Introduction to the new mainframe

Chapter 2 Hardware systems and LPARs
Objectives

In this chapter you will learn:

- About S/360 and zSeries hardware design
- About processing units and disk hardware
- How mainframes differ from PC systems in data encoding
- About some typical hardware configurations
Introduction

Here we look at the hardware in a complete system although the emphasis is on the processor “box”

Terminology is not straightforward

- Ever since “boxes” became multi-engined, the terms system, processor, and CPU have become muddled
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Terminology:

- System box from IBM possibly a zSeries machine
- Individual processors in the system
- "processors"
- "CPUs"
- "engines"
- "PUs"
- "CPs"
- IFLs, ICFs, zAAPs, IFLs spares
- "system" = CPs running an operating system

A few people use "CEC"

Many use "system"
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Conceptual S/360

Parallel Channels

Processes

Storage Control

Main Storage

Control Unit

Control Unit

3 Control Unit

1

5

6

A

B

0

1

3 Control Unit

0

1

3 Control Unit

0

1

Communication line

Another System

Devices

X

Y

Z

5

3

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Early system design

- System/360 was designed in the early 1960s
- The central processor box contains the processors, memory, control circuits and channel interfaces
  - Early systems had up to 16 channels whereas modern systems have over 1000
- Channels connect to control units
- Control units connect to devices such as disk drives, tape drives and communication interfaces
Device address

address: 1 3 2

channel number  control unit number  device number

In the early design the device address was physically related to the hardware architecture.
Parallel channels had large diameter heavy copper “bus and tag” cables.
Current design

Current CEC designs are considerably more complex than the early S/360 design
This new complexity includes

- I/O connectivity
- I/O operation
- Partitioning of the system
I/O Connectivity

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CEC box

Partition 1

Partition 2

Channels (CHPIDs or PCHIDs)

01 02 ... 40 41 42 ...

00 11

01 Control Unit

02 Control Unit

C0 Control Unit

C1 Control Unit

01 Control Unit

02 Control Unit

ESCON Director (switch)

FICON switch

0 1

0 1

0 1

0 1

Control unit addresses (CUA)

Unit addresses (UA)

E - ESCON channel
F - FICON channel
O - OSA-Express channel

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I/O Connectivity

- ESCON and FICON channels
- Switches to connect peripheral devices to more than one CEC
- CHPID addresses are two hex digits
- Multiple partitions can share CHPIDs
- I/O subsystem layer exists between the operating system and the CHPIDs
I/O Connectivity

- I/O control layer uses a control file IOCDS that translates physical I/O addresses into devices numbers that are used by z/OS
- Device numbers are assigned by the system programmer when creating the IODF and IOCDS and are arbitrary (but not random!)
- On modern machines they are three or four hex digits
I/O Connectivity

- External device label
- Four hex digits in range 0000-FFFF
- Arbitrarily assigned by sysprog
- Used in JCL, commands, messages, EREP

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System Control and Partitioning

- Specialized microprocessors for internal control functions

Diagram:
- HMC
- SE
- CP
- CHPID
- Memory
- Processors
- Channels

- LPAR1
- LPAR2
- LPAR3

Located in operator area
Located inside CEC but can be used by operators
System Control and Partitioning

- Among the system control function is the ability to partition the system into logical partitions (LPARs)
- Initial limit was 15 LPARs but newer machines allow 30 partitions
- Practical considerations can limit the number to less than this as each LPAR needs memory, I/O, and processing power
LPARs

System administrators assign:

- Memory
- Processors
- CHPIDs either dedicated or shared

This is done partly in the IOCDS and partly in a system profile on the Support Element (SE) in the CEC. This is normally updated through the HMC.

Changing the system profile and IOCDS will usually require a power-on reset (POR) but some changes are dynamic.
Characteristics of LPARs

- LPARs are the equivalent of a separate mainframe for most practical purposes
- Each LPAR runs its own operating system
- Devices can be shared across several LPARs
- Processors can be dedicated or shared
- When shared each LPAR is assigned a number of logical processors (up to the maximum number of physical processors) and a weighting
- Each LPAR is independent
Consolidation of mainframes

- Many installations used to have several boxes
- A single larger machines running many LPARs is often more cost effective, as software licenses for multiple small machines can total more than those for a single large one
Modern processor offer many specialist processor types. Most of the additional types are not counted as full processors for software charging

- Central Processor (CP) - A full z/OS processor
- System Assistance Processor (SAP) - Used for the I/O subsystem – each machine has at least one
- Integrated Facility for Linux (IFL) - Special processor for Linux - optional
- zAAP – Used for JAVA code – optional
- zIIP – Used for Dataprocessing code – optional
- Integrated Coupling Facility (ICF) - For coupling facilities
- Spares

SAPs, IFLs, ICFs, zAAPs and zIIPS are not counted in the model number and or against software costs
Capacity on Demand

Various forms of Capacity on Demand exist

Additional processing power to meet unexpected growth or sudden demand peaks
Disk Devices

Current mainframes use 3390 disk devices
The original configuration was simple with a controller connected to the processor and strings of devices attached to the back end
**Current 3390 Implementation**

- **Host Adapters (2 channel interfaces per adapter)**

- **Cluster Processor Complex**
  - cache
  - NVS

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- **Common Interconnect (across clusters)**

- **Device Adapters**

  - RAID array
  - RAID array
Modern 3390 devices

- The 2105 Enterprise Storage Server just shown is very sophisticated.
- It emulates a large number of control units and 3390 disks. It can also be partitioned and connect to UNIX and other systems as SCSI devices.
- There are 11 TB of disk space up to 32 channel interfaces, 16GB cache and 284MB of non-volatile memory.
Modern 3390 Devices

- The physical disks are commodity SCSI-type units
- Many configurations are possible but usually it is RAID-5 arrays with hot spares
- Almost every part has a fallback or spare and the control units are emulated by 4 RISC processors in two complexes.
Modern 3390 Devices

- The 2105 offers FlashCopy, Extended Remote Copy, Concurrent Copy, Parallel Access Volumes, Multiple Allegiance
- This is a huge extension of the original 3390 architecture and offers a massive performance boost.
- To the z/OS operating system these disks just appear as traditional 3390 devices so maintaining backward compatibility
EBCDIC

- The IBM S/360 through to the latest zSeries machines use the Extended Binary Coded Decimal Interchange character set for most purposes
- This was developed before ASCII and is also an 8 bit character set
- z/OS Web Server stores ASCII data as most browsers run on PCs which expect ASCII data
- UNICODE is used for JAVA on the latest machines
Clustering

Clustering has been done for many years in several forms

- Basic shared DASD
- CTC/GRS rings
- Basic and Parallel sysplex

Image is used to describe a single z/OS system, which might be standalone or an LPAR on a large box
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Basic shared DASD

Limited capability
Reserve and release against a whole disk
Limits access to that disk for the duration of the update
CTC Ring

Global Resource Sharing (GRS) used to pass information between systems via the CTC ring
Request ENQueue on a data set, update, the DEQueue
Loosely coupled system
Parallel Sysplex

This extension of the CTC ring uses a dedicated Coupling Facility to store ENQ data for GRS. This is much faster. The CF can also be used to share application data such as DB2 tables. Can appear as a single system.
Typical Systems

This shows two very small systems

- On the left is a Multiprise 3000, which was designed for small installations with internal disk drives
- On the right is a FLEX-ES emulation system, which runs on a PC running Linux or UNIX
Medium Mainframe Configuration

This is a completely modern implementation with no older devices. A z890 is featured with two external disk controllers, tape drives, printers, LAN attachments and consoles.
Medium Single System

This system could be running several LPARs

- A production z/OS with interactive applications
- A second production LPAR devoted to batch
- A test z/OS LPAR for testing new software
- One or more LPARs running Linux, perhaps running web applications
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Moderately Large Configuration

Two machines – a new z990 and an older 9672, Parallel Sysplex with coupling facility

Multiple ESS and older DASD connected via a switch 3745 communications controllers for an SNA network 3490E tape drives retained for compatibility OSA Express connections to various LANs Consoles
Larger system

- This is the sort of mixture of device generations that might be found in any enterprise
- New devices are brought in but older ones are still viable until they reach the end of their life
- z/OS will usually run on older devices until an architectural change forces their withdrawal
- This sort of change is usually well publicized and several years notice is given of any incompatibility which will usually coincide with the machine being at end of life
Summary

- Terminology is important
- The classic S/360 design is important as all later designs have enhanced it. The concepts are still relevant
- New processor types are now available to reduce software costs
- EBCDIC character set
- Clustering techniques and parallel sysplex
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Bulk FSP

DCA = power + control interface

Connections for up to 28 channel adapter cards

System frame "Box"

HMC

Processor Book 0

Processor Book 1

I/O Cage 2

I/O Cage 3

Support Element

Support Element

Ethernet

FSP

Bulk Power Unit

FSP

Bulk Power Unit

FSP

DCA

FSP

DCA

FSP

DCA

MCM

Memory

MCM

Memory

Connections for up to 28 channel adapter cards

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