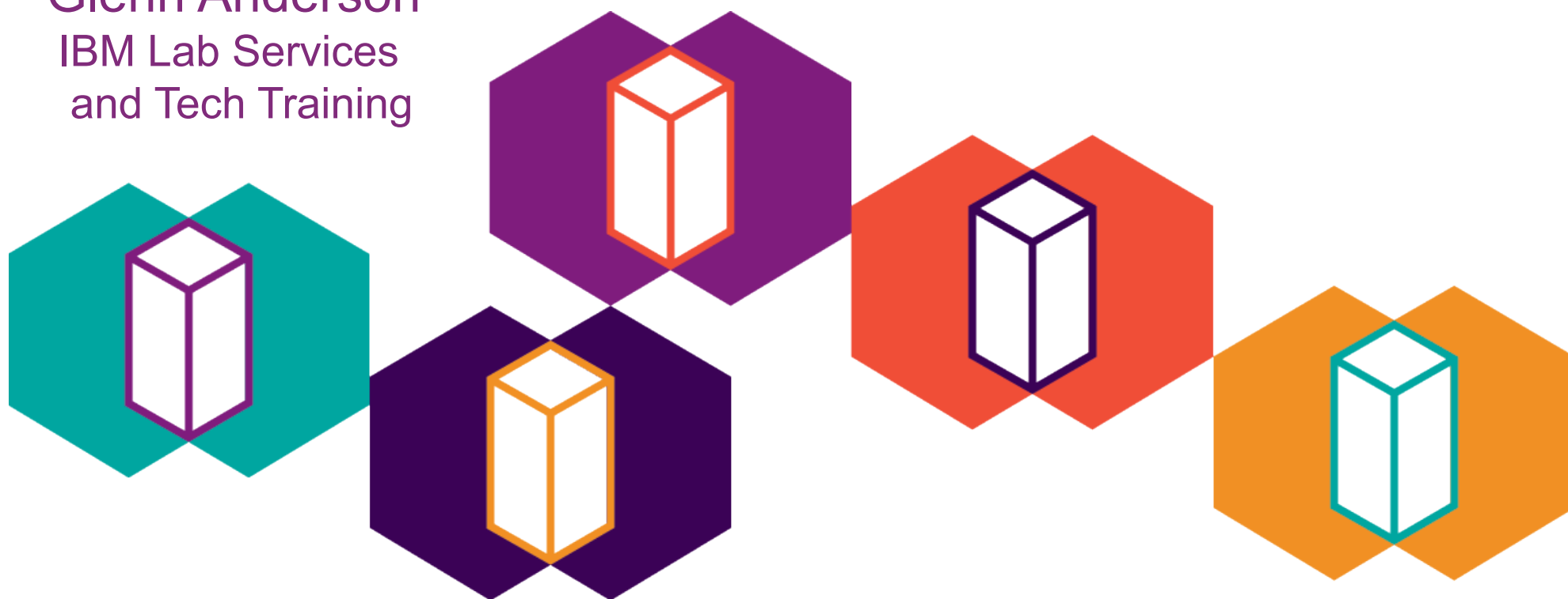


z/OS Performance Hot Topics

Glenn Anderson
IBM Lab Services
and Tech Training



Washington Systems Center Techdocs



www.ibm.com/support/techdocs

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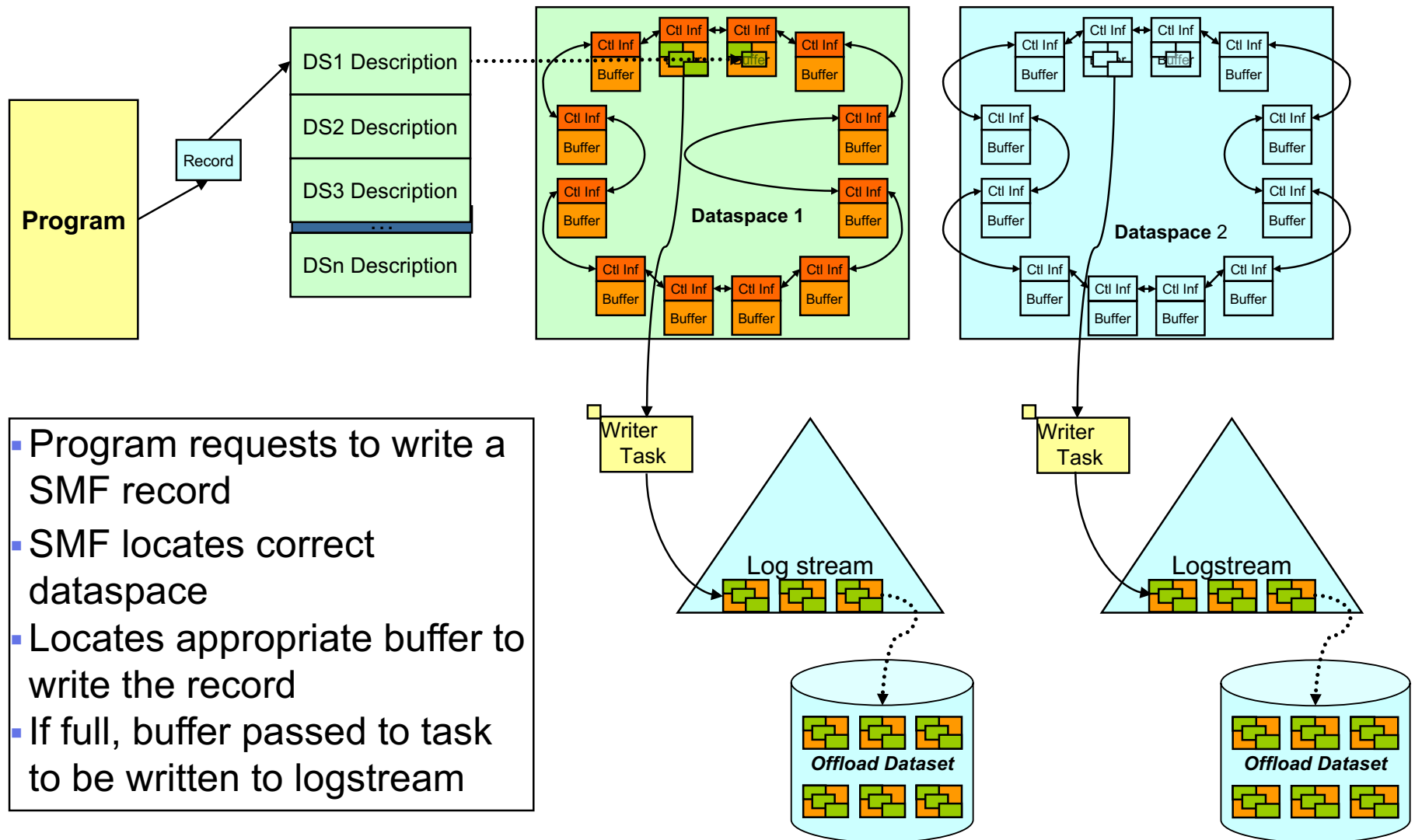
Topics to be covered



- New SMF functions – zEDC compression, digital signatures, real-time streaming
- z/OS Ver 2.3 preview of performance functions
- Defining logical CPs
- CPU MF and RNI
- RMF zEvent Mobile Application



SMF Data Flow Using Log Streams



- Program requests to write a SMF record
- SMF locates correct dataspace
- Locates appropriate buffer to write the record
- If full, buffer passed to task to be written to logstream

IBM z Enterprise Data Compression



What is it?

- ✓ *zEDC Express is an IO adapter that does high performance industry standard compression*
- ✓ *Used by z/OS Operating System components, IBM Middleware and ISV products*
- ✓ *Applications can use zEDC via industry standard APIs (zlib and Java)*
- ✓ *Each zEDC Express sharable across 15 LPARs, up to 8 devices per CEC.*
- ✓ *Raw throughput up to 1 GB/s per zEDC Express Hardware Adapter*

What Changes?

- **Disk Savings:** Many people are already getting value from CMPSC compression and software compression today
- **Performance:** High throughput alternative to existing System z compression for large or active files.
- **Industry Standard:** Low cost compressed data exchange across all platforms
- **Pervasive:** Standard APIs allow quick adoption by middleware products running on System z

What is the Value?

- **QSAM/BSAM compression** can save disk cost
- **Business Partner Data Exchange** can have higher throughput with lower CPU cost
- **Sterling Connect:Direct** saves additional link bandwidth, elapsed time.
- **ISV Products** delivery expanded customer value
- **Java** transparently accelerates java.util.zip
- **IBM Encryption Facility** for standard compliant data exchange
- **Improved availability** with SMF compression

Compression Coprocessor (CMPSC) vs. zEDC



Compression Coprocessor

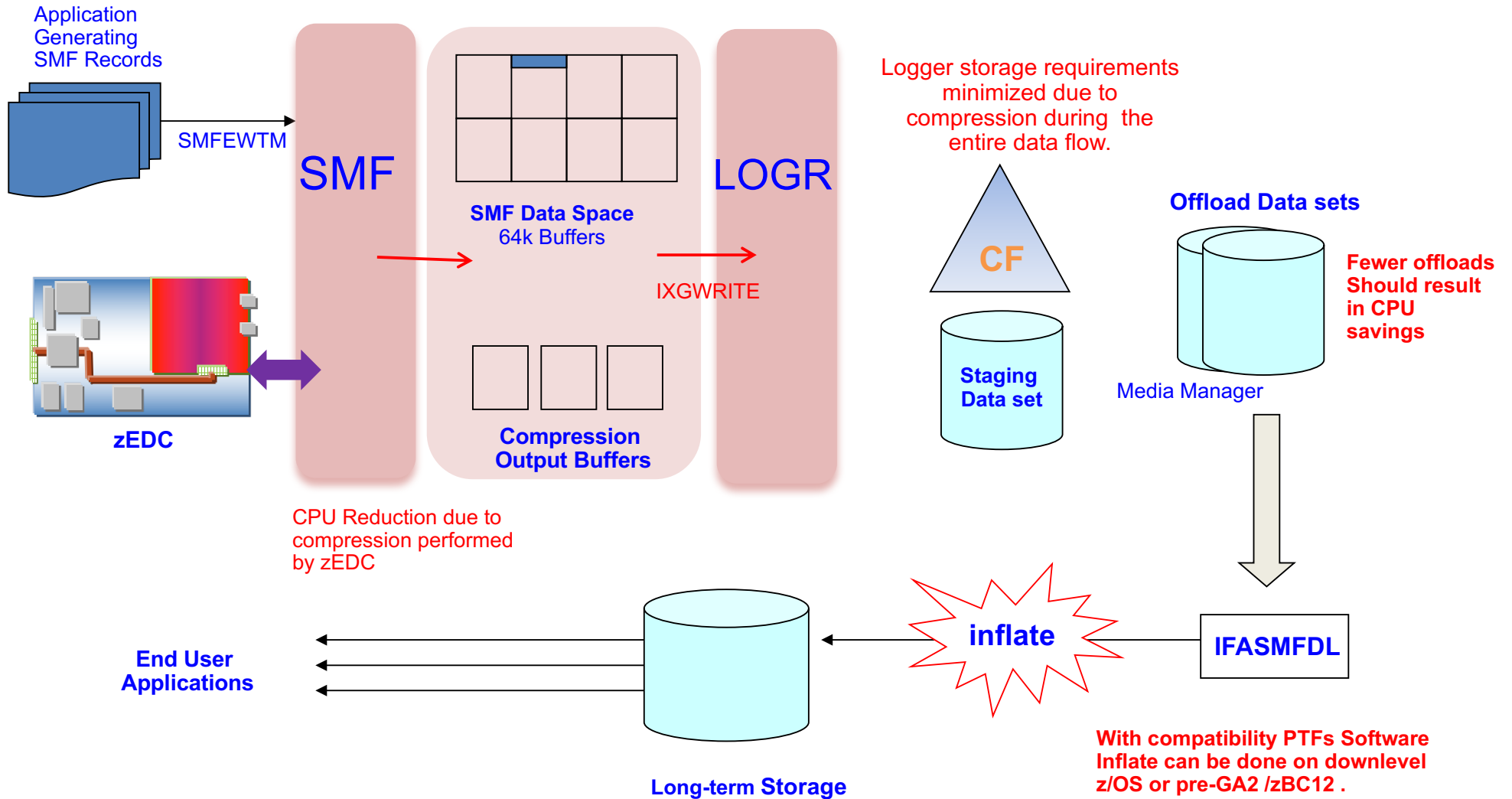
z Enterprise Data Compression

<p>On Chip</p> <p>In every IBM eServer™ zSeries® today (and tomorrow)</p> <p>Mature: Decades of use by Access Methods and DB2®</p> <p>Work is performed jointly by CPU and Coprocessor</p> <p>Propriety Compression Format</p>	<p>PCIe Adapter</p> <p>New with IBM zEnterprise® EC12 GA2 and IBM zEnterprise BC12</p> <p>Mature: Industry Standard with decades of software support</p> <p>Work is performed by the PCIe Adapter</p> <p>Standards Compliant (RFC1951)</p>	
<p>Use Cases</p>		
<p><u>Small object compression</u></p> <ul style="list-style-type: none"> ▪ Rows in a database 	<p><u>Large Sequential Data</u></p> <ul style="list-style-type: none"> ▪ QSAM/BSAM Online Sequential Data ▪ Objects stored in a data base 	<p><u>Industry Standard Data</u></p> <ul style="list-style-type: none"> ▪ Cross Platform Data Exchange
<p><u>Users</u></p> <ul style="list-style-type: none"> ▪ VSAM for better disk utilization ▪ DB2 for lower memory usage ▪ The majority of customers are currently compressing their DB2 rows 	<p><u>Users</u></p> <ul style="list-style-type: none"> ▪ QSAM/BSAM for better disk utilization and batch elapsed time improvements ▪ SMF for increased availability and online storage reduction ▪ DFSMSdss for better disk and tape utilization for backup data ▪ DFSMShsm for improved CPU, disk reduction 	<p><u>Users</u></p> <ul style="list-style-type: none"> ▪ Java for high throughput standard compression via java.util.zip ▪ Encryption Facility for z/OS for better industry data exchange ▪ IBM Sterling Connect: Direct® for z/OS for better throughput and link utilization ▪ ISV support for increased client value

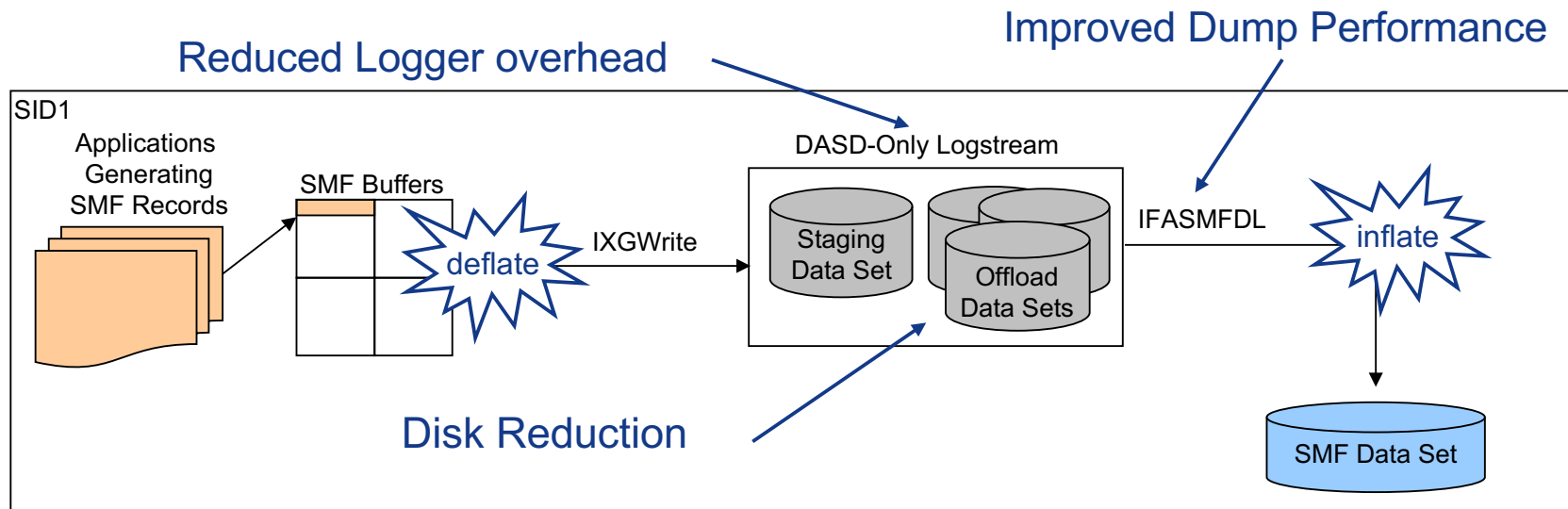
zEDC and SMF Logstream Data

- New SMFPRMxx **COMPRESS** keyword on **LSNAME** and **DEFAULTLSNAME**
 - A buffer of SMF records is compressed by zEDC Express before it is written to the system logger
 - SMF data is only compressed while it is resident in the system logger
 - **PERMFI**X to specify amount of storage used for SMF buffers that can remain permanently fixed
- When compressed data is processed by IFASMF DL, it decompresses the SMF records for selection and writing
 - **SOFTINFLATE** parameter to process compressed SMF records using software algorithm, for a pre-z/OS V2.1 system or no zEDC Express

SMF Data Flow Overview



This example shows a DASD-Only logstream used for SMF recording



- Compression SMF logstreams reduce the amount of data in System Logger up to **4x** and reduce the elapsed time to extract IFASMF DL data up to **15%**
- zEDC compression must be available on all systems that will access zEDC compressed SMF logstreams
- Setup from SMFPRMxx either globally or per Logstream

```
SMFPRMxx in SYS1.PARMLIB
DEFAULTLSNAME(DEFAULT,...,COMPRESS)
LSNAME(SMF30,TYPE(30),...,COMPRESS(PERMFIX(10M)))
LSNAME(RMF,TYPE(70:79)...,COMPRESS)
```

RMF Postprocessor PCIE Activity Report



RMF Postprocessor Interval Report [System Z2] : PCIE Activity Report

RMF Version : z/OS V2R1 SMF Data : z/OS V2R1
 Start : 08/13/2013-05.45.00 End : 08/13/2013-06.00.01 Interval : 15:00:000 minutes

▼ General PCIE Activity

Function ID	Function PCHID	Function Name	Function Type	Function Status	Owner Job Name	Owner Address Space ID	Function Allocation Time	PCI Load Operations Rate	PCI Store Operations Rate	PCI Store Block Operations Rate	Refresh PCI Translations Operations Rate	DMA Address Space Count	DMA Read Data Transfer Rate	DMA Write Data Transfer Rate
0001	0380	Hardware Accelerator	1014044B	Allocated	FPGHWAM	0014	900	0	0.091	0	2.91	1	62.0	0
0011	05C4	Hardware Accelerator	1014044B	Allocated	FPGHWAM	0014	900	0	0.091	0	2.92	1	14.3	19.1
0020	038C	10GbE RoCE	15B31003	Allocated	VTAM	00DE	900	0.889	0	0	0	1	42.9	0

▼ Hardware Accelerator Activity

Function ID	Time Busy %	Request Execution Time	Std Dev for Request Execution Time	Request Queue Time	Std Dev for Request Queue Time	Request Size	Transfer Rate Total
0001	0.005	31.4	4.88	545	68.0	75.2	0.110
0011	0.004	30.7	5.35	541	93.3	74.4	0.109

▼ Hardware Accelerator Compression Activity

Function ID	Compression Request Rate	Compression Throughput	Compression Ratio	Decompression Request Rate	Decompression Throughput	Decompression Ratio	Buffer Pool Size	Buffer Pool Utilization
0001	1.46	0.088	4.11	0	0		64	0
0011	1.46	0.087	3.94	0	0		64	0

100%

▼ General PCIE Activity

Function ID	Function PCHID	Function Name	Function Type	Function Status	Owner Job Name	Owner Address Space ID	Function Allocation Time	PCI Load Operations Rate	PCI Store Operations Rate
0001	0380	Hardware Accelerator	1014044B	Allocated	FPGHWAM	0014	900	0	0.091
0011	05C4	Hardware Accelerator	1014044B	Allocated	FPGHWAM	0014	900	0	0.091
0020	038C	10GbE RoCE	15B31003	Allocated	VTAM	00DE	900	0.889	0

▼ Hardware Accelerator Activity

Function ID	Time Busy %	Request Execution Time	Std Dev for Request Execution Time	Request Queue Time	Std Dev for Request Queue
0001	0.005	31.4	4.88	545	68.0
0011	0.004	30.7	5.35	541	93.3

▼ Hardware Accelerator Compression Activity

Function ID	Compression Request Rate	Compression Throughput	Compression Ratio	Decompression Request Rate	Decompression Thr
0001	1.46	0.088	4.11	0	0
0011	1.46	0.087	3.94	0	0

zEDC RMF Reporting



New RMF report shows the utilization of each device.

RMF Postprocessor Interval Report : PCIE Activity Report

RMF Version : z/OS V2R1 SMF Data : z/OS V2R1

Start : 02/24/2014-05.48.00 End : 02/24/2014-05.48.44 Interval : 00:45:000 minutes

Hardware Accelerator Activity

Function ID ↓↑	Time Busy % ↓↑	Request Execution Time ↓↑	Std Dev for Request Execution Time ↓↑	Request Queue Time ↓↑	Std Dev for Request Queue Time ↓↑	Request Size ↓↑	Transfer Rate ↓↑
0013	0.889	7.78	0.417	15.0	0.953	24.3	21.5

Hardware Accelerator Compression Activity

Function ID ↓↑	Compression Request Rate ↓↑	Compression Throughput ↓↑	Compression Ratio ↓↑	Decompression Request Rate ↓↑	Decompression Throughput ↓↑	Decompression Ratio ↓↑	B
0013	885	11.8	1.14	0	0		64

The percent of this interval where this specific zEDC Express device was executing requests

Compression ratio of all requests serviced by zEDC. This will span all users of this device.

Average request queue time in Microseconds for this device.

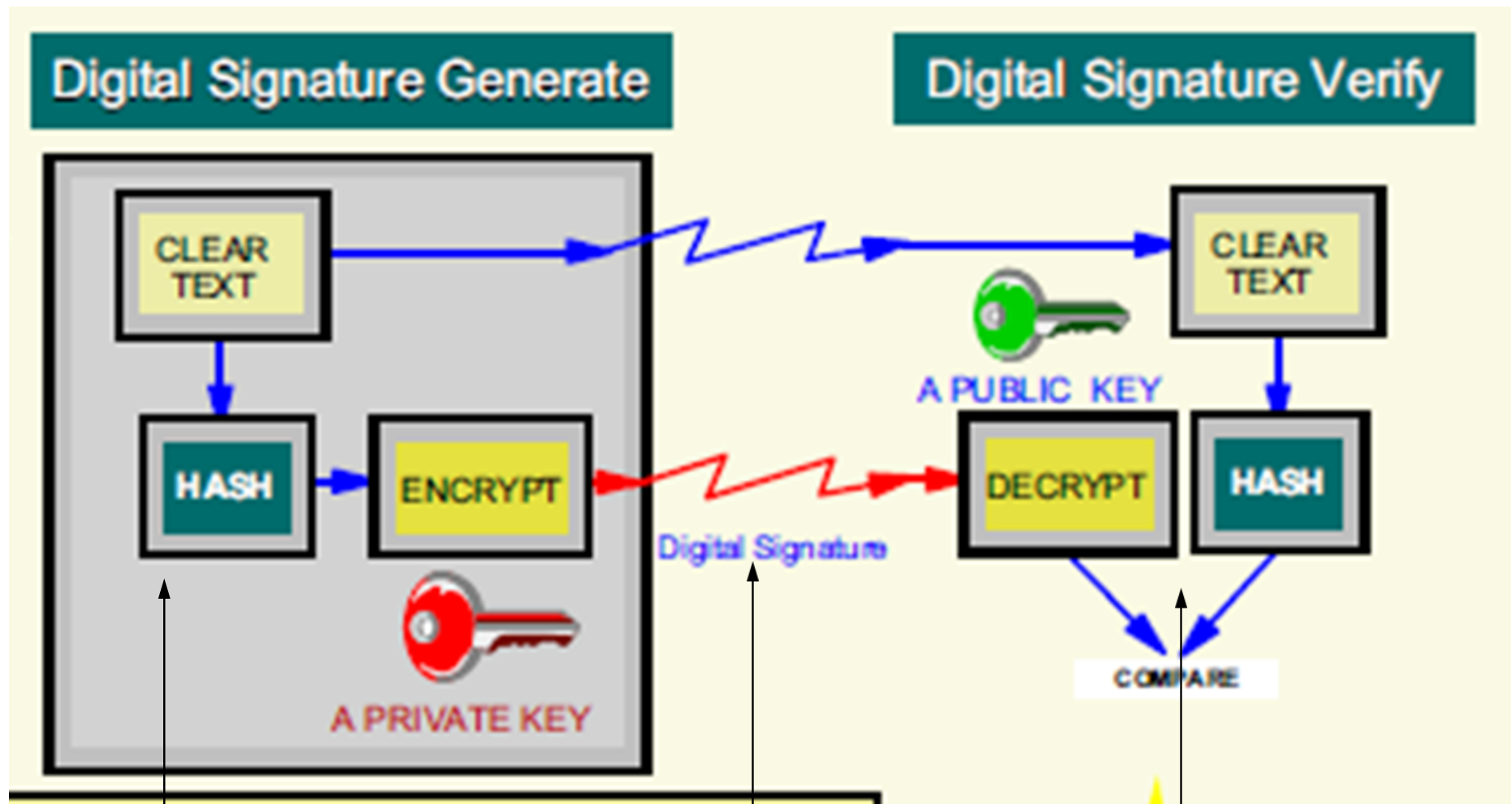
SMF 30 support for zEDC

- Using zEDC, CPU time for job could go down
- How much zEDC capacity a job used?
- zEDC usage info added to Type 30 records
 - Total number of zEDC requests
 - Total queue time in microseconds
 - Total execute time in microseconds
 - Deflate and inflate statistics for number of bytes input and output



- z/OS 2.2 – support for digitally signed SMF records when using system logger
 - Validate SMF records, provide protection and verification for SMF data
 - Use digital signatures to detect a change, addition or removal of an SMF record from a group of records
 - Provide a trusted repository for auditing records created by z/OS system components

How SMF digitally signs records

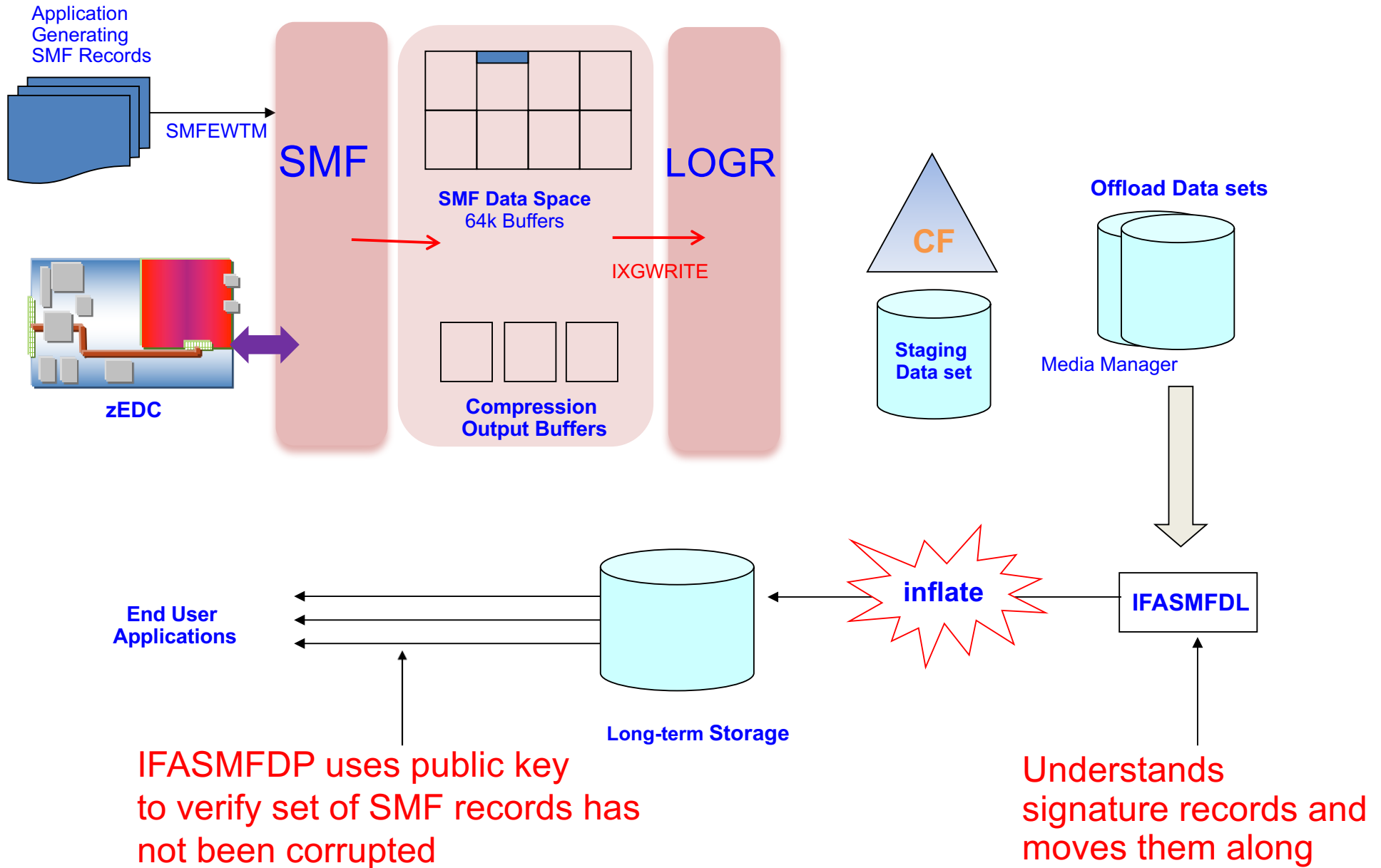


SMF record written to system logger and hashed

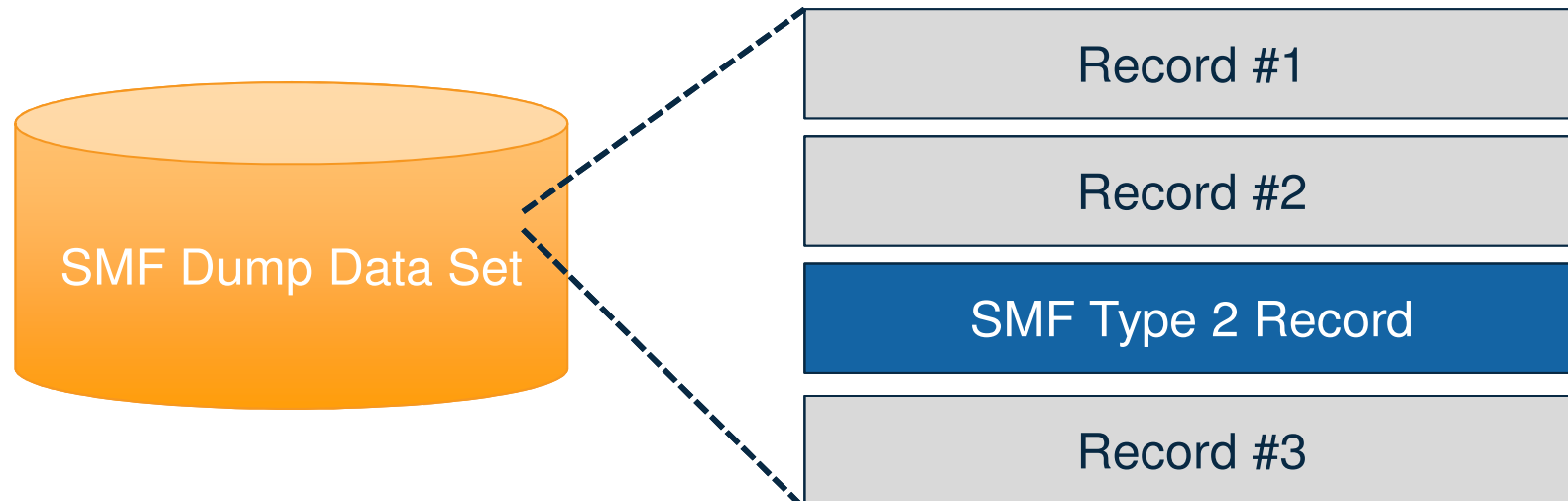
SMF digitally signs the hash and writes signature to log stream (Type 2 Record)

IFASMFDP uses public key to verify SMF records

SMF Data Flow Overview



SMF Type 2 Records



Setting up digitally signed SMF records



- Create public / private key pair using ICSF
- Update SMFPRMxx to have SMF sign records
 - **RECSIGN** along with **HASH** and **TOKENNAME** (globally or on LSNAME)
- Use IFASMFDL to carry signature records to data sets
 - **NOSIGSTRIP** / **SIGSTRIP**
- Use IFASMFDP to validate records
 - **SIGVALIDATE** along with **HASH** and **TOKENNAME**

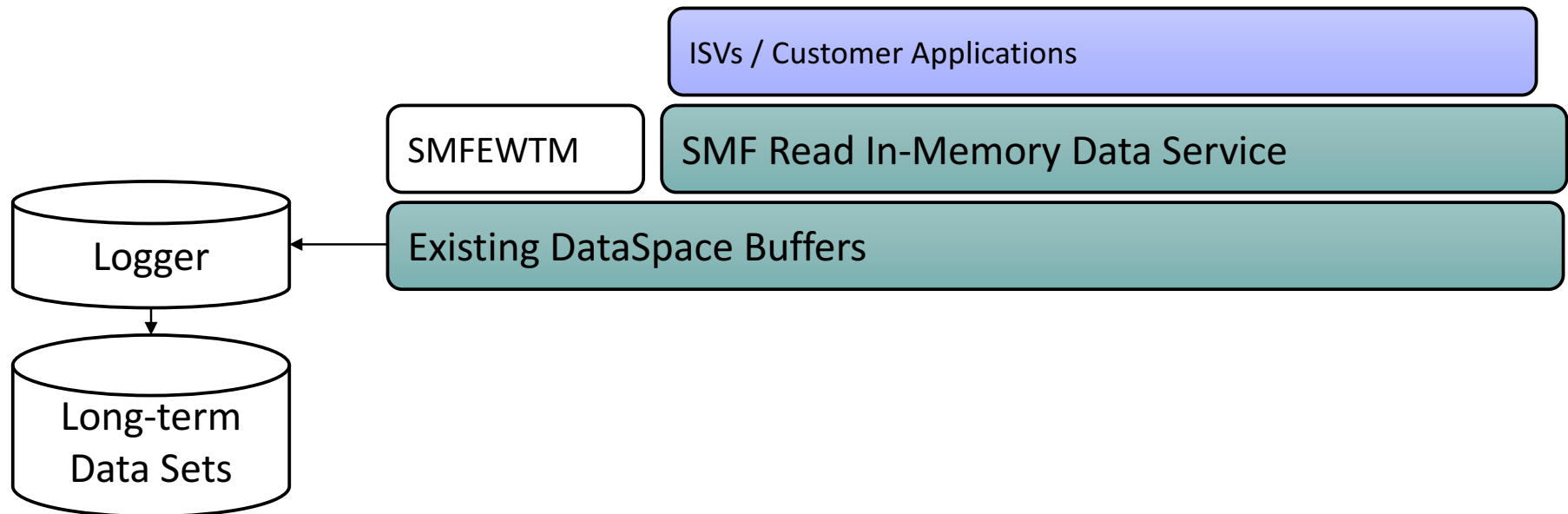
z/OS SMF Real-time Services

- New Real-Time SMF services provided on top of existing buffer technology
- Define new “In-memory (INMEM) Resources” for specific records
- Can write SMF records to a real-time resource only – No disk required
 - Co-exists with current SMF logstream technology
 - Not supported when RECORDING(DATASET) used
- APIs allow application to access SMF data as it is buffered
 - Unauthorized access policed via SAF
 - Connect/Get/Disconnect model similar to traditional QSAM access
- Potential use-cases include
 - Detecting security violations in real-time
 - Real time monitoring resource usage
 - Dynamic Job Scheduling based on current resource consumption



SMF callable services overview

- New SMF callable services can provide bulk in-memory data retrieval or real-time data retrieval.
- Historical data, when available, can be pulled from in-memory buffer. When not available the data can be obtained from traditional long-term storage however the cross-over is NOT transparent, the application needs to manage this.



Define an In-memory Resource



- Up to 32 in-memory resources can be defined
 - Each resource can have a unique set of records collected to be read
 - Up to 8 programs can connect to resource to read records
 - Resource name similar to LSNNAME – IFASMF.xxxx – up to 26 characters
- RESSIZMAX can be used to define the buffer size
 - Note: In memory buffer treated as a wrapping buffer that is never emptied
- Accepts all expected TYPE or NOTYPE statements
 - The TYPEs recorded in-memory will not be processed by DEFAULTLSNAME processing
 - Allows for InMemory only records (i.e. never written to permanent storage)

```
/*
/*
/* Define in-memory resources
/*
/*
/*
INMEM(IFASMF.INMEM.RES5,TYPE(0:30),RESSIZMAX(128M))
INMEM(IFASMF.INMEM.RES6,TYPE(30:90),RESSIZMAX(128M))
INMEM(IFASMF.INMEM.RES7,TYPE(0:127),RESSIZMAX(128M))
```

Putting the pieces together

- How can this new data access pattern be used?
 - Turn on for any SMF records required for real-time analysis
 - Turn on SMF records that are “transient” – They do not require long-term storage and are only valuable for real-time analysis
 - Control access to real-time data – Only give SAF access to specific users
 - No need to change existing SMF configuration – Continue to store long-term data in data sets or logstreams



- **Detect excessive memory consumption – SMF 30**

- Monitor high water mark for real memory usage for jobs and send alerts if usage exceeds normal consumption

```
INMEM ( IFASMF . INMEM . RES5 , TYPE ( 30 ) , RESSIZMAX ( 128M ) )
```

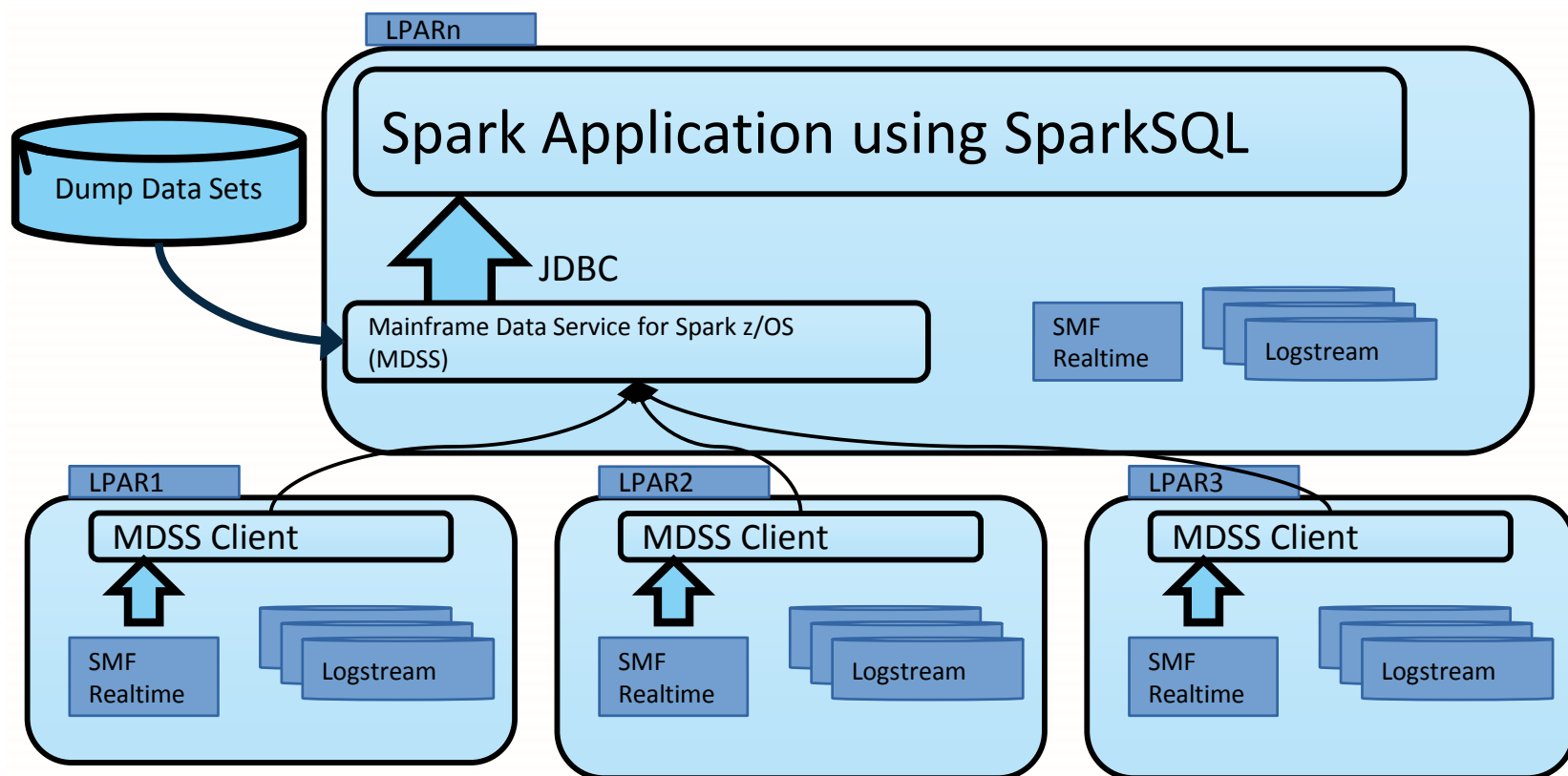
- **Detect security violations in real-time – SMF 80**

- Monitor volume of datasets/files accessed per user within a given time period and raise alerts for above normal access rates

```
INMEM ( IFASMF . INMEM . RES5 , TYPE ( 80 ) , RESSIZMAX ( 128M ) )
```



Analyzing SMF data with Spark



- Spark application is agnostic to data source
- MDSS required on at least one system; agents on all systems
- Logstream recording mode required for realtime interfaces

z/OS monitoring enhancements - HFTS



Previewed in z/OS Ver 2.3 (GA in September)

- OA48570 (SMF) and OA48571 (Supervisor)
 - High-Frequency Throughput Statistics (HFTS) data via new SMF 98 records
 - Functions:
 - Defined in SMFPRMxx via new keyword HFTSINTVL(ss) | NOHFTSINTVL
 - Writing interval is based on seconds (5, 10, 15, 30, 60) and when the function is used the recommended interval is 20 seconds
 - Supervisor Exploitation
 - Type 98 subtype 1 records contain performance information for the z/OS supervisor component about the workload and its significant jobs. It includes metrics such as utilization, concurrency, efficiency, contention, and queuing

■ Enhanced Encryption Support

- Development of policy based data set encryption for z/OS data sets, zFS file systems, and Coupling Facility Structures without requiring changes to applications
- DFSMS
 - Via use of SAF or SMS policies
 - Use the Central Processor Assist for Cryptographic Functions (CPACF) to encrypt and decrypt extended format (version 2 only) sequential BSAM and QSAM data sets and all types of extended format VSAM data sets as written to and read from disk
 - Data set level encryption is planned to allow the data to remain encrypted during admin functions such as backup/restore, migration/recall, and replication

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z/OS V2.3 enhanced encryption support



■ Coupling Facility

- Via use of CFRM policy
- Ability to encrypt / decrypt list and cache structure CF data using CPACF as it is sent to and returned from the CF
- Data will be encrypted as it travels on the CF link and will remain encrypted while resident in the CF

■ zFS

- Support the encryption of individual files (file content), access control lists, security information, and symbolic link contents
- Use of zFS encryption can be paired with compression to offset the overhead of encryption

z/OS Ver 2.3 WLM enhancements



More granular resource controls* Honor Priority by Service Class

```
-----  
Command ==> Modify a Service Class Row 1 to 4 of 4  
-----  
Service Class Name . . . . . : FAST  
Description . . . . . : Velocity=80 goal  
Workload Name . . . . . : STCWORK (name or ?)  
Base Resource Group . . . . . : (name or ?)  
Cpu Critical . . . . . : NO (YES or NO)  
I/O Priority Group . . . . . : NORMAL (NORMAL or HIGH)  
Honor Priority . . . . . : NO (DEFAULT or NO)  
-----  
Specify BASE GOAL information. Action Codes: I=Insert new period,  
E=Edit period, D=Delete period.  
-----  
Action  -- Period  --  ----- Goal -----  
#  Duration  Imp.  Description  
-----  
1  2000000  2  Average response time of 00:00:01.000  
2  2000000  3  Average response time of 00:00:10.000  
3  4  Execution velocity of 80  
-----  
***** Bottom of data *****
```

- Specifies whether work in this service class is exempted from default IFAHONORPRIORITY and IIPHONORPRIORITY processing

Recommendations for HonorPriority



- Some zIIP work may be very latency sensitive and require to be dispatched quickly .
 - Namely some DB2 work, such as prefetch SRBs.
 - zIIP capacity may be constrained but CP capacity might be available to help
- Recommendation:
 - At the system level (IEAOPTxx) specify or default to IIPHonorPriority=Yes to allow CPs to help zIIP work.
 - Use the service class specific HonorPriority=No to selectively exclude work from receiving help.
 - Examples could be SPARK or Java batch that you do not want to be processed on general purpose processors

More granular resource controls* Memory Limit for Resource Groups

```
-----  
Command ==> Modify a Resource Group  
-----  
Enter or change the following information:  
Resource Group Name . . . . . : MEMLIMIT  
Description . . . . . : Provide a memory limit for work  
Define Capacity:  
— 1. In Service Units (Sysplex Scope)  
  2. As Percentage of the LPAR share (System Scope)  
  3. As a Number of CPs times 100 (System Scope)  
Minimum Capacity . . . . . : _____  
Maximum Capacity . . . . . : _____  
Memory Limit (System Scope) 24 _____ GB
```

- Specifies the maximum amount of memory that address spaces associated with the resource group through classification may consume on the local system (System Scope)
- The attribute is specified as absolute value in GB in the range 1 – 99,999,999.

➔ IBM recommends that you use memory pools when it is required to limit memory consumption for new workloads such as Apache SPARK that provided guidance on how to operate them in a memory pool.

Statement of Direction - zHyperlink



- zHyperLink is the first new mainframe input/output (I/O) channel link technology since FICON
 - A short-distance, mainframe-attach link designed for up to 10x lower latency than High Performance FICON
 - Intended to speed up DB2® for z/OS® transaction processing and improve active log throughput
 - Point-to-point optical connection between the mainframe and storage
 - Link length is limited to 150 meters,
- IBM intends to deliver field upgradable support for zHyperLink on any existing IBM System Storage® DS8880
 - Hardware capability is already included in the DS8880 R8.2 delivered in December (model numbers 984, 985, 986 and 988)



Recommendations for defining logical CPs



- New Best Practice document for defining logical CPs and zIIPs to an LPAR
 - www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/TD106388

- Recommendations
 - Define 1-2 more logicals than needed to meet CPs by weight
 - Don't define all the logicals on a CEC to the LPAR

 - Reasons:
 - **Work runs most efficiently if you run with defined weight using VHs and VMs**
 - LPAR Busy value displayed on online monitors is relative to number
 - LPAR time slice is sensitive to number of logicals, fewer logicals leads to longer timeslice
 - Reduce the impact of a CPU Loop, fewer logicals limits potential impact
 - z/OS operations like Quiesce need to be done even for parked logicals
 - Additional system resources utilized for each logical processor



CPU Measurement Facility

- Available on all System z processors since the z10
- Provides hardware instrumentation data for production systems
- Two Major components
 - Counters
 - Cache and memory hierarchy information
 - SCPs supported include z/OS and z/VM
 - Sampling
 - Basic - Instruction time-in-CSECT
 - Diagnostics – opcodes, hot spots
 - PE MODE no longer required
- In z/OS V2.2
 - HIS will no longer require USS definitions
 - z/OS 2.1 with APAR OA43366
 - Modify HIS (F HIS) command is restructured
- Minimal Overhead
 - z/OS HIS started task
 - Gathered on an LPAR basis
 - Writes SMF 113 records
 - z/VM Monitor Records
 - Gathered on an LPAR basis – all guests are aggregated
 - Writes new Domain 5 (Processor) Record 13 (CPU MF Counters) records

SMF 113 records used as input to zPCR workstation tool, for capacity planning using RNI

Components of workload capacity performance

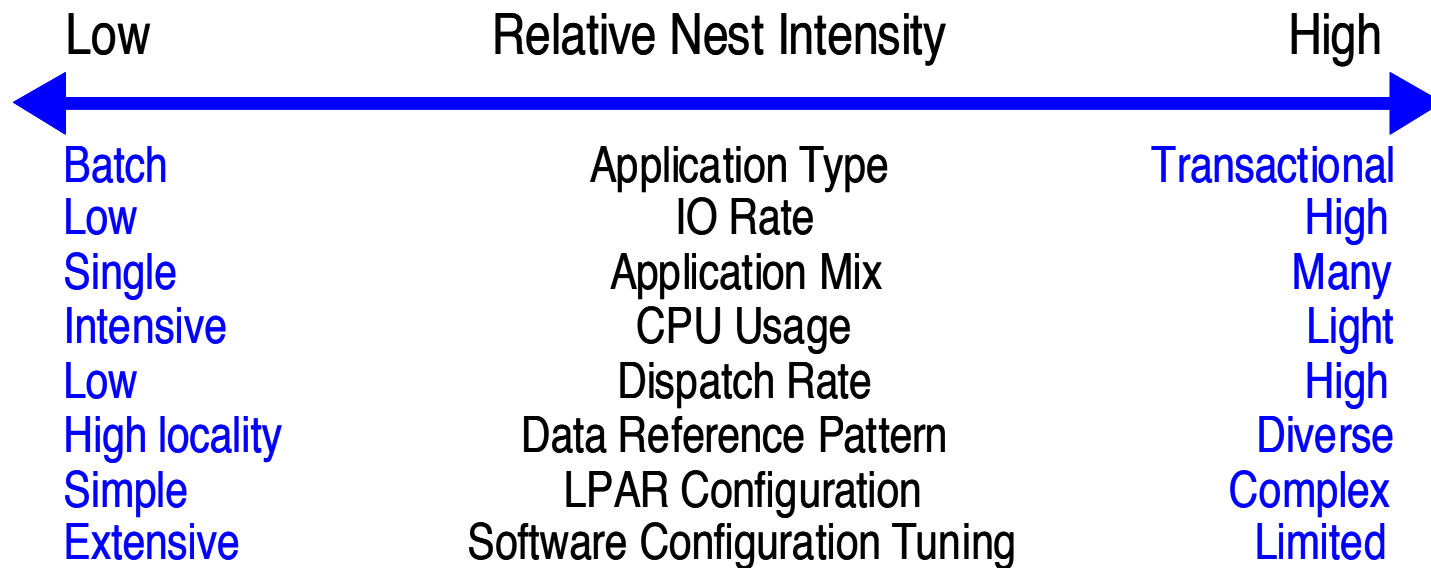


- Memory Hierarchy or "nest"
 - ▶ Many design alternatives
 - cache (levels, size, private, shared, latency, MESI protocol), controller, data buses
 - ▶ Workload effect
 - Quite variable
 - Sensitive to many factors: locality of reference, dispatch rate, IO rate, competition with other applications and/or LPARs, and more
 - ▶ **Relative Nest Intensity**
 - Activity beyond the private cache(s) is the most sensitive area
 - due to larger latencies involved
 - Reflects activity distribution and latency to chip-level caches, book-level caches and memory
 - Level 1 cache miss percentage also important
 - Data for calculation available from CPU MF (SMF 113) starting with z10

Relative Nest Intensity (RNI)



- Many factors influence a workload's capacity curve
- However, what they are actually affecting is the workload's RNI
- It is the net effect of the interaction of all these factors that determines the capacity curve
- The chart below indicates the trend of the effect of each factor but is not absolute
 - ▶ for example, some batch will have high RNI while some transactional workloads will have low
 - ▶ for example, some low IO rate workloads will have high RNI, while some high IO rates will have low



z13 vs EC12 hardware comparison



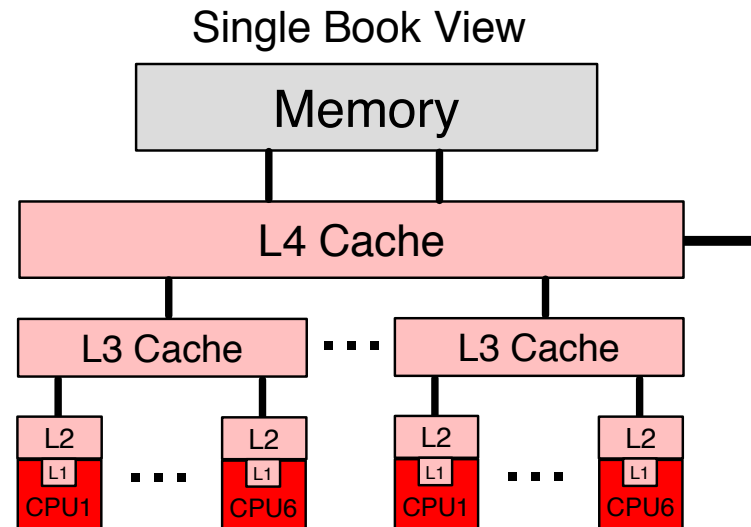
zEC12

▶ CPU

- 5.5 GHz
- Enhanced Out-Of-Order

▶ Caches

- L1 private 64k i, 96k d
- L2 private 1 MB i + 1 MB d
- L3 shared 48 MB / chip
- L4 shared 384 MB / book



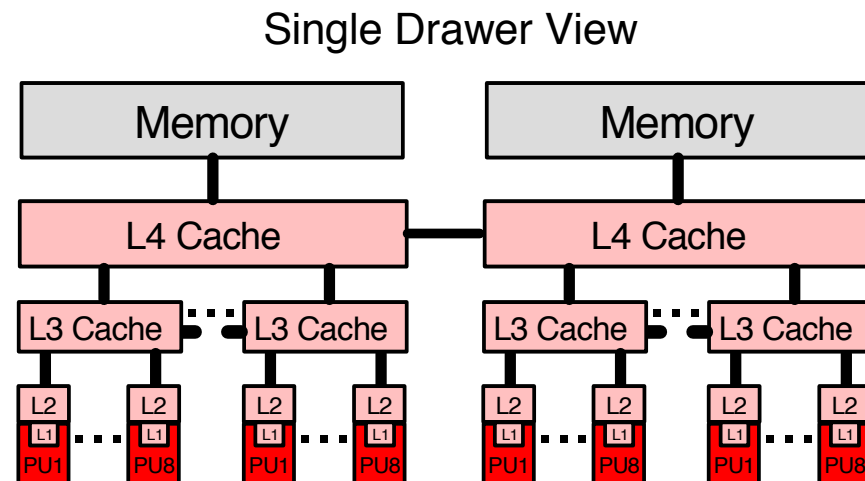
z13

▶ CPU

- 5.0 GHz
- Major pipeline enhancements

▶ Caches

- L1 private 96k i, 128k d
- L2 private 2 MB i + 2 MB d
- L3 shared 64 MB / chip
- L4 shared 480 MB / node
 - plus 224 MB NIC



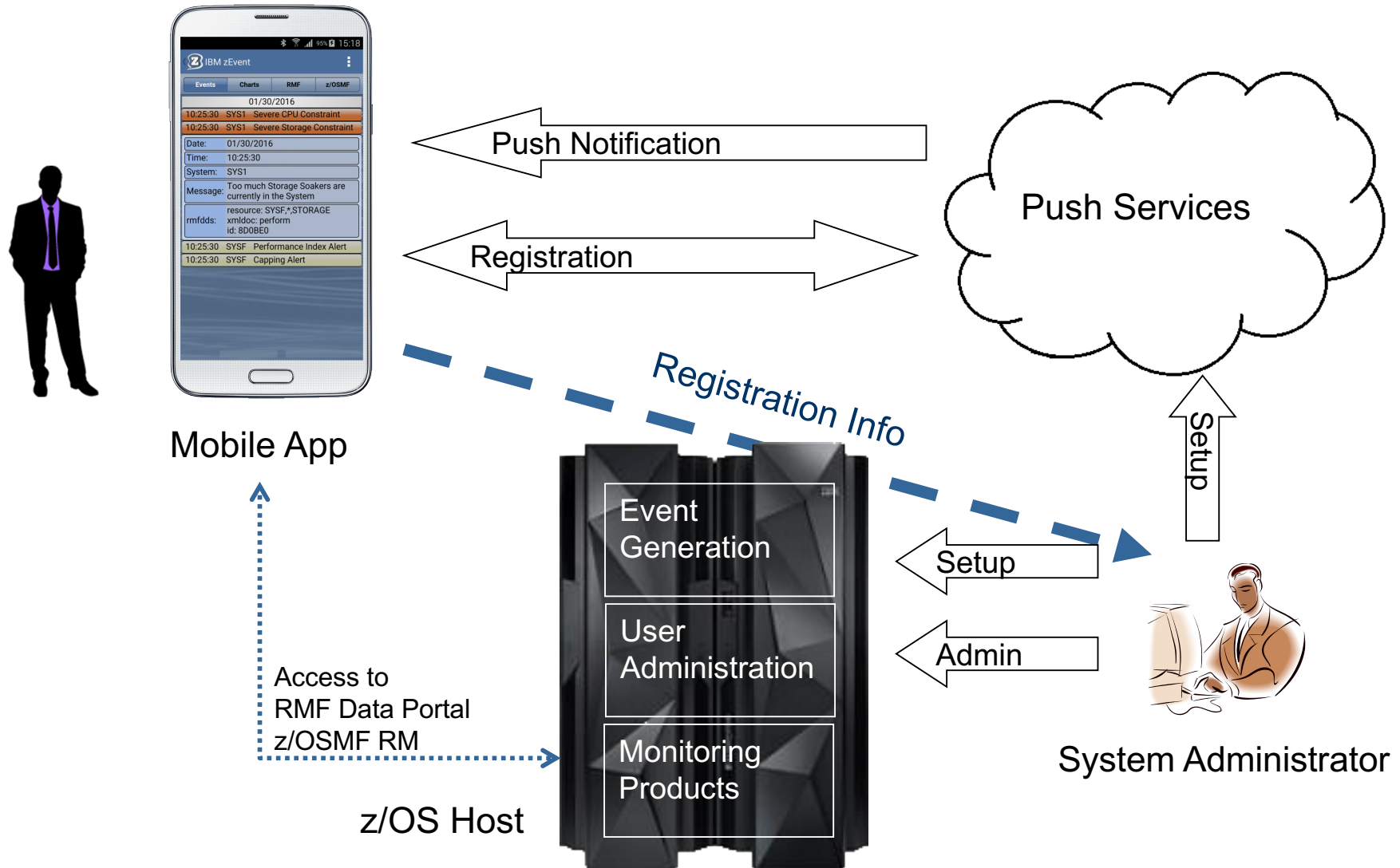
The zEvent Mobile Application



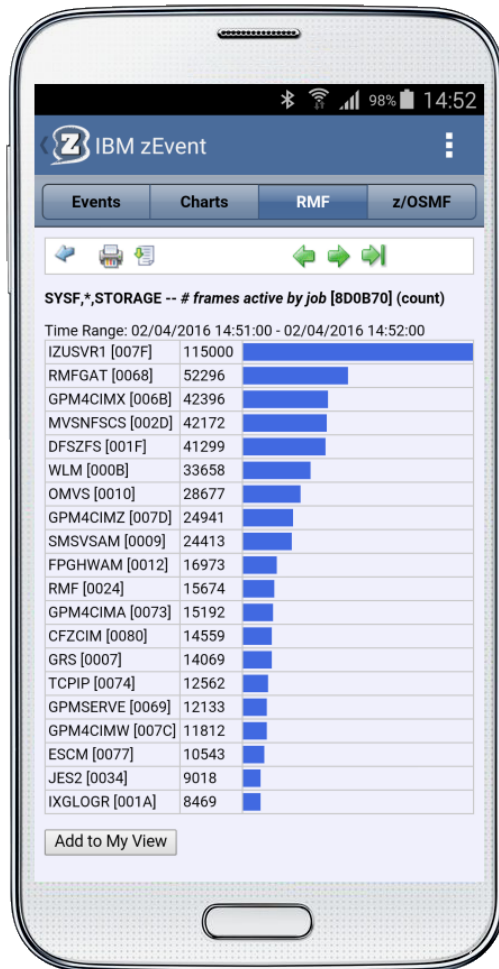
- Receive push messages based critical system events
- Access to z/OS performance data from mobile devices
- Single point of control for the enterprise
- Developed with IBM Mobile First Studio
- Available in the app stores for Android and iOS
- Supported Monitoring Facilities:
 - RMF Performance Data Portal
 - z/OSMF Resource Monitoring



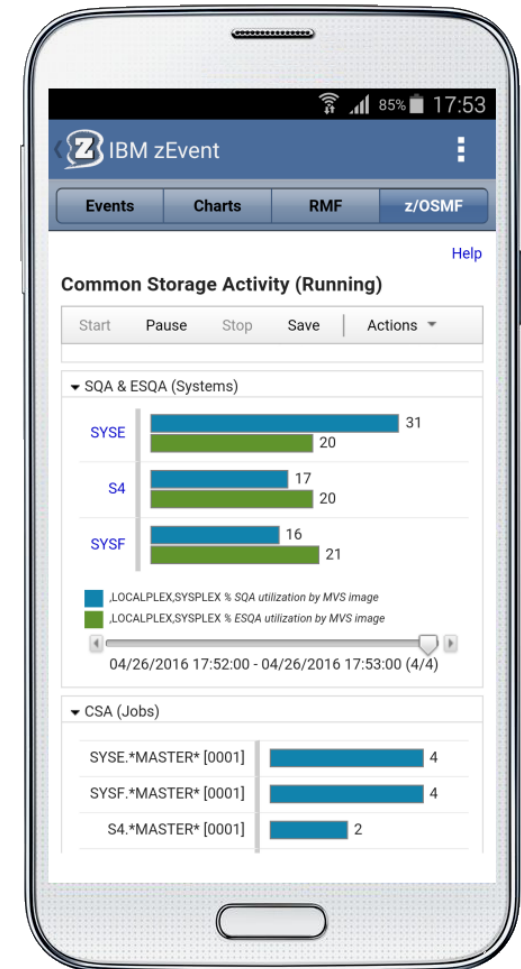
zEvent – Components



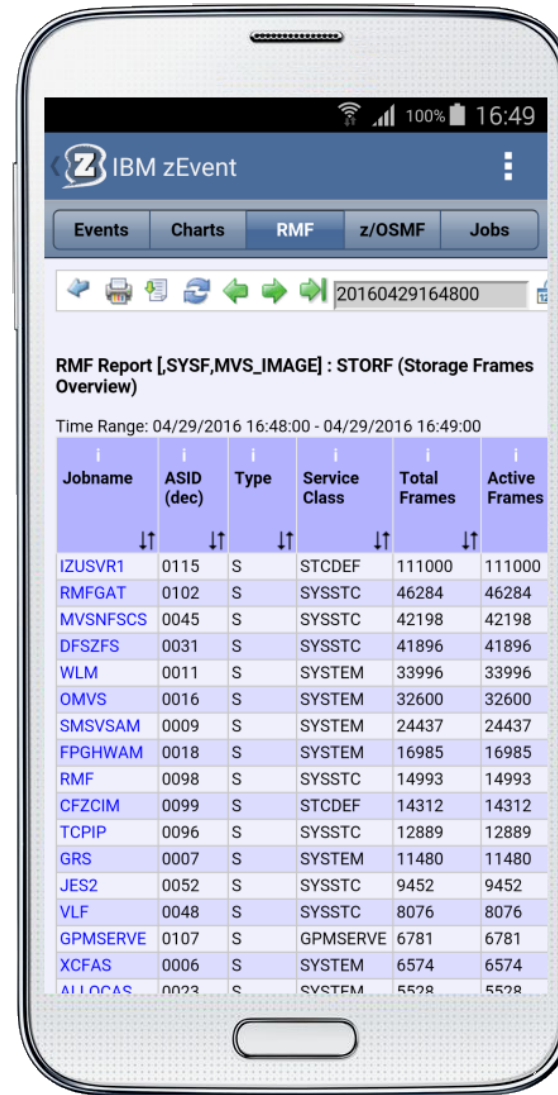
Tabs and Dialogs – RMF & z/OSMF



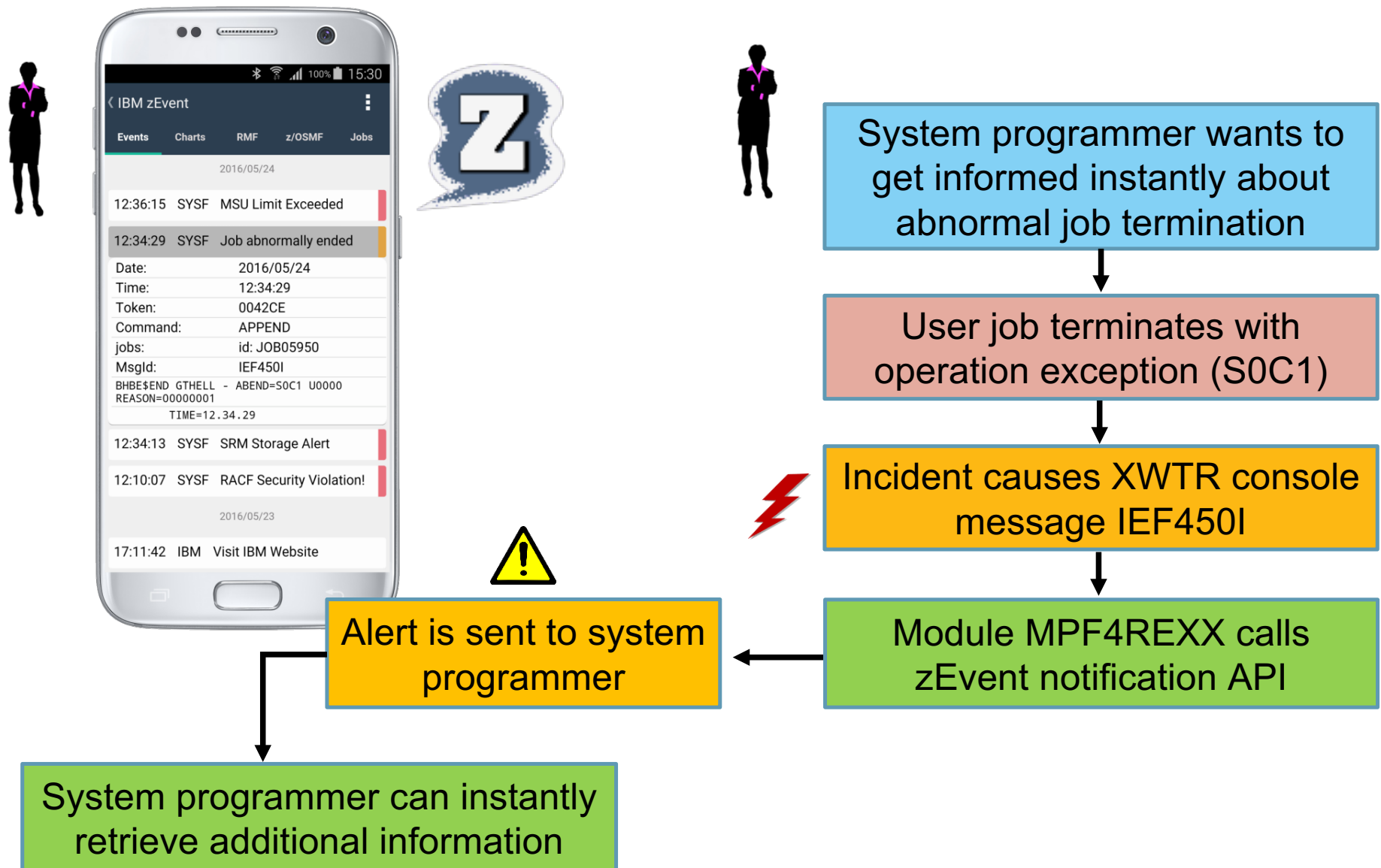
- RMF and z/OSMF allow the mobile user to logon to the z/OS system and to obtain additional information to further analyze a performance event
- RMF accesses the RMF performance data portal
- z/OSMF accesses z/OSMF RM



Launch in Context – RMF Monitor III Report



Example – Job Abend



Summary



- New SMF functions – zEDC compression, digital signatures, real-time streaming
- z/OS Ver 2.3 preview of performance functions
- Defining logical CPs
- CPU MF and RNI
- RMF zEvent Mobile Application

