ICF Catalog Management Overview

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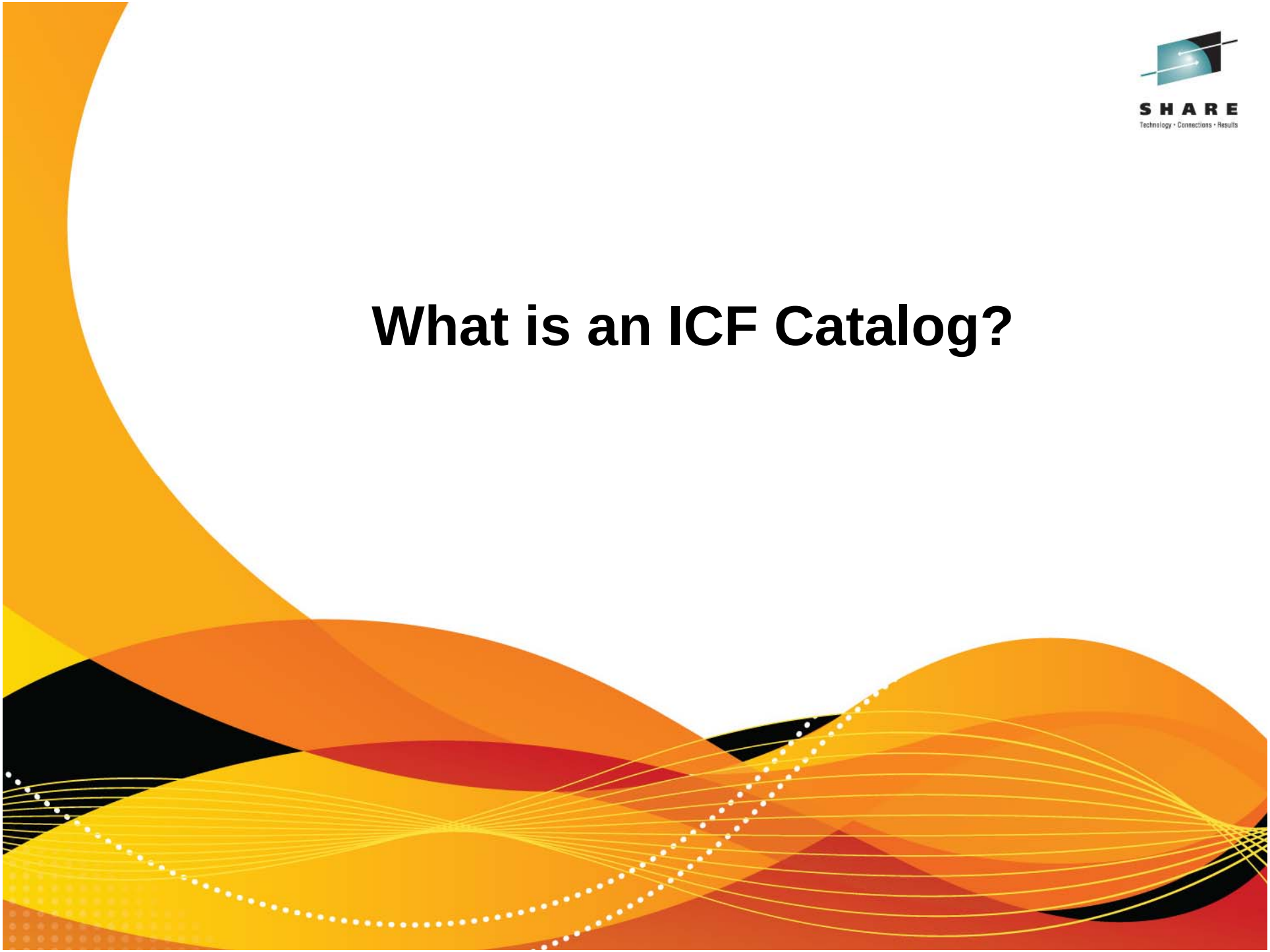
Session 9965

Agenda

- What is an ICF Catalog?
- Catalog Management
- Catalog Problems
- Catalog Maintenance Procedures

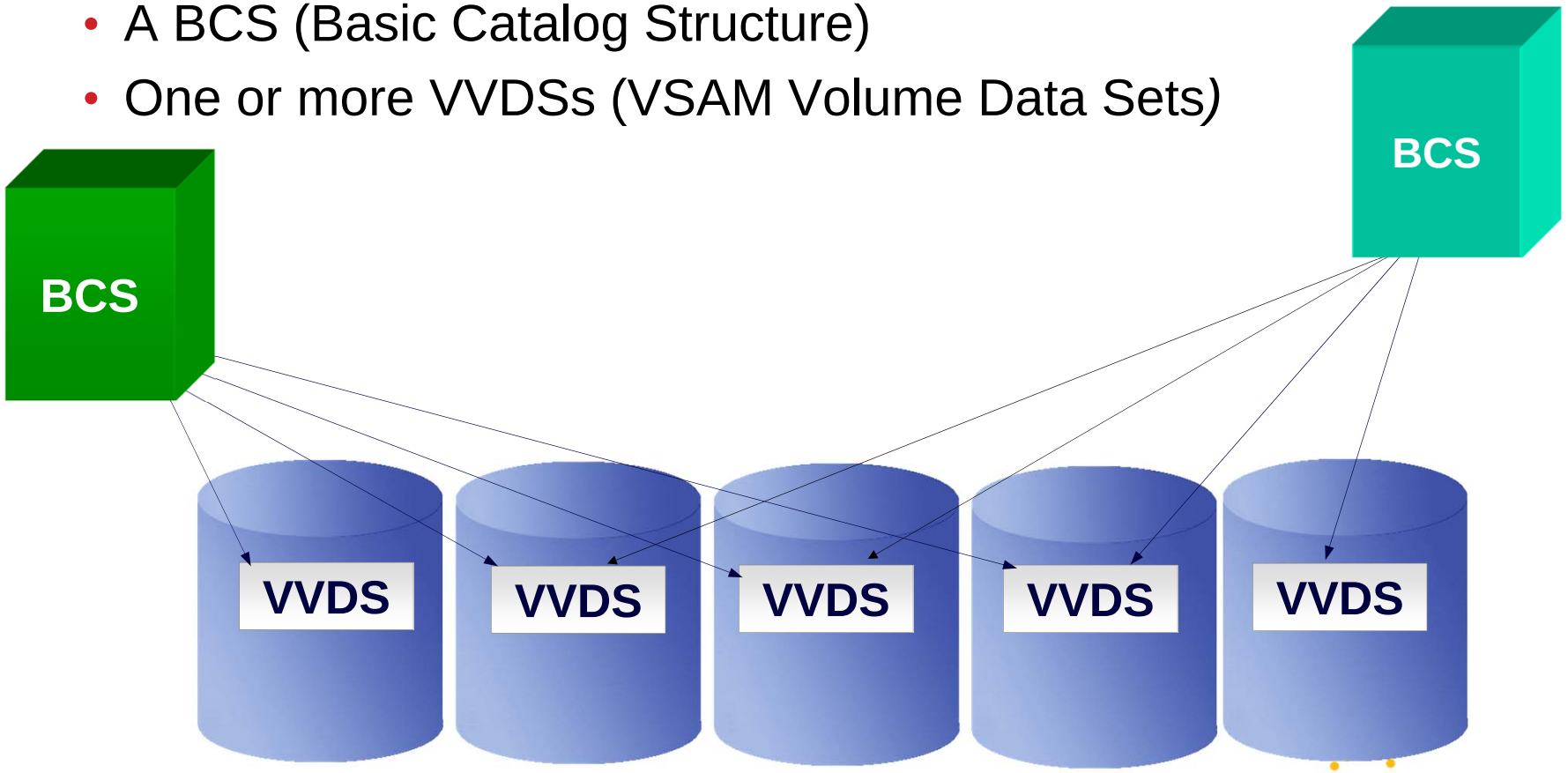


What is an ICF Catalog?

Catalog Structures

An ICF Catalog Consists of:

- A BCS (Basic Catalog Structure)
- One or more VVDSs (VSAM Volume Data Sets)



Catalog Structures

The BCS

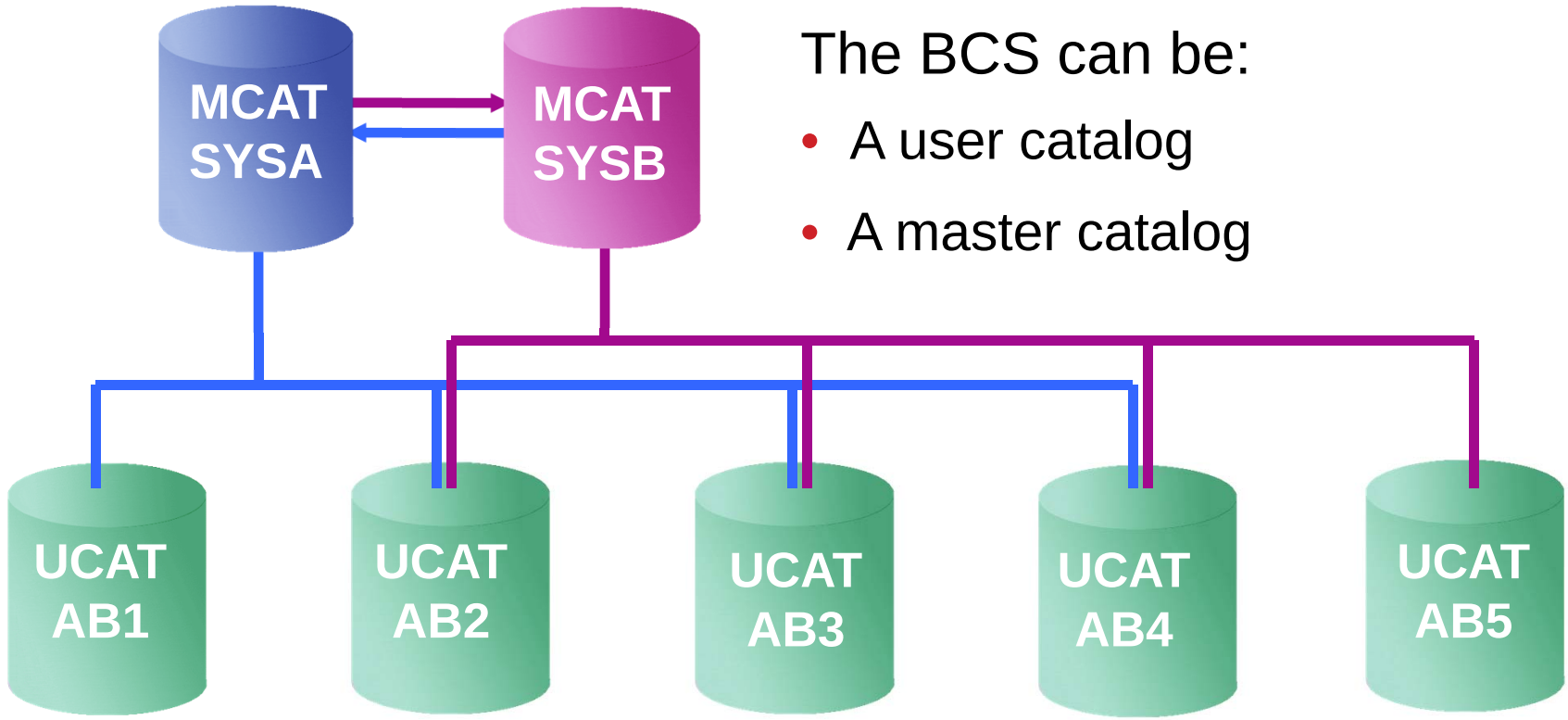
- Is physically a VSAM KSDS
- Records have keys
- Limited to 123 extents
- Contains entries for all data sets, non-VSAM and VSAM, on tape or DASD
- Contents consist of associative information, volsers, and other information needed to locate a data set
- ➢ Data set attribute, extent, and statistic information is not in the BCS – it's in the VVDS

Catalog Structures

The BCS – Record Types

- Non-VSAM record (type code ‘A’)
- GDG sphere record (type code ‘B’)
- Cluster sphere record (type code ‘C’)
- Data component (type code ‘D’)
- Cluster extension record (type code ‘E’)
- Alternate index (type code ‘G’)
- Index component (type code ‘I’)
- GDG extension record (type code ‘J’)
- Path record (type code ‘R’)
- Truename record (type code ‘T’)
- User catalog connector records (type code ‘U’)
- Alias records (type code ‘X’)

Catalog Structures



The BCS can be:

- A user catalog
- A master catalog

Alias Names:

ABC1	**CDE1**	**FGH1**	**JKL1**	**MNO1**
ABC2	**CDE2**	**FGH2**	**JKL2**	**MNO2**

Catalog Structures

The VVDS

- Is physically a VSAM ESDS
- Records have component names, not keys
- Access is direct by RBA to a control interval
- Contains the BCS names for the data sets on the volume
- Record types are:
  - VSAM Volume Record (VVR) for a VSAM component
    - *Type 'Z' for a primary record (DSNs, attributes, extents)*
    - *Type 'Q' for a secondary record (DSNs, extents)*
  - Non-VSAM Record (NVR) for non-VSAM data sets
    - *Type 'N' record (DSNs)*
  - Various control records (VVCR, VVCN, VVCM)

Catalog Structures

VVDS Rules

- The name of the VVDS is:

  SYS1.VVDS.Vvolser

- The size of the VVDS is your choice and should be at least 1 cylinder
  - Implicitly allocated if you don't allocate – the default size will be TRK(10,10)
- Since z/OS 1.7 a system default can be set
  - Default is not preserved across an IPL
  - F CATALOG,VVDSSPACE(*prim,sec*)
    - *Space values specified are in tracks*

Catalog Structures

Volume Table of Contents (VTOC)

- A system data set which maintains extent and allocation information for a volume
- Used to find empty space for new allocations and to locate non-VSAM data sets
- Used to obtain information not kept in the VVDS for all VSAM data sets and SMS managed non-VSAM data sets
- Data Set Control Blocks (DSCBs)
  - “F0” – Free DSCB
  - “F1” – DSN and 3 extent definitions
  - “F3” – 13 extent definitions
  - “F4” – VTOC “DSN” definition

Catalog Structures

BCS Relationships

- For a VSAM component – the BCS points to the VVR in the VVDS
- For non-VSAM data sets – the BCS points to the VTOC Format 1 (“F1”) DSCB
  - Even if they are SMS managed

Working with Catalogs

Catalog Management

Identifying the Master Catalog at IPL

- Specified in the SYSCAT statement of LOADxx
  - In SYSn.IPLPARM or SYS1.PARMLIB
  - The value of “xx” is specified on the Hardware Management Console (HMC)
- If LOADxx is missing, then the location of the master catalog is specified via the SYSCATyy member of SYS1.NUCLEUS
  - The operator is prompted for “yy” at IPL
  - The default member is SYSCATLG

Catalog Management

SYSCAT Statement in LOADxx

```
SYSCAT   volserxycscatname
*---+----1----+----2----+----3----+----4----+----5----+----6----+----7--
*        VVVVVV    |<-------   CATALOG DATASET NAME    ------->|VVVVVVVV
*        |    |                                                 | HLQ  |
*        |    |                                                 | OF   |
*        CATVSN                                                  | TCDB |
```

- Columns 10-15 – The volume serial of the master catalog
- Column 16 – The character ‘1’ unless SYS% to SYS1 conversion is active, in which case this will be a ‘2’
- Column 17 – Alias name level of qualification (default: 1)
- Columns 18-19 – CAS service task lower limit (default: X’3C’)
- Columns 20-63 – The 44-byte data set name of the master catalog
- Columns 64-71 – The high level qualifier of the tape volume catalog (default: SYS1)
- Column 72 – Specify ‘Y’ to enable AUTOADD when CAS makes the first connection to the coupling facility

Catalog Management

SYSCATyy Member in SYS1.NUCLEUS

```
Bytes
----+----1----+----2----+----3----+----4----+----5----+----6----
|VVVVV|   |<-------   CATALOG DATASET NAME    ------->|VVVVVVV|
|     |   |                                           | HLQ   |
| VOL |   |                                           | OF    |
|     |   |                                           | TCDB  |
```

- Columns 1-6 – The volume serial of the master catalog
- Column 7 – The character ‘1’ unless SYS% to SYS1 conversion is active, in which case this will be a ‘2’
- Column 8 – Alias name level of qualification (default: 1)
- Columns 9-10 – CAS service task lower limit (default: X’3C’)
- Columns 11-55 – The 44-byte data set name of the master catalog
- Columns 55-62 – The high level qualifier of the tape volume catalog (blank means there is no tape volume catalog)
- Column 63 – Specify ‘Y’ to enable AUTOADD when CAS makes the first connection to the coupling facility

Catalog Management

Types of Entries in a Master Catalog

- System related data sets
  - SYS1 and other data sets needed at IPL time
  - Page data sets
  - IODF
- User catalog connector records
  - Created with IDCAMS IMPORT CONNECT
- Alias records
  - Created with IDCAMS DEFINE ALIAS
  - An alias name defined in the master catalog can be used to reference a user catalog

Catalog Management

Defining a Catalog

- Use IDCAMS DEFINE USERCATALOG
- Cannot span volumes
- Cannot be defined as a striped data set
- Can be an Extended Addressibility data set with z/OS 1.12 or higher
- Allocate in cylinders
  - Results in maximum possible CA size of 1 cyl
- Specify secondary space value > 1 cyl
  - To prevent each CA split from requiring another extent

Catalog Management

Defining a Catalog (continued)

- Recommend Data CISIZE of 4KB
  - Provides a compromise between minimizing data transfer time and reducing the occurrence of spanned records
- Use minimum Index CISIZE of 3584 if using a 4KB Data CISIZE
  - Don’t take the default
- Start with STRNO(3)
  - Default is 2
- Don’t code BUFFERSPACE
  - Use BUFND and BUFNI instead
- Take the defaults for SHAREOPTIONS and RECORDSIZE

Catalog Management

Example of Defining a Non-SMS Managed Catalog

```
//DEFCAT   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 DEFINE USERCATALOG -
  (NAME(CATALOG.USERCAT1) -
   VOLUMES(VOL001) -
   ICFCATALOG -
   CISZ(4096) STRNO(3) -
   CYLINDERS(20,5))
/*
```

Catalog Management

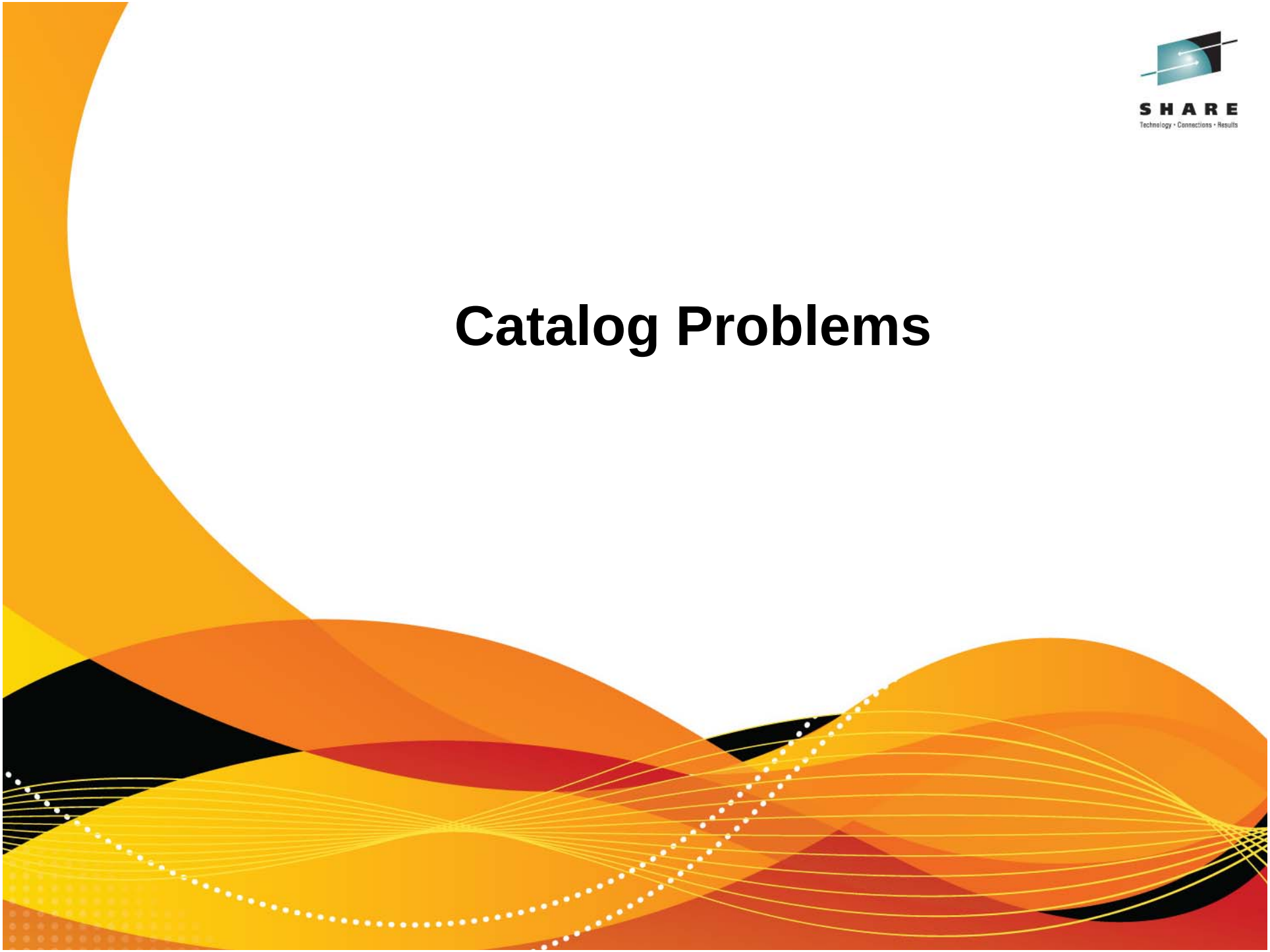
Example of Defining an SMS Managed Catalog

```
//DEFCAT   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 DEFINE USERCATALOG -
  (NAME(CATALOG.USERCAT1) -
   MGMTCLAS(MCVSAM) -
   STORCLAS(SCSMS) –
   DATACLAS(DCVSAM) -
   ICFCATALOG -
   CISZ(4096) STRNO(3) -
   CYLINDERS(20,5))
/*
```

Catalog Management

BCSs Can Be Shared

- If sharable: SHR(3 4), the default, tells catalog management the BCS is expected to be shared, so all necessary shared access integrity code is executed
- If not: SHR(3 3) tells catalog management the BCS is not going to be shared, so no shared access integrity code is executed
- The BCS must be on a shared DASD device



Catalog Problems

Catalog Problems

Things go bump in the night …

- Volumes fail and have to be restored
- Catalogs (BCSs and VVDSs) become corrupted and have to be restored
- Data sets become uncataloged, don't ever get cataloged, or are cataloged to the wrong catalog
- Data sets are cataloged, but don't exist
- CAS or caching problems

Problem Indicators

- Inconsistencies between a BCS and its own records, or between a BCS and its related VVDSs
  - ✓*Cluster records with missing truename records*
  - ✓*Orphaned truename records (truename without a matching cluster sphere record)*
  - ✓*Truename loop failure (cluster sphere record that points back to a different cluster sphere record)*
  - ✓*Invalid data content inside a BCS or VVDS*
  - ✓*BCS cluster sphere record that is missing its corresponding VVDS record (or vice versa)*

Problem Indicators

- Missing BCS self-describing cluster sphere record
  - ✓*Is always the first record in the BCS*
- Broken sequence set (SSI) forward address chain pointer problem
  - ✓*Can be caused by using incorrect share options (SHR) when defining the BCS*
- Duplicate or out of sequence records in BCS
  - ✓*Can be caused by a system or CAS crash in the middle of a CI or CA split*

Finding Catalog Problems

Using Access Method Services (IDCAMS)

- EXAMINE INDEXTEST – ensures that sequential and key direct access is accurate
- EXAMINE DATATEST – reads all data CIs to ensure structural integrity
- DIAGNOSE ICFCATALOG (without compare) – checks information integrity within each BCS record (inside-the-BCS only)
- DIAGNOSE VVDS (without compare) – checks information integrity within each VVDS record (inside-the-VVDS only)
- DIAGNOSE is a tool that you use to see synchronization problems between the BCS and VVDS record structure

IDCAMS EXAMINE

Using IDCAMS EXAMINE to Find Problems

```
//STEP1    EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 EXAMINE NAME(CATALOG.UCATTEST) INDEXTEST DATATEST
/*
```

Messages from IDCAMS

EXAMINE

- You want to see:
  - IDC01724I INDEXTEST COMPLETE – NO ERRORS DETECTED
  - IDC01709I DATATEST COMPLETE – NO ERRORS DETECTED
- You may get other messages…
  - IDC0xxxx – Supportive informational messages
  - IDC1xxxx – Individual data set structural error messages
  - IDC2xxxx – Summary error messages
  - IDC3xxxx – Function not performed error messages

Messages from IDCAMS

BCS EXAMINE With Errors

```
IDCAMS  SYSTEM SERVICES          TIME: 18:11:37  01/18/09  PAGE 1
 EXAMINE NAME(CATALOG.ICF.VTSO002) INDEXTEST DATATEST
IDC01700I INDEXTEST BEGINS
IDC01724I INDEXTEST COMPLETE - NO ERRORS DETECTED
IDC01701I DATATEST BEGINS
IDC11733I DATA COMPONENT KEY SEQUENCE ERROR
IDC01717I DATA KEY --  TMVS328.V.D.PMTP0725.ACCINFO.IND
IDC01714I ERROR LOCATED AT OFFSET 00000009
IDC11734I SEQUENCE SET AND DATA CI KEY SEQUENCE MISMATCH
IDC01716I INDEX KEY -- TMVS328.V.D4.PMCOPY1.PDBAUEPC.D
IDC01717I DATA KEY  -- TMVSF5D.QAREPRO.DB2.EXTRACT
IDC01714I ERROR LOCATED AT OFFSET 00000FF6
IDC21703I MAJOR ERRORS FOUND BY DATATEST
IDC0001I FUNCTION COMPLETED, HIGHEST CONDITION CODE WAS 8
```

Key Sequence Error

Index & Data Key Mismatch

IDCAMS DIAGNOSE

Using IDCAMS DIAGNOSE

```
//STEP1    EXEC PGM=IDCAMS
//INCAT    DD DISP=SHR,DSN=CATALOG.UCATTEST
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 DIAGNOSE ICFCAT INFILE(INCAT)
/*
```

Messages from IDCAMS

DIAGNOSE

- IDC21364I – ERROR DETECTED BY DIAGNOSE: {VVDS|ICFCAT} ENTRY: *entry* RECORD: *rec* OFFSET: *offset* REASON: *reason-code*
- This message produces a return code of 8
- Some common *reason-codes*…
  - 11 – Incomplete delete detected
  - 20 – Association not found
  - 23 – Truename loop failure
  - 33 – Incomplete update detected
  - 45 – Volume cell not found

Fixing Catalog Problems

If EXAMINE Identified the Problem

- Can delete data set and recover from recent backup
- Can unload a non-BCS KSDS data set by reading data component directly as an ESDS, sorting data, and then loading into new KSDS
- If a BCS index component is severely damaged, the BCS must be recovered from backup
  - Repair can be accomplished with IBM Tivoli Advanced Catalog Management for z/OS

Fixing Catalog Problems

If DIAGNOSE Identified the Problem

- May indicate an incomplete catalog entry
- If it is an entry in a BCS, delete the catalog record and attempt to recatalog

  DELETE xxx NOSCRATCH

  DEFINE xxx … RECATALOG
- If the truename exists without the associated cluster records:

  DELETE xxx TRUENAME

Fixing Catalog Problems

If DIAGNOSE Identified the Problem (continued)

- If it is an entry in a VVDS:

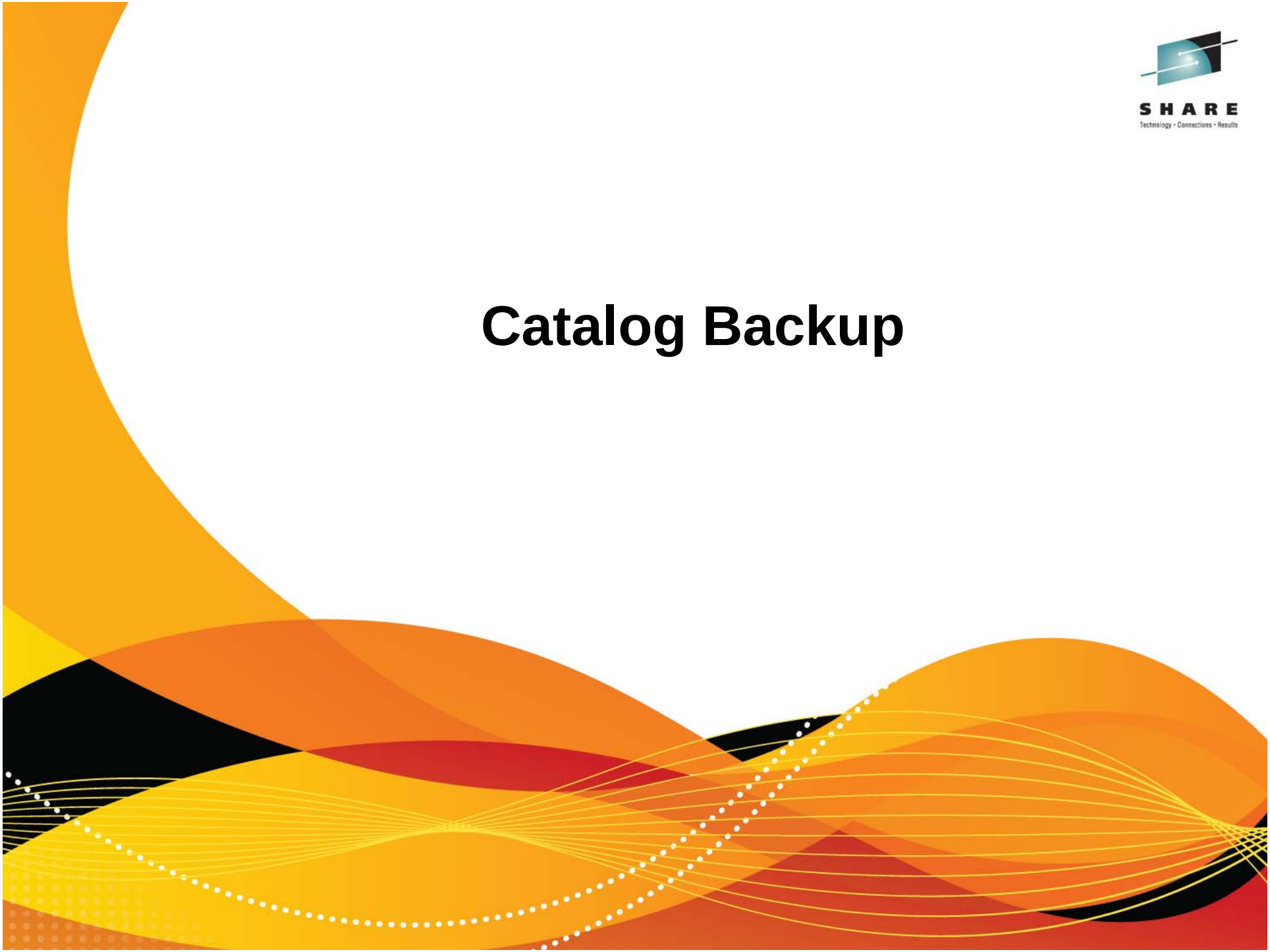
  DELETE xxx VVR

  DELETE xxx NVR

- It may be possible to recatalog the data set

  DEFINE CLUSTER(NAME(xxx) … RECATALOG)

- If missing some portions from the volume, then it must be deleted
  - IDCAMS cannot recreate the data



Catalog Backup

Catalog Backup

IDCAMS EXPORT

- Unloads the catalog records and alias names
- EXPORT may not be able to back up the BCS if it is damaged
- If there is a broken sequence set chain pointer, EXPORT will back up only what can be accessed by the index
  - Many records may not be backed up, but a return code of 0 will be received

Catalog Backup

Using IDCAMS EXPORT to Back Up Catalogs

```
//STEP1    EXEC PGM=IDCAMS
//OUTCAT   DD DSN=BACKUP.CATALOG.TEST,DISP=(NEW,CATLG),
//         SPACE=(CYL,(20,5)),UNIT=SYSDA
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 EXPORT CATALOG.UCATTEST OUTFILE(OUTCAT) TEMPORARY
/*
```

Backing Up the BCS

Rule #1: Back up as often as you can

- How often is enough? It depends…
  - At least once a day for all catalogs
  - More often for volatile catalogs – where you are creating lots of SMF records – indicating heavy data set DEFINEs, DELETEs, and allocation extensions
  - More often for critical catalogs – ones that would present a major problem if recovery isn't fast
  - Less often for non-volatile catalogs

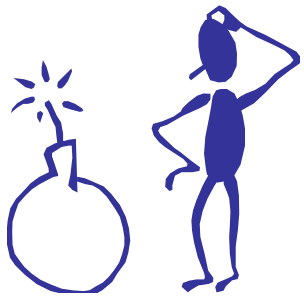
Backing Up the BCS

Rule #2: Verify all BCSs are included in the backup

- When was the last time you audited your backup job to see the list of catalogs backed up?
- Obtain a list of connected catalogs in all master catalogs

```
LISTCAT UCAT
        LISTING FROM CATALOG -- CATALOG.MASTER.CAT
USERCATALOG --- CAT.ICF.USER1
USERCATALOG --- CAT.ICF.USER2
...
```

- Compare the list to your catalog backup job, and ensure that all are backed up



Backing Up the BCS

Rule #3: Double check that the backups are working

- Establish a regular method to check catalog backup return codes
- Ensure you run EXAMINE INDEXTEST on each catalog – and then check the output!
- Consider duplexing your backups – and create a third copy for your disaster recovery (DR) site

Backing Up the BCS

Rule #4: Verify that you can recover

- Can you locate your backups? If duplexed, catalog each in a different user catalog
- Can you locate your SMF data? How many systems are sharing the catalog? What catalog is it cataloged in?
- Test, test, test – if a problem occurs and you can't recover, your goose is …

SHARE in Orlando 2011

Catalog Recovery

Catalog Recovery

- Catalogs can be recovered/restored with IDCAMS IMPORT (after having been EXPORTed)
- Because of the dynamic nature of catalogs, this process is useful only when a backup has been taken immediately before the recovery

Recovery Using IDCAMS

Using IDCAMS IMPORT to Recover a Catalog

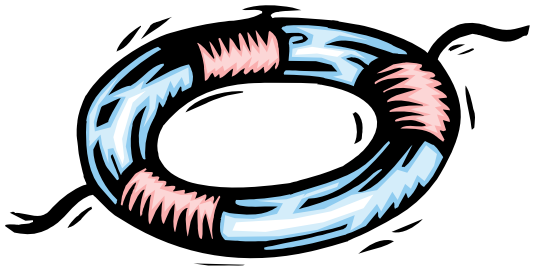
```
//STEP1    EXEC PGM=IDCAMS
//INCAT    DD DSN=BACKUP.CATALOG.TEST,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
 IMPORT INFILE(INCAT) OUTDATASET(CATALOG.UCATTEST) ALIAS
/*
```

Catalog Forward Recovery

BCS Forward Recovery

SMF Records Are the Only Way

- For BCS forward recovery, SMF record types required:
  - Type 61 – Data set define
  - Type 65 – Data set delete
  - Type 66 – Data set alter



- These records, written between the time of backup and restore, identify all new data sets created, deleted, and extended
- You must have something, and you must know how to use it!
- You should practice BCS forward recovery

ICFRU

Used for BCS Forward Recovery

- IBM field developed product
- Incorporated into DFSMS 1.7 and higher
- Takes IDCAMS EXPORT copy of the BCS and SMF records from all sharing systems as input
- Creates a new EXPORT format backup which is used as input to IDCAMS IMPORT to rebuild the catalog

ICFRU

Components of ICFRU

- CRURRSV – Record Selection and Validation
  - Processes dumped SMF data sets
  - Extracts appropriate records
- CRURRAP – Record Analysis and Processing
  - Processes the extracted and sorted SMF records, together with an EXPORT copy of the catalog
  - Produces a new EXPORT format data set to be imported to build a new catalog

Other Catalog Maintenance Activities

Reorganizing Catalogs

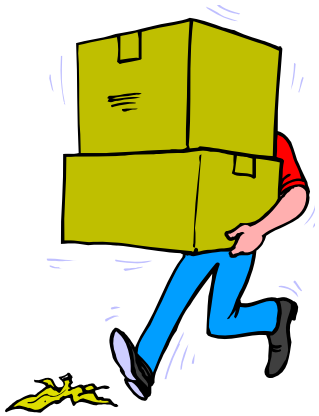
What Is Reorganization and When Do I Do It?

- The process by which a catalog is backed up and then immediately recovered to rebuild the index and data components and is commonly used to:
  - Remove CA and CI splits
  - Reduce extents
  - Change an attribute
- Recommended only when the catalog is approaching maximum extents, or there has been a large amount of data set deletion activity against the catalog
- IDCAMS EXPORT followed by IMPORT can be used to reorganize a catalog

Splitting and Merging Catalogs

What Is Splitting and Merging?

- The process by which a group of data set entries are moved or copied from one catalog to another for space, performance, or other reasons
- Catalogs may be combined (merged) or divided (split) to achieve the best balance



Splitting and Merging Catalogs

Using IDCAMS

- IDCAMS REPRO MERGECAT is used to move data set entries either individually, by a high level qualifier group, or all entries from one catalog to another
  - The output catalog may already have other data set entries in it
  - Entries are deleted from the input catalog after they are successfully added to the output catalog
  - The VVRs for the data set entries moved are updated to point to the new output catalog

Splitting and Merging Catalogs

Using IDCAMS (continued)

- IDCAMS REPRO NOMERGECAT is used to copy the entire input catalog into a new, empty output catalog
  - The output catalog must be empty
  - The VVRs for the data set entries copied are updated to point to the new output catalog following REPRO NOMERGECAT processing
    - All subsequent processing must be done to the new output catalog

Disaster Recovery Planning

What About that Disaster Recovery (DR) Test?

- Disaster recovery is not your everyday task to perform, but it needs to be prepared for every day
- Plan the timing of your DR catalog backups so that you can know the state of the corresponding data to be recovered
- You want to have the catalog entries synchronized with the data recovered as closely as possible

Summary of Activities

Daily Activities

- ✓Backup
- ✓Diagnostics
- ✓Disaster recovery backups

Periodic Activities

- ✓Catalog reorganization
- ✓Splitting or merging

Final Thoughts

- Daily activities ensure catalog integrity and prevent loss of data
- Minimizes risk of catastrophic catalog failure
- Ensures readiness in case of disaster
- Improves catalog recoverability in case of catalog failure

For More Information

- *z/OS DFSMS Access Method Services for Catalogs* – SC26-7394
- *z/OS DFSMS: Managing Catalogs* – SC26-7409
- *ICF Catalog Backup and Recovery: A Practical Guide* – IBM Redbook SG24-5644

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