

# The Future of the Mainframe

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# The Death of the Mainframe

***A fairly well accepted notion in computing is that the mainframe is going the way of the dinosaur.***

**Forbes, March 20, 1989**

***The mainframe computer is rapidly being turned into a technological Dinosaur...***

**New York Times, April 4, 1989**

***On March 15, 1996, an InfoWorld Reader will unplug the last mainframe.***

**Stewart Alsop, InfoWorld 1991**

***...the mainframe seems to be hurtling toward extinction.***

**New York Times, Feb. 9, 1993**

***Its the end of the end for the mainframes***

**George Colony, Forrester Research,  
Business Week, Jan. 10, 1994**



## **Three Reasons that speak for the Future of the Mainframes**

- 1. Investment in existing applications**
- 2. Leading edge technology**
- 3. Attractive business for both IBM and its customers**

## **One Reason that speaks against the Future of Mainframes**

- 1. Low volume development and manufacturing**  
**Looking into the future**

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# **The worldwide number of CICS transactions executed each second is in the same ballpark as the number of hits on the WWW net**

**In 2001 worldwide approx. 15 000 enterprises used CICS . Of the 2000 largest companies more than 90 % use CICS.**

**There are 30 Mill. active CICS Terminals worldwide.**

**For comparision: in March 2001 there were 379 Mill. Internet connections worldwide, most of them in private homes.**

**Average CICS Terminal use: 4 - 6 hours/day.**

**Average internet connection use: estimated 10 hours/month.**

<http://www.hursley.ibm.com/infopack/A33578.pdf>

J. Gray: How High is High Performance Transaction Processing? <http://research.Microsoft.com/~Gray/Talks/>

R. Fox: „Net Population Newest Numbers“. Comm. ACM, Vol. 44, No.7, July 2001, P.9 .

# The Significance of COBOL

**Cobol remains the most widely deployed programming language in big business, accounting for 75% of all computer transactions. Cobol is pervasive in the financial sector (accounting for 90% of all financial transactions), in defence, as well as within established manufacturing and insurance sectors. We estimate that **there are over 200 billion lines of Cobol in production today, and this number continues to grow by between three and five percent a year.****

**Gary Barnett: The future of the mainframe. Ovum Report, October 2005  
<http://store.ovum.com/Product.asp?tnpid=&tnid=&pid=33702&cid=0>**

# The Significance of COBOL

**75% of all business data is processed in COBOL. - Gartner Group**

**There are between 180 billion and 200 billion lines of COBOL code in use worldwide. Existing legacy systems are predominantly written in COBOL.- Gartner Group**

**Replacement costs for COBOL systems, estimated at \$25 per line, are in the hundreds of billions of dollars. - Tactical Strategy Group**

**15% of all new applications (5 billion lines) through 2005 will be in COBOL. - Gartner Group. CICS transaction volume (such as COBOL-based ATM transactions) grew from 20 billion per day in 1998 to 30 billion per day in 2002. - The Cobol Report.**

<http://www.cobolwebler.com/cobolfacts.htm>

Gartner Inc., From the Dustbin, Cobol Rises, 2001, Reprinted in Microfocus Outlook, COBOL Technology and Contemporary Business Systems, May 2002

<http://www.eweek.com/article2/0,3959,25993,00.asp>

<http://www.info.uni-karlsruhe.de/lehre/2002WS/hps/Cobol-X1.pdf>



# **Example: Credit Suisse (Zürich)**

**2006**

**12 Mill. lines of code in PL/1**

**6 Mill. lines of code in Java**

**PL/1 source code has 78 000 Elements**

**Main programms (24 000)**

**Copy Books**

**Subroutines**

**On-Line programs**

**1 000 GUI Services with 15 Mill. Calls/day**

**30 Mill. \$ Investment to restructure existing Code**

**“Rip and Rewrite”  
is a high-risk, low-reward proposition**

**ovum report, Oktober 2005**

## **Three Reasons that speak for the Future of the Mainframes**

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Looking into the future**

	Compaq Proliant W2000	SUN Exxxx Solaris	HP HP9000 HPUX	IBM S/390 OS/390
Processor Technology	7	6	10	10
Systems Performance	30	50	50	50
Clustering Performance	2	4	4	10
Single Systems Availability	20	30	30	50
Multiple Syst. Availability	20	24	32	40
Workload Management	5	20	30	50
Partitioning	4	28	16	40
Systems Management	<u>28</u>	<u>24</u>	<u>28</u>	<u>40</u>
Totals	116	186	200	290

**Application Server Evaluation Model, Technology Comparision**

**Gartner Group, February 2001**

**High Numbers are better**

# **zSeries, S/390, z/OS, OS/390**

## **Leading Edge Technology**

### **Unique zSeries and z/OS Facilities:**

- **Architecture, e.g. Hardware Protection prevents Buffer overflows**
- **Compatibility 1964 - 2007**
- **Hardware-Technology, e.g. TCM Multi-Chip Module, common L2 Cache**
- **Input/Output Architecture ([see publication](#))**
- **Symmetric Multiprocessing**
- **Scalability, using the Coupling Facility ([see publication](#))**
- **Partitioning and PR/SM LPAR Mode ([see publication](#))**
- **Hipersockets ( z/OS – zLinux Integration )**
- **Goal-oriented Workload Manager**
- **CICS-Transactionmanager**
- **WebSphere Web Application Server**
- **Persistent Reusable Java Virtual Machine ([see publication](#))**

G. Amdahl  
G.A. Blaauw  
F.P. Brooks

B.O. Evans

## **/360 Architecture**

April 7, 1964

- 8 Bit Byte
- Main Store Byte Addressing
- General Purpose Register
- Supervisor/Problem State (Kernel/User State)
- I/O Channel
- **Extended Lifetime** – strictly upwards and downwards compatibility over a line of models

# **What has happened since 1964 ?**

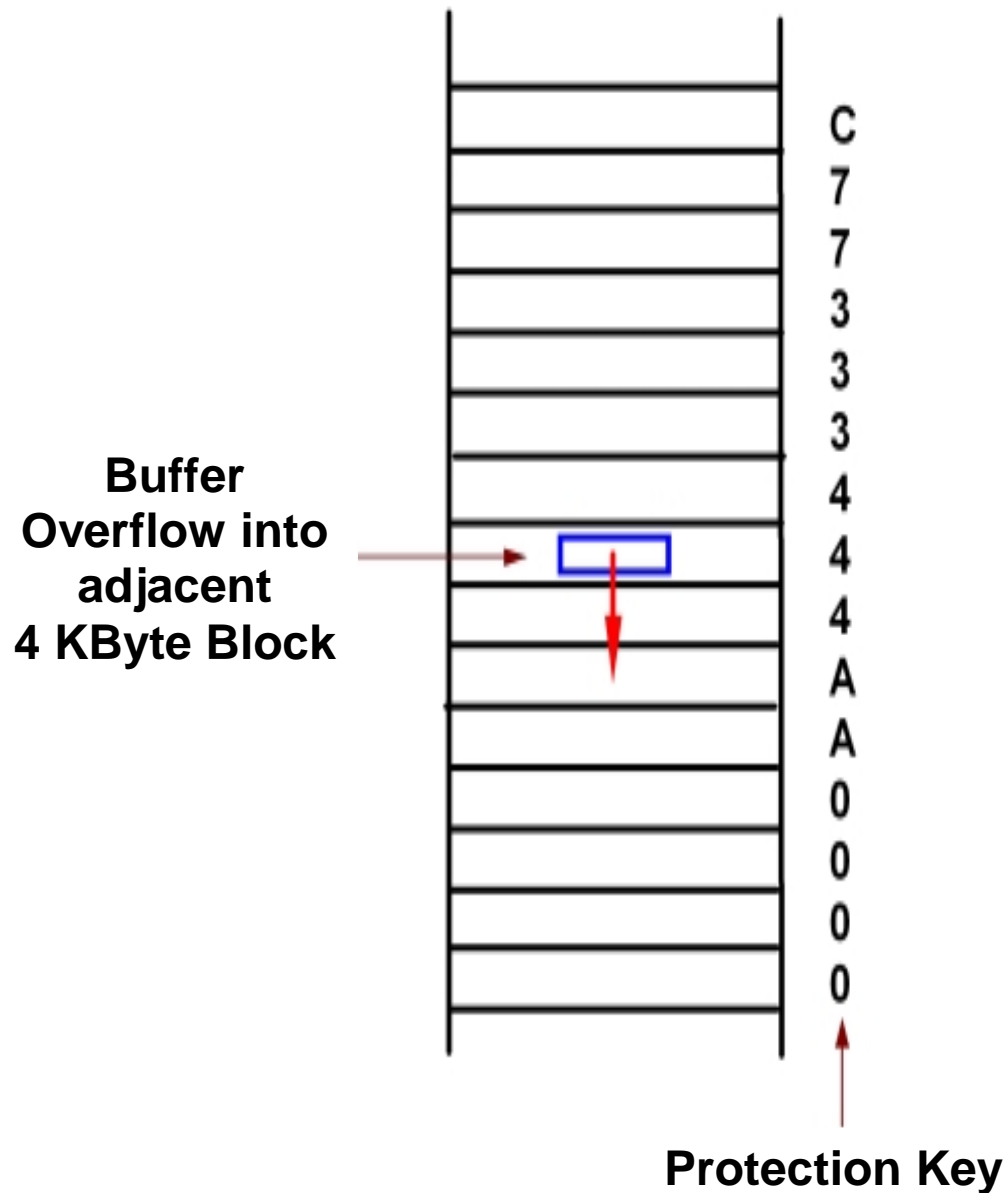
**Many efforts to come up with a better computer architecture**

- **B5000**
- **VAX**
- **HP Precision**
- **MIPS**
- **Itanium**
- **many others**

**Given today's knowledge: What should Amdahl, Blaauw and Brooks have done differently in 1964 ?**





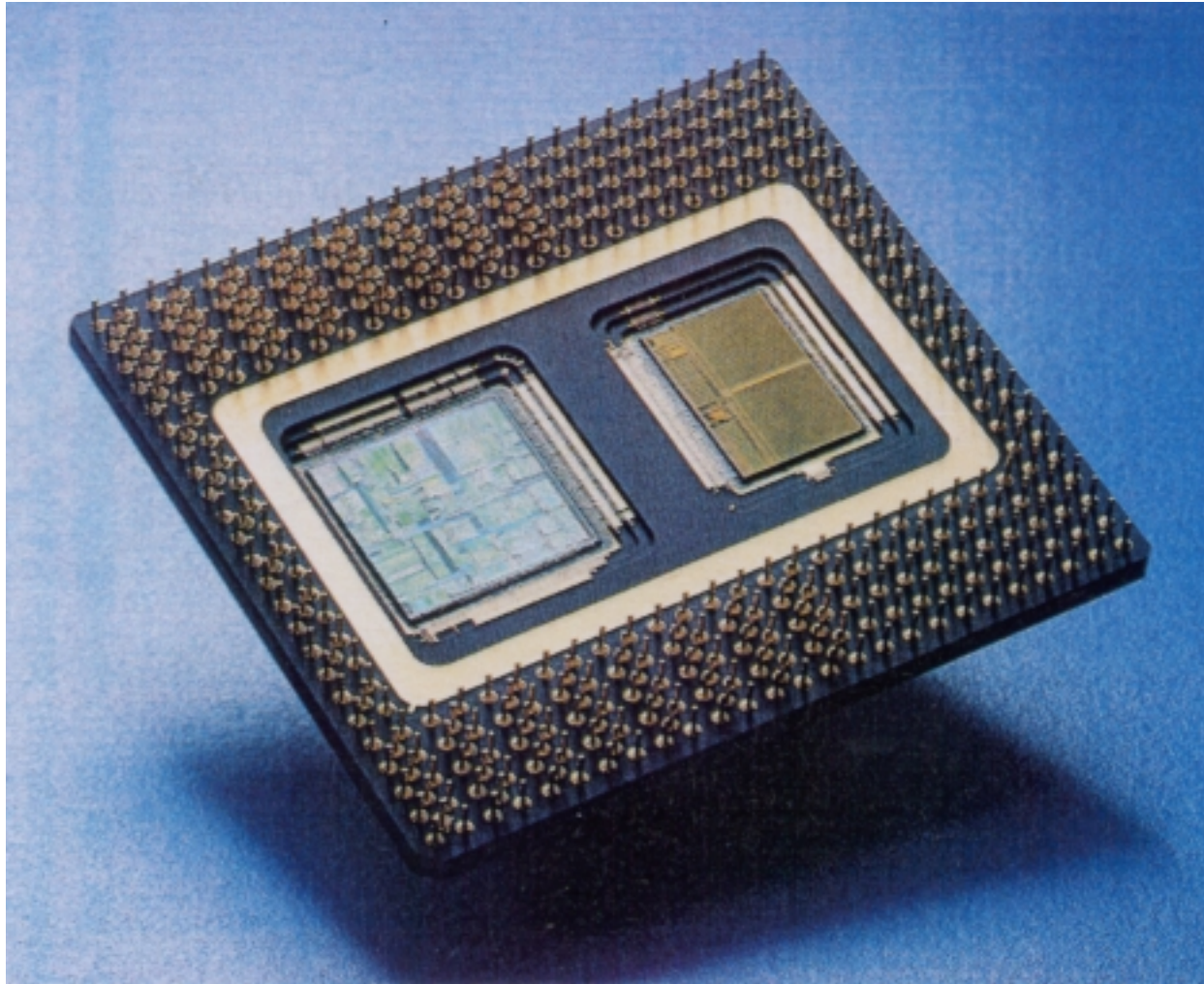


Main Store, partitioned into  
4 KByte Blocks (page  
frames) using different  
protection keys

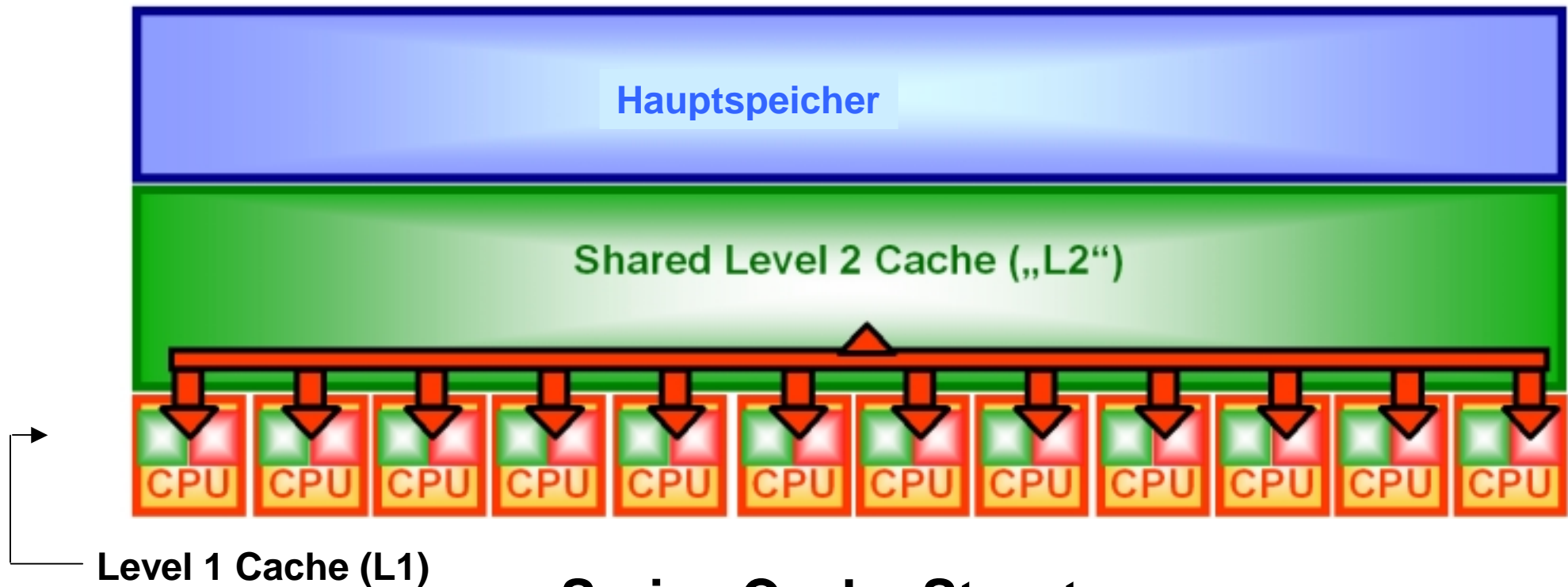
**Buffer  
Overflow  
Prevention**



**z9  
Multichip  
Module**

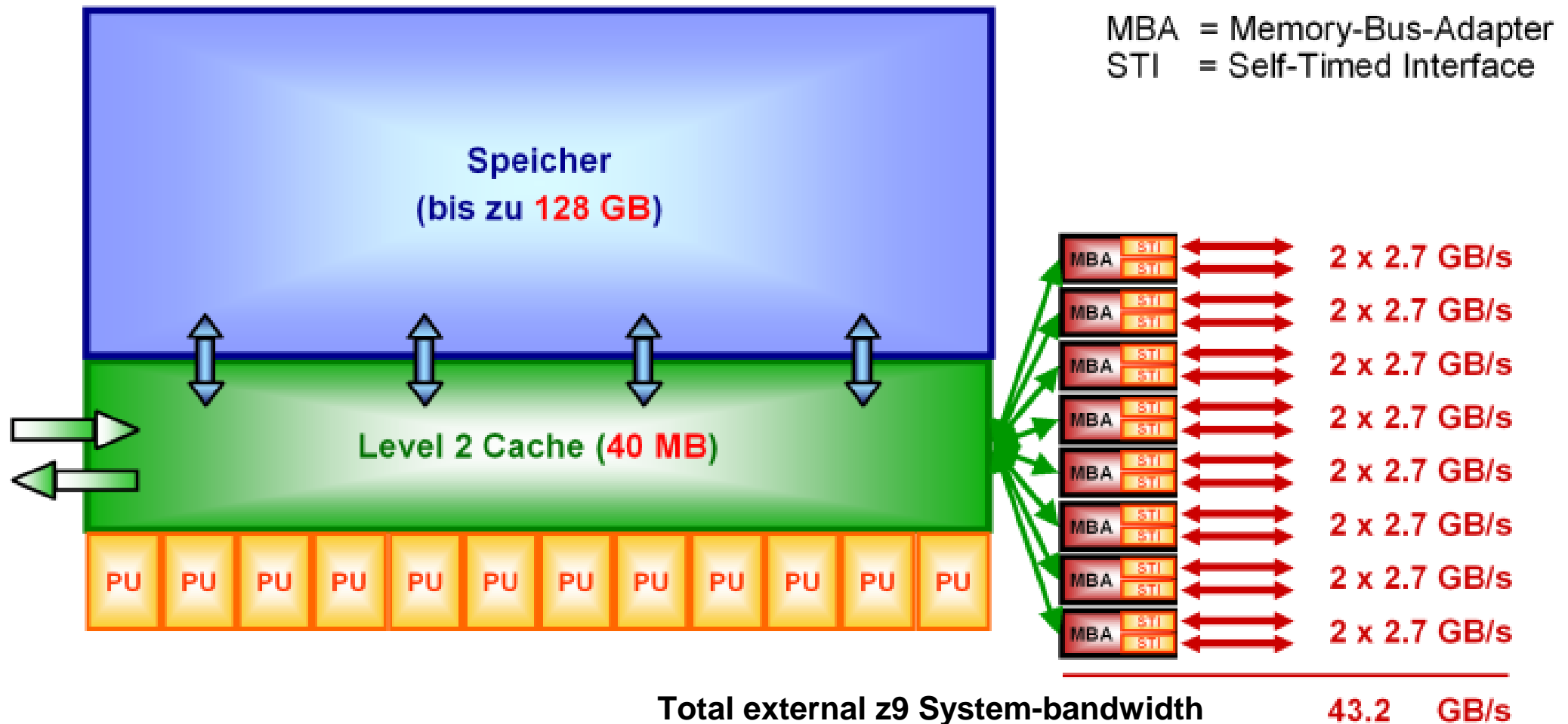


**Pentium Pro**  
**387 Pin Multi Layer Ceramic (MLC) Multi Chip Carrier (MCM) Module**

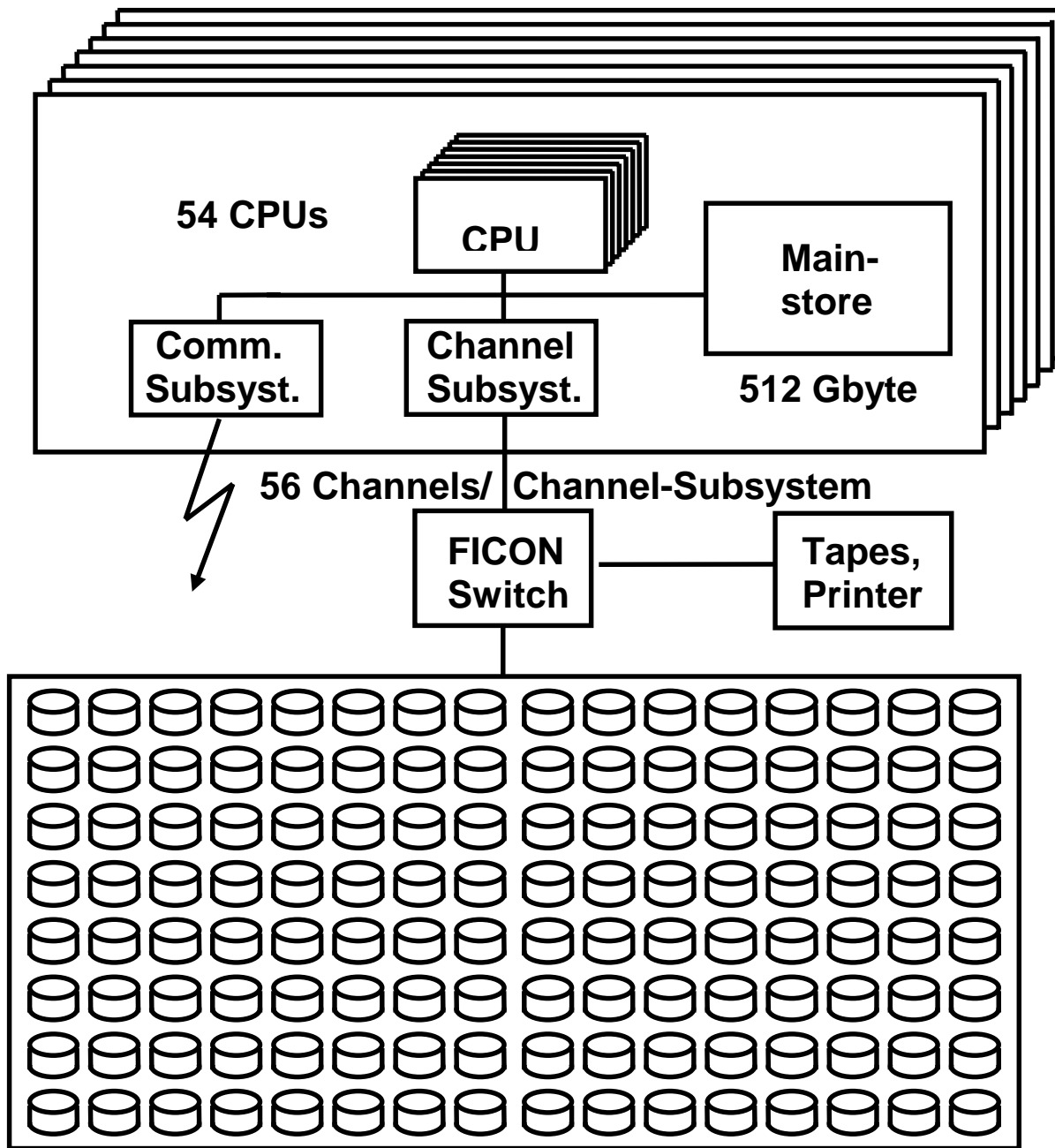


## **zSeries Cache Structure**

**Central L2 Switch, permits concurrent access by all processors  
CICS, DB2 and IMS Lock Management, significant performance Improvement**



Contrary to other Systems, I/O devices communicate with the L2 cache and not with main store. zSeries engineers were able to solve the resulting cache coherence problems.



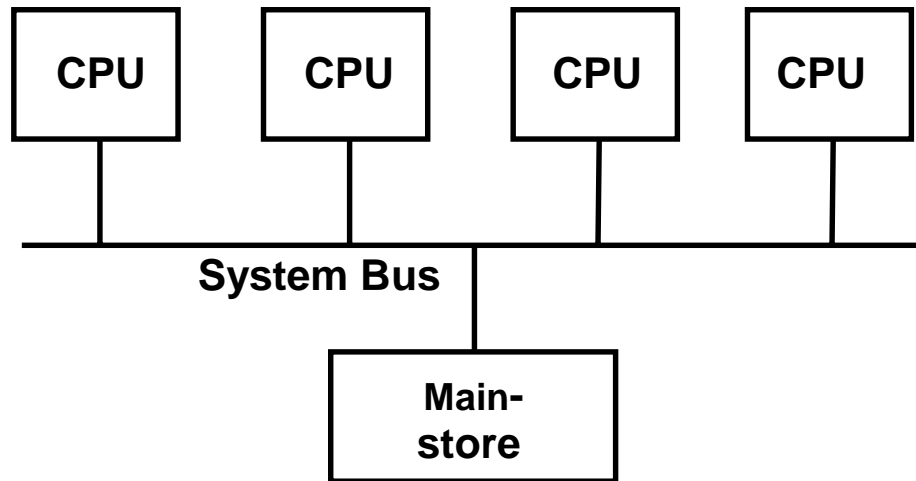
## **zSeries large system configuration**

**128 000 disks  
(devices)  
2 Channel Subsynt.**

**Logical Volumes**

**10 - 1000 TeraByte  
disk space**



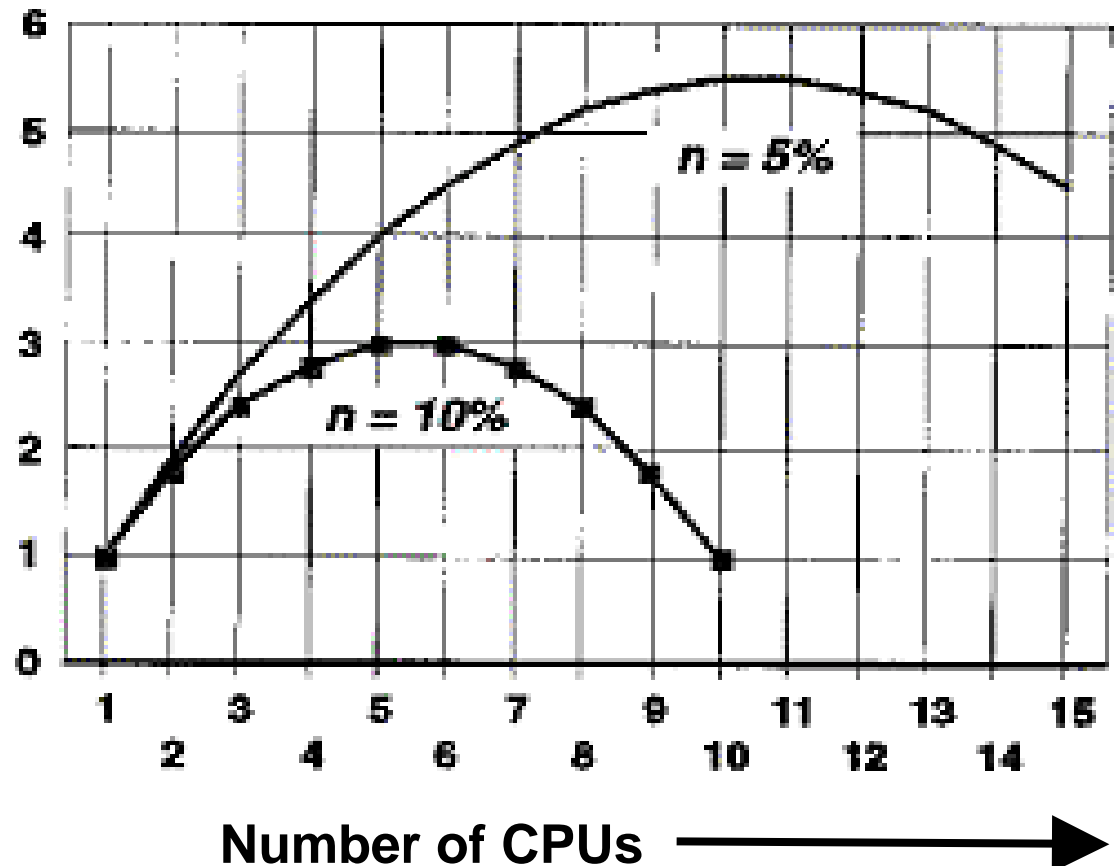


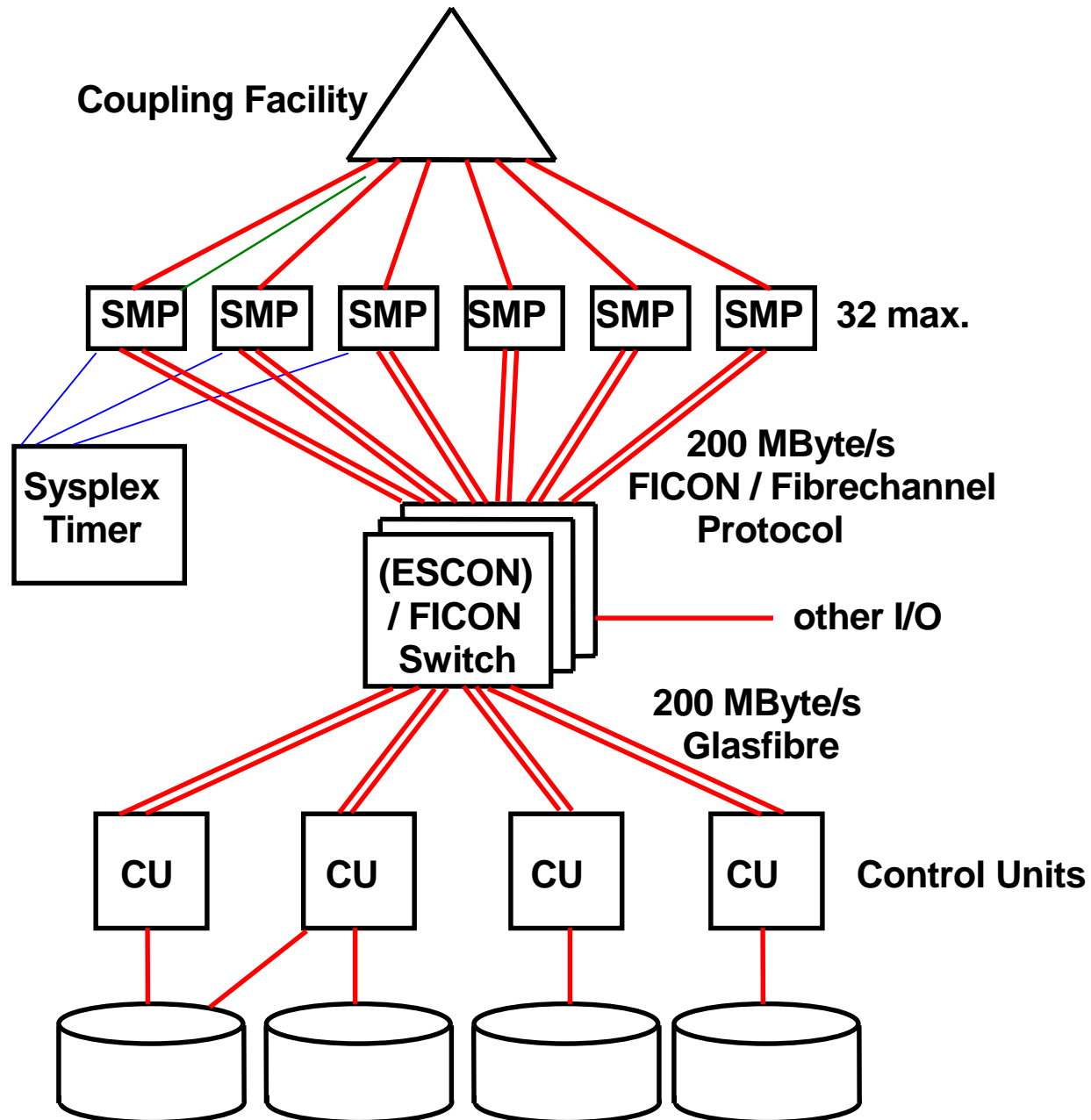
**Symmetric  
Multiprocessor,  
SMP.  
Single z/OS  
Instance**

**Relative  
Performance**

**z/OS up to 32 CPUs**

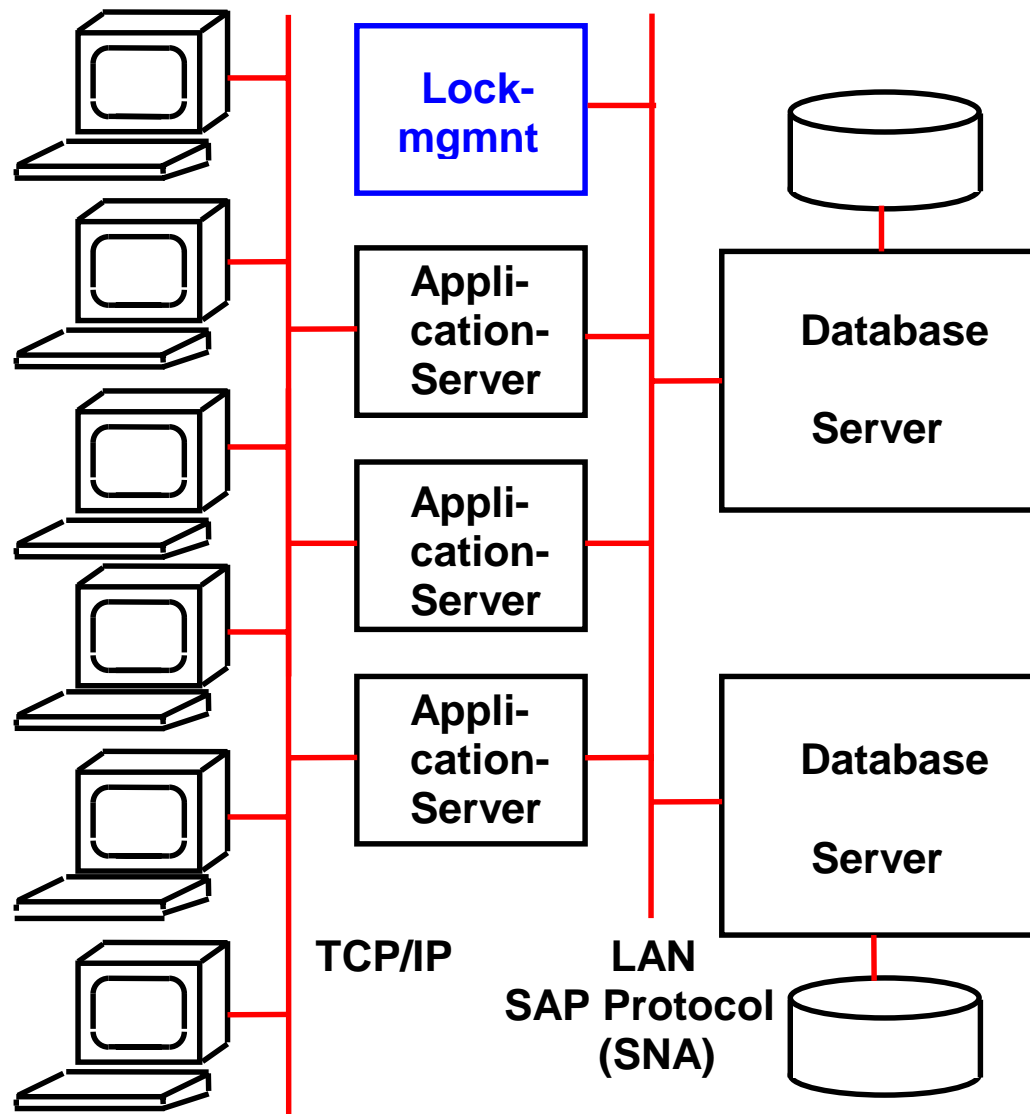
**other Platforms  
approx. ½ for  
Transaction- and  
Database applications**





## Sysplex with Coupling Facility



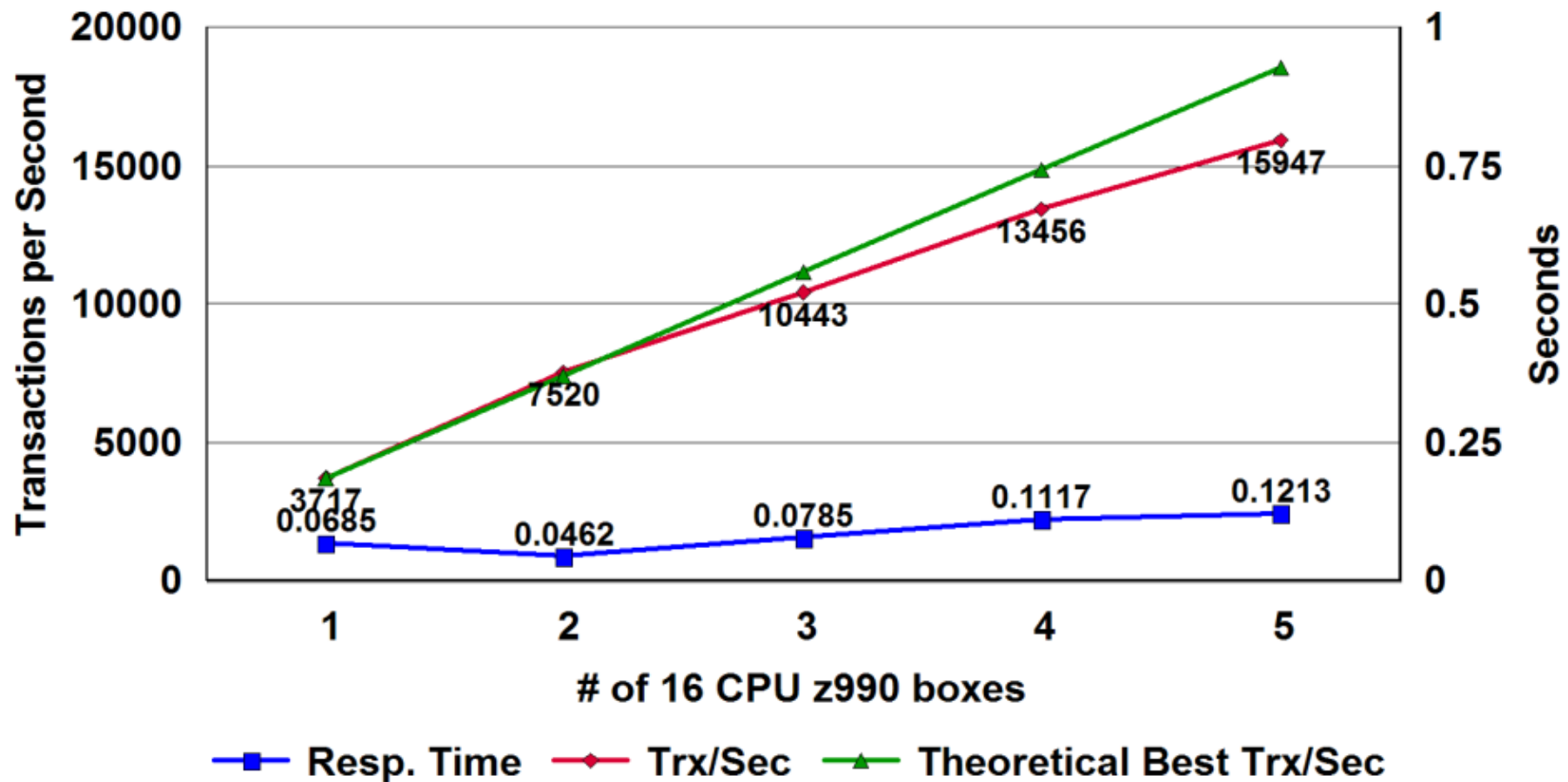


Presentation

**Separate System for  
the SAP Lock  
management**

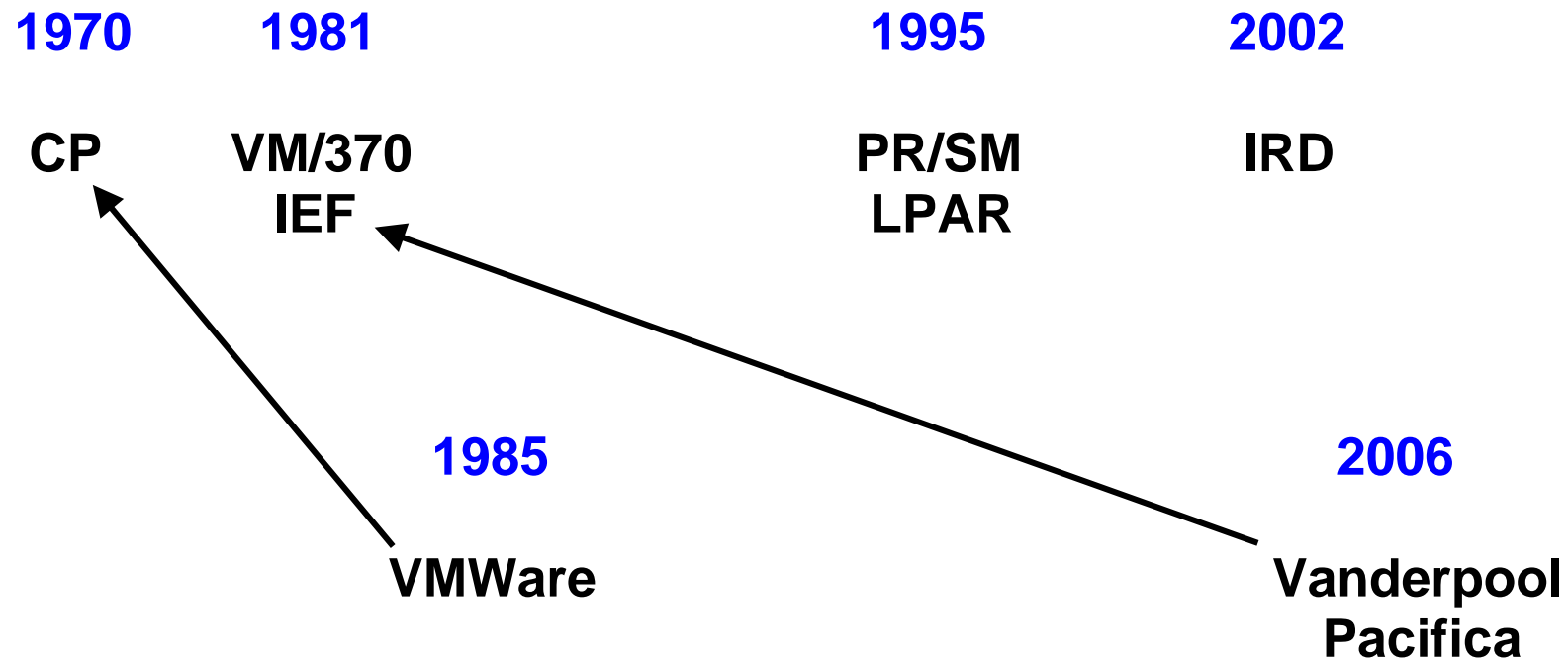
**You cannot scale a  
transaction  
processing system,  
if you do not solve the  
locking problem**

**Jim Gray,  
Andreas Reuter, 1993**



**25 000 MIPS at 95 % Utilization sustained 15 947 Transactions/s  
with subsecond response time**

# The Development of Virtualization



**Physical  
Storage  
Addresses**

**PR/SM  
Partition  
real (absolute)  
Addresses**

FF...FF



00...00

FF...FF



00...00

FF...FF

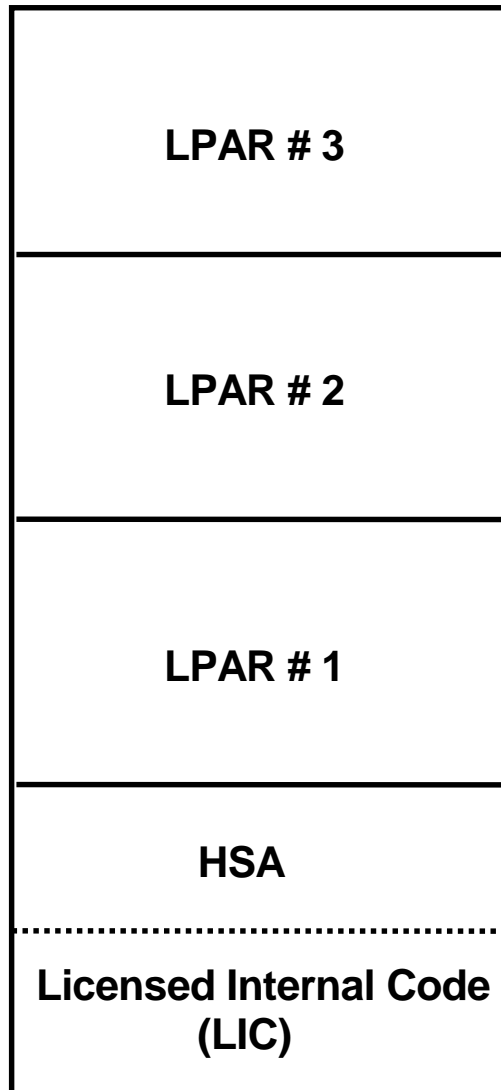


00...00

FF...FF



00...00



## **zSeries LPAR PR/SM Virtualisierung.**

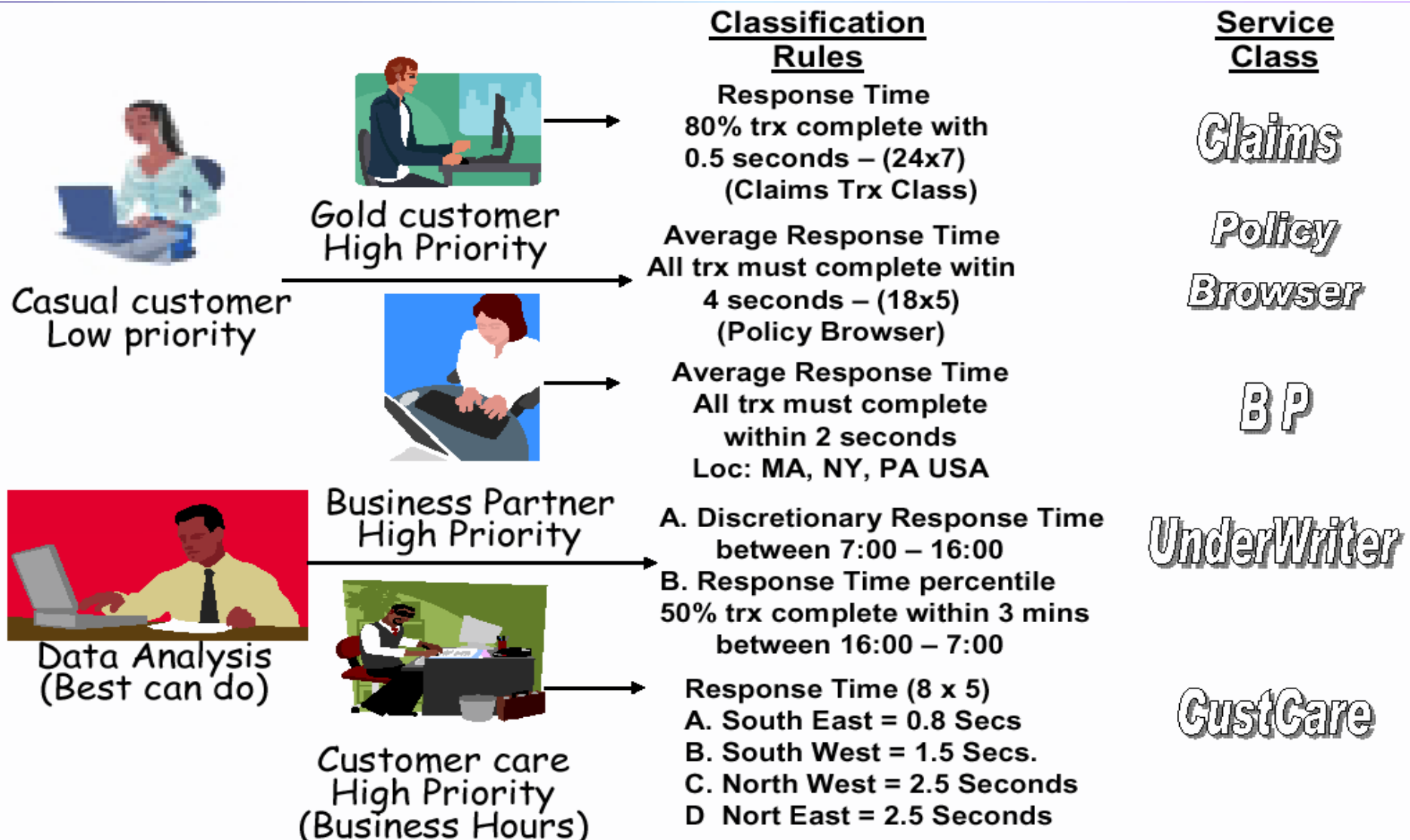
**Contrary to all other  
platforms, LPARs use real  
storage.**

**Dynamic LPAR Storage  
management.**

**IRD**

# Goal oriented Work Load Manager

## Policy driven Work Load Mgmt.





# Use of Java Threads

The existing application isolation mechanisms, such as class loaders, do not guarantee that two arbitrary applications executing in the same instance of the JVM will not interfere with one another. Such interference can occur in many places. For instance, mutable parts of classes can leak object references and can allow one application to prevent the others from invoking certain methods. The internalized strings introduce shared, easy to capture monitors. Sharing event and finalization queues and their associated handling threads can block or hinder the execution of some application. Monopolizing of computational resources, such as heap memory, by one application can starve the others.

*Grzegorz Czajkowski, Laurent Daynès:*  
*Multitasking without Compromise: a Virtual Machine Evolution.*  
<http://research.sun.com/projects/barcelona/papers/oopsla01.pdf>

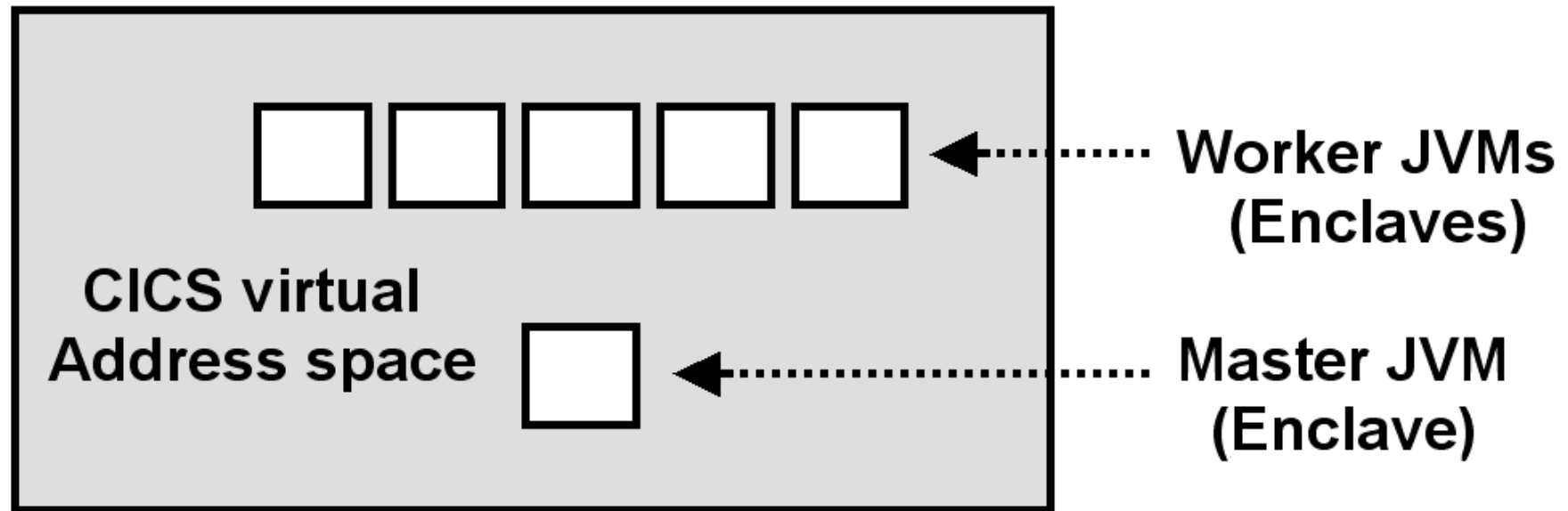
Java gives the virtuoso thread programmer considerable freedom, but it also presents many pitfalls for less experienced programmers, who can create complex programs that fail in baffling ways.

*Bo Sandén: Coping with Java Threads. IEEE Computer, Vol. 37, Nr. 4, April 2004, p. 20.*

<http://www-ti.informatik.uni-tuebingen.de/~spruth/DiplArb/jmueller.pdf>

# Persistent Reusable Java Virtual Machine (PRJVM) Technology.

The PRJVM is a regular JVM with some additional functions



Multiple PRJVMs within the CICS address space

The first PRJVM plays the role of the *Master PRJVM* and manages the JVM Set

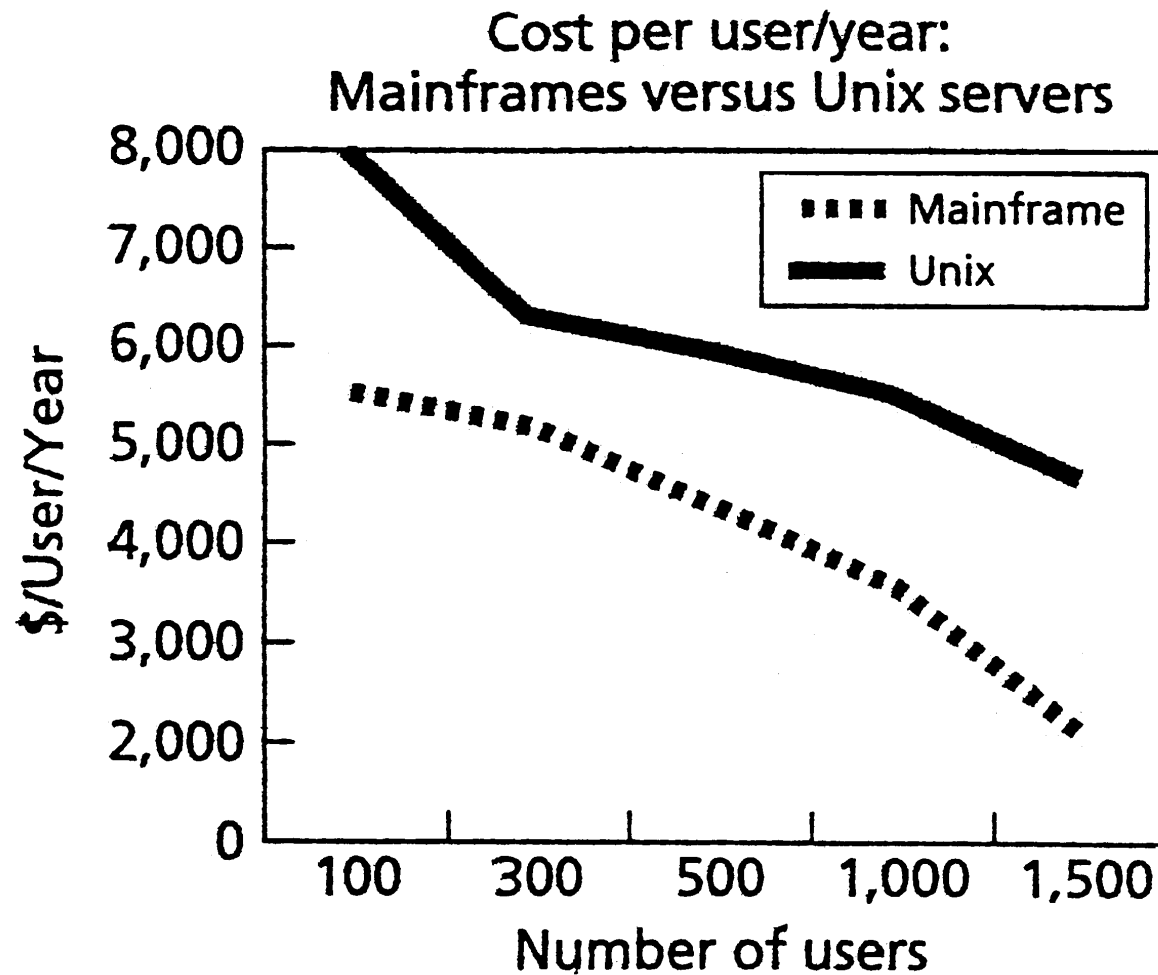


## **Three Reasons that speak for the Future of the Mainframes**

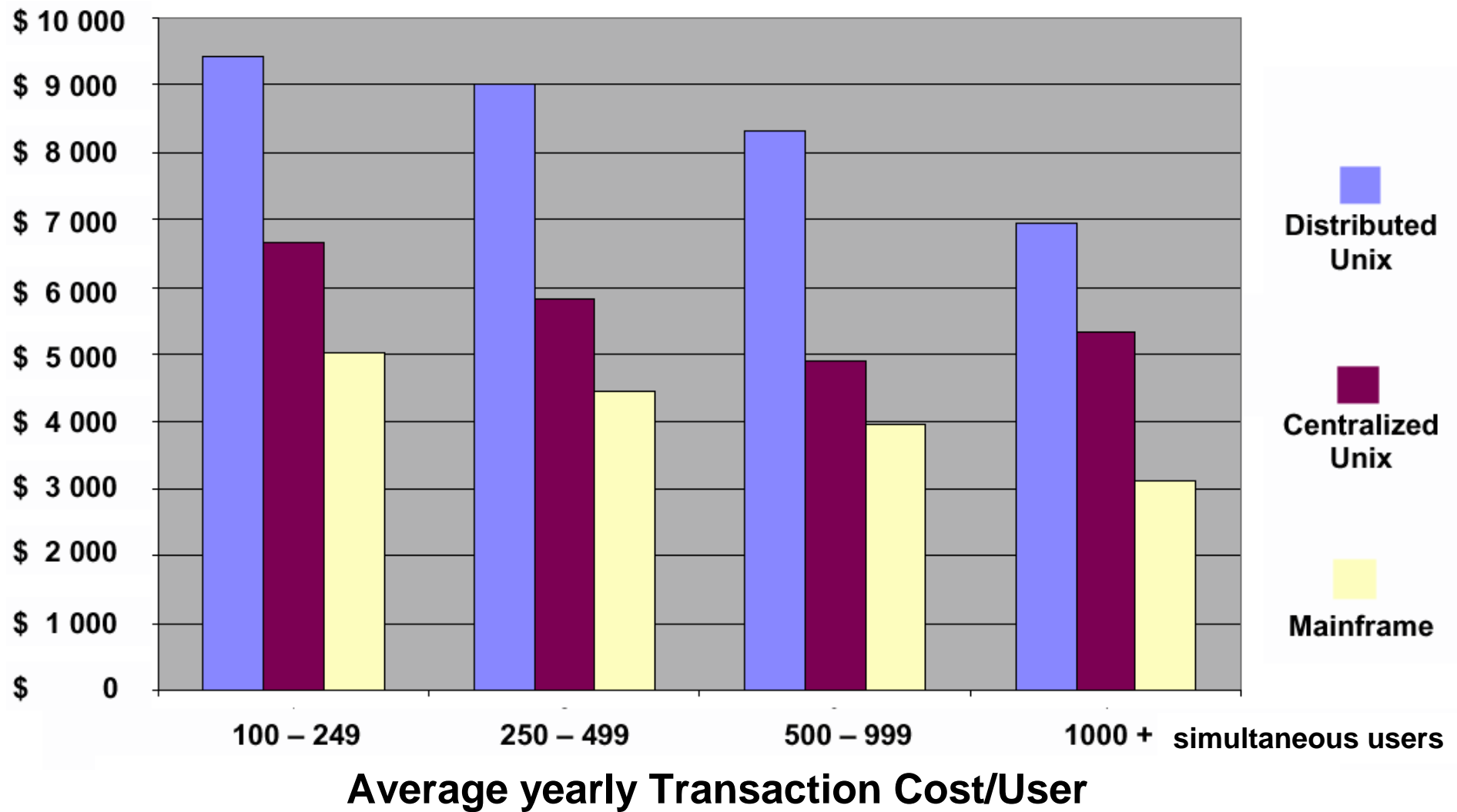
- 1. Investment in existing applications**
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Looking into the future**



**Declining cost per user due to mainframe scalability versus Unix server scalability.**



IDC, 2/1999

Armonk, NY - 26 Feb 2007:

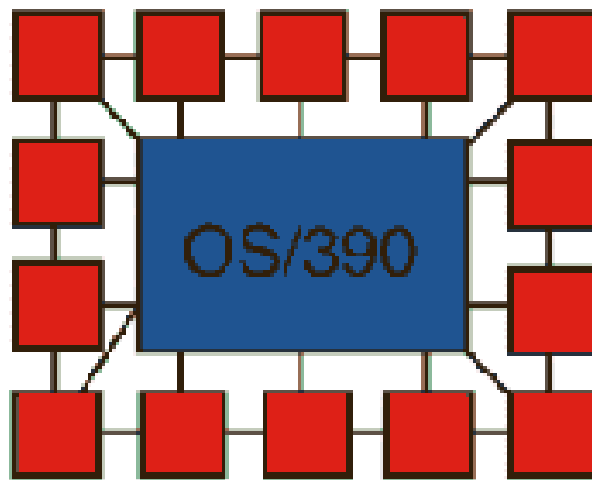
# IBM Mainframe Revenue and Profit Growth

**IDC reported today that IBM continues to hold the number one position in worldwide server revenue share with 32.8 percent revenue share for 2006 .**

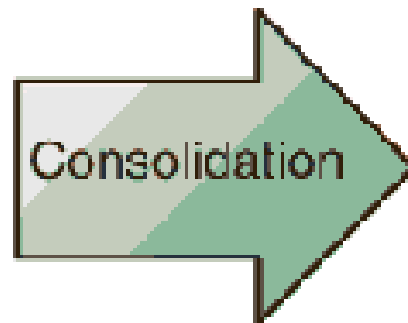
**IBM's leadership position in global server revenue in 2006 was augmented by noteworthy revenue growth in its System z mainframe business .**

**IDC Worldwide Quarterly Server Tracker, 4Q06, issued on February 26, 2007**

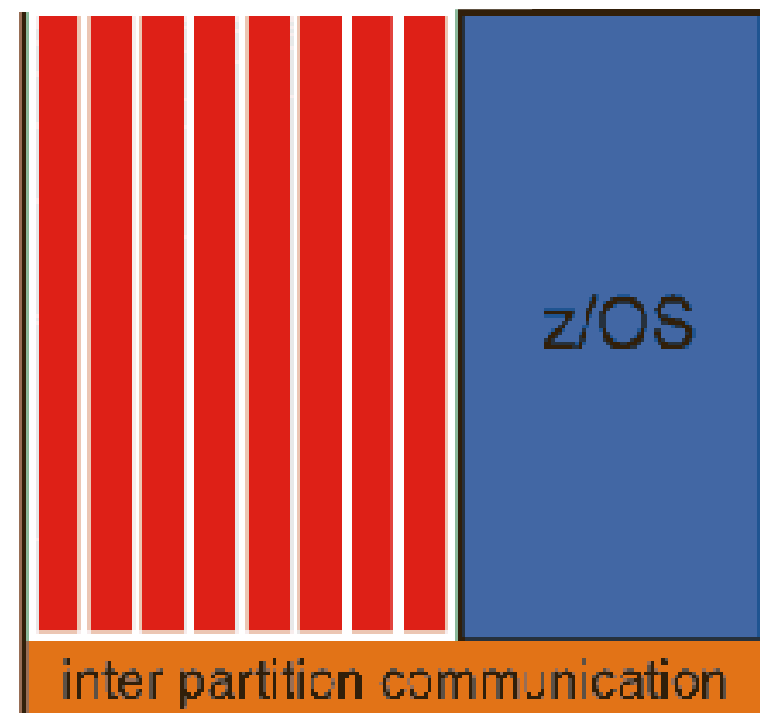
<http://www-03.ibm.com/press/us/en/pressrelease/21148.wss>



flocks of middle-tier  
Unix servers  
surrounding z/OS  
corporate data



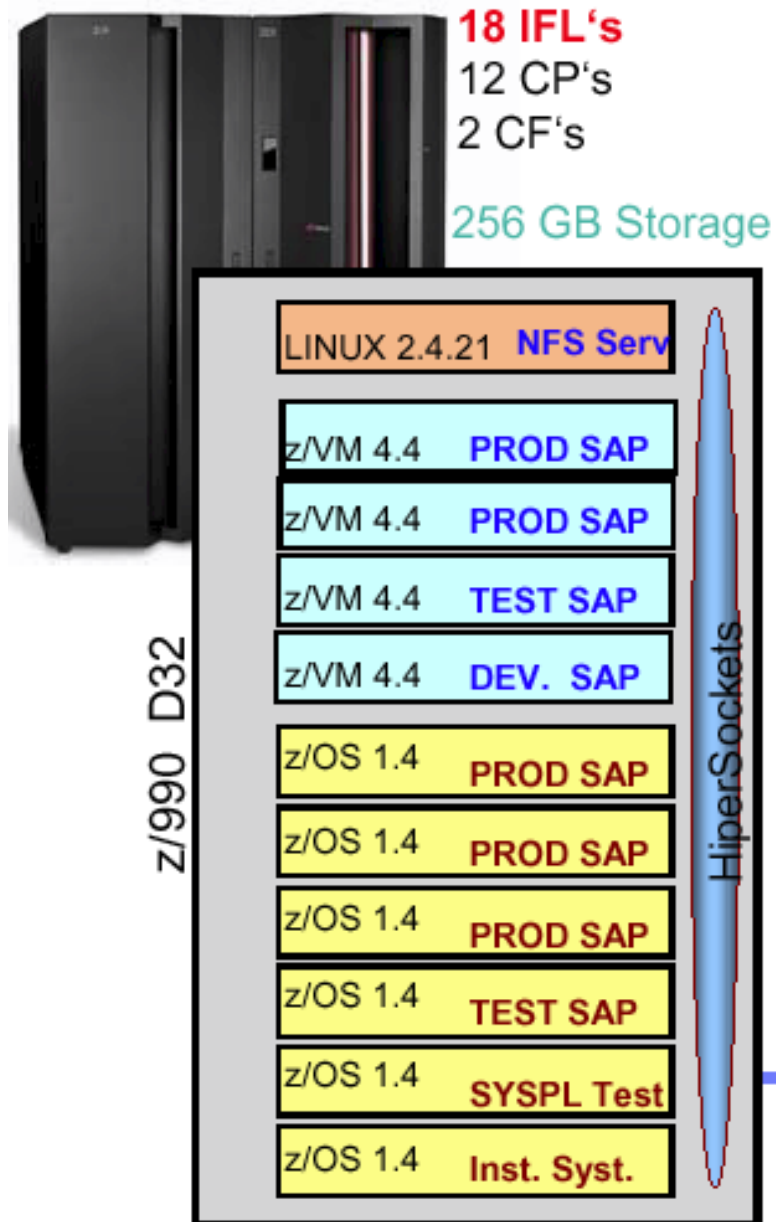
## Linux on zSeries



Integrated “logical” middle-tier  
servers access corporate data  
via high speed, low latency  
interpartition communication  
**“network in a box”**

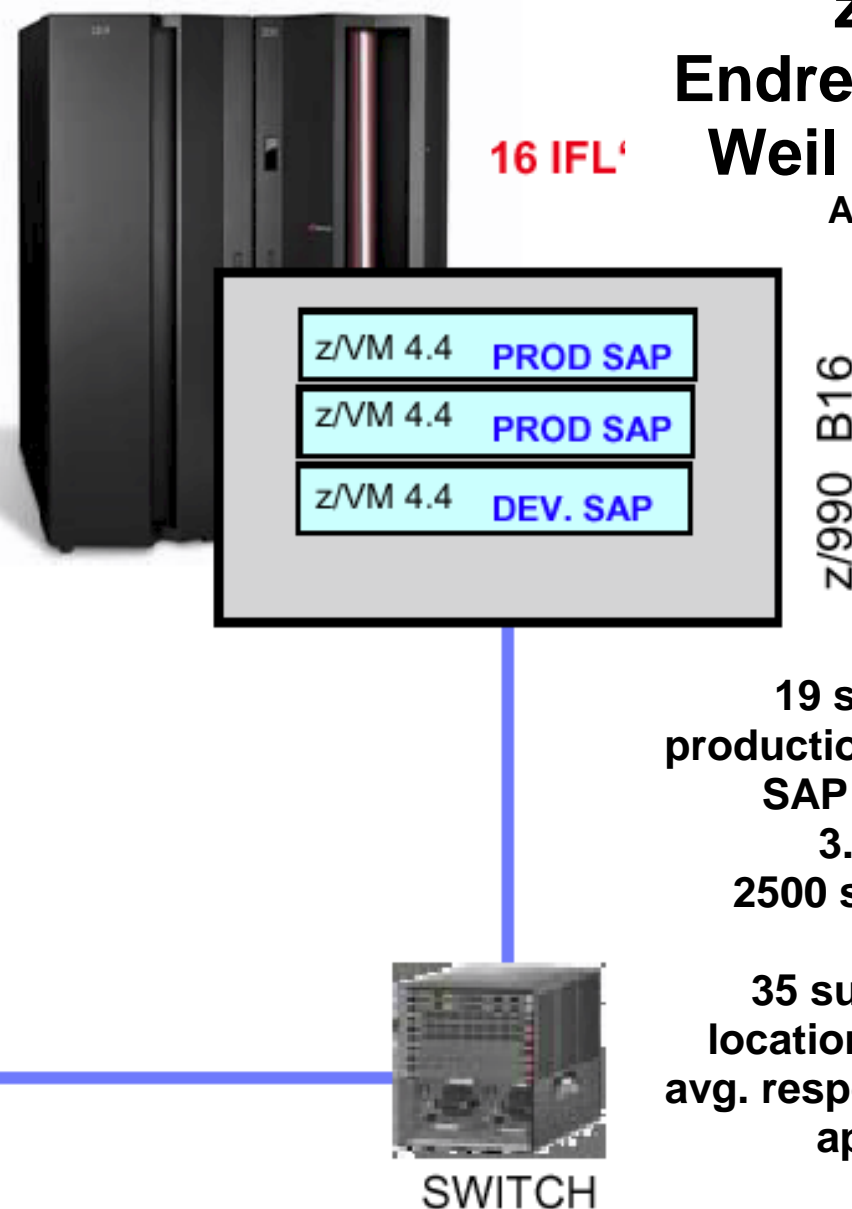
The iQDIO Interface provides a high speed IP-Datacommunications between the LPARs of a zSeries system. Works like an IP-LAN interchange; data exchange via main storage Hipersockets.

## Actual LPAR structure



## SAP/R3 und zLinux Endress+Hauser, Weil am Rhein.

August 2004



# First National Bank of Omaha



	<i><b>Servers</b></i>	<i><b>Reliability</b></i>	<i><b>Utilization</b></i>	<i><b>Staff</b></i>
<i><b>First move:</b></i> Implemented distributed computing architecture that became <b>too difficult to monitor, maintain, upgrade and scale</b>	<ul style="list-style-type: none"><li>■ 30+ Sun Solaris servers</li><li>■ 560+ Intel servers</li></ul>	Un-acceptable	12%	24 people growing at 30% year
<i><b>Next move:</b></i> Consolidated back on the mainframe	z990	Much improved	84% with additional reserve capacity <b>on-demand</b>	Reduced to 8 people

Seven times better utilization on mainframe hardware

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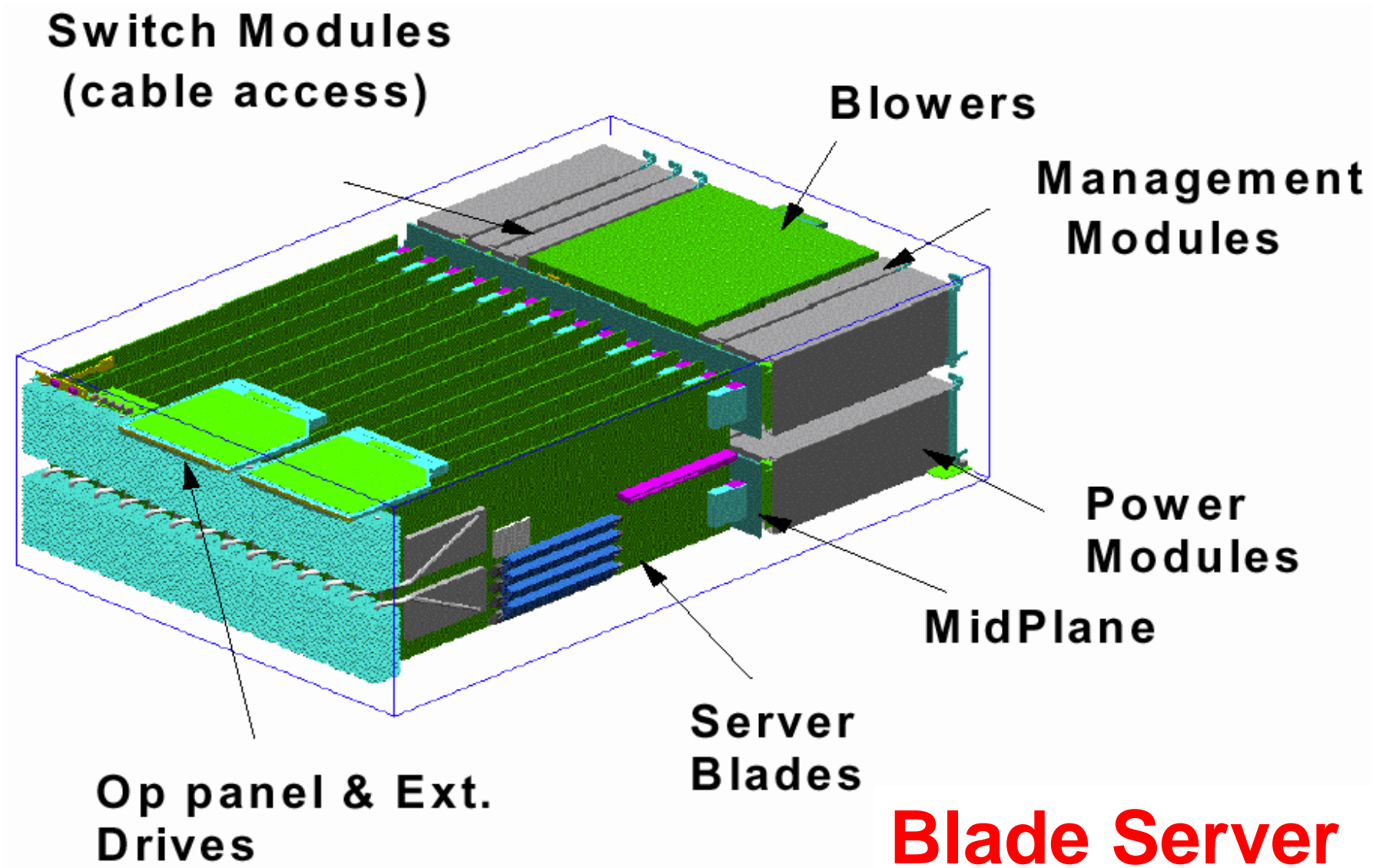
- 1. Low volume development and manufacturing**  
**Looking into the future**



# Looking into the Future

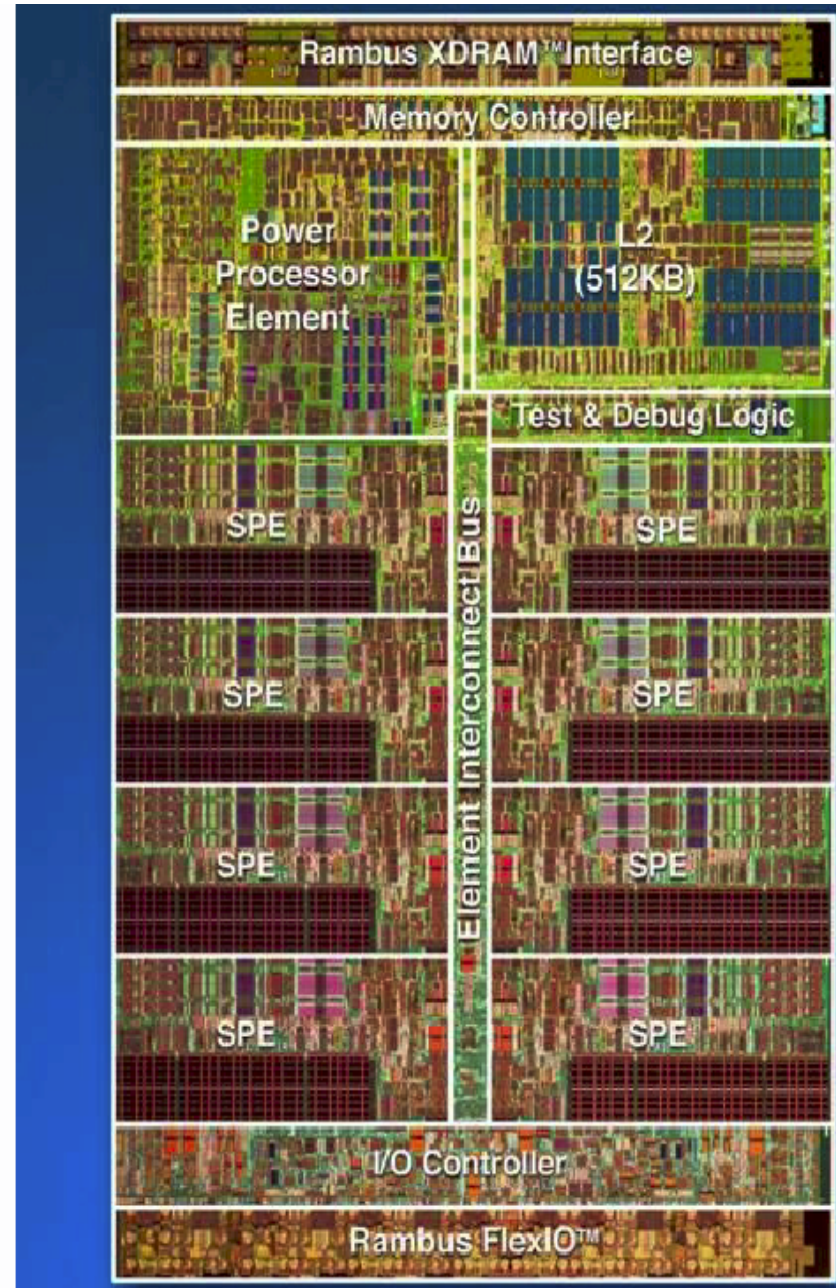
In the future we will see 4 different platform-types :

1. **Embedded Systems** Handy, Palmtop, RFID, refrigerator IP address,  
Computer embedded into the human body (pacemaker)
2. **Personal Computer** Office, Home Computer for Mail, correspondence and  
photographic processing, **extension into Blades**
3. **Game Computer** X-Box, Sony, Nintendo,  
High Performance computer with **Blades**
4. **Mainframe** offers functions not available on other Platforms:  
Performance impact, availability, I/O,  
additional cost and development effort.....



# Cell Processor Chip

- ~250M transistors
- ~235mm<sup>2</sup>
- Top frequency >4GHz
- 9 cores, 10 threads
- > 256 GFlops (SP) @4GHz
- > 26 GFlops (DP) @4GHz
- Up to 25.6GB/s memory B/W
- Up to 75 GB/s I/O B/W
- Large design investment (time & money)



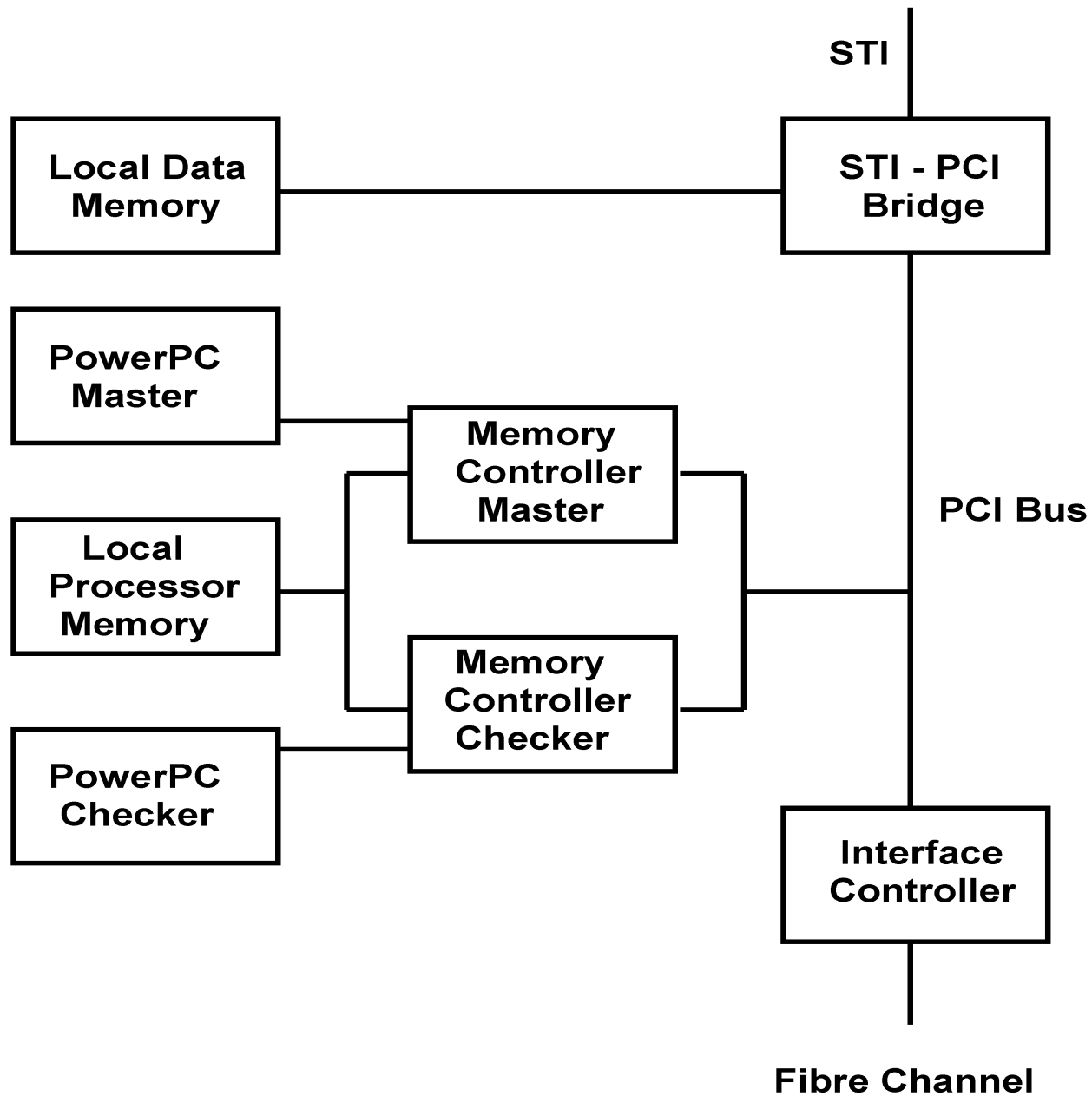
# Cell Applications

- Home Computer Entertainment
  - Game consoles, home servers, media boxes, ...
- Medical imaging, radar imaging, ...
- Simulation
- High performance computing
  - Life sciences, seismic, and a few others fit well; broader Cell-based HPC needs Research
- Video surveillance
- Online gaming
  - Backend servers
- Digital media – content mgmt & delivery
  - Backend servers for content providers
- Digital media – production
  - Render farms, ...

# Mainframe Properties

**Mainframes have hardware and software functions, that require additional development effort and manufacturing cost. This will not change in the future.**

**These functions are needed. The resulting expense is not justified in other platforms.**



**zSeries Fibre Channel, based on the Common I/O Card**

# **Software Implementation for different Platforms**

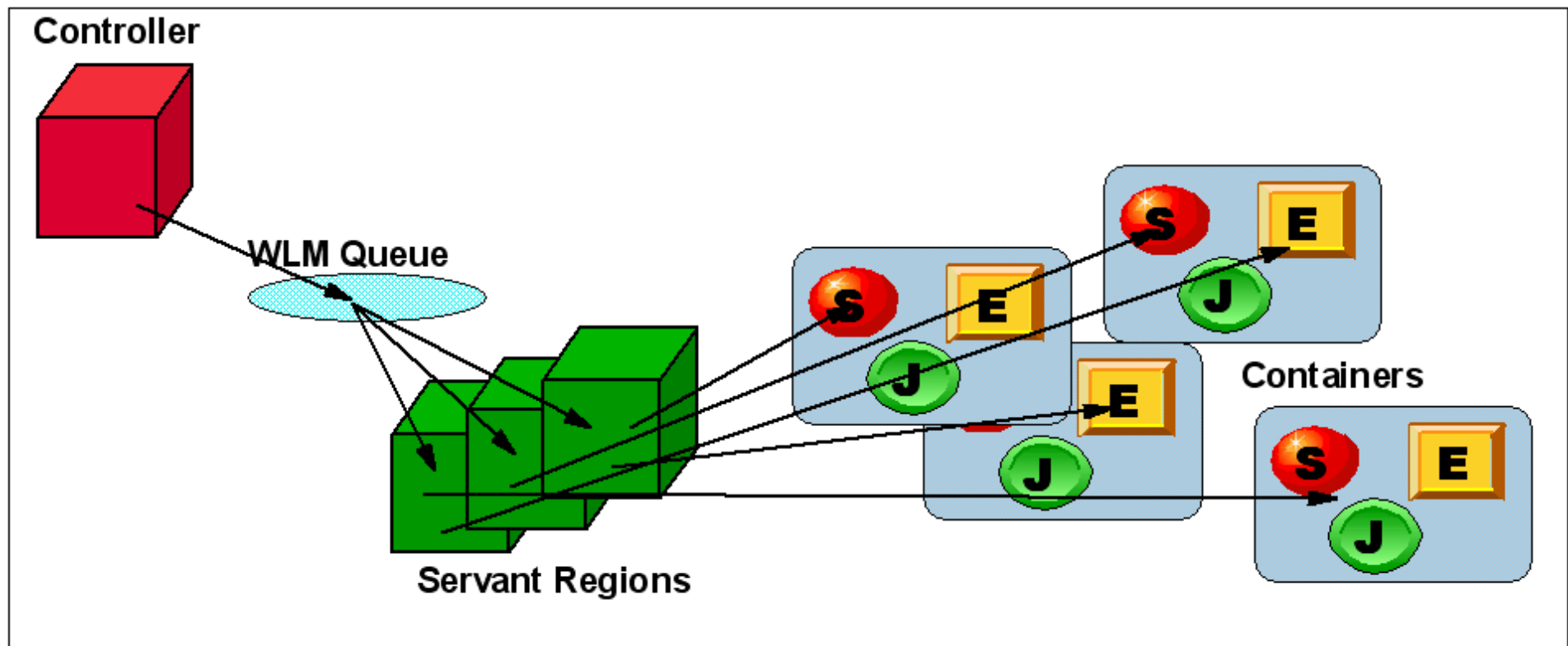
**Separate Implementations for z/OS and all other Platforms**

**CICS  
DB2**

**and for WebSphere ?**

**common Code Basis, but special z/OS features.**





**A z/OS WebSphere Server has a Controller and multiple Servants, which do the actual work. The Controller manages Servants using the z/OS Goal oriented Work Load Manager.**



**Ovum report believes PC technology will catch up with mainframes**

**Yes, e.g. a coupling facility integrated in each PC**

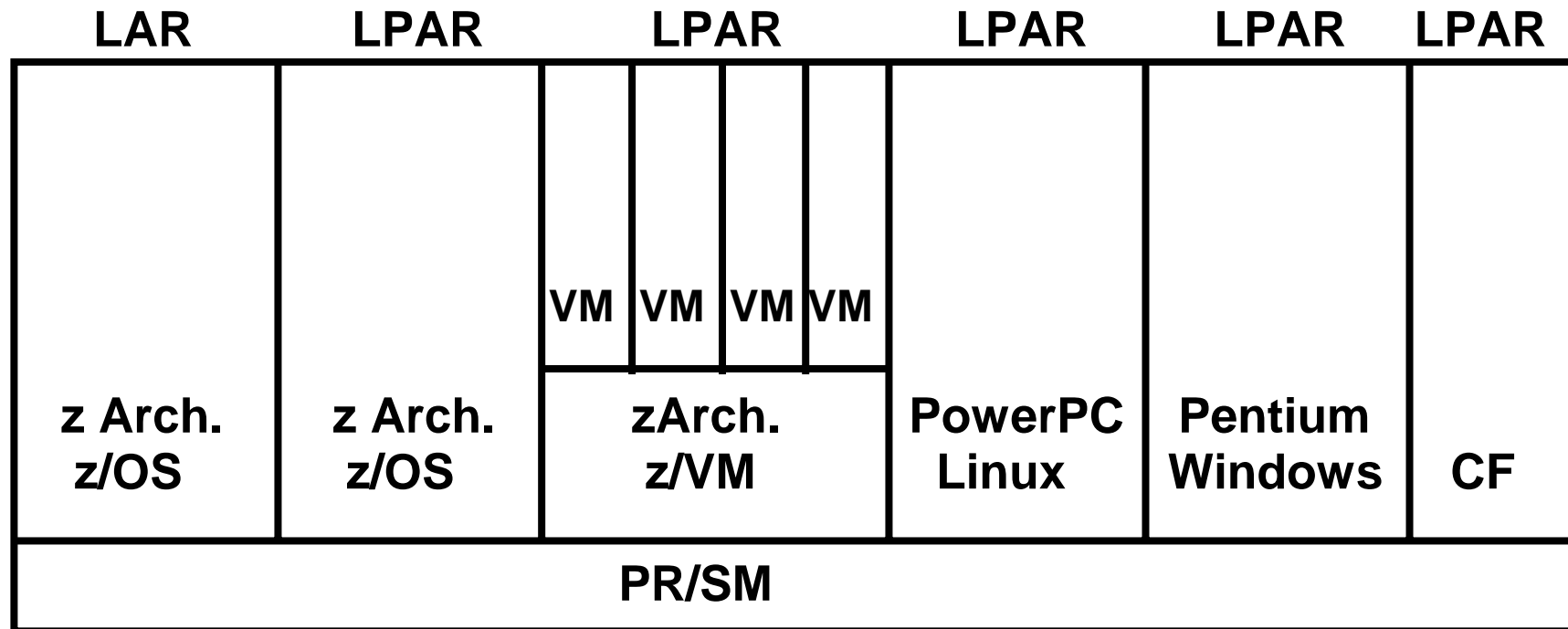
**But, 1 Billion \$ investment in next generation Mainframe**

**Remember PC introduction in 1980 ?**

**No cache, virtual storage, virtualisation, disk I/O,  
PC-DOS vs. OS/370, .....**

**By the time PC technology catches up, mainframes will be much further advanced.**

**System integration issues and Service Oriented Architecture (SOA)  
favour mainframes**



## Future SOA Configuration – Network in a Box

The iQDIO Interface provides a high speed IP-Datacommunications between the LPARs of a zSeries system. Works like an IP-LAN interchange; data exchange via main storage Hipersockets.

VM – (emulated) Virtual Machine, z/OS test system, Apple, Solaris

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## Lehrbuch



# Willkommen auf **jedi.informatik.uni-leipzig.de**

## Uni Leipzig z/OS Web Application Server

Im dramatisch ansteigenden Internet-Computing erleben die vor ca. fünfzehn Jahren als Dinosaurier abgestempelten Mainframes eine unglaubliche Renaissance. Nach dem Motto "The mainframes are dead, long live the mainframes" erobern die Großrechner besonders auf dem Internet-Markt verlorengegläubtes Terrain zurück und verdrängen zunehmend PCs und Workstations in dem Bereich der Client/Server-Architekturen. Die Anzahl der bereits bestehenden und geplanten Mainframe-Installationen in den Geschäftsbereichen e-economy und e-business übertrifft weltweit inzwischen alle Erwartungen. Dieser Trend stützt sich vorrangig auf hohe Zuverlässigkeit, Sicherheit und enorme Verarbeitungsleistung.

Auf dieser Web-Seite werden die Bemühungen am Institut für Informatik der Universität Leipzig, den interessierten Studenten und Absolventen grundlegende Kenntnisse in der Hard- und Software-Architektur der IBM /390-Rechner einschließlich modernster Internet-Technologien zu vermitteln, vorgestellt.





