7. April 1964 – IBM System /360

Mainframe 50 Jahre

Roland Trauner
Mainframe, zEnterprise, System z, zSeries
IBM Germany
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Xing, Linkedin, Facebook, Twitter, IBM Greenhouse, Threema

IBM

The IBM mainframe

- Unveiled on April 7, 1964, by IBM Chairman Thomas Watson Jr., the mainframe, also known as System/360, enabled companies to do multiple tasks on a computer at the same time.
- Cost to develop: $5 billion (about $70 billion in today's dollars)
- Impact on IBM: Big Blue added 60,000 employees and five new major plants
- Speed of original mainframe: Up to 750,000 additions per second
- Memory: Up to 8 MB
- Cost: Rented for $2,700 to $115,000 a month
- First customers: Bank of America, Time-Life, Allstate, NASA Institute of Space Study

Press Release April 7, 1964

A new generation of electronic computing equipment was introduced today by International Business Machines Corporation.

- IBM Board Chairman Thomas J. Watson Jr. called the event the most important product announcement in the company's history.
- The new equipment is known as the IBM System/360.
- It combines microelectronic technology, which makes possible operating speeds measured in billionths of a second, with significant advances in the concepts of computer organization.

At a press conference at the company's Poughkeepsie facilities, Mr. Watson said:

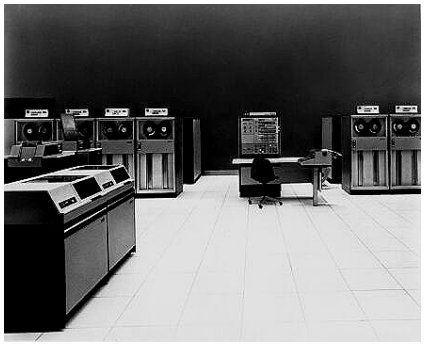
- **"System/360 represents a sharp departure from concepts of the past in designing and building computers. It is the product of an international effort in IBM's laboratories and plants and is the first time IBM has redesigned the basic internal architecture of its computers in a decade. The result will be more computer productivity at lower cost than ever before. This is the beginning of a new generation - - not only of computers - - but of their application in business, science and government."**

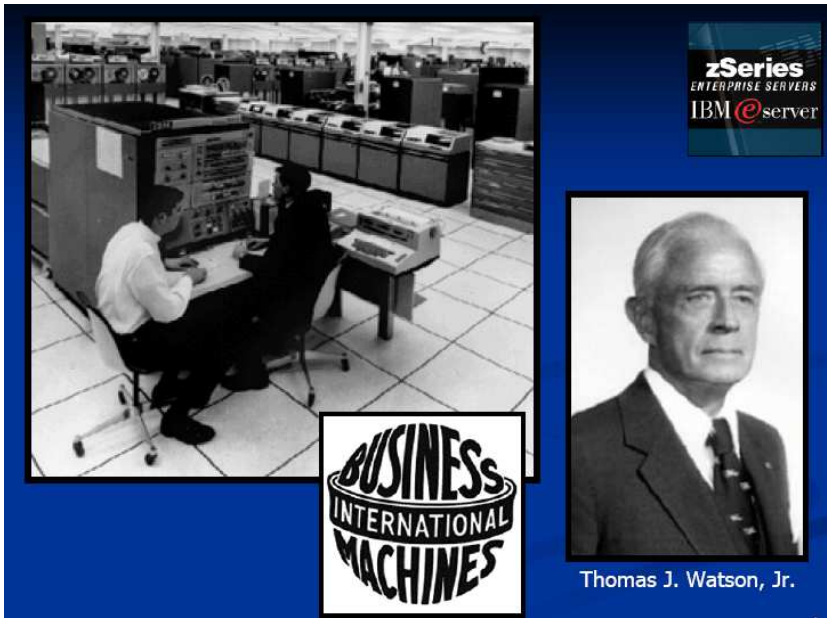
System /360

System/360 included in its central processors 19 combinations of graduated speed and memory capacity.

Incorporated with these were more than 40 types of peripheral equipment.

Built-in communications capability made the system available to remote locations, regardless of distance.





History of 60s

- 1st commercially available computer system (1964)
- 1st open specification system
  - Strictly defined programming interfaces
  - Peripherial interfaces (I/O like disk or tape)
  - Published processor architecture
- Online transaction processing
  - Airlines (1964)
  - Medical care (1968)
  - CICS – transaction monitor, available 1968
- Database
  - IMS™ – Apollo 11 Mission to Moon
    - Available 1969

IBM 360-20

IBM 360-30

History of 60s

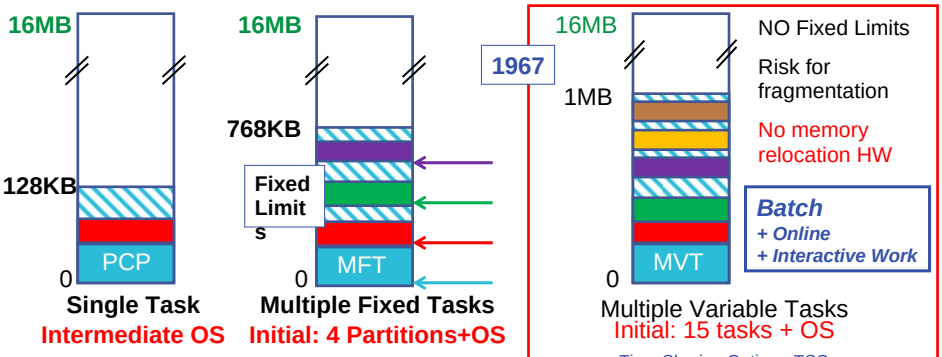
- **1965**
- IBM ships the midrange 360 model 40 computer which had COBOL and FORTRAN programming languages available as well as the stock Basic Assembly Language (BAL) assembler

- **1967**
- First IBM 360/Model 91 shipped to NASA GSFC

- **1969**
- First shipment of IBM 360 Model 85. The 360 family was intended to have 3 operating systems:
  - DOS/360 operating system for the small machines. It could run two "real-time" sessions and one batch session.
  - OS/360 operating system for the midrange and high end.
  - TSS/360 operating system for Time-sharing Multi-user system

OS/360 - Operating Systems + "Job Control Language" (JCL)

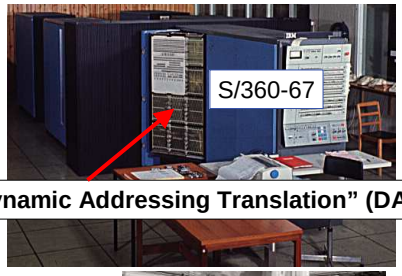
- **GOAL - ONE Operating System (OS)**
  - multiprogramming / variable number of concurrent task / variable size
  - multiprocessing
- **Reality - Complex to implement vision & the OS needed to be able to deal…**
  - with limited amount of REAL memory (minimum 8KB / **maximum 8MB**)
  - Basic (BOS - 8KB), TAPE (TOS - 16KB), DASD (DOS more than 16KB) and OS/360-versions
  - **Typical memory size for large systems became over time around 512KB to 1MB**



IBM 360-50

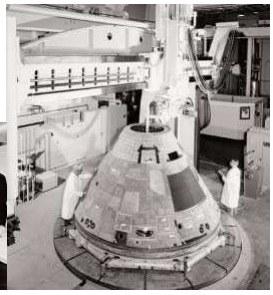
Innovations: Virtual Storage + CP/67 & CMS + MP + Supercomputer….

- S/360 Model 67 - first IBM system with Virtual Storage and Multi Processor (MP) capabilities
  - **Control Program/67 (CP/67) with Cambridge Monitor System (CMS)**
    The "unofficial" operating system from the IBM Cambridge Scientific Center ***"version of Virtual Machine (VM)….)***
  - **Time Sharing System (TSS) -**
    the "official" time-sharing OS from IBM
    It did NEVER "fly"…



"Dynamic Addressing Translation" (DAT

- NASA….Goddard Space Flight Center used the S/360 model 95 supercomputers…



- Run by an IBM System/360, a massive turret lathe shapes a heat shield for an Apollo spacecraft

History of 70s

- 1st virtualization 1972
  - VM/370
  - same year: DOS/VS , MVS/370 – OSVS1
  - OSVS2 (SVS)
- 1st "off the shelf" applications
  - Enterprise Resource Planning (ERP) – available 1972
  - Business intelligence – SAS – 1976
- Business process automation
  - For retail, stock, processing and delivery

The 1970ties…the architecture matures and expands

- **Fully integrated (MONOLITHIC) memory circuits – with S/370 Model 145**
  - **1,400+ circuit elements per monolithic chip => 174 complete memory circuits**
  - **Virtual Storage (memory) announced in 1972 - with S/370 Model 148**
  - ***2KB / 4KB pages of memory - 64KB / 1MB segment sizes***
  - ***HW Dynamic Address Translation (DAT) of Virtual to Real addresses***
  - ***HW ISOLATION of Program Addressing Areas = Address Spaces***
  - ***VM/370 announced to assist migration from OS/360 to OS/VS (VS1, SVS, MVS)***
- **Workload Management - System Resource Manager (SRM)**
  - ***BUSINESS NEED - DRIVEN by MIXED Workload – Tx/DB-Online, Time Sharing, Batch….***
  - ***Priority (CPU+IO), Working SETs, Paging Rate, Response time (TSO, IMS, CICS,..)***
- **Channel Subsystem - 256 Channels**
- **Extended MP support (158MP/168MP)**
- **Operating systems – MVS, VS1, VM/370**
  - **OS/360 → PCP → MFT → MVT → SVS → MVS (VSAM, VTAM)**
  - **DOS/360 → DOS/VS → VS1**
  - **CP/67 → VM/370**
- **JES2 (HASP) & JES3 (ASP) – a religious battle**
- **SMP/E - Install & Maintenance MVS, FMIDs, SYSMODS, USERMODS, HOLD, pre-req, co-req,…**

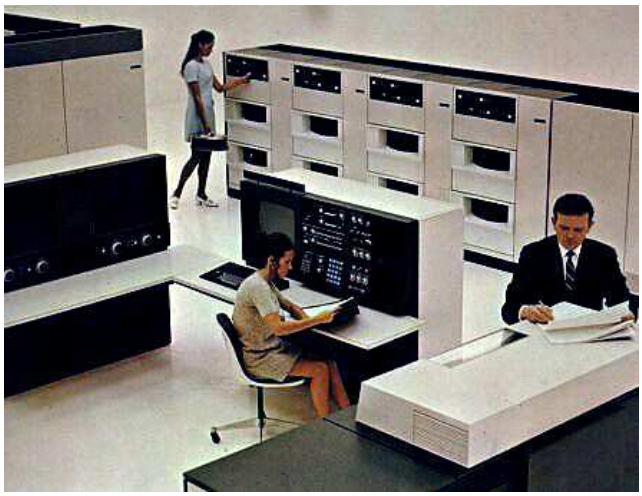
History of 70s

- **1970**
- IBM announces a family of machines with an enhanced instruction set, called System/370. The 370s proved so popular that there was a two-year waiting list of customers who had ordered a systems.
- **1971**
- First shipments of IBM S/370 Models 155 and 165 as well as the S/360 Model 195.
- **1973**
- Introduction of virtual memory on IBM S/370 Models 158 and 168.

IBM

IBM 370-125

IBM 370-165



IBM 4331

IBM 4341

IBM 4381

Parallel Channel

History of 80s

- First commercial release of relational database
  - DB2® since 1982
  - SQL language invented by IBM in 1978
- Further enhancing mainframe technology
  - 31-bit processing, support for large memory (many 2-Gigabyte data objects can be processed in single mainframe)
- MVS/SP
- MVS/XA
- MVS/ESA (1988)

A word from a competitor

"I make fun of a lot of other databases, all other databases in fact, except the mainframe version of DB2. It's a first rate piece of technology."

Larry Ellison

IBM

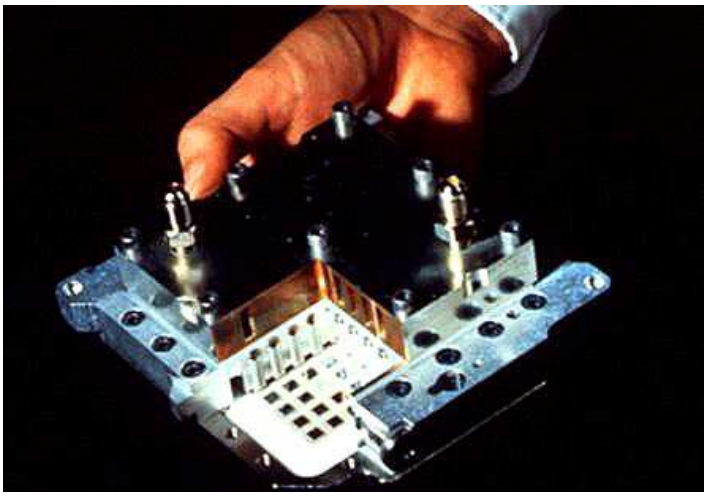
IBM 3084

IBM 3090

- The most powerful IBM computer system of its time (1985), the **3090** high-end processor of the IBM 308X computer series incorporated one-million-bit memory chips, **Thermal Conduction Modules** to provide the shortest average chip-to-chip communication time of any large general purpose computer.
- The Model 200 (entry-level with two central processors) and Model 400 (with four central processors) IBM 3090 had 64 and 128 megabytes of central storage, respectively.
- At the time of announcement, the purchase price of a Model 200 was $5 million. A later six-processor IBM 3090 Model 600E, using vector processors, could perform computations up to 14 times faster than the earlier four-processor IBM 3084.

IBM 3090

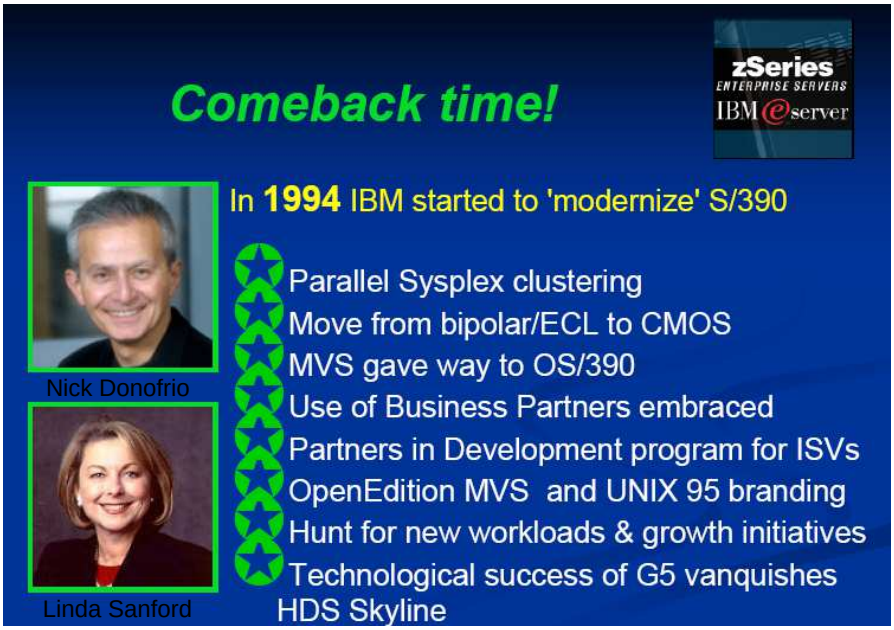
IBM 3090 TCM



IBM ES9000

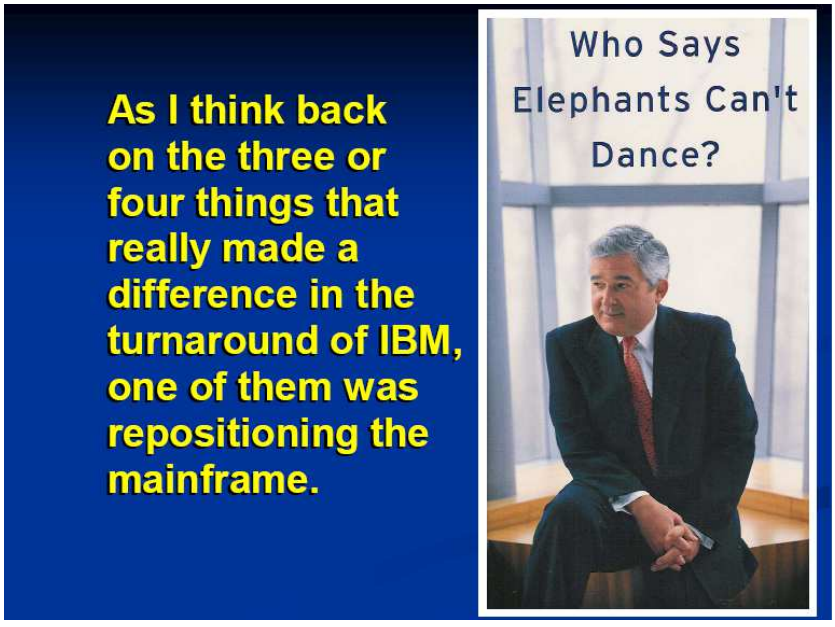
IBM ES9000

- 1990 the ES/9000 models came out with fiber-optical I/O channels (ESCON), and IBM began using the name System/390.
- The ES/9000s exploited new technologies, such as high-speed fiber optic channels with IBM's new ESCON architecture, ultra-dense circuits and circuit packaging that provided higher performance, extended supercomputing capabilities and twice the processor memory previously available.
- The line spanned a 100-fold performance range increase from the smallest (model 120) to the most powerful (model 900 six-way multiprocessor).
- Basic purchase prices for the air-cooled processors of ES/9000 ranged from approximately $70,500 to $3.12 million. Basic purchase prices for the water-cooled models ranged from $2.45 million to $22.8 million.



History of 90s

- First “share everything“ cluster
  - Parallel Sysplex® (1994)
- New microprocessor-based technology
  - CMOS (1995)
- OS/390 (1995)
- New operating system arrives
  - Linux® for S/390®



"I predict that the last mainframe will be unplugged on March 15, 1996."

— Stewart Alsop, Infoworld, March 1991

Eating My Own Words – February 14, 2002
A letter to Lou Gerstner from Stewart Alsop

Dear Lou:

Let me loudly congratulate you upon your retirement from IBM. I clearly remember the reaction most people had when you arrived as CEO in 1993 (after a number of people had reportedly turned the job down, by the way): How the heck can some guy who knows squat about computers save what was once the world's greatest technology company?

And then you promptly came out with a truly memorable quote: "The last thing IBM needs right now is a vision." Did we have a field day with that! Gerstner is no leader! He'll just sell off pieces of the company and dismantle this icon.

Given all our chatter, it would have been easy for you to embrace some emerging technology as the Next Big Thing to save IBM. You would have been hailed as a visionary. Instead you declared that "the last thing IBM needs right now is a vision." Can you imagine Carly Fiorina saying, "The last thing HP needs right now is a vision"? Or Ken Lay saying last October, "The last thing Enron needs right now is a vision"? If only!

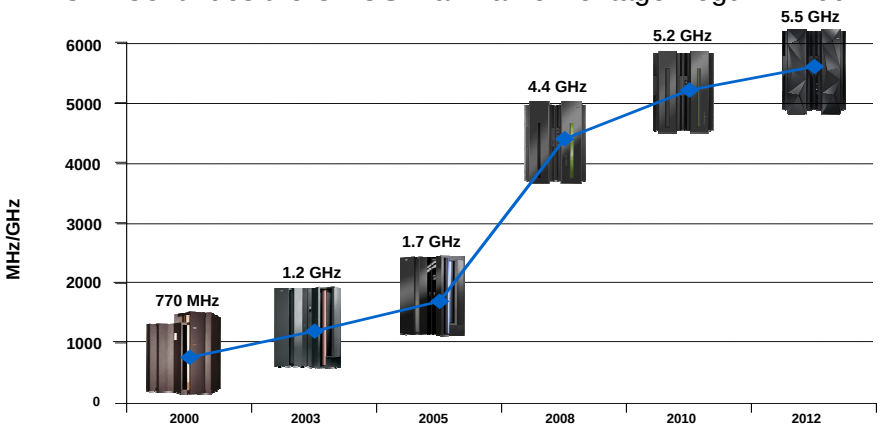
But IBM didn't need a vision; it needed to execute smartly for its legions of customers. It needed to give them the services and technology they asked for. You got the company to buckle down and deliver on the great strength that had been buried under layers of bureaucracy: integrating computer systems and applying technology to solve customer problems. That's boring stuff, but it made IBM a successful company with satisfied customers. And in the wake of the recent bursting of the Internet and telecom bubbles, satisfied customers seem awfully sexy.

Of course, the most impressive thing about your tenure at IBM has been your ability to ignore the nattering nabobs. Just 18 months before you signed on, **I wrote a column predicting the death of the mainframe. (I even predicted that the last one would be unplugged and retired by 1996!)** So it was a thrill for me, just one week ago, to pose for your upcoming annual report. Your photographer put me in front of a plate covered by letters spelling out the words DEATH TO THE MAINFRAME. **Well, let me metaphorically eat my words now. While those 1991-era mainframes are virtually extinct, it is clear that corporate customers still like to have centrally controlled, very predictable, reliable computing systems--exactly the kind of systems that IBM specializes in. It is also perfectly clear that you were right, and I was wrong.** Have fun in retirement!

History – 2000 on

- Increased LPARs, 15 to 60
  - Enhanced server consolidation
- Increased I/O Connectivity
  - Multiple Logical Channel Subsystems
  - Up to 1024 channels
  - InfiniBand
- Introduced the fastest Quad Core Chip
  - 4.4 GHz

zEC12 Continues the CMOS Mainframe Heritage Begun in 1994



2000 z900	2003 z990	2005 z9 EC	2008 z10 EC	2010 z196	2012 zEC12
189 nm SOI 16 Cores Full 64-bit z/Architecture	130 nm SOI 32 Cores Superscalar Modular SMP	90 nm SOI 54 Cores System level scaling	65 nm SOI 64 Cores High-freq core 3-level cache	45 nm SOI 80 Cores OOO core eDRAM cache RAIM memory zBX integration	32 nm SOI 101 Cores OOO and eDRAM cache improvements PCIe Flash Arch extensions for scaling

56

IBM zEnterprise EC12 and zBC12 – September 2013

IBM zEnterprise EC12 (2827)

- Announced 08/12 – Server w/ up to 101 PU cores
- 5 models – Up to 101-way
- Granular Offerings for up to 20 CPs
- PU (Engine) Characterization
  - CP, SAP, IFL, ICF, zAAP, zIIP, IFP
- On Demand Capabilities
  - CoD, CIU, CBU, On/Off CoD, CPE, FoD
- Memory – up to 3 TB for Server and up to 1 TB per LPAR
  - 32 GB Fixed HSA
- Channels
  - PCIe bus
  - Four LCSSs
  - 3 Subchannel Sets
  - FICON Express8 and 8S
  - zHPF
  - OSA 10 GbE, GbE, 1000BASE-T
  - InfiniBand Coupling Links
  - Flash Express
  - zEDC Express
  - 10GbE RoCE Express
- Configurable Crypto Express4S
- Parallel Sysplex clustering
- HiperSockets – up to 32
- Up to 60 logical partitions
- Enhanced Availability
- IBM zAware
- Unified Resource Manager
- Operating Systems
  - z/OS, z/VM, z/VSE, z/TPF, Linux on System z

IBM zEnterprise BladeCenter Extension (2458)

- First Announced 7/10
- Model 003 for zEC12 – 08/12
- zBX Racks with:
  - BladeCenter Chassis
  - N + 1 components
  - Blades
  - Top of Rack Switches
  - 8 Gb FC Switches
  - Power Units
  - Advance Management Modules
- Up to 112 Blades
  - POWER7 Blades
  - IBM System x Blades
  - IBM WebSphere DataPower Integration Appliance XI50 for zEnterprise (M/T 2462-4BX)
- Operating Systems
  - AIX 5.3 and higher
  - Linux for Select IBM x Blades
  - Microsoft Windows for x Blades
- Hypervisors
  - PowerVM Enterprise Edition
  - Integrated Hypervisor for System x

IBM zBC12 (2828)

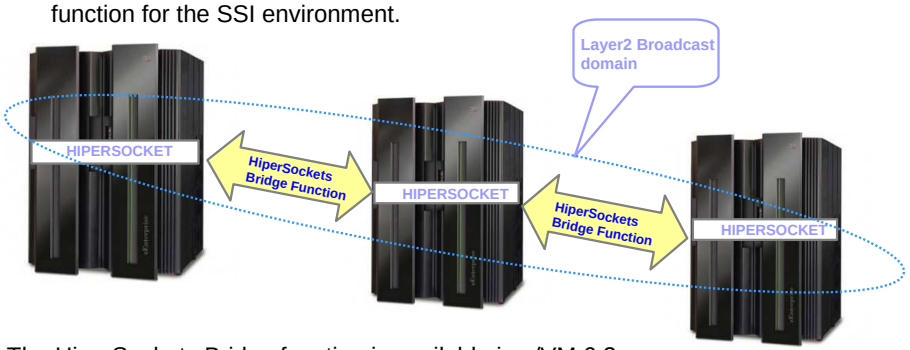
- Announced 07/13
- 2 models – H06 and H13
  - Up to 6 CPs
- High levels of Granularity available
  - 156 Capacity Indicators
- PU (Engine) Characterization
  - CP, SAP, IFL, ICF, zAAP, zIIP, IFP
- On Demand Capabilities
  - CoD, CIU, CBU, On/Off CoD. CPE
- Memory – up to 512 GB for Server
  - 16 GB Fixed HSA
- Channels
  - PCIe bus
  - Two LCSSs
  - 2 Subchannel Sets
  - FICON Express8 and 8S
  - zHPF
  - OSA 10 GbE, GbE, 1000BASE-T
  - InfiniBand Coupling Links
  - Flash Express
  - zEDC
  - 10GbE RoCE Express
- Configurable Crypto Express 4S
- Parallel Sysplex clustering
- HiperSockets – up to 32
- Up to 30 logical partitions
- IBM zAware
- Unified Resource Manager
- Operating Systems
  - z/OS, z/VM, z/VSE, z/TPF, Linux on System z

Realität 2014:

HIPERSOCKET Bridge – Network HA Overview

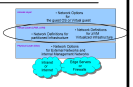
A HiperSockets channel is an intra-CEC communications path.

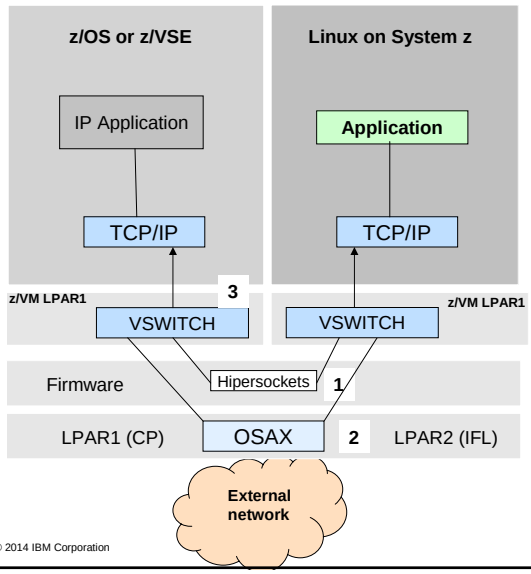
The HiperSockets Bridge provides inter-CEC Hipersockets LAN connection to combine many HiperSockets LANs into a Layer 2 broadcast domain. An ideal function for the SSI environment.



The HiperSockets Bridge function is available in z/VM 6.2 with a z114, z196 or zBC12, zEC12 processor. Must be sure to have z/VM and processor maintenance levels..

System z Network alternatives between z/VM LPARs





Optimize server to server networking – transparently – zEC12+zBC12

"HiperSockets™-like" capability across physical systems

Up to 50% CPU savings for FTP file transfers across z/OS systems versus standard TCP/IP **

Up to 48% reduction in response time and 10% CPU savings for a sample CICS workload exploiting IPIC using SMC-R versus TCP/IP ***

Up to 40% reduction in overall transaction response time for WAS workload accessing z/OS DB2 ****

Up to 3X increase in WebSphere MQ messages delivered across z/OS systems *****

Shared Memory Communications (SMC-R):

Exploit RDMA (Remote Direct Memory Access) over Converged Ethernet (RoCE) with qualities of service support for dynamic failover to redundant hardware

Typical Client Use Cases:

Help to reduce both latency and CPU resource consumption over traditional TCP/IP for communications across z/OS systems

Any z/OS TCP sockets based workload can **seamlessly** use SMC-R without requiring any application changes

NEW **z/OS V2.1 SMC-R** NEW **z/VM V6.3 support for guests** NEW **10GbE RoCE Express**

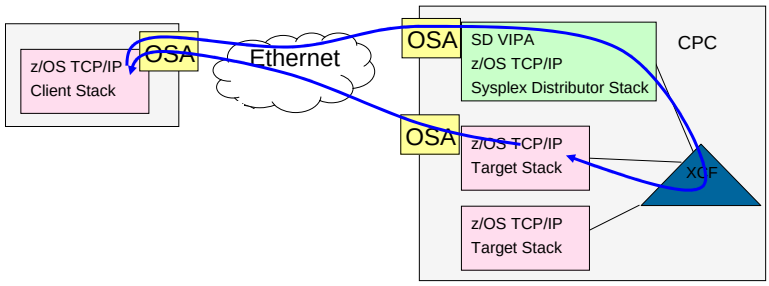
** Based on internal IBM benchmarks in a controlled environment using z/OS V2R1 Communications Server FTP client and FTP server, transferring a 1.2GB binary file using SMC-R (10GbE RoCE Express feature) vs standard TCP/IP (10GbE OSA Express4 feature). The actual CPU savings any user will experience may vary.

*** Based on internal IBM benchmarks using a modeled CICS workload driving a CICS transaction that performs 5 DPL (Distributed Program Link) calls to a CICS region on a remote z/OS system via CICS IP interconnectivity (IPIC), using 32K input/output containers. Response times and CPU savings measured on z/OS system initiating the DPL calls. The actual response times and CPU savings any user will experience will vary.

**** Based on projections and measurements completed in a controlled environment. Results may vary by customer based on individual workload, configuration and software levels.

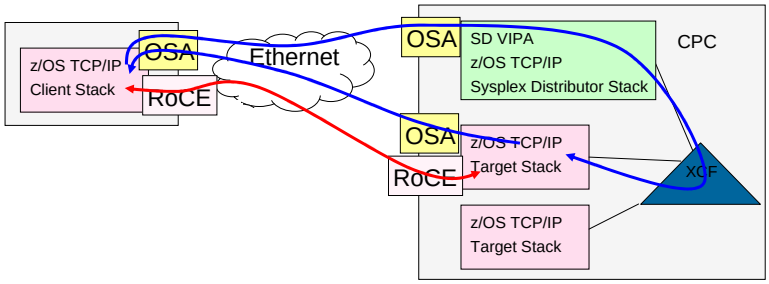
***** Based on internal IBM benchmarks using a modeled WebSphere MQ for z/OS workload driving non-persistent messages across z/OS systems in a request/response pattern. The benchmarks included various data sizes and number of channel pairs The actual throughput and CPU savings any user will experience may vary based on the user workload and configuration.

Sysplex Distributor before RoCE



- Traditional Sysplex Distributor
  - All traffic from the client to the target application goes through the Sysplex Distributor TCP/IP stack
  - All traffic from the target application goes directly back to the client using the TCP/IP routing table on the target TCP/IP stack.

Sysplex Distributor after RoCE



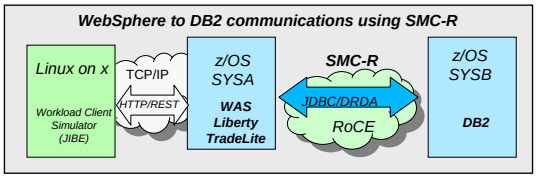
- RoCE Sysplex Distributor
  - The initial connection request goes through the Sysplex Distributor stack.
  - The session then flows directly between the client and the target over the RoCE features.

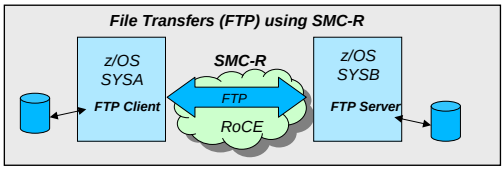
Note: As with all RoCE communication the session end also flows over the OSAs.

IBM

Impact of SMC-R on real z/OS workloads – early benchmark results

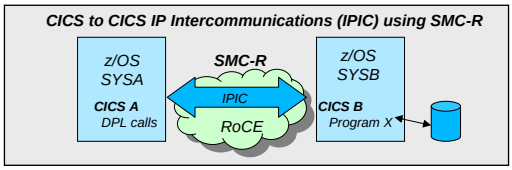
40% reduction in overall transaction response time
for WebSphere 8.0 Liberty profile TradeLite workload accessing z/OS DB2 in another system measured in internal benchmarks *





Up to ***50% CPU savings*** for FTP binary file transfers across z/OS systems when using SMC-R vs standard TCP/IP **

Up to 48% reduction in response time and up to 10% CPU savings for CICS transactions using DPL (Distributed Program Link) to invoke programs in remote CICS regions in another z/OS system via CICS IP interconnectivity (IPIC) when using SMC-R vs standard TCP/IP ***



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System/360 – Announced April 7, 1964

IBM

Größer, schneller, besser am 7. April 2014 --- Pläne für den 7. April 2064…?

Thank You

Roland Trauner, IBM Germany
Mister Mainframe ;)
trauner@de.ibm.com
Xing, Linkedin, Facebook, Twitter, IBM Greenhouse, Threema