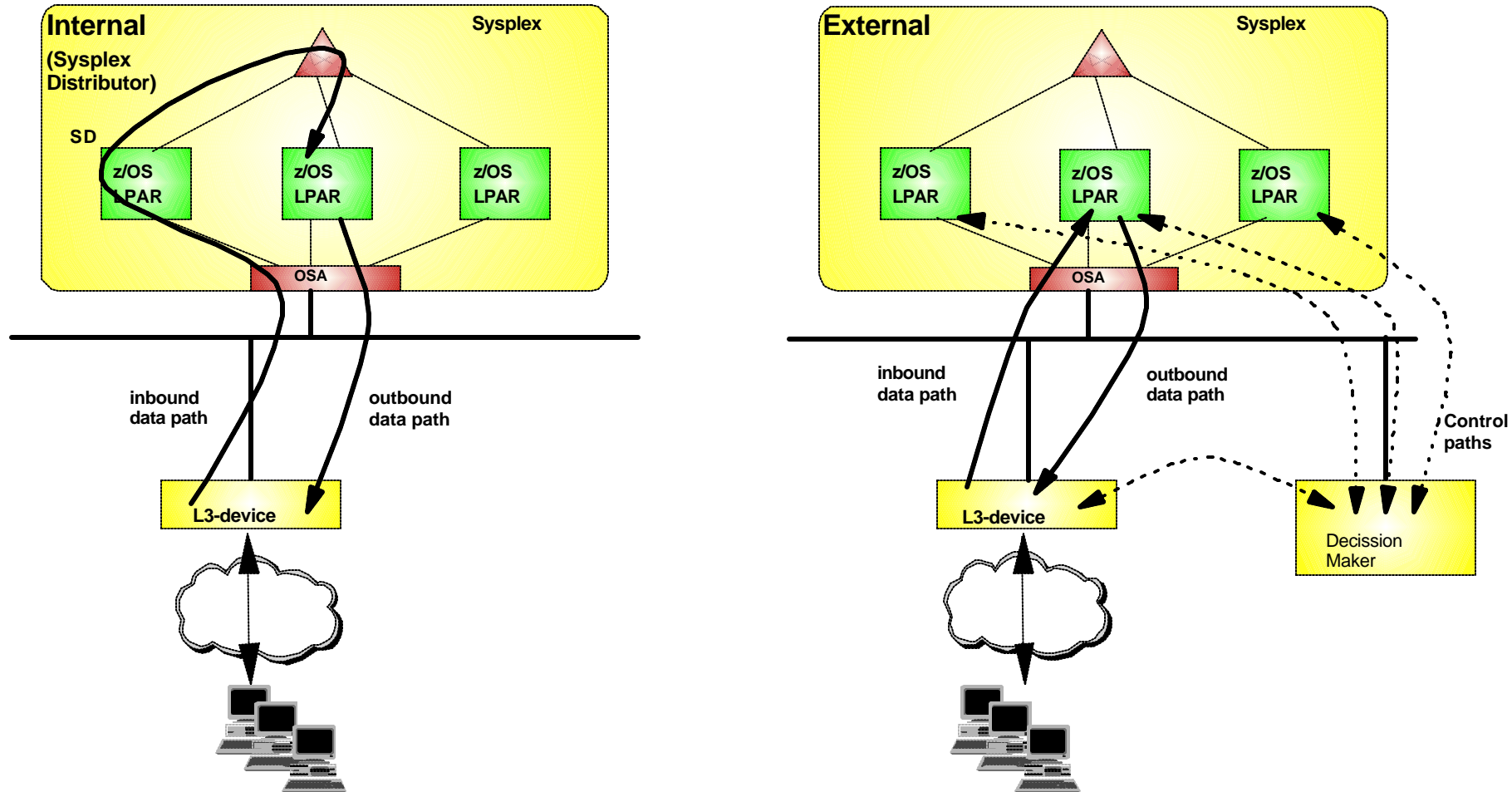


- Tunneling: encapsulating an IPv6 packet in an IPv4 packet and send the IPv4 packet to the other tunnel end-point IPv4 address.
  - ▶ The tunnel endpoint placement depends on connectivity needs
    - Placing endpoints in routers allows entire sites to be connected over an IPv4 network
    - Placing endpoints in hosts allows access to remote IPv6 networks without requiring updates to the routing infrastructure
- AWM can help model and measure the effect of IPv6 network traffic
  - ▶ Network response time for IPv6 application traffic
    - Native and/or through IPv6/IPv4 tunnels
  - ▶ Effect on IPv4 networks and existing IPv4 applications



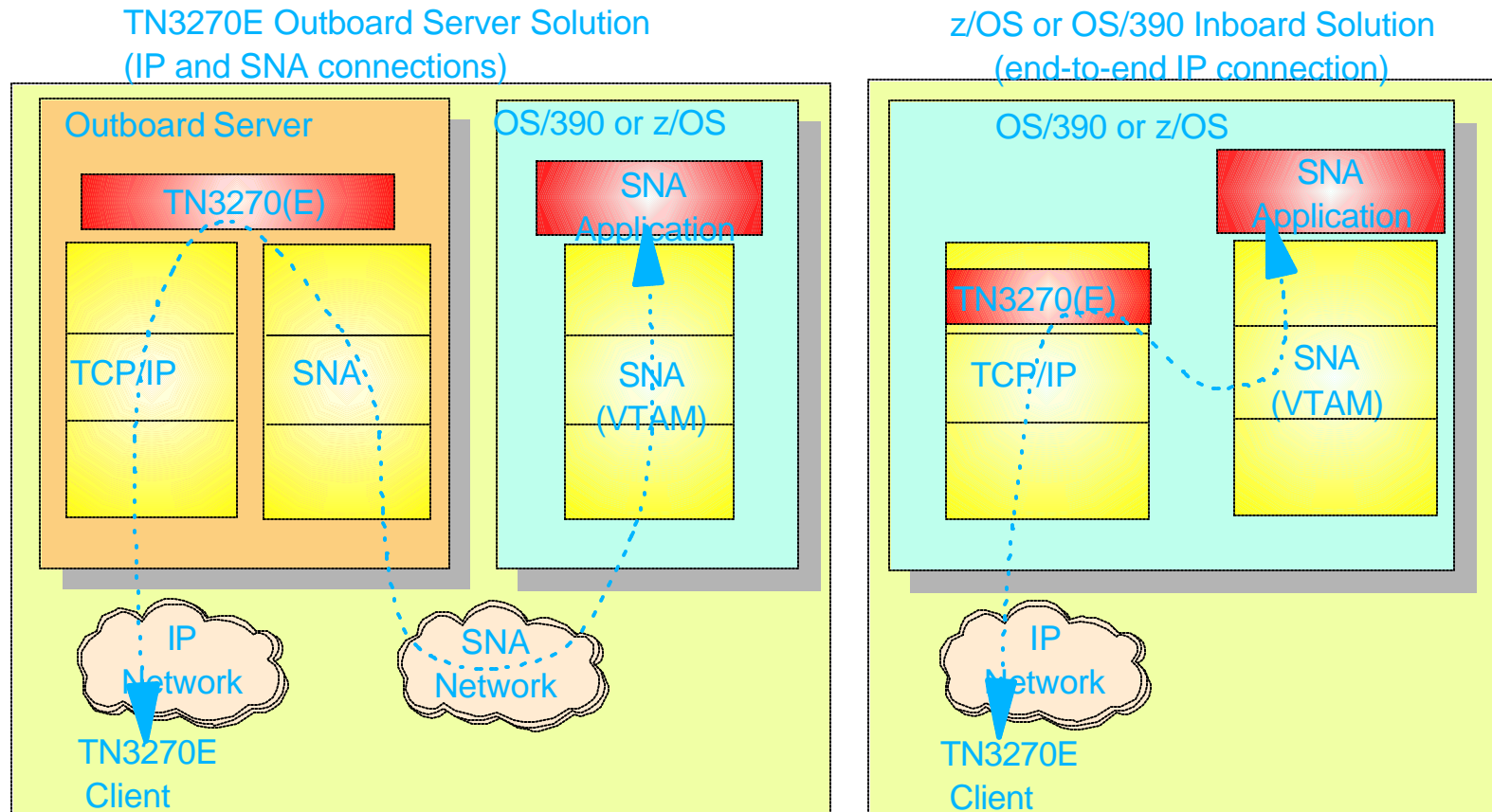
# Application Client Benchmarks

# Modeling Load Balancing Solutions



- AWM can be used to model and measure the effect of a Load Balancing solution prior to deployment
  - ▶ Capacity planning (How many target servers are needed?)
  - ▶ Network Impact
  - ▶ Effect on end-user response time

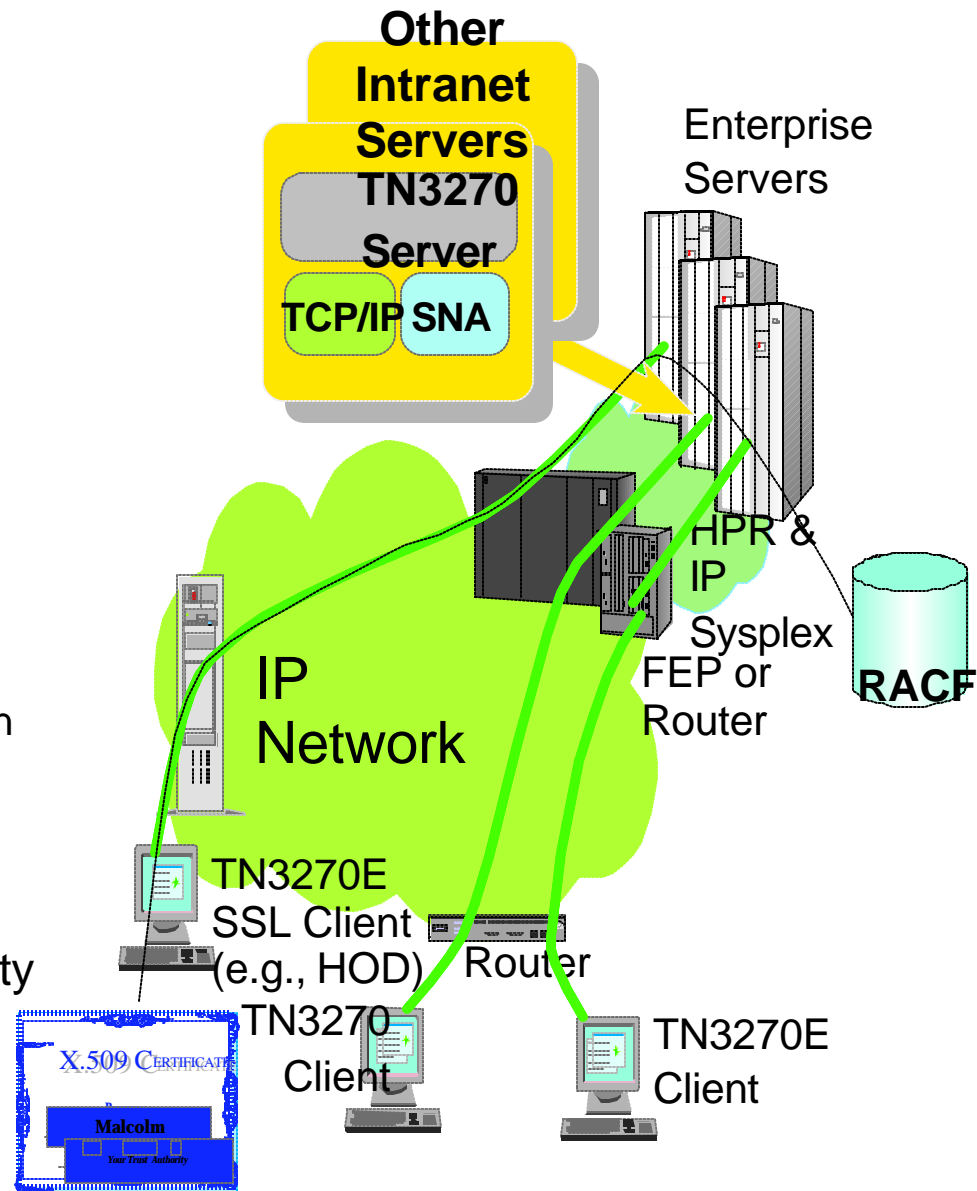
# TN3270(E) Server Positioning



- Application Workload Modeler can be used to simulate TN3270(E) client activity
  - ▶ Capable of simulating large number of TN3270(E) clients/activity
    - Used internally to benchmark 60,000 client sessions to a single z/OS TN3270 server
  - ▶ Can be used to benchmark outboard vs inboard TN3270(E) server solution
    - Determine cost/performance/scalability characteristics of each solution
  - ▶ Aids in decision making process for TN3270(E) server placement

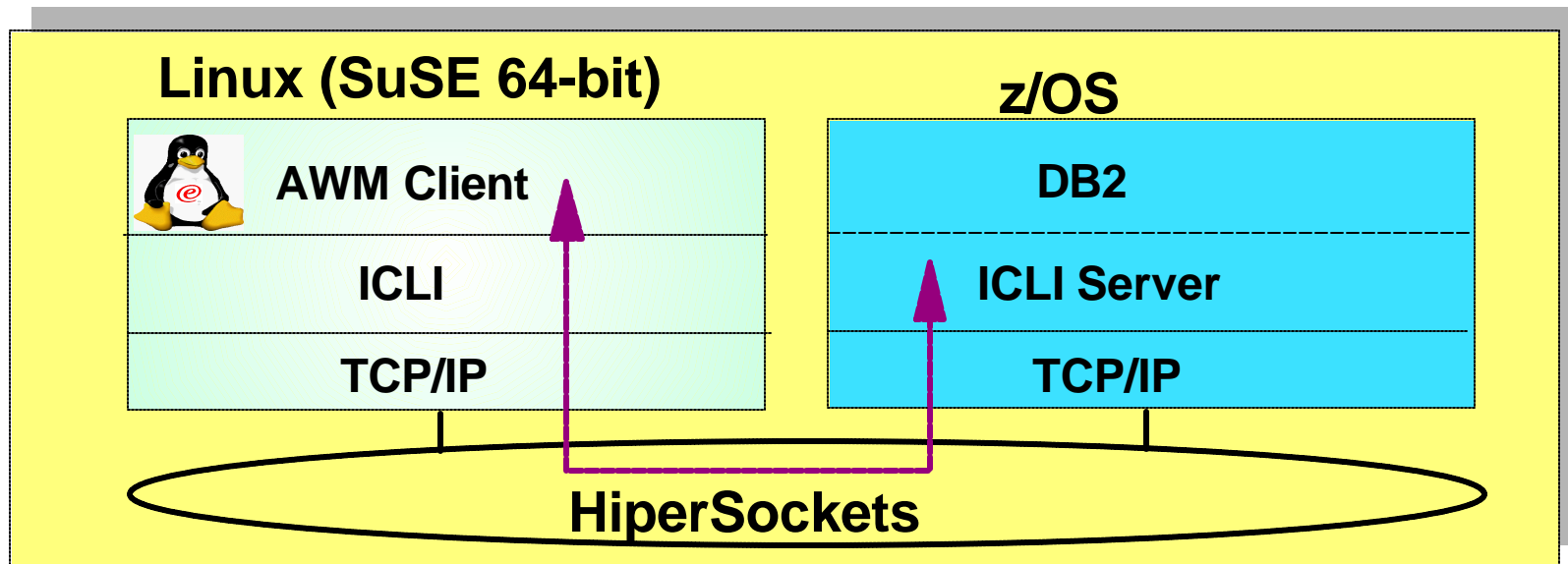
# TN3270(E) Client Simulation...

- Additional TN3270(E) Client Simulation Capabilities
  - ▶ TN3270(E) SSL Client Simulation
    - Analysis of SSL performance, cost, overhead
  - ▶ Simulation for IBM TN3270(E) Value Add extensions such as SSL Express Logon Support
    - PKI-Based Identification and Authentication (Single Signon Support)
    - Certificate provides SNA session verification and Logon
    - Supported in HOD V5, PCOMM V5.5
  - ▶ Allows evaluation of these technologies and proper capacity planning prior to deployment



# SAP R/3 ICLI benchmarks

## zSeries

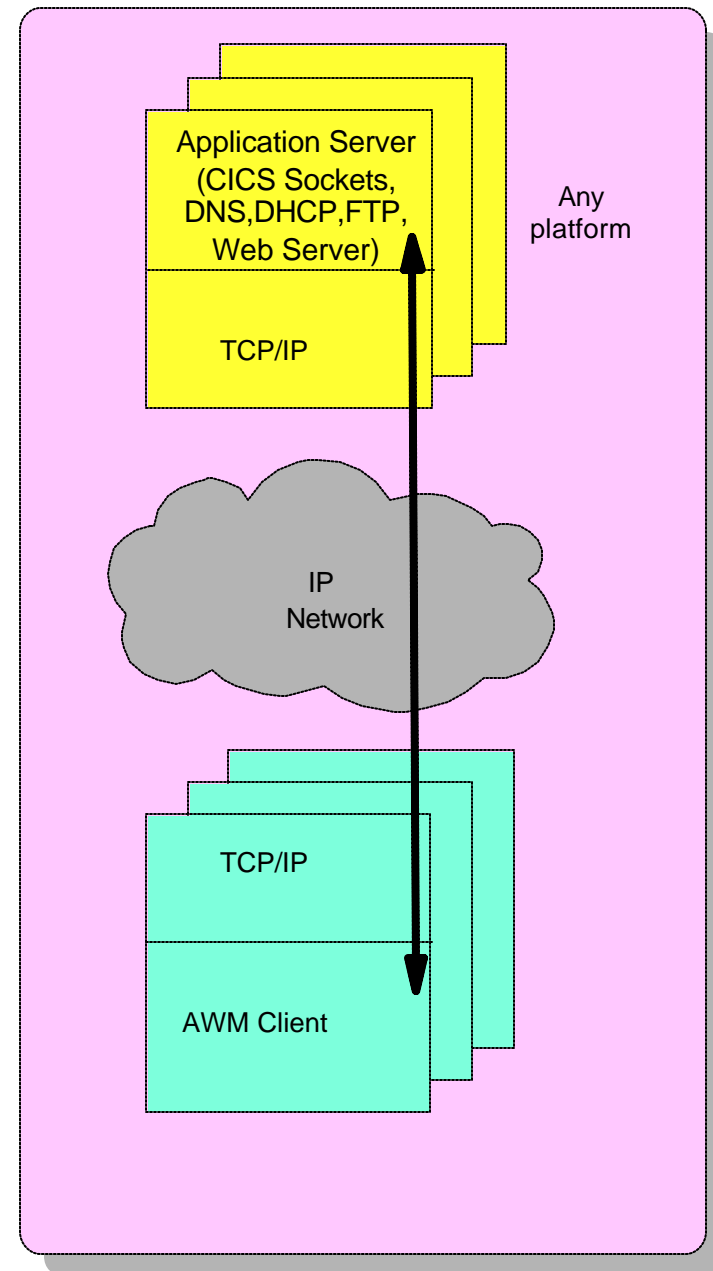


- SAP R/3 communications modeling
  - ▶ Model Application Server to Database Server communications
    - Using SAP R/3 Integrated Call Level Interface
    - Drives the entire Communications path
  - ▶ Allows simulation of multiple Application Servers
    - Each servicing hundreds/thousands Client requests
  - ▶ Useful in evaluating SAP R/3 consolidation on zSeries
    - Detailed response time metrics, throughput rates



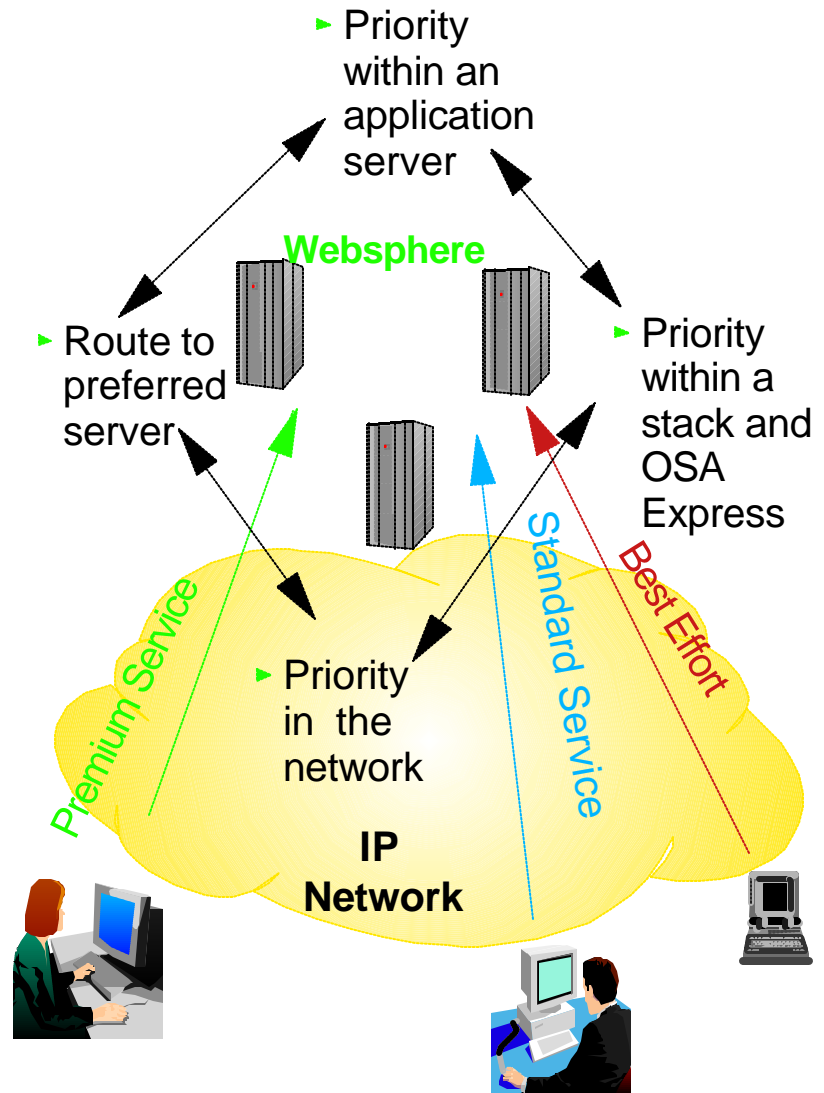
# Additional Application Client Mode Functions

- CICS Sockets
  - ▶ Simulate client traffic to TCP/IP CICS sockets application
- Domain Name System (DNS)
  - ▶ Drive hostname resolution processing
  - ▶ Customized list of hostnames
- Dynamic Host Configuration Protocol (DHCP)
  - ▶ Simulate client DHCP requests
- File Transfer Protocol (FTP)
  - ▶ Simulate FTP Client requests
    - inbound/outbound file transfers
- Simple Mail Transfer Protocol (SMTP)
  - ▶ Simulate SMTP client requests
- Web Server
  - ▶ Simulates Web Server client requests
    - Customized list of URLs
- Customized statistics produced for each workload type



# Policy / QoS Modeling

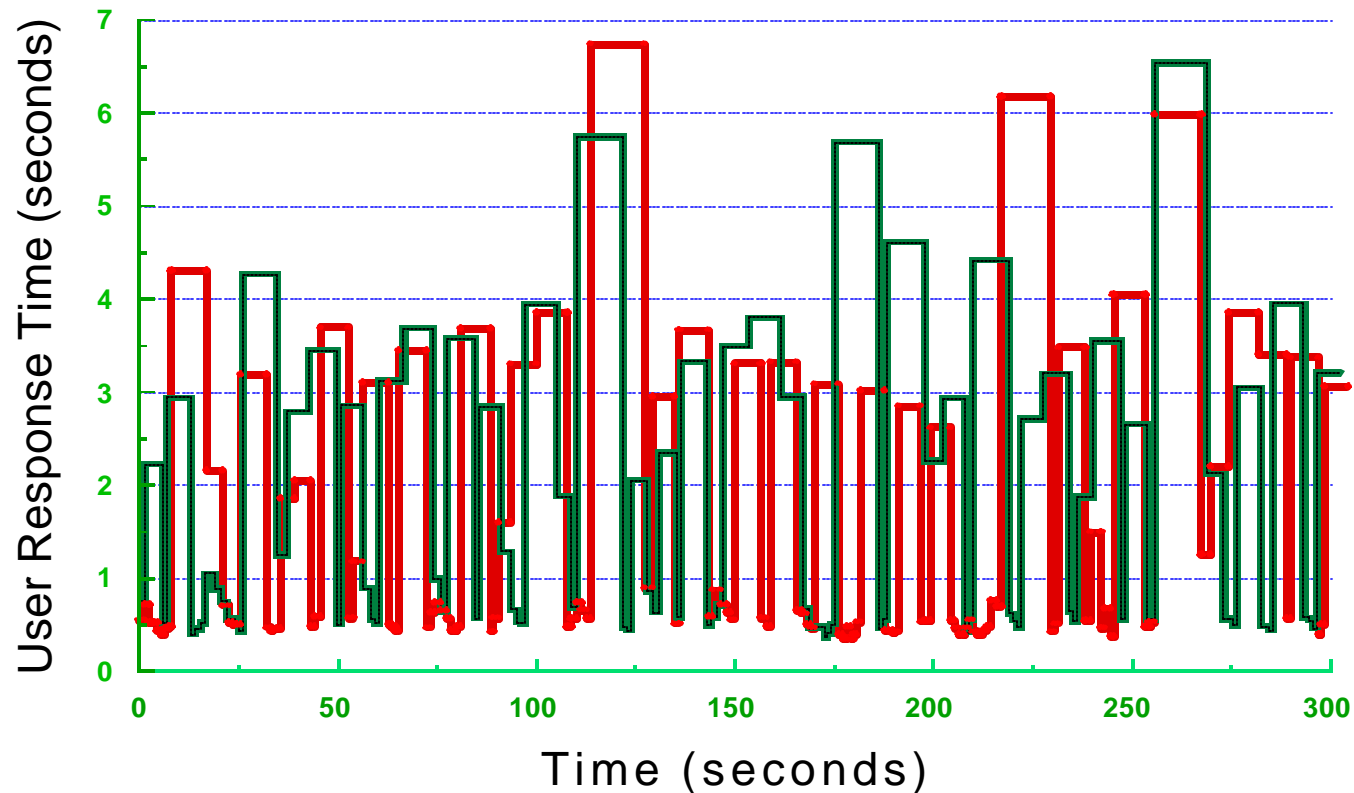
- Applications/workloads have unique SLA objectives
  - ▶ Priority should extend beyond Server resources (CPU, storage, etc.)
  - ▶ Network traffic can be prioritized using Differentiated Services (Quality of Service - QoS)
- AWM can be used to model and measure the effect of a QoS policy prior to deployment
  - ▶ Does the QoS policy have the desired effect?
  - ▶ What is the impact on traffic that is not included in QoS policy?
  - ▶ Helps answer what/if questions when tuning a QoS policy



# QoS WebSphere Measurement Example 1

## Transient Behavior of User Response Time (WebSphere)

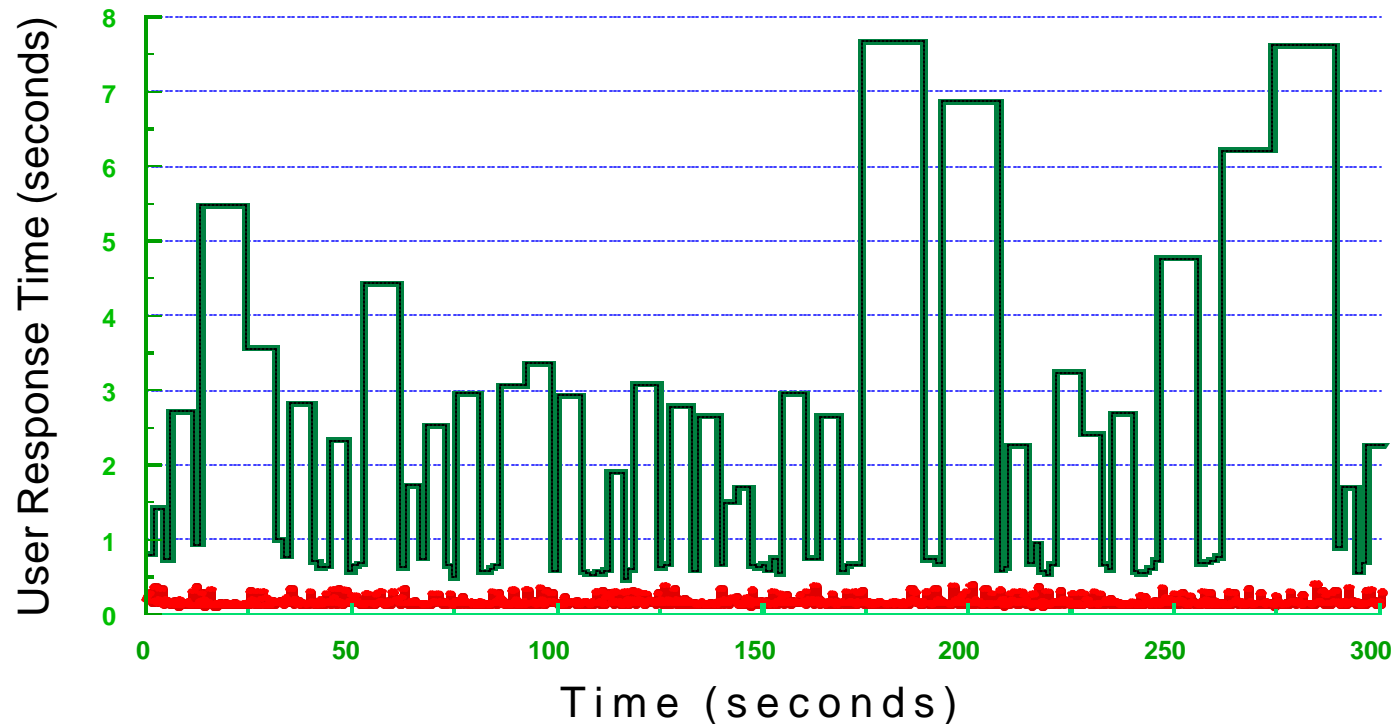
- o Network DiffServ Enabled (CBWFQ)
- o WebSphere PA and QoS Support NOT enabled



# QoS WebSphere Measurement Example 2

## Transient Behavior of User Response Time (WebSphere + IBM HTTP Server for OS/390)

- o Network DiffServ Enabled (CBWFQ)
- o WebSphere PA and QoS Support Enabled



- Higher Priority Access (ToS = 5); Average Response Time = 157 msec (98-393 msec)
- Lower Priority Access (ToS = 0); Average Response Time = 1506 msec (465-7669 msec)

**Application Workload Modeler use in demonstrating the value of Integrating WebSphere with Network QoS**

# For more information...

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- Application Workload Modeler web site:  
*<http://www.ibm.com/software/network/awm/index.html>*
  - Additional Product information
  - Announcement letter
  - Product Documentation
  - Links to other relevant sites
- Or send an e-mail with any questions to ***awm@us.ibm.com***