*z*Frame: Exploiting FLEX-*ES* for small mainframe users.

*z*Frame: a Technical Overview and Update

For the

MVMUA

Metropolitan VM Users Association

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zFrame™

Cornerstone's zFrame Objectives:

- **Integrate proven software and hardware technologies using IBM based systems to support S/390 customers running OS/390, zOS, zVM, and VSE in the below 150 MIPS range.**
- **Provide a packaged solution capable of supporting mission critical production loads.**
- **Offer everything, including maintenance and services, at affordable price points.**

What is "Cornerstone"

✓ CSI was established in 1991 as IBM's first business partner with a focus on system services.
✓ Became an IBM Business Partner Reseller in 1992
✓ CSI is currently one of IBM's largest Premier Business Partners
✓ HQ in Irvine, CA
✓ Offices located in Atlanta, Dallas, Valencia, Toronto, and London with coverage in Europe, Asia, and South America
✓ Focus on IBM zSeries Systems and Support including:
   ✓ zOS, zVM, VSE, Websphere, DB2, Linux and UNIX porting, Lotus, and other zSeries products
✓ CSI is the largest reseller of FLEX-ES(tm) based systems - zFrame(tm) and the most experienced.

How zFrames are being used

- **Mission Critical Production**
  - ► **Insurance, Banking, Government, Military, Retail, Distribution**
- **Disaster Recovery or Backup Systems**
- **Out-sourcing**
- **In-sourcing**
- **Development and Test**

Hardware and Software Emulation - . . .some good, some bad, but all are part of our history . . .

- 1401 Emulation on S/360
- 7090 and 7094 on S/360
- FBA
- VTape
- FakeTape
- P/370 and P/390
- CP/67
- VM
- VMTool
- Microcode
- LPAR
- First S/360 instructions were executed under emulation on a 7030 in 1963 . . .

FLEX-ES Architectural Compliance

- **Meets all IBM definitions for the zSeries architecture (through ALS3)**
  - ‣ Subjected to (and passed) the same verification tests as new IBM hardware
- **Fully compatible with all current IBM operating systems and products**
- **Recommended by IBM for developers of new vendor software products**

This is a true, full function zSeries system, not just a highly capable API.

IBM CMOS - FLEX-ES similarities

- **IBM Systems**
- *FLEX-ES*

IBM Systems	FLEX-ES
CP and SAP (System Assist Processor)	Emulated (CP) Processor and Host (SAP) Processor
CP Instruction Cache	Translated Instruction Cache
IOCP Configuration	*FLEX-ES Configuration File*
LPARs	Multiple Instances

Processor Performance

- **Current Processor Peformance**
  - ▶ **Intel Pentium technology allows (approx):**
    - Single processor systems up to 36 MIPS
    - Dual processor systems up to 65 MIPS
    - Three processor systems up to 110 MIPS
  - ▶ **AMD Opteron (just coming on-line)**
    - Single processor up to 60 MIPS
    - Dual/Triple processor of 110 and 140 MIPS
- **S/370, ESA, or 64 bit zSeries mode**
  - 64 bit currently restricted to PWD systems
    - – Runs z/OS 1.6 and zVM 5.1
- **6 GB of memory for S/390**
  - Maximum of 1.9 GB per "instance"

Current zFrame Models

- **Standard model base configurations**

	MIPS (approx)	S/390 Memory	Disk (GB)	# of Proc.	xSeries
z8	8 (throttled)	3.4 GB	330 GB	2/1	232 2 x 1.4 GHz
z18	14-18	3.4 GB	330 GB	2/1	232 2 x 1.0 GHz
z30	30	3.4 GB	330 GB	2/1	236 2 x 3.2 GHz
z60	60	3.4 GB	330 GB	2/2	236 2 x 3.2 GHz
z90	110	3.4 GB	330 GB	4/3	260 4 x 3.6 GHz

IBM PWD Program

- **PWD = (IBM's) PartnerWorld for Developers (ISVs)**
- **For Developers of S/390 software to be sold**
- **Special deals on IBM Software**
  - ‣ **"On loan" at no cost**
- **Special deals on *FLEX-ES* based solutions**
- **Special line of zFrame systems for these PWD members**

Current zDev Models

■ **Standard zDev base configurations**

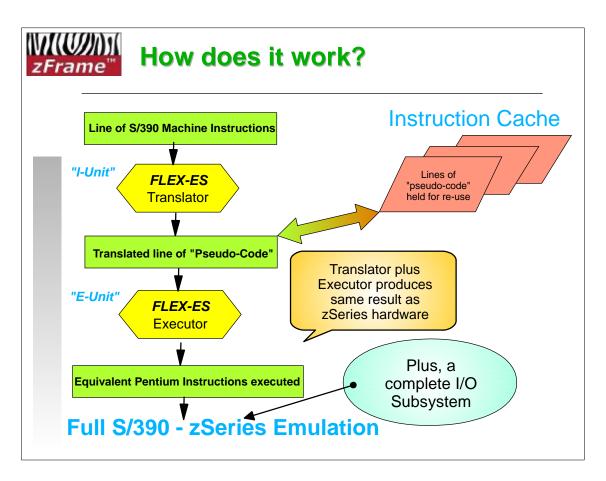|	MIPS (approx)	S/390 Memory	Disk (GB)	# of Proc.	xSeries
zPad	36 (I/O Limited)	1.25 GB	60 GB	1/1	TP T42
zDev1	36	3.4 GB	160 GB	2/1	236 2 x 3.6 GHz
zDev2	65	3.4 GB	330 GB	2/2	236 2 x 3.6 GHz
zDev3	105 - 110	3.4 GB	330 GB	4/3	260 4 x 3.6 GHz
zDevY	110	6.0 GB	420 GB	2 / 2	Opteron 2 x 2.6 GHz

More on Opteron zDevY

- **Not available in IBM xSeries "Industrial Strength" Servers**
  - ‣ **Not suitable for Commercial / Production**
  - ‣ **May be appropriate for development use**
- **Single Core processors up to 2.6 GHz**
  - ‣ **About 60 MIPS per processor**
- **Dual Core processors up to 2.2 GHz**
  - ‣ **Estimating 45 - 50 MIPS per processor**
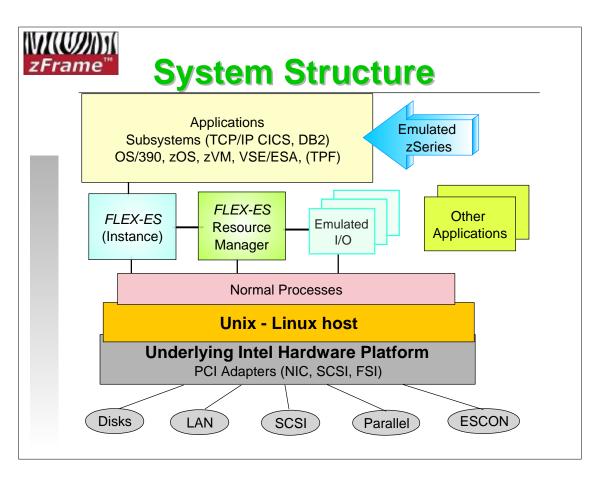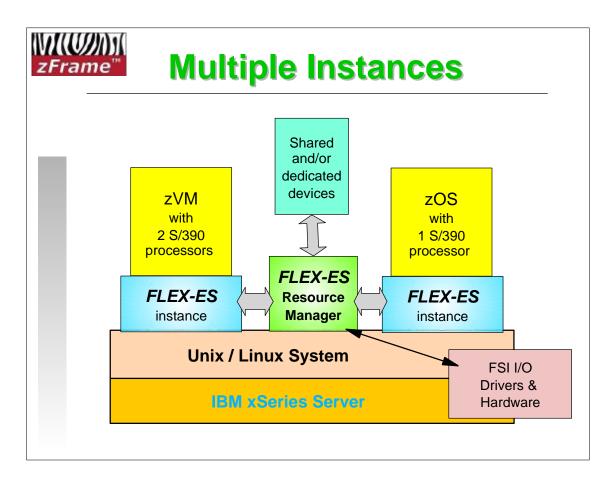- **Exploiting economical SATA RAID or high performance SCSI RAID disks**

IBM Software License Charges

MIPS	License Base	Comments
8	ESL (OTC)	Inexpensive, OTC: (N/A: zOS, zVM 4.x)
16	1/3 GOLC	Attractive pricing. Limited to Pentium III 1.0 GHz
30	2/3 GOLC	Fastest Uni-Processor Less cost than 36 MIPS z800
60	GOLC - H30	Same license as MP3000 H30
110	GOLC - H50	Same license as MP3000 H50

License base is determined by IBM, is used on an "RPQ" basis uniquely for each system, and is subject to change.

How does it work?

Line of S/390 Machine Instructions

"I-Unit"

FLEX-ES Translator

Instruction Cache

Lines of "pseudo-code" held for re-use

Translated line of "Pseudo-Code"

"E-Unit"

FLEX-ES Executor

Translator plus Executor produces same result as zSeries hardware

Equivalent Pentium Instructions executed

Plus, a complete I/O Subsystem

Full S/390 - zSeries Emulation

System Structure

Applications
Subsystems (TCP/IP CICS, DB2)
OS/390, zOS, zVM, VSE/ESA, (TPF)

Emulated zSeries

FLEX-ES (Instance)

FLEX-ES Resource Manager

Emulated I/O

Other Applications

Normal Processes

Unix - Linux host

Underlying Intel Hardware Platform
PCI Adapters (NIC, SCSI, FSI)

Disks   LAN   SCSI   Parallel   ESCON

Multiple Instances

zVM
with
2 S/390
processors

Shared
and/or
dedicated
devices

zOS
with
1 S/390
processor

FLEX-ES
instance

FLEX-ES
Resource
Manager

FLEX-ES
instance

Unix / Linux System

FSI I/O
Drivers &
Hardware

IBM xSeries Server

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zFrame Disk Subsystem

- **Disk Capacity**
  - ‣ **1.4 or 2.8 TB internal disk capacity**
    - Effective S/390 space, in RAID-5 configuration
  - ‣ **Multiple more TB when using external disk enclosures**
  - ‣ **Very economical cost point**
- **Disk Performance**
  - ‣ *Very* **good performance: 1K - 3K IO / sec**
  - ‣ **20 - 30** *micro*__seconds for cache read hit__
  - ‣ **See** http://www.perfassoc.com/jsc/pdf/papers/flex-es_io_performance_02.pdf
- **RAID-5 Disk array (IBM ServeRAID adapters)**
    - Full data redundancy
    - 256MB battery backed up cache
    - Dual SCSI320 channels for performance
    - Benchmarks show RAID-5 gives best performance

Other I/O Device Support

- **LAN Attachment**
  - ► **Multi-ported Ethernet adapters: 10/100/1000**
- **Tape Drives**
  - ► **3480, 3490(E), SDLT, etc.**
  - ► **SCSI, Parallel channel, ESCON channel**
- **Channels (Parallel & ESCON)**
  - ► **Any channel attached devices**
    - ● printers, terminal ctlrs, 37x5, tapes, etc.
- **ICA (Integrated Communications Adptr)**
  - ► **6 BSC/SDLC lines as ICA (RS232)**
- **Network attached printers**

Extended Capabilities

- **Shared DASD**
  - ► **Between instances on one system**
  - ► **Between two different zFrame systems**
    - ● across TCP/IP connection
- **CTC Connections**
  - ► **Between instances on one system**
    - ● has been used for "basic sysplex" implementation
  - ► **Between instances on two different systems**
- **FakeTape**
  - ► **Emulate tape on disk files**
  - ► **Via NFS to another system**
- **Network Channels**
    - ● Access devices (i.e. tape) on one FLEX system from another FLEX system via IP connection

Recent Enhancements

- **Faketape library (AFLIB)**
  - ‣ **And related new functions**
- **Compressed faketape**
  - ‣ **Opens up new possibilities**
- **Support for SuSE Linux as base**
  - ‣ **Improved flexibility and support**
- **FLEX-CUB & the *zCenter***
  - ‣ **A complete new way to exploit FLEX technology**
- **Partnerships**

  Let's look at these in more detail.....

FakeTape Library: AFLIB

- **zOS: integrated into SMS and RMM**
  - High function, Tape management system
  - VTS (Virtual Tape System) type capability
  - Tested on and packaged for zOS 1.5 and 1.6
- **OS390: Full Integration not available**
  - Basic 'automounter' mode only
  - Tested on and packaged for OS/39 2.10
- **Features**
  - Multiple tape libraries from multiple Instances
  - "Tape library" can be on same system or across channel or NFS connection
  - Library can be on a FLEX-CUB control unit
- **Requirements:**
  - FLEX-ES Ver, 7
  - Extra cost option

fsihost for zVM

- **Allows zVM users to issue commands to the host Linux/Unix system**
  - can send commands to linux to manipulate files
    - ‣ rename (mv) , remove, etc.
    - ‣ fsihost (cmd ls -l
    - ‣ pipe cms fsihost dev 7ff (cmd cat myfile | > my file a V
  - Can send commands via linux to FLEX-ES command line processor
    - – fsihost (cmd **echo mount 580 /faketape/new-file | flexescli localhost zvm**
  - Allows automation and control of faketape mounting (or other activities) from within zVM
  - Use 'enabling EXECs' to simplify further
    - – **flex mount 580 /faketape/other-file**
- **Requirements:**
  - Free download for FLEX-ES and FLEX-CUB users

Compressed FakeTape

- **FakeTape files can be automatically compressed as they are created**
  - ‣ **Multiple controls on which tape files are compressed**
  - ‣ **Compression is done at the Flex host level**
    - Pentium cycles rather than zSeries cycles
  - ‣ **Transparent to zSeries operating system**
  - ‣ **Consider:**
    - writing compressed tape files across an NFS connection to a remote server
    - Combining Compressed FakeTapes with AFLIB
- **Requirements:**
  - FLEX-ES Ver, 7

Moving to SuSE Pro 9.3 as base

- **Just starting a move to use SuSE Pro 9.3 Linux**
  - ► **Better support than previous RedHat**
  - ► **More current version of drivers and kernel**
  - ► **Positions us better for move to 64 bit**
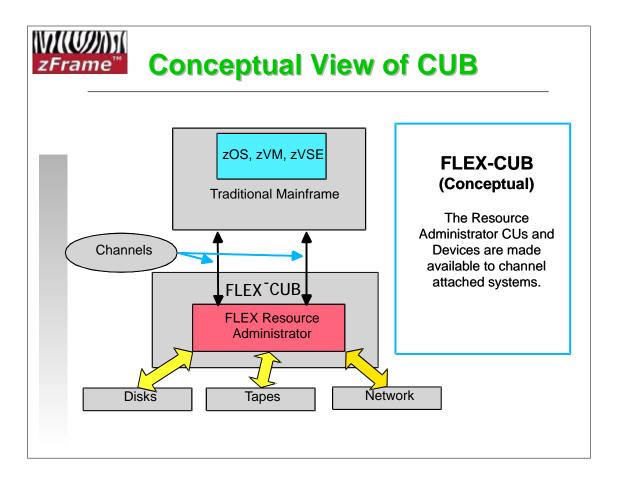 - ► **UnixWare 7.1.4 also available**

Partnerships

- **CA (Computer Associates)**
  - ► **Special pricing for FLEX-ES based systems**
  - ► **Ongoing relationship between CA & CSI**
- **Vanguard**
  - ► **zVguard: turnkey packaging of IBM and Vanguard products on zFrame at special prices**
- **Geac**
  - ► **zFrame based systems for Geac application sets**

CUB: Control Unit Behavior

- **Implemented in the CSI *zCenter***
  - ► **Utilizes FLEX-ES I/O capabilities**
  - ► **Provide Disk/Tape/Network devices to any "mainframe"**
    - Via ESCON/Parallel channels to traditional zSeries
    - via Network Channels to other FLEX/zFrame systems
    - Use AFLIB to implement a Virtual tape system
    - Emulate disks using xSeries hardware
    - Many 'interesting' possibilities

Conceptual View of CUB

zOS, zVM, zVSE

Traditional Mainframe

Channels

FLEX-CUB

FLEX Resource Administrator

Disks   Tapes   Network

FLEX-CUB
(Conceptual)

The Resource Administrator CUs and Devices are made available to channel attached systems.

Storage Server

- Emulate multiple types of disk devices
  - ► All are RAID-5 protected using IBM high performance disks and RAID controllers
- Capacities from 330 GB to over 6 TB
- Transparent, tunable, and very effective disk cache (1 – 3 GB of memory)
- One or multiple channels to connect to one or more clients (DASD can be shared)
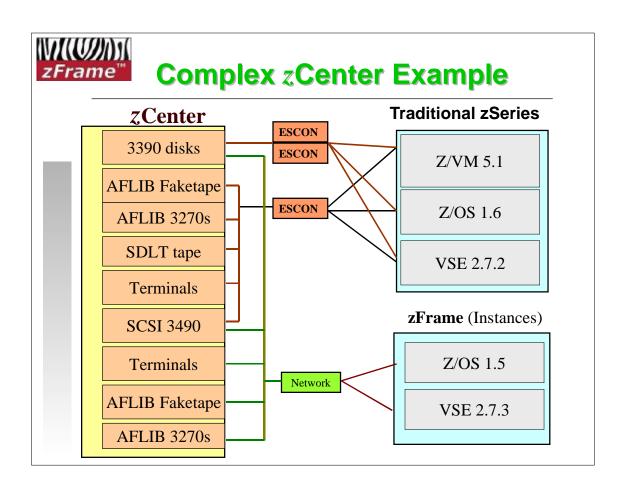- Can be configured as multiple Logical CUs

Tape Server

- **Two Major kinds of tape service**
  - ► **SCSI tape server** allows connection of SCSI tape devices to mainframes as traditional 34x0 devices
    - Either media compatible 3480/90 or new technology such as SDLT (320+ GB in one Cartridge)
  - ► **FakeTape server** allows creation of a Virtual Tape System with up to 6 TB of online storage
    - FSI provided software to support tape library functions in zOS (AFLIB) and zVM. (OEM support for VSE)
    - Backup/offload of tape files via included SDLT tape drive
    - Tape files can be compressed for even greater capacity

Terminal – Network Server

- Connect your IP attached workstations to your zSeries without using TCP/IP stack cycles
- Makes IP connected workstations appear as local, non-SNA 3270 devices on a 3174
- Can be "EMIF'ed", providing operator console support to multiple LPARs (as IBM 2074) replacing multiple 3174s.
- IP attached workstations utilize standard "TN3270" type terminal emulators

Complex zCenter Example

Full *z*Center Configuration

- **Combine FLEX-CUB and standard zFrame in one package**
  - ▸ **Provide I/O services to channel attached traditional mainframe**
  - ▸ **With full, normal zFrame processor capabilities**
  - ▸ **In one compact rack mounted package**
  - ▸ **Share DASD between zFrame and zSeries**

Channels to zSeries

Disk arrays
SCSI Tapes
*z*Center (CUB)
*z*Frame
UPS

FLEX-ES - *z*Frame

- **The *z*Frame uses *FLEX-ES* as part of a total integrated solution for 'small' S/390 users.**
- **Other components include**
  - ▸ **IBM xSeries eServers**
  - ▸ **Unix or Linux in customized configuraiton**
  - ▸ **Other I/O (tapes, adapters, etc.)**
  - ▸ **Build & configuration services**
  - ▸ **On-Site Installation & Training**
  - ▸ **On-Going Support**

Objective: Provide a product, services, and support, equivalent to a new IBM processor.

Limitations

- **There are some limitations**
  - ‣ **FICON channels (none)**
  - ‣ **Parallel Sysplex (no CF or timer)**
  - ‣ **No Hardware encryption support**
  - ‣ **64 bit zSeries support is currently only for PWD developers**
  - ‣ **No QDIO emulation / support**

Futures......

- **Where do we go from here....?**
  - ‣ **Faster Pentium Processors**
  - ‣ **Exploit AMD processor family**
  - ‣ **64 bit (IA64, EM64T, or AMD) processors**
    - ● "64 on 64"
  - ‣ **Changes to IBM Software Licensing**
    - ● Allow 64 bit mode for Commercial users
    - ● Consistant Software licensing methodology
  - ‣ **Continued FLEX-ES enhancements**
    - ● z9 instructions
    - ● ..... ?

Additional References (1)

IBM Redbooks

- **SG24-6215:** "NUMA-Q Enabled for S/390: Technical Introduction"
  - Still the best overall introduction to FLEX-ES
  - Skip over NUMA-Q (xSeries 430) specific sections
- **SG24-6501:** "S/390 PWD Netfinity enabled for S/390"
- **SG24-6507:** "S/390 PWD ThinkPad Enabled for S/390"
- **SG24-6834:** "S/390 Partners in Development: EFS Systems on a Linux Base"
- **SG24-7007:** "EFS Systems on a Linux Base: Getting Started"
- **SG24-7008:** "EFS Systems on a Linux Base: Additional Topics"
  - Excellent for users who want to get a little deeper
  - Not just for Linux based systems

Additional References (2)

Whitepaper

- *"Exploring the I/O Performance Characteristics of Intel Based FLEX-ES Servers for z/OS"* by Dr. H. Pat Artis, Performance Associates, Inc.
  http://www.perfassoc.com/flex-es_io_performance_02.pdf
  - This was on an old server; recent tests on new model shows approx 2x this performance.

Support Listserve (FLEX-ES)

- www.listserv.uga.edu to subscribe

Web pages

- www.csihome.com (and take the zFrame link)
- www.funsoft.com (Fundamental Software Inc)