The IBM zEnterprise EC12 (zEC12) server introduces the Flash Express feature (FC 0402) that provides a new PCIe I/O card that resides in the PCIe I/O drawer that implements internal Flash Solid State Disks (SSD). Each Flash Express card has a maximum capacity of 1.6 TB and is installed by pair to ensure availability and redundancy. A maximum of four pairs of cards can be installed on a zEC12 providing a maximum capacity of 6.4 TB of storage. In addition, data that resides on Flash SSD is encrypted through the use of smart cards and an integrated smart card reader on the primary and alternate Support Elements (SE). For complete and detailed instructions, see IBM zEnterprise EC12 Technical Guide, SG24-8049.

With the z/OS V1R13 RSM Enablement Offering web deliverable (FMID JBB778H) for z/OS V1R13, z/OS will exploit Flash through a new tier of memory called Storage Class Memory (SCM) for paging and SVC dump processing. This function is expected to provide faster paging and dump processing because flash storage is faster compared to hard disk storage. In addition to support for the existing large (1 MB) pages and frames, zEC12 supports pageable large pages when SCM is configured and allocated to z/OS.

Configuring Flash Storage on zEC12

Our zEC12 was delivered with two pairs of Flash Express cards. The cards were installed and configured online by our local hardware support personnel. This configuration task also formats the flash storage to prepare it for use by customer LPARs. There is no HCD/IOCP definition required for Flash Express installation. However, Flash Express cards are assigned PCHIDs according to their physical location in the I/O drawer even though they have no customer-usable ports.

You can allocate flash storage through a new dialog available on either the HMC or SE. Figure 1 shows the initial view of P91, our zEC12, after its Flash cards were configured.
Note in Figure 1 that with two pairs of cards only 2848GB of flash storage is available for customer allocation. The remaining storage is reserved for internal usage for flash firmware.

A user with a system programmer role can manage the allocations using the select action dropdown menu in the Partitions table in the Manage Flash Allocation panel. For example, selecting Add Allocation allows the user to choose an existing LPAR to allocate initial and maximum amounts in 16 GB increments. Figure 2 shows an example of the New Flash Allocation panel.
Note that when allocating flash storage to LPARs using the New Flash Allocation panel, you must be careful to select the correct LPAR. The order of Existing Partitions in the New Flash Allocation might list non-flash-supporting images first (such as CFs), which can lead to the accidental allocation of flash storage to those LPARs.

Our complete LPAR allocation of Flash is shown in Figure 3:
Configuring storage class memory on z/OS on zEC12

Flash can be allocated before the LPARs are activated and detected by z/OS during IPL, or configured on dynamically after IPL. You can specify a new PAGESCM keyword in IEASYSxx with the z/OS V1R13 RSM Enablement installed to control the use of SCM. PAGESCM defaults to ALL to allow allocation of all increments specified in the Manage Flash Allocation panel while specifying PAGESCM=NONE prevents the use of any SCM. The system issues new message IAR031I during IPL to indicate the amount of SCM that was allocated to the LPAR based on the PAGESCM value. For example, on a system with nothing specified for PAGESCM and 64G of SCM allocated to the LPAR, message IAR031I reports

IAR031I USE OF STORAGE-CLASS MEMORY FOR PAGING IS ENABLED – PAGESCM=ALL,
ONLINE=00065536M
Two existing operator commands have been updated to show information related to SCM for a given system.

1. The DISPLAY M command has been updated to show the status of a system’s SCM, including displaying details for each online increment:

   -RO J90,D M=SCM
   IEE174I 15.50.16 DISPLAY M
   STORAGE-CLASS MEMORY STATUS
   256G DEFINED
   ONLINE
   0G-64G
   192G OFFLINE-AVAILABLE
   12% IN USE
   SCM INCREMENT SIZE IS 16G

   -RO J90,D M=SCM(DETAIL)
   IEE174I 15.52.34 DISPLAY M
   STORAGE-CLASS MEMORY STATUS - INCREMENT DETAIL
   256G DEFINED
   ADDRESS IN USE STATUS
   0G 0% ONLINE
   16G 0% ONLINE
   32G 27% ONLINE
   48G 20% ONLINE
   ONLINE: 64G OFFLINE-AVAILABLE: 192G PENDING OFFLINE: 0G
   12% IN USE
   SCM INCREMENT SIZE IS 16G

2. The Auxiliary Storage DISPLAY ASM command has been updated to identify the SCM blocks that the system is currently using, in addition those in use on page data sets.

   -RO J90,D ASM
   IEE200I 15.55.54 DISPLAY ASM
   TYPE FULL STAT DEV DATASET NAME
   PLPA 18% OK 8571 SYS1.J90.PLPA
   COMMON 0% OK 8570 SYS1.J90.COMMON
   LOCAL 5% OK 8570 SYS1.J90.LOCAL
   LOCAL 5% OK 8570 SYS1.J90.LOCAL2
   LOCAL 5% OK 8571 SYS1.J90.LOCAL3
   LOCAL 5% OK 8571 SYS1.J90.LOCAL4
   LOCAL 5% OK 8572 SYS1.J90.LOCAL5
   SCM 8% OK N/A N/A
   PAGEDEL COMMAND IS NOT ACTIVE

   -RO J90,D ASM,SCM
   IEE207I 15.57.56 DISPLAY ASM
   STATUS FULL SIZE USED IN-ERROR
   IN-USE 8% 16,777,216 1,458,024 0
Allocating new flash storage increments to an LPAR that is already active with the z/OS V1R13 RSM Enablement Offering installed will result in the system detecting and reporting the new SCM values through new message IAR034I:

IAR034I ADDITIONAL STORAGE-CLASS MEMORY DETECTED

-RO J90,D M=SCM
IEE174I 15.58.55 DISPLAY M
STORAGE-CLASS MEMORY STATUS
272G DEFINED
ONLINE
 0G-64G
208G OFFLINE-AVAILABLE
12% IN USE
SCM INCREMENT SIZE IS 16G

You might notice that the IN USE % reported by D M=SCM is higher than the % FULL value reported by D ASM. This is because ASM creates a pool of available SCM blockids for quick allocation that is considered in-use by the D M command processor.

You can configure offline SCM increments online to an active system using the CONFIG command with the new SCM option. The reconfiguration value that you specify must be a multiple of the SCM increment size.

RO J90,CF SCM(16G),ONLINE
IEE195I SCM LOCATIONS 64G TO 80G ONLINE
IEE712I CONFIG PROCESSING COMPLETE

-RO J90,D M=SCM(DETAIL)
IEE174I 15.59.45 DISPLAY M
STORAGE-CLASS MEMORY STATUS - INCREMENT DETAIL
272G DEFINED
ADDRESS IN USE STATUS
 0G  0%  ONLINE
 16G  0%  ONLINE
 32G  27%  ONLINE
 48G  20%  ONLINE
 64G  0%  ONLINE
ONLINE: 80G OFFLINE-AVAILABLE: 192G PENDING OFFLINE: 0G
9% IN USE
SCM INCREMENT SIZE IS 16G

IBM is expected to support dynamic reconfiguration of SCM increments at a later date. Until then, to remove SCM increments from an LPAR will require deactivating the image and using the Remove Allocation option from the Manage Flash Allocation panel on the SE or HMC. The firmware processing to deallocate increments can take several minutes depending on how much flash storage is being deallocated, and you might see "Uninitialized" or “Unavailable” amounts during that period; as result the system might be temporarily unable to allocate those amounts to any other LPAR. However, this
condition is transient. Figure 4 highlights the unavailable fields while this transition was in progress.

![P91 Flash Allocations](image)

**Figure 4: P91 Flash Allocations**

**RMF support for Storage Class Memory**

APAR OA38660 introduces RMF support to report on SCM statistics in the following reports:

- Monitor I Paging Activity
- Monitor I Page Data Set Activity
- Monitor II Page Data Set Activity (PGSP)

SMF records 71 and 75 are changed with APAR OA38660 to provide this new support. In addition, new overview conditions are added based on SMF record 71.

The following images show snippets of these updated reports to highlight the new SCM statistics. Let’s start with the real-time Monitor II Page Data Set Activity report.
Note the new line of type S in Figure 05 that represents SCM. All DASD-related fields are N/A for this line. Note also that because of its superior performance, the majority of paging activity is going to SCM.

The Monitor I Page Data Set Activity report provides similar new statistics for SCM.

Finally the Paging Activity report now reports statistics on SCM paging blocks, as well as the SHARED, HIGH SHARE, and COMMON frames backed by SCM slots. Figure 7 and Figure 8 show these new fields.
Additional information related to Flash Storage and Storage Class Memory can be found in latest versions of the following Redbooks:

- IBM zEnterprise System Connectivity Handbook, SG24-5444
- IBM zEnterprise EC12 Technical Introduction, SG24-8050
- IBM zEnterprise EC12 Technical Guide, SG24 8049

You should also consult the PSP bucket for information on the z/OS V1R13 RSM Enablement Offering web deliverable (FMID JBB778H) for z/OS V1R13.