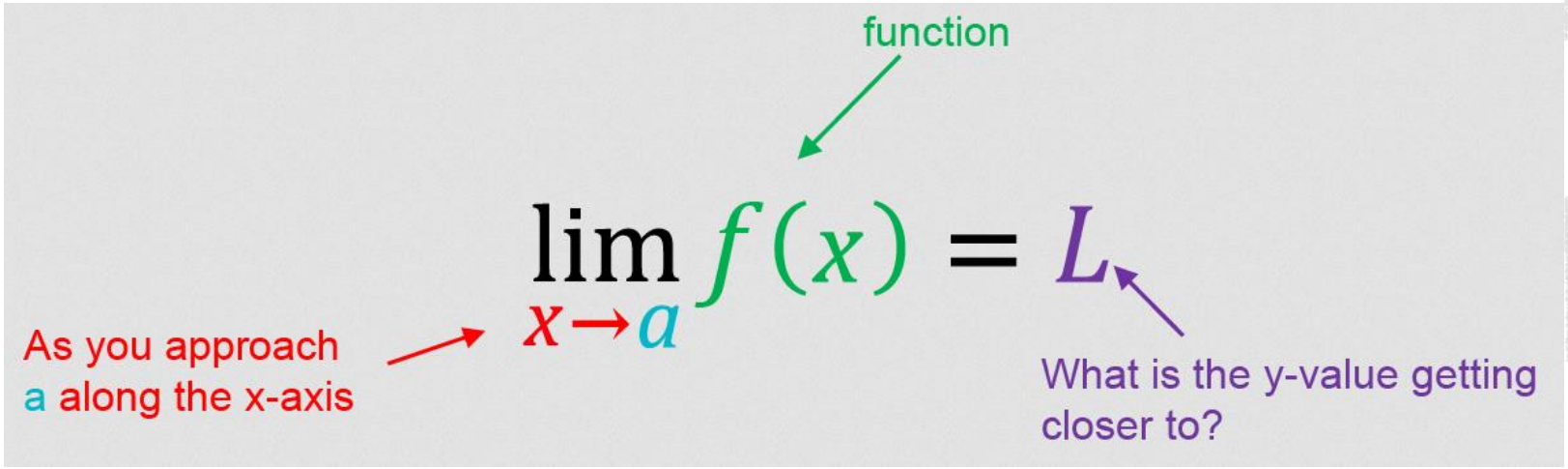
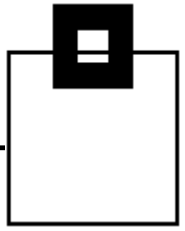
Db2 for z/OS Know your Limits!



Agenda



- Limits through the machine
- Limits through logic
- Limits through design
- Future directions

Agenda

- Limits through the machine
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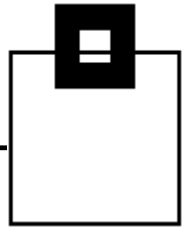
Limits through the machine

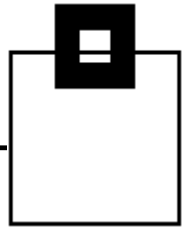


They say that space is infinite - up to a point

The same is true for Db2!

If you can imagine having infinite disk space and infinite memory, what limits could there possibly be?

Limits through the machine



In the beginning was the VSAM Cluster…

Well before Db2 saw the light of day

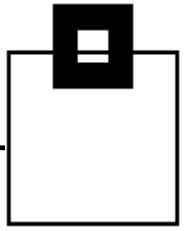
Older than me!

Size limits of 4GB per dataset – that is HUGE!

We will never get that much data…

Remember Bill Gates and the apocryphal story about 640KB of RAM…

Limits through the machine



The VSAM limit is actually split into different limits that the DBA and Db2 must work with

- Simple/Segmented VSAM Linear Dataset (LDS from now on) is limited to 2GB
- Partitioned Space 1GB, 2GB, 4GB, 8GB, 16GB, 32GB, 64GB – For larger than 4GB objects you must have a data class in SMS with the Extended Format and Extended Addressability set
- Non-partitioned indexes also have PIECESIZE which starts at 256KB and then binary steps all the way up to 268435456KB !
  - Thankfully you can also allocate in MB or GB

Limits through the machine

Piecesize continued…

- However any value larger than 2GB requires DSSIZE or LARGE on the tablespace definition

Here you can also see that a seemingly simple question
"How many pieces (datasets) can my index have?"

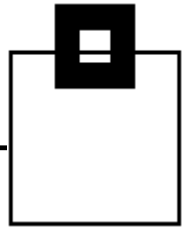
Gets a rather complex answer:

MIN (4096 , 2^{32} / (DSSIZE / TS PGSIZE))

Eg: 128GB DSSIZE with 8KB Tablespace Page Size gives 256 Pieces (datasets) or for a 4GB DSSIZE with 4KB Tablespace Page Size gives 4096 Pieces (datasets).

All clear on that??

Limits through the machine



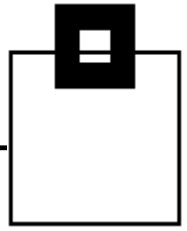
Hooray for Db2 12 FL500!

In Db2 12 we get the Relative Page Numbering (RPN) PBR with variable DSSIZE and *also* a variable DSSIZE for the partitioning indexes. Plus the DSSIZE GB does not have to be a binary number.

To do this the RID has increased to seven bytes but it completely decouples the number of partitions from the equation which is a very good thing!

However the rule is still true that for larger than 4GB objects you must have a data class in SMS with the Extended Format and Extended Addressability set.

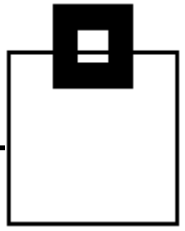
Limits through the machine



These dataset limits then go into the LDS arena:

- A simple or segmented space can have 32 LDSs
- A non-partitioning index can have a „number“ of pieces
- A LOB space can have 254 LDSs
- A Partition can only have one of course!

Limits through the machine



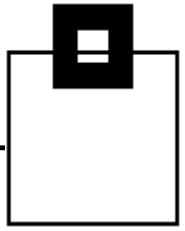
This is then the first set of limits for us.

You must monitor how many LDSs all of your simple, segmented and LOB objects have and you must get warned well before you hit the buffers! If you have 32 LDSs the REORG might take a while…

Partitioned objects are of course different…

Here you must monitor how full each partition is and how full each index is and how many pieces there are. Is that all?

Limits through the machine



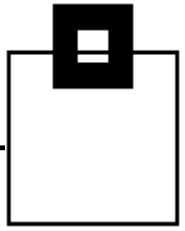
No! Of course not…

The Partition By Growth (PBG) Universal Table Space (UTS) construct brought with it some "new" problems:

1) No partitioning index allowed – only NPSIs on these
2) MAXPARTITIONS is the new LDS limit

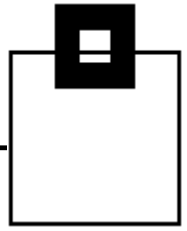
So, for all your PBGs you must monitor not only how many partitions they currently have, but also how full is that very last partition when you have it allocated!

Limits through the machine



Ok, so now you are checking how many LDSs of which size for all of your different objects – Everything must be ok now??

Limits through the machine



No! Of course not…

Think SMS Copy Pool sizes…When you are using flashcopy or just normal Image Copy you must guarantee that you have enough space to actually do all the copies you want to do…

Normally this job is done by the storage team but I think it would be a good idea if the DBA also checked whether or not the copy pool is up to its name - or is it only a puddle?

Agenda

- Limits through the machine
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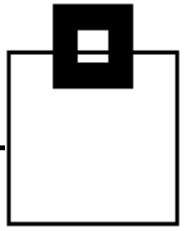
Limits through Logic

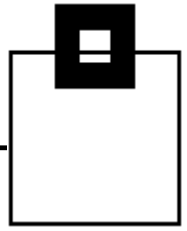


Now we get to the part where Db2 constructs start saying “no”

Think SEQUENCEs here… A quick look in the SQL guide will show you that when you create a SEQUENCE:

```
CREATE SEQUENCE ROY_TEST_SEQ_ASC
        START WITH 1
        INCREMENT BY 1
        MAXVALUE 9999
        CACHE 10;
```

Limits through Logic

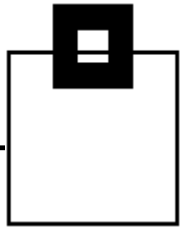


You actually get:

```
CREATE SEQUENCE ROY_TEST_SEQ_ASC
        START WITH 1
        INCREMENT BY 1
        MAXVALUE 9999
        NO CYCLE
        CACHE 10;
```


The “NO CYCLE” is the, by default, bad guy here… This is a -904 waiting to happen…

Limits through Logic



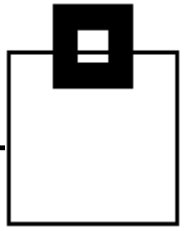
For all of SEQUENCEs you must periodically see how close to the top or the bottom of your available range.

This is also true for Identity columns and XML DOC Ids:

```
SEQTYPE CHAR(1) NOT NULL
Type of sequence object:
      A Alias for a sequence
      I An identity column
      S A user-defined sequence
      X An implicitly created DOCID column for a
           base table that contains XML data.
```

You want to get these *way* before they hit the buffers!

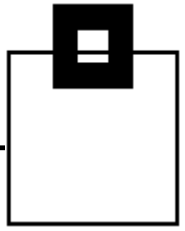
Limits through Logic



Now in the time before SEQUENCEs lots of shops were using SMALLINT or INTEGER defined fields in their tables' Primary Keys doing exactly what a modern sequence does.

Naturally no-one has "updated" these pre-sequence sequences to use proper sequences and so you have another layer of danger lurking out there...

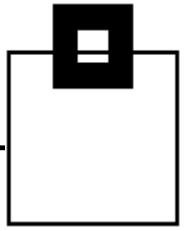
Limits through Logic



You must find all your numerically defined primary key fields and see if they are approaching the Db2 numeric limits...

Item	Limit
Smallest SMALLINT value	-32768
Largest SMALLINT value	32767
Smallest INTEGER value	-2147483648
Largest INTEGER value	2147483647
Smallest BIGINT value	-9223372036854775808
Largest BIGINT value	9223372036854775807
Smallest DECIMAL value	$1 - 10^{31}$
Largest DECIMAL value	$10^{31} - 1$

Limits through Logic



But what are you checking?

Are you looking at just the Db2 Catalog values after a RUNSTATS?

Or

Are you selecting all the columns dynamically from the User Data so you get real values?

Horses for courses - as we say in England…

Agenda

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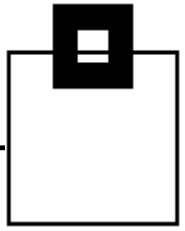
Limits through Design

Design limits that require checking:

How many columns in a table?
How many columns in an index?
How many bytes long is my index?
Is there a Database limit?
Is there an Object limit?
Death by DBAT?

Limits through Design

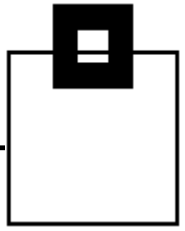


How many columns in a table?

From day one Db2 has allowed 750 columns as the absolute maximum. Depending on View definitions you can actually be forced to have less…

Something to check just in case that ALTER ADD COLUMN is gonna fail horribly…

Limits through Design



How many columns in an index?

From day one Db2 has allowed 64 columns as the absolute maximum. However the byte count varies depending on whether or not the index is a good old partitioning index (PI) or any other index.

For a PI you get a maximum size for:

PADDED indexes of 255 – n bytes

NOT PADDED indexes of 255 – n – 2m – 2d bytes.

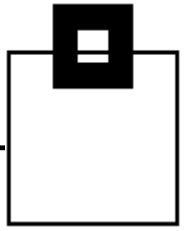
Where:

n is the number of columns which are NULLable

m is the number of varying length columns

d is the number of DECFLOAT columns

Limits through Design



How many columns in an index?

From day one Db2 has allowed 64 columns as the absolute maximum. However the byte count varies depending on whether or not the index is a good old partitioning index (PI) or any other index

For any other indexes you get a maximum size for:

PADDED indexes of 2000 – n bytes

NOT PADDED indexes of 2000 – n – 2m – 2d bytes.

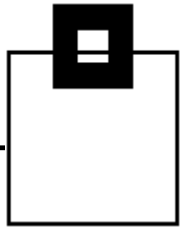
Where:

n is the number of columns which are NULLable

m is the number of varying length columns

d is the number of DECFLOAT columns

Limits through Design



How many bytes long is my index?

In Db2 12 IBM came up with the Fast Traversal Block (FTB) which most people call Fast Index Traversal (FIT) and this comes with a bunch of limits:

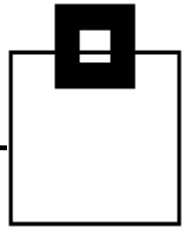
1) Must be a unique index

2) Must have a total length <= 64 bytes

3) No TIMEZONE usage

4) No active versioning

Limits through Design



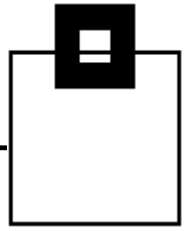
So you can see that you might well be using a FIT and then do e.g.

ALTER INDEX x.y ADD INCLUDE COLUMN (col1)

and *__boom__* the index is no longer eligible for FIT usage...

Check before *every* ALTER INDEX whether or not the index is used by FIT and whether or not your ALTER will tip it over the edge!

Limits through Design



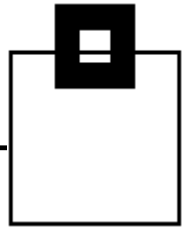
Is there a Database limit?

Yes indeed there is, but nowadays at 65,217 (Back in DB2 V5.1 it was 32,511) it is pretty hard to reach!

However, if you have a lot of implicit Tablespaces where no-one tidies up and DROPs the implicit database it can add up quickly!

Objects perhaps?

Limits through Design



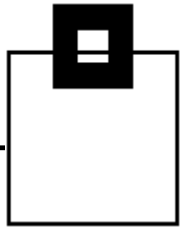
Is there an Object limit?

Actually yes there is! In a Database you can have a maximum of 32,767 OBIDs (Object Ids). Now remember the OBID is not 1:1 for any and all objects.

Each tablespace, index or referential relationship takes two, whereas each table, check constraint, aux for LOB, XML for XML, trigger or view with INSTEAD OF takes one.

So make sure you check these counts on a regular basis as well.

Limits through Design



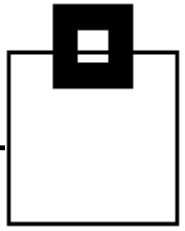
Death by DBAT?

You all know what happens when you run out of DBATs right?

It is not pretty…

Just a –DISPLAY DDF DETAIL is all you need…

Limits through Design

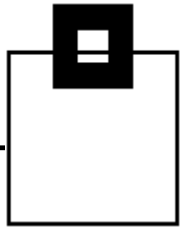


Sadly not…

The problem here is that the DBAT counts that are output when you do a –DISPLAY are, of course, only the *local* counts…

With Datasharing you only see the data of the Member that you are directly connected to which is about as useful as a one legged man at an **** kicking contest…

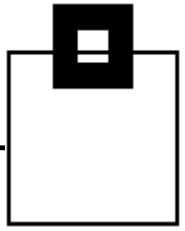
Limits through Design



Here is an example output from a datasharing system:

```
DSNL080I  -SB11 DSNLTDDF DISPLAY DDF REPORT FOLLOWS:
DSNL081I STATUS=STARTD
DSNL082I LOCATION           LUNAME            GENERICLU
DSNL083I xxxxxxxx           xxxxxxxx.xxxxxxxx -NONE
DSNL084I TCPPORT=xxxx  SECPORT=0     RESPORT=xxxx  IPNAME=-NONE
DSNL085I IPADDR=::xxx.xxx.x.xx
DSNL086I SQL    DOMAIN=xxxx.fritz.box
DSNL086I RESYNC DOMAIN=xxxx.fritz.box
DSNL087I ALIAS              PORT  SECPORT STATUS
DSNL088I TEST110            0     0       STOPD
DSNL089I MEMBER IPADDR=::xxx.xxx.x.xx
DSNL090I DT=A  CONDBAT=  10000 MDBAT=  200
DSNL091I MCONQN=    0 MCONQW=   0
DSNL092I ADBAT=    0 QUEDBAT=      0 INADBAT=      0 CONQUED=      0
DSNL093I DSCDBAT=      0 INACONN=      0
DSNL094I WLMHEALTH=100 CLSDCONQN=      0 CLSDCONQW=      0
DSNL100I LOCATION SERVER LIST:
DSNL101I WT IPADDR            IPADDR
DSNL102I 32 ::xxx.xxx.x.xx
DSNL102I 32 ::xxx.xxx.x.xx
DSNL105I CURRENT DDF OPTIONS ARE:
DSNL106I PKGREL = COMMIT
DSNL099I DSNLTDDF DISPLAY DDF REPORT COMPLETE
```

Limits through Design



So you have two choices… write a little REXX that runs a round robin style of –DISPLAYs or get all warm and cuddly with IFI command processing to do it all in one call…

However you get the data, the interesting numbers are in the following two lines of output:

```
DSNL090I DT=A  CONDBAT=  10000 MDBAT=  200
DSNL092I ADBAT=    0 QUEDBAT=      0 INADBAT=      0 CONQUED=      0
```

The MDBAT is your MAXDBAT value and ADBAT is the current number DBATs.

You *must* monitor this all the time to see if any member is running out of DBATs!

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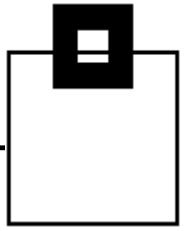
Future directions



IBM keep lifting the limits of Db2.

Now with RPN the last big bottleneck has been broken – You still must do a TS Level REORG with TP level inline image copies to migrate to it and you need a new Mapping table but when you are there it is a much better green than where you are standing now!

Will they ever raise the other limits?

I do not know of course, but I hope they raise the eligibility of FITs soon!

Questions???

Many thanks for your attention and now….