Access Path Recovery for Db2 11 + 12 using RUNSTATS Rescue

Still important in an AI/ML world?

Roy Boxwell, SEG

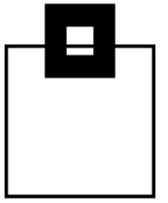
Realworld Experiences from:

REWE GROUP

FIDUCIA GAD ZUKUNFTSERFAHREN

DATEV

RUNSTATS Rescue – Why?



A fact of life is:

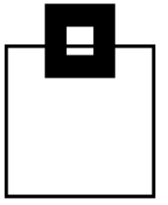
- Access Paths change…
  - Sometimes they get better…
  - Sometimes they don't!

Why does that happen? The classic reasons are:

- Statistics changes
- Index changes
- Any other reason… (APAR, Version, Rainy day etc.)

Wouldn't it be great if you could „turn back time“ – To get the last „good“ statistics and then be rescued from your bad access path?

RUNSTATS Rescue – Db2 Help?



What does Db2 offer when this situation occurs?

For Static SQL – Plan Stability and BIND QUERY

Original Package

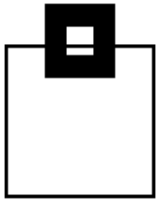
Previous Package

Current Package

Does Plan Management work all the time?

With Schema changes it fails… (View, Index etc.)

RUNSTATS Rescue – Db2 Help?



For Dynamic SQL you get:

Dynamic SQL – BIND QUERY

However BIND QUERY has one major limitation:

"Ensure that object names and SQL keywords in the statement text are specified by uppercase characters, especially for dynamic SQL statements."

RUNSTATS Rescue – Db2 Help?

New in Db2 12 is:

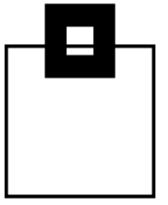
IBM Analytics

Dynamic Plan Stability

- DB2 12 plan – base infrastructure
  - Opaque parameter CACHEDYN_STABILIZATION
  - Capture
    - Command with / without monitoring
    - Global variable
  - FREE
  - EXPLAIN (current, invalid)
  - Invalidation
  - LASTUSED (identify stale statements)
  - Instrumentation (query hash, explain, cache + catalog hit ratio)
  - APPLCOMPAT is part of matching criteria
- Key DB2 12 limitations
  - Temporal stabilization not currently included
  - REBIND support not included
    - No PLANMGMT/SWITCH/APREUSE

How many SQLs are “worth” locking down? Top 10, 20?

RUNSTATS AI/ML – Db2 Help?



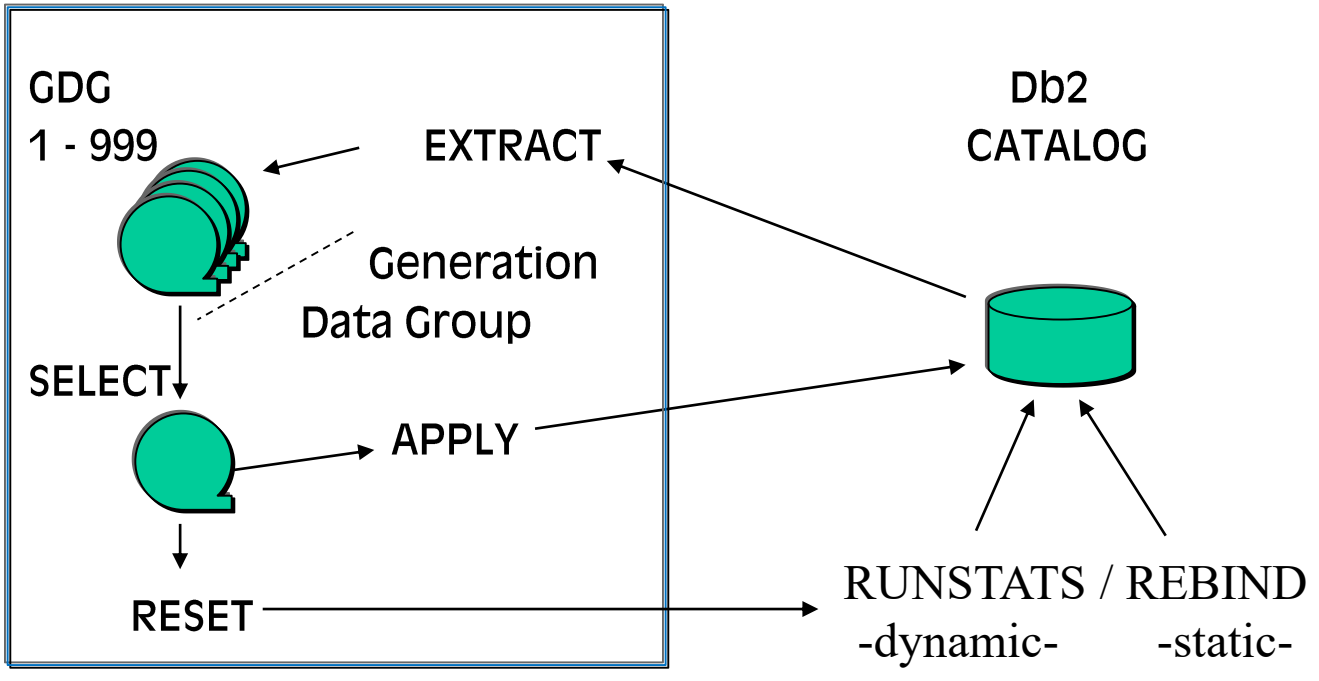
Well, as you are all aware, AI and ML should come and rescue us from bad access paths as well.

How?

The problem is the well known outlier problem. The AI/ML learns on 1000's of SQLs that all run "nominally".

When your application gets a deviant or outlier access path that the AI/ML has not seen before how will it react? Ignore it and hope to learn more for next time… or something completely different?

RUNSTATS Rescue – At a glance



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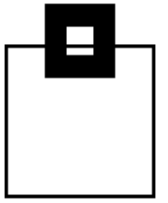
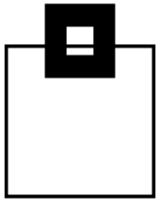


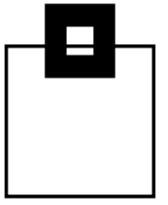
- Keeps a repository and allows to consistently restore statistics
- Quick and easy to use
- Supports dynamic SQL out-of-the-box
- Supports static SQL where Plan Management fails:
  - BINDs resulting from modified programs
  - Schema changes – VIEW changes etc.
- Verifies RUNSTATs as the **reason** for performance degradations

RUNSTATS Rescue (RR)



- RR is a part of Software Engineering's ImpactExpert family of products for Db2 z/OS and as such is a selection from the ImpactExpert Main Menu
- Along with RR there are various tools to help in checking that access paths are *not* going to get worse after a REBIND, a BIND, or a RUNSTATS
- This presentation is only going to go into detail about RR and not all the other functionality that is available in the other tools

RUNSTATS Rescue procedure



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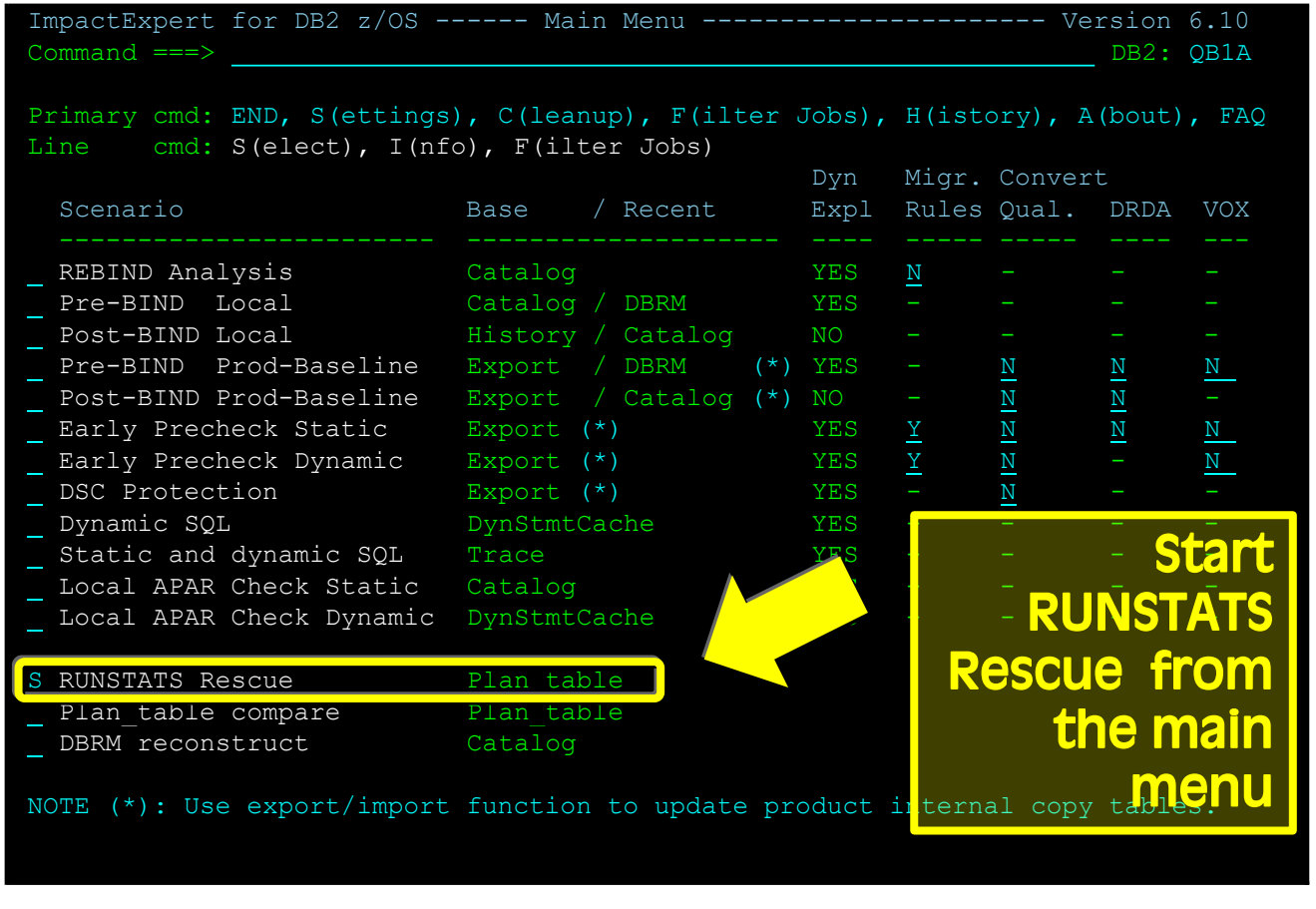
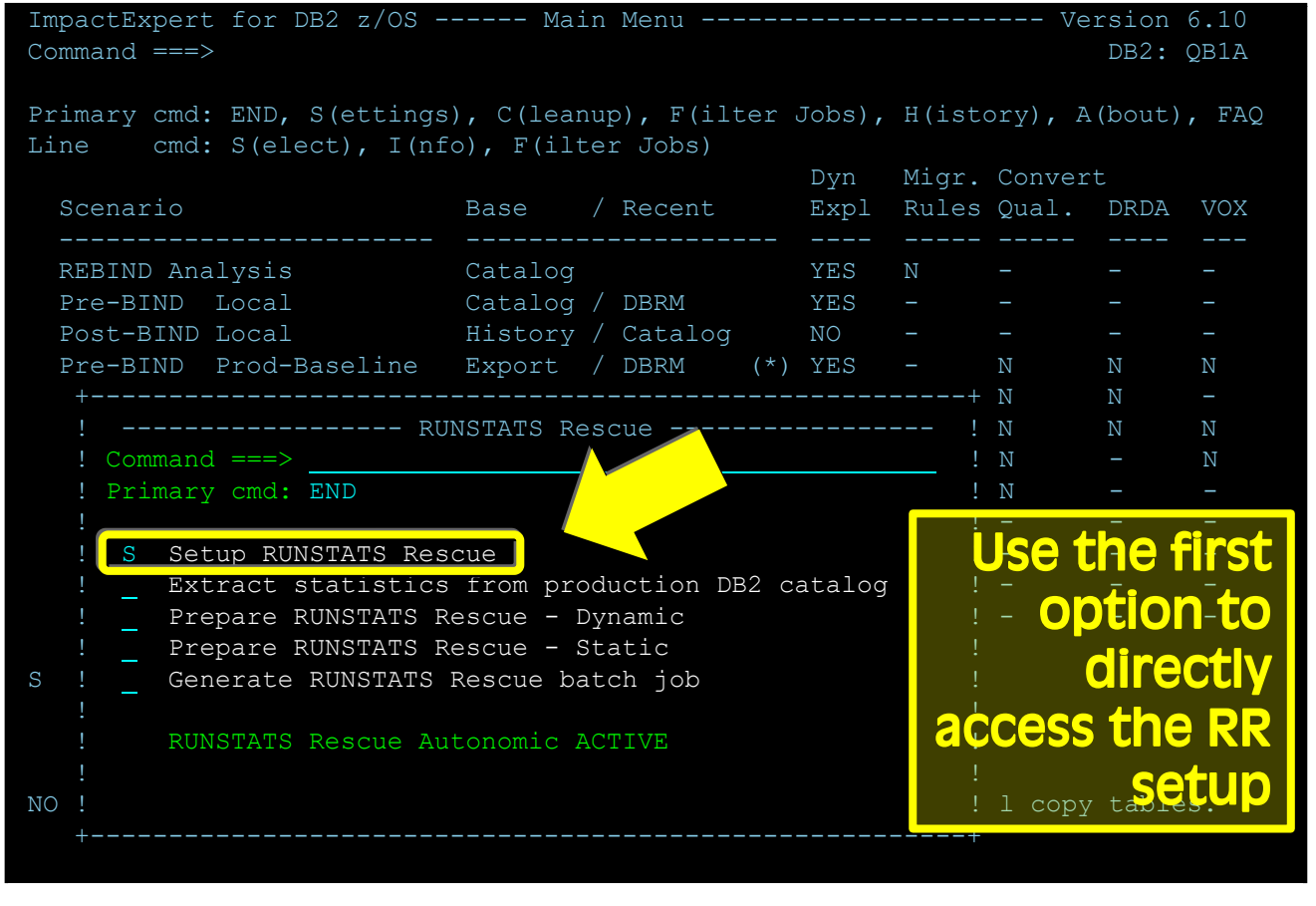
RUNSTATS Rescue – Embedded or Stand-alone



RUNSTATS Rescue – setup



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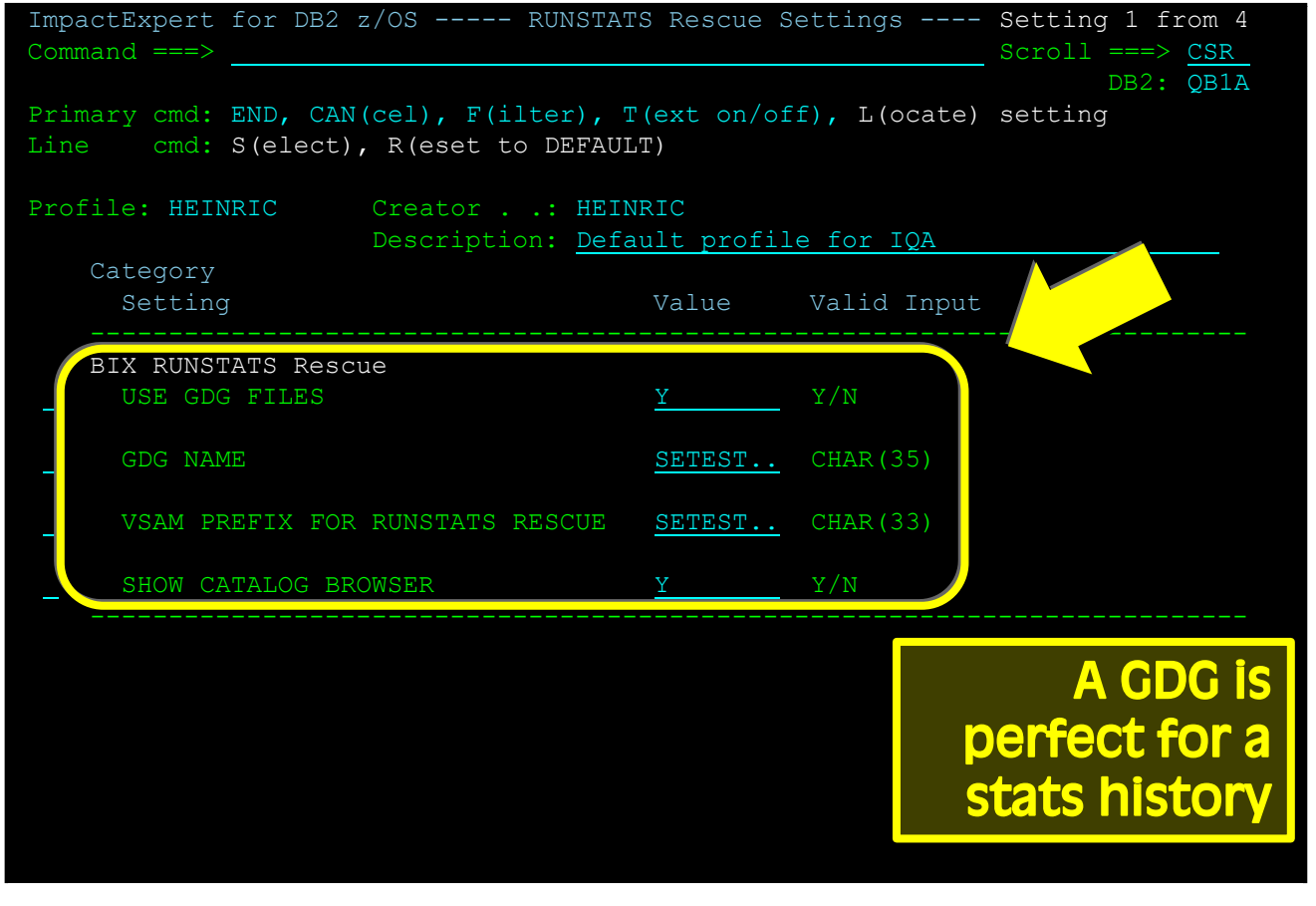

RUNSTATS Rescue – statistics repository

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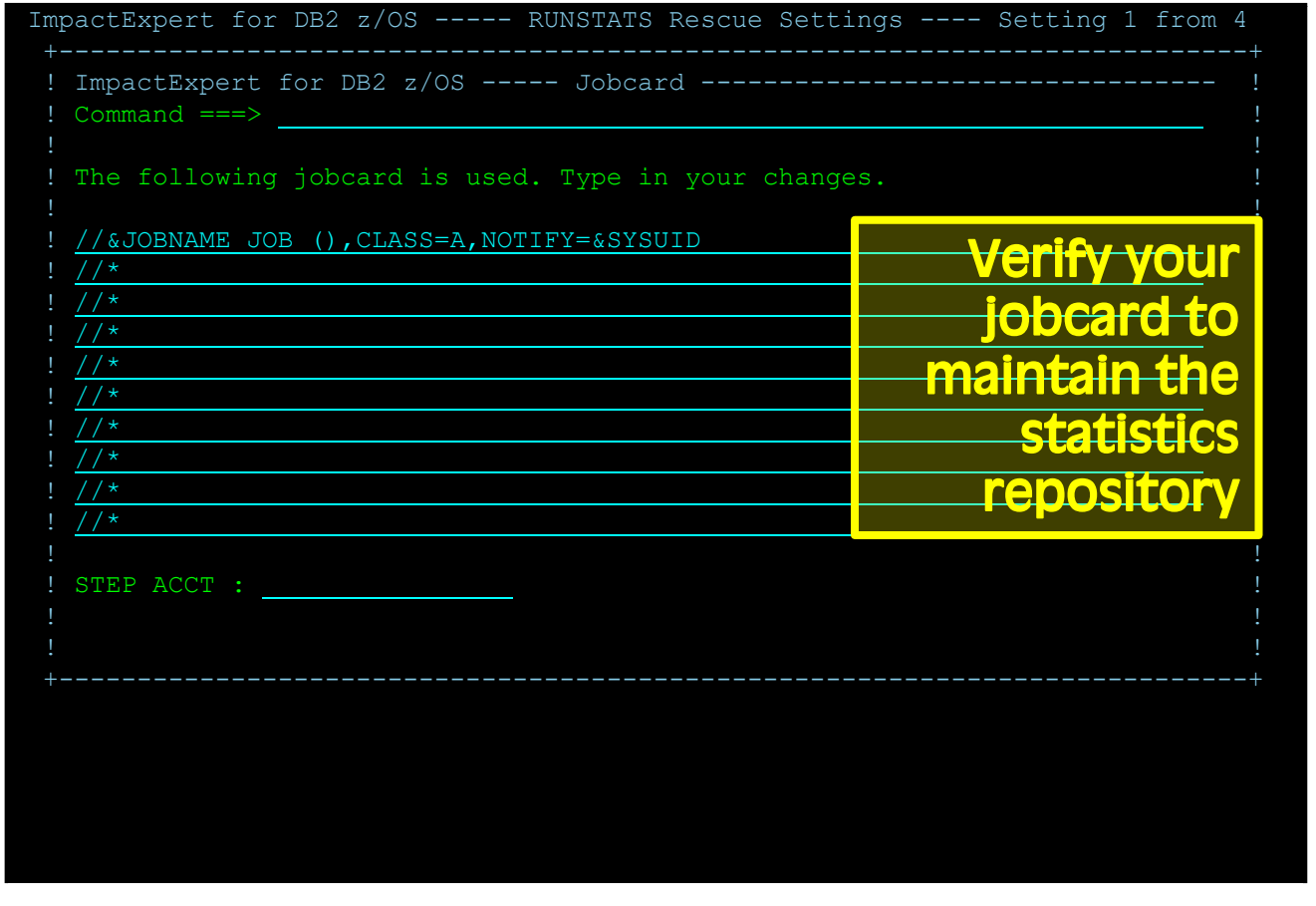
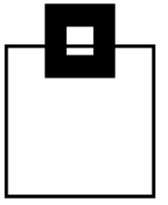


RUNSTATS Rescue – statistics repository

```
ImpactExpert for DB2 z/OS ----- Change Data ----------------------------------
EDIT       SYS16200.T134620.RA000.HEINRIC.R0118781          Columns 00001 00072
Command ===> ____________________________________________ Scroll ===> CSR
000125 </PROD-SIM>
000126 //REPRO2    EXEC PGM=IDCAMS,COND=(0,LT)
000127 //SYSPRINT  DD SYSOUT=*
000128 //SYSIN     DD *
000129   REPRO INFILE(IN)     OUTFILE(OUT)
000130 //IN        DD DISP=SHR,
000131 //             DSN=SETEST.BIX-RR.CATSTTS.STATS
000132 //OUT       DD DISP=(,CATLG),SPACE=(CYL,(50,10
000133 //             DCB=(RECFM=VB,LRECL=8500),
000134 //             DSN=SETEST.BIX-RR.STATS(+1)
000135 //BIX6RSCG EXEC PGM=BIX6RSCG,
000136 //       PARM=('QB1A,IOAP06OB,IOA061OB,Y,N')
000137 //STEPLIB   DD DISP=SHR,DSN=SE.PRODUCT.BTFOR.IOA0610.QB1A.LOAD
000138 //          DD DISP=SHR,DSN=SYS1.SIEALOAD
000139 //          DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000140 //          DD DISP=SHR,DSN=DSNB10.DSNLOAD
000141 //BIXGDG    DD DISP=SHR,DSN=*.REPRO2.OUT
000142 //BIXPROT   DD SYSOUT=*
000143 //BIXINPUT  DD *
000144 //SYSOUT    DD SYSOUT=*
000145 //ERRORLOG  DD SYSOUT=*
000146 //*SEDYNSQL  DD SYSOUT=*
000147 //
****** ***************************** Bottom of Data ****************************
```

Using a GDG is a simple way to keep *n* generations of statistics. In z/OS 2.2 the limit was raised from 255 -> 999

RUNSTATS Rescue procedure



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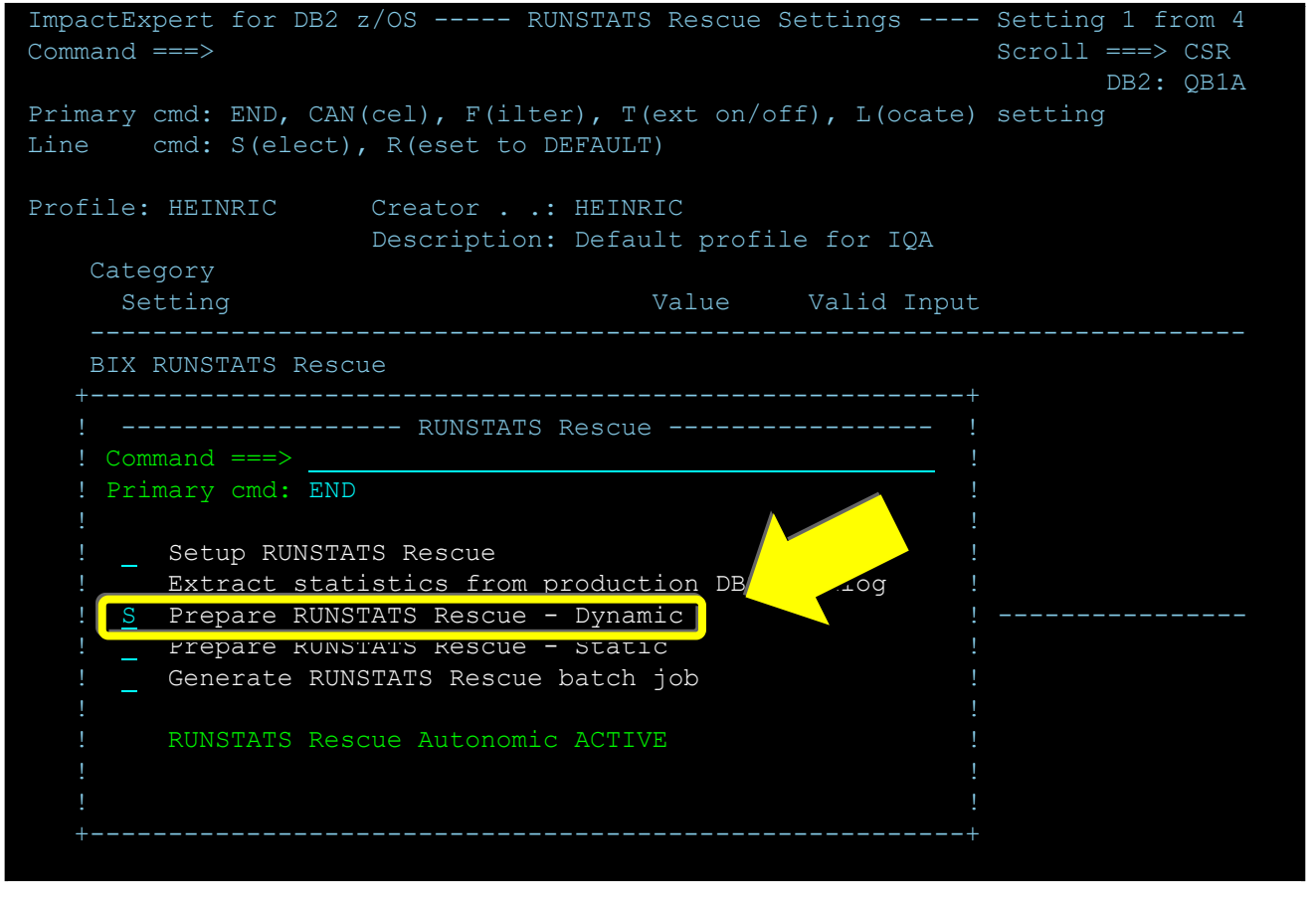
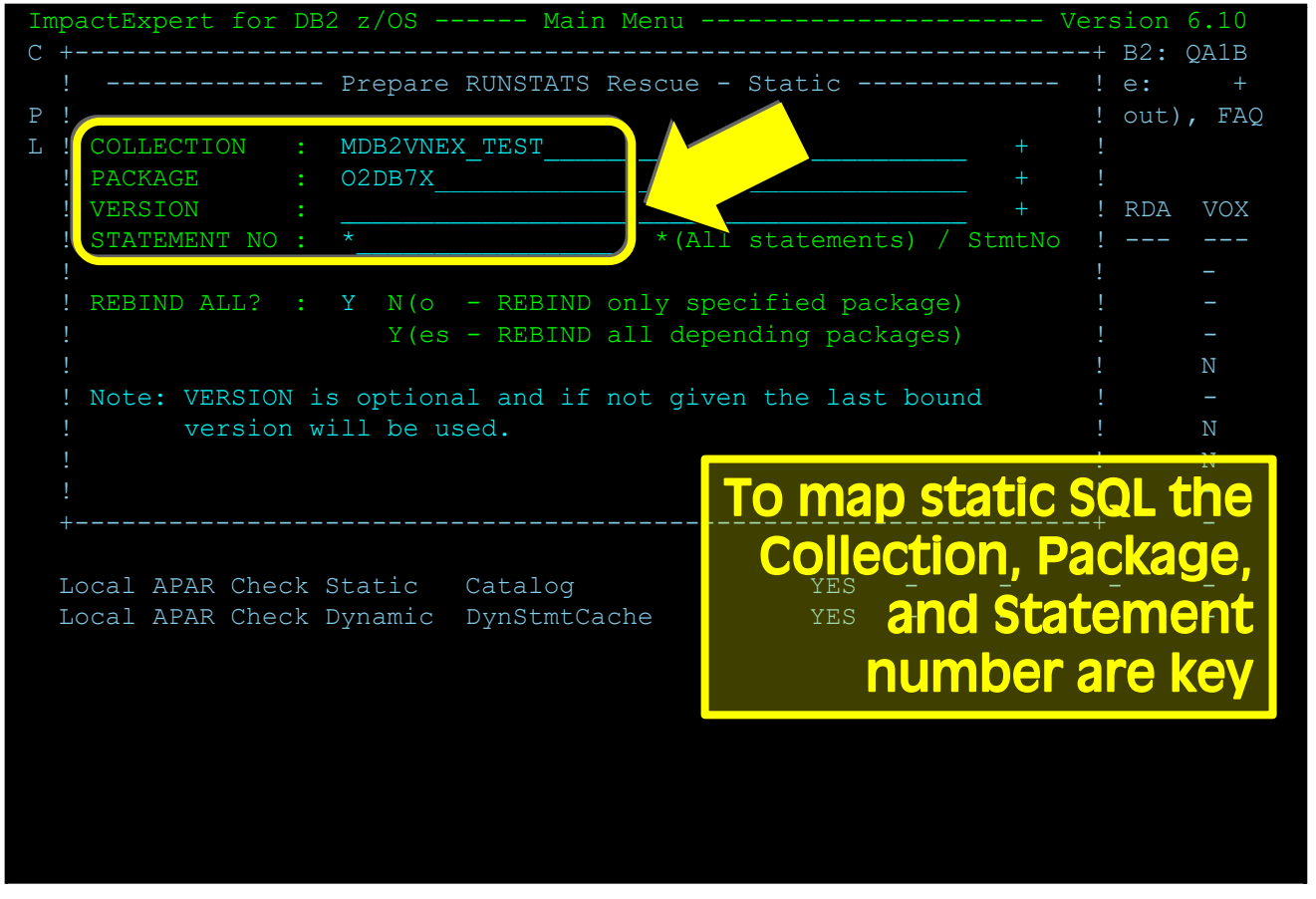
RUNSTATS Rescue – dynamic SQL



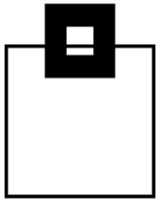
RUNSTATS Rescue – dynamic SQL

RUNSTATS Rescue – static SQL



To map static SQL the Collection, Package, and Statement number are key

RUNSTATS Rescue procedure



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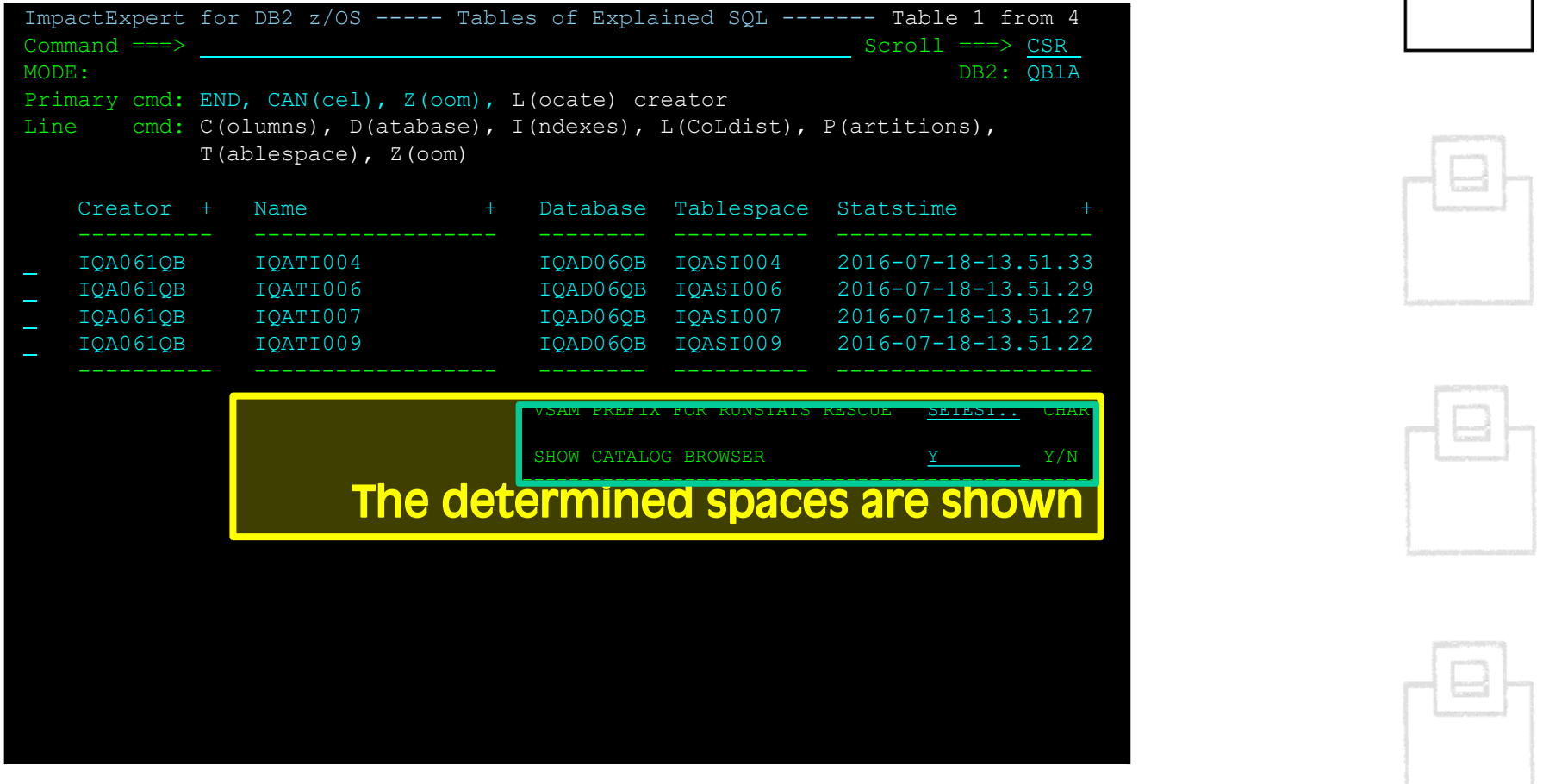

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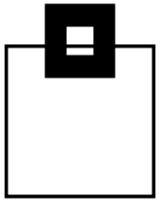

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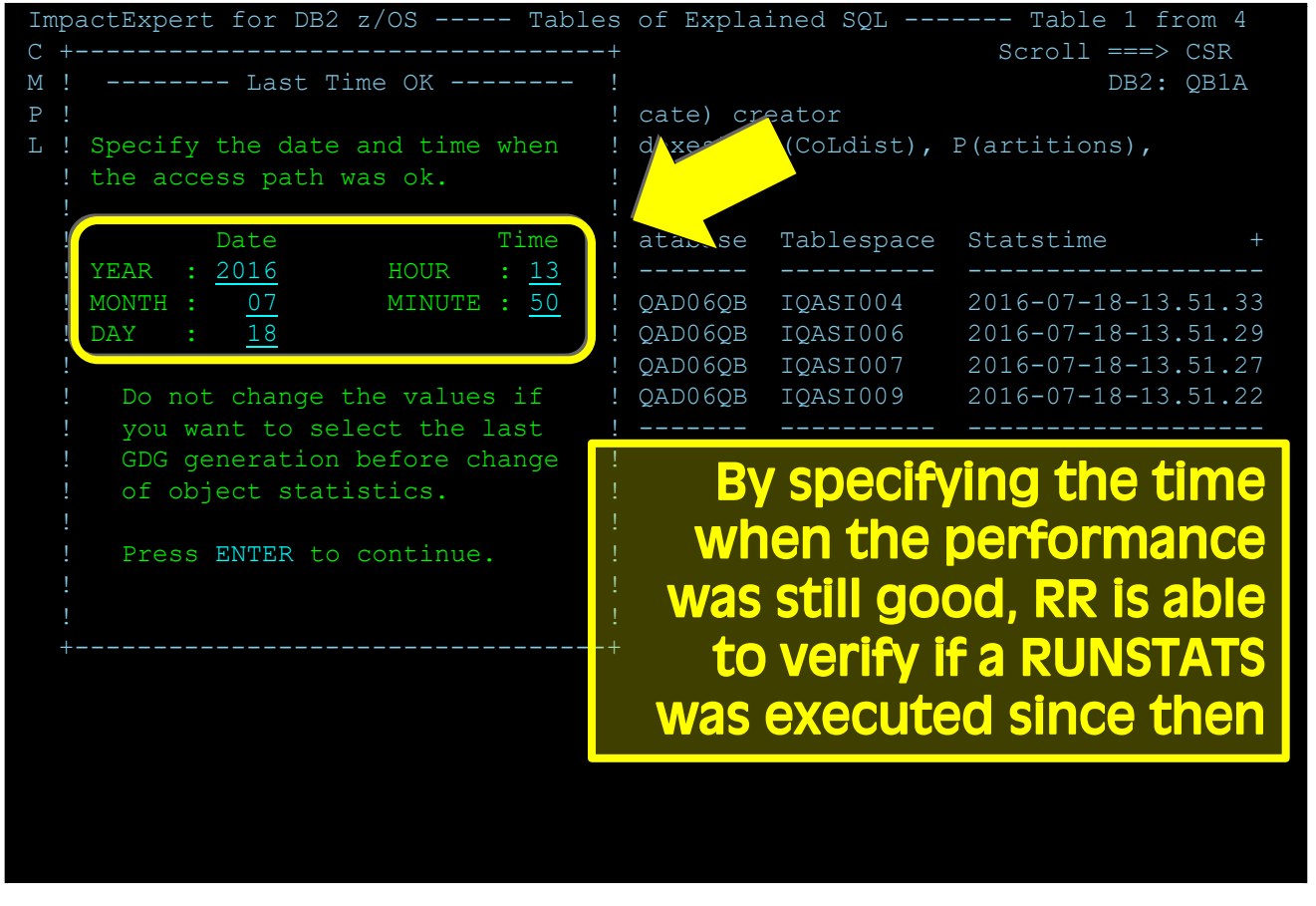

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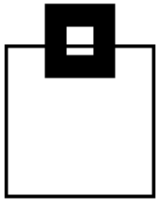

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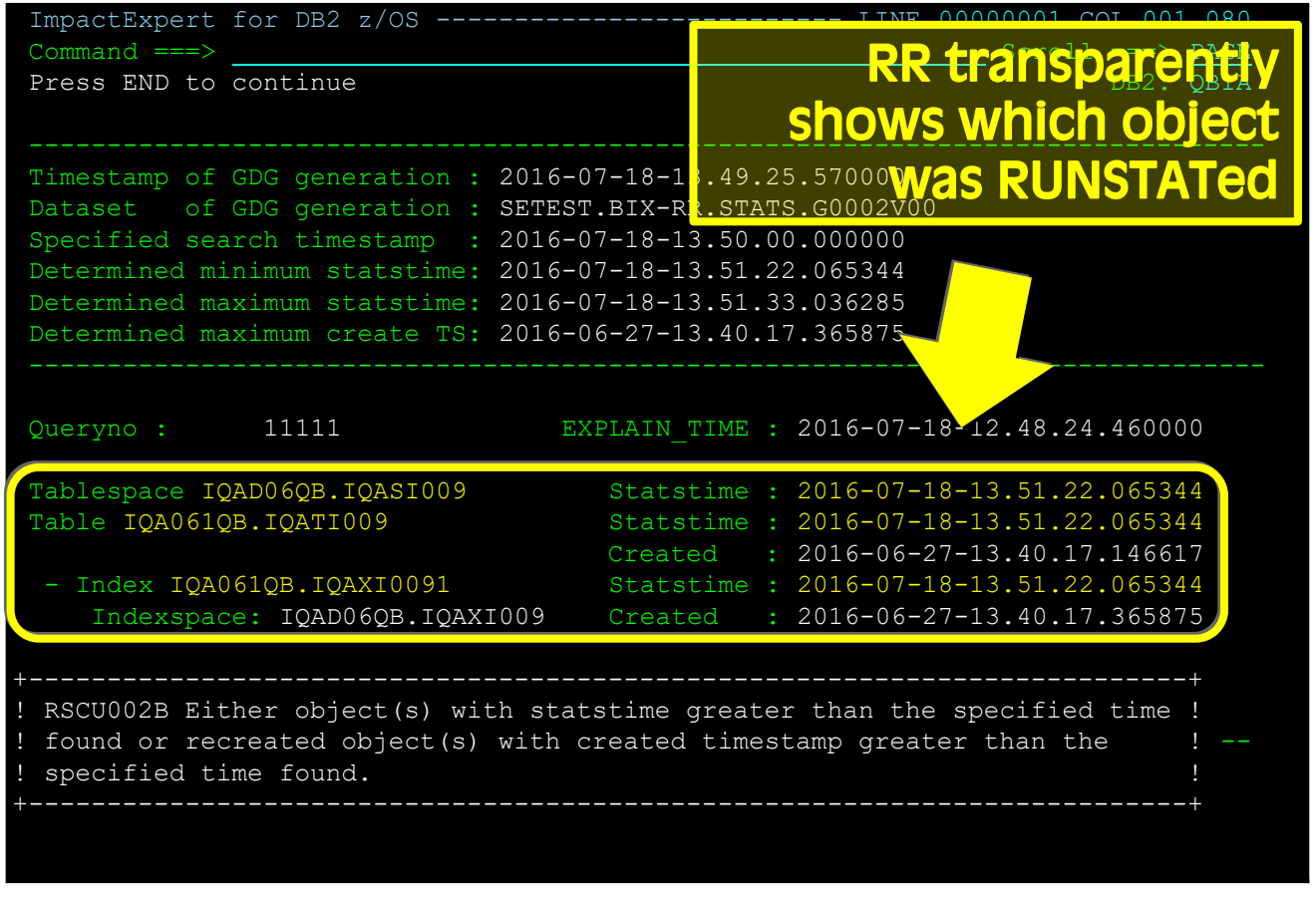

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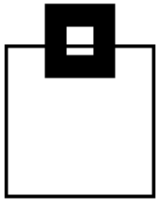

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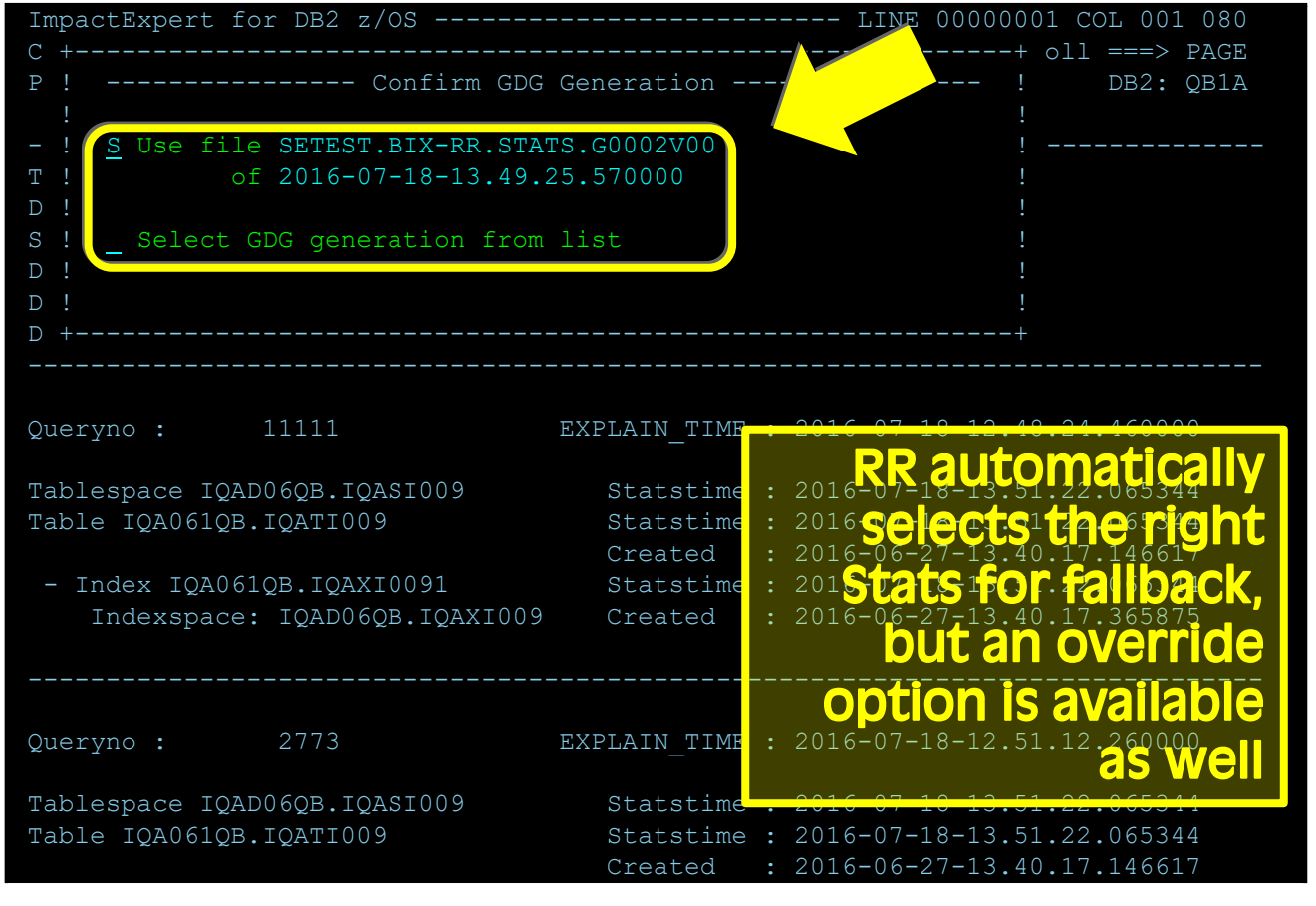
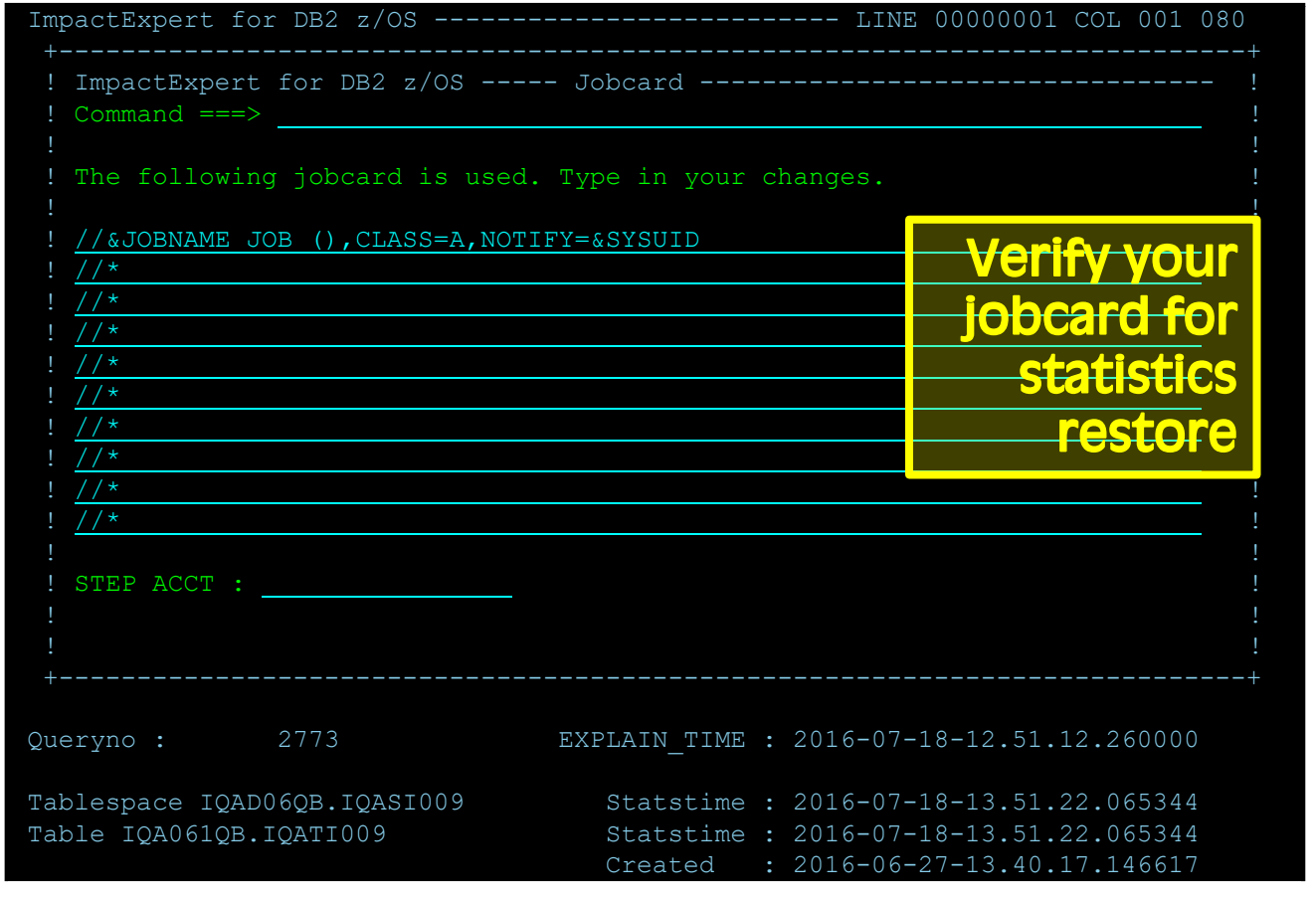


RR automatically selects the right Stats for fallback, but an override option is available as well

RUNSTATS Rescue – dynamic SQL



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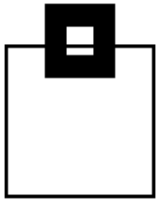
000106 //          DD DISP=SHR,DSN=CEE.SCEERUN
000107 //          DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000108 //          DD DISP=SHR,DSN=DSNB10.SDSNLOAD
000109 //SYSOUT    DD SYSOUT=*
000110 //ERRORLOG DD SYSOUT=*
000111 //BIXINPUT DD DISP=OLD,DSN=*.REPRO.IN1
000112 //PDB2OUT   DD SYSOUT=*,RECFM=FBA
000113 //PDB2RUNI DD DISP=OLD,DSN=SETEST.BIX-RR.STATS.GDG
000114 //PDB2RUNO DD DISP=OLD,DSN=SETEST.BIX-RR.CATSTTS.RESCUE
000115 //PDB2IN    DD *
000116 <PROD-SIM>
000117   <DB2-SYSTEM ALIAS-CREATOR="IQA061QB"
000118               CATALOG-CREATOR="SYSIBM"
000119               GTT-IX-BPOOL="BP0"
000120          >
000121   </DB2-SYSTEM>
000122 </PROD-SIM>
000123 //PDB2TSIN DD *
000124 IQAD06QB.IQASI004
000125 IQAD06QB.IQASI006
000126 IQAD06QB.IQASI007
000127 IQAD06QB.IQASI009
000128 //
****** ***************************** Bottom of Data ****************************
```

Extract job is tailored for execution

RUNSTATS Rescue procedure



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  - **Rescue the stats**

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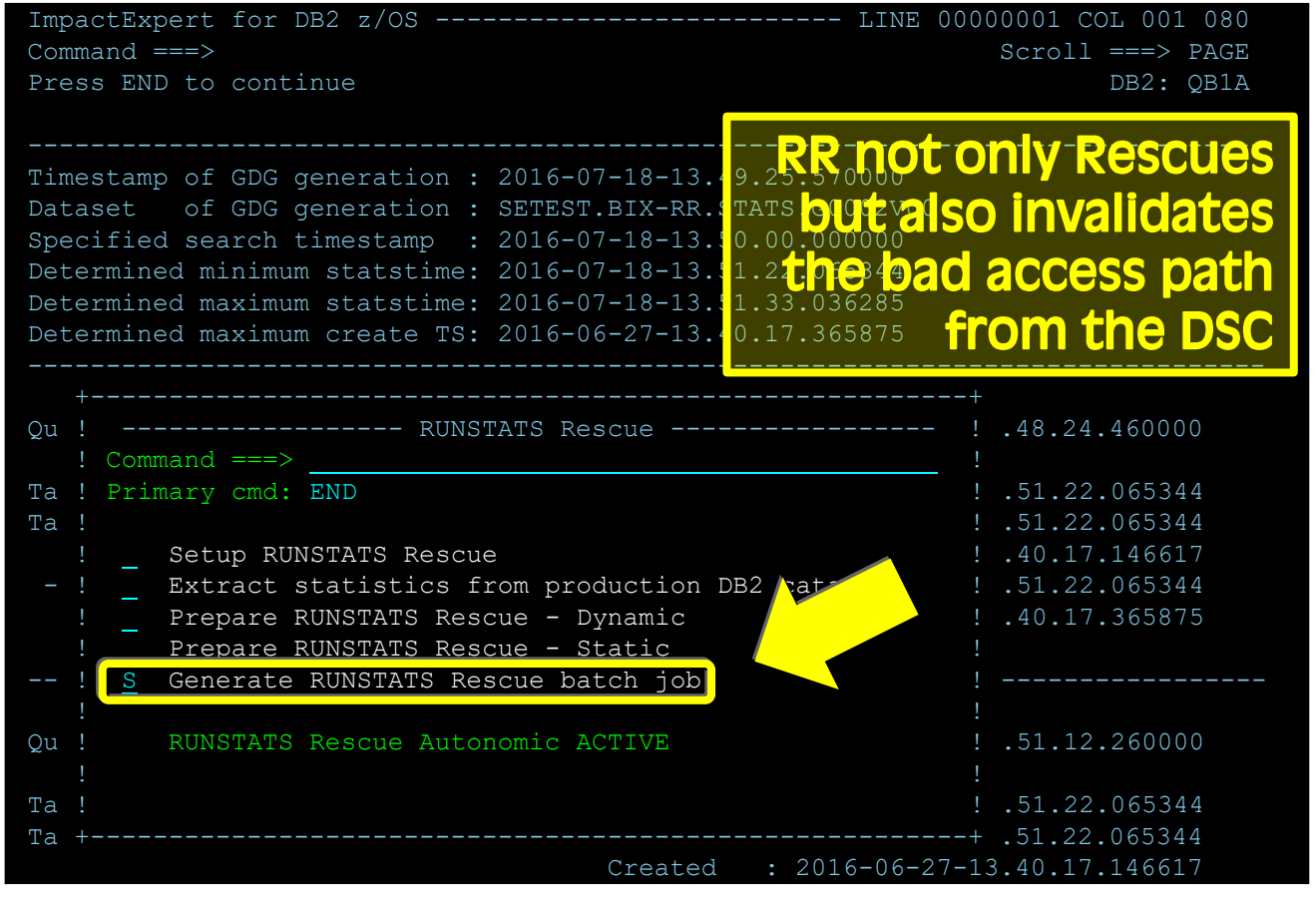

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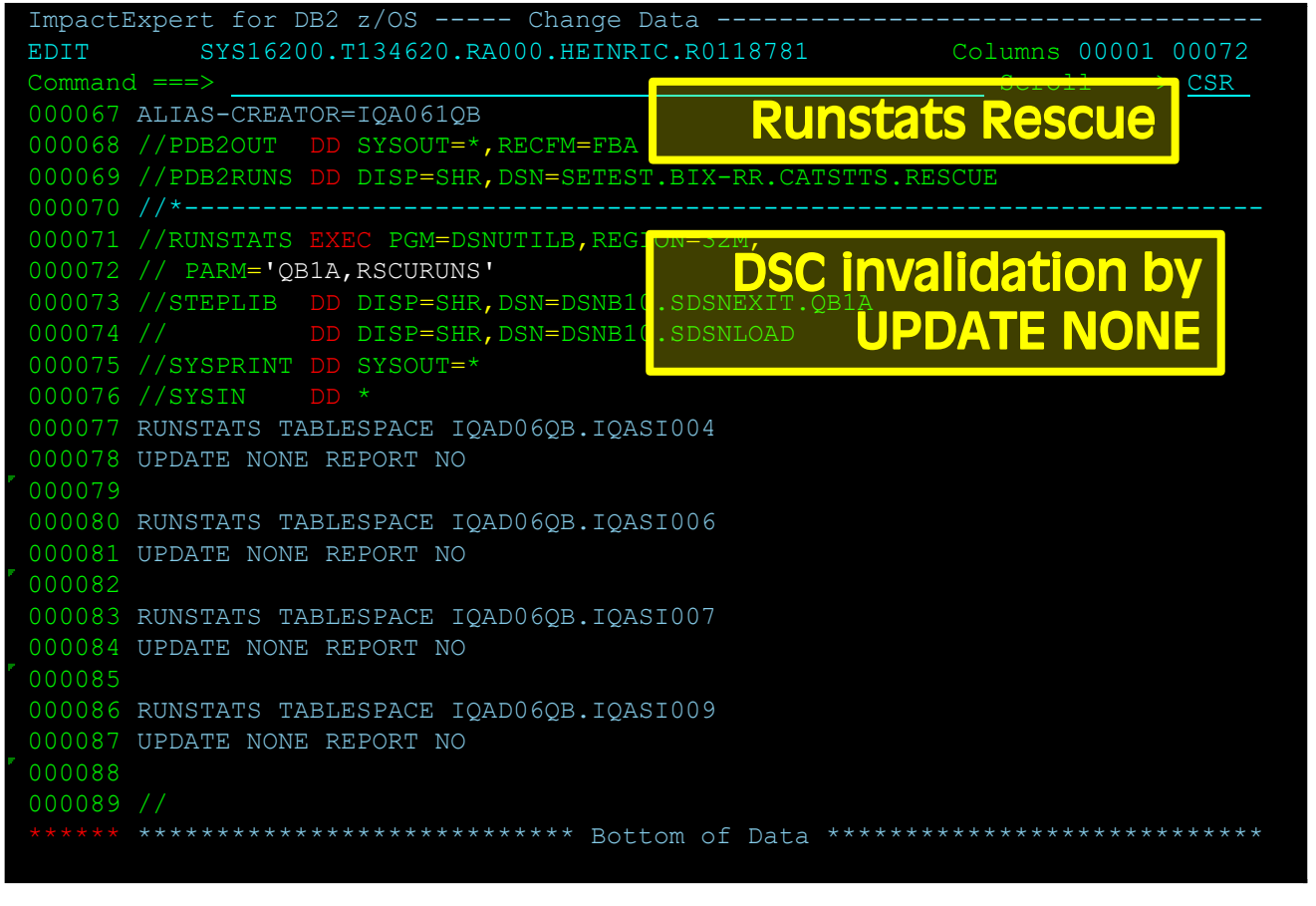


RUNSTATS Rescue – static SQL

- Basically the same as dynamic but the starting data requirement is a package and/or a statement id

- From this basis the rest of RR is the same as dynamic apart from the final recover step where RR generates a REBIND instead of a RUNSTATS of course!

RUNSTATS Rescue summary I

- When you have 1000's of partitions on a multi tera-byte database - Without a tool you have no chance to react effectively!
- Buys much-needed time during critical events
- Cost-effective and time-saving
- Identifies whether or not RUNSTATS was guilty (ZPARM, SQL New Release, or Bufferpool etc.)

RUNSTATS Rescue summary II

- Complements IBM-Plan Management where it does not work (any changed object e.g. views, dynamic SQL)
- Saves statistics and recovers back to them using a simple, guided semi-automatic process
- Helps to automate a rescue process
- Guarantees stable Access Paths for Dynamic as well as Static SQL in Db2 11 & 12 and not just for your “Top 10 or 20”

REWE GROUP – AT HOME IN TRADE AND TOURISM

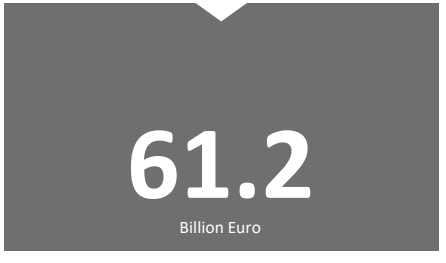
As one of the leading trade and tourism groups in Europe, REWE Group is a constant companion in life – whether it is for daily food shopping, DIY and garden products or the next holiday.

REWE Group comprises REWE and BILLA supermarkets and consumer markets, the discounter PENNY, toom Baumarkt DIY stores and BIPA drugstores.

DER Touristik Group, as the tourism division of REWE Group, is one of Europe's leading travel and tourism groups. It relies on brand diversity, meets customer wishes individually and is driving forward its own digitisation strategy.

SUCCESSFUL IN GERMANY AND EUROPE

REWE Group in figures:



TOTAL EXTERNAL REVENUE 2018

EMPLOYEES 2018

STORES 2018

ACTIVE IN 22 EUROPEAN COUNTRIES WITH STORES AND TRAVEL AGENCIES

in Germany and the following countries:

AUSTRIA BILLA, MERKUR, PENNY, BIPA, ADEG, DERTOUR, JAHN REISEN, MEIERS WELTREISEN, ADAC REISEN, BILLA REISEN · **BELGIUM** KONING AAP · **BULGARIA** BILLA · **CROATIA** BIPA · **CZECH REPUBLIC** BILLA, PENNY, DERTOUR, JAHN REISEN, MEIERS WELTREISEN, ITS BILLA TRAVEL, EXIM HOLDING · **DENMARK** APOLLO · **FINLAND** APOLLO · **FRANCE** KUONI · **GREAT BRITAIN** KUONI · **HUNGARY** PENNY, DERTOUR, JAHN REISEN, MEIERS WELTREISEN, ITS BILLA TRAVEL, EXIM HOLDING · **ITALY** PENNY · **LITHUANIA** IKI · **NETHERLANDS** PRIJSVRIJ.NL · **NORWAY** APOLLO · **POLAND** DERTOUR, JAHN REISEN, MEIERS WELTREISEN, ITS BILLA TRAVEL, EXIM HOLDING · **ROMANIA** PENNY · **RUSSIA** BILLA · **SWEDEN** APOLLO · **SWITZERLAND** KUONI, HELVETIC TOURS, ITS COOP TRAVEL · **SLOVAKIA** BILLA, DERTOUR, JAHN REISEN, MEIERS WELTREISEN, ITS BILLA TRAVEL, EXIM HOLDING · **UKRAINE** BILLA

REWE GROUP AT A GLANCE

REWE-SYSTEMS – NATIONAL INVENTORY MANAGEMENT ON DB2 Z/OS

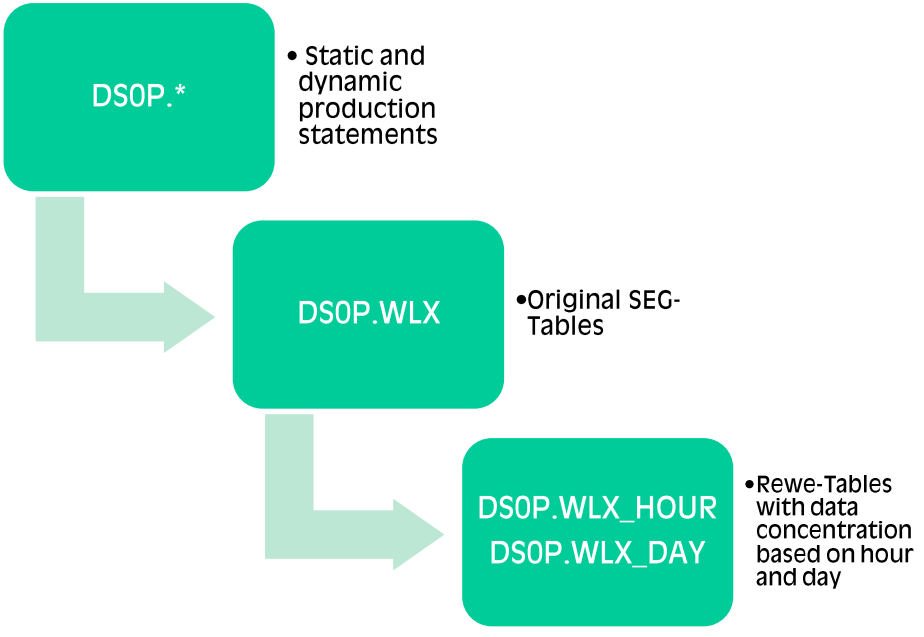
	2015	2020
Hardware	2 x EC12	1 x EC13, 1 x EC14
LPAR	12	12
Data-Sharing-Group	1	2
Data-Sharing-Member	20	15 / 2
Tables	25,000	30,000
Table Creators	530	645
Tables distinct	6,000	7,500
Plans	350	357
Packages	130,000	132,000
Packages distinct	13,000	13,400
Package Statements	3,000,000	3,500,000
Dynamic Statements	??	1,400,000

REWE-SYSTEMS – AGGREGATION OF A DAILY WORKLOAD

	Dynamic	Static
Statements distinct	1,400,000	65,000
Executions	6,000,000,000	24,000,000,000
CPU	382 Hours	135 Hours
Elap	1,598 Hours	453 Hours
Getpage	217,000,000,000	76,000,000,000

Workload from the 30th March 2020 as gathered by SEG-WLX

REWE-SYSTEMS – SEG-WLX-WORKFLOW WITH CUSTOM CONCENTRATION



REWE-SYSTEMS – SEG-WLX-OUTPUT TOP 10 (SPLIT BY APPLICATION - CLASSIC)

DB2 WLX-DATEN VON MONTAG 30.03.2020

BEZEICHNUNG	CPU-ZEIT	LAUF-ZEIT	GETPAGES	ROWS-PROCESSED	EXECUTIONS	WAIT-TIME
GESAMT:	511:46:22	2042:06:45	293.970.540.843	52.263.380.050	29.681.884.880	735:09:04
PRODUKT_ZAM	47:44:17	176:28:16	28.875.210.572	3.406.181.283	762.052.616	74:55:02
SELECT T4191.MBBK AS wwIdent, T4191.WVZ_LIEF_DAT AS wvzLiefe	3:33:07	4:30:00	2.447.023.548	1.250.298	59.621	3:15
SELECT T4100.MBBK, T4100.VORGANG_DATUM, T4100.VORGANG_NR, T4	3:17:15	9:08:53	1.458.034.156	165.588.483	176.327	2:14:33
SELECT t4902a.LP_MANDANT, t4902a.LP_BILANZST, t4902a.LP_BERE	2:06:22	2:46:53	578.636.037	1.539	29.661	1:29
SELECT mbbk , vorgangDatum , vorgangNr , gegenID , bewertArt	1:56:13	2:42:27	166.940.766	1.696.734	47.886	14:43
INSERT INTO RKWWC0.T4734_BO_BON_UMS (MBBK, ARTIKELNR, EINSTE	1:42:20	19:42:11	924.920.116	73.061.928	73.061.928	14:06:23
SELECT erg.bewertart, erg.streckembbk, erg.sblmbbk FROM (SE	1:35:03	2:13:54	460.715.086	2.128.237	46.470	12:05
SELECT mbbk as empfaengerID, vorgangDatum , vorgangNr AS vor	1:32:57	2:20:26	109.114.983	1.250.100	20.289	16:02
SELECT T4403.LIEFERANT_NR AS lieferantNummer, T1300.NAME AS	1:21:07	2:38:16	341.896.601	3.334.318	13.009	21:58
SELECT	1:05:02	2:27:50	269.071.437	11.090.856	69.002	56:41
SELECT T4190.MBBK ,T4190.WVZ_LIEF_NR ,T4190.WVZ_LIEF_DAT ,T4	1:04:07	3:07:17	889.914.790	74.012.780	428.073	1:38:29
PRODUKT_ZMOB	39:34:23	155:40:39	28.227.464.880	2.298.441.630	359.128.353	67:06:16
SELECT LISTUNGSBEREICH as listungsbereich , BAUSTEIN as baus	13:24:20	21:59:30	4.795.031.852	87.786.324	530.130	5:05
SELECT T4100.MBBK, T4100.VORGANG_DATUM, T4100.VORGANG_NR, T4	1:43:46	18:01:06	809.456.819	38.729.246	3.535.171	15:49:44
SELECT DISTINCT T4201.KOMM_KLAMMER_ID, T4100.NVE FROM rkwwc0	1:33:27	2:20:42	1.789.610.461	96.971	18.268	17:05

. . .

- Monitoring from
  - ➢ KPIs of a product or an application
  - ➢ KPIs of REWE „Standard Statements“

REWE-SYSTEMS – SEG-RUNSTATS-RESCUE

- Current Runstats values are secured daily using the standard Runstats-Rescue job
- It takes about 10 minutes to complete
- We keep the data for one year
- Regular training and testing for all nine DBAs

➔ Important fallback system to insure production keeps running smoothly
➔ Only used twice so far – Once is enough…
➔ Rescue took less than 30 minutes

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- Possible enhancements:
- Before the actual rescue, the ability to review the values that will be used (insert into sys-shadow?)
- Backup the changed runstats value before doing the Rescue in case of a newer statstime

- If the timestamp when „everything was fine“ is unkown:
- Display and Fallback to older disparate Runstats values (E.g. from two different days)

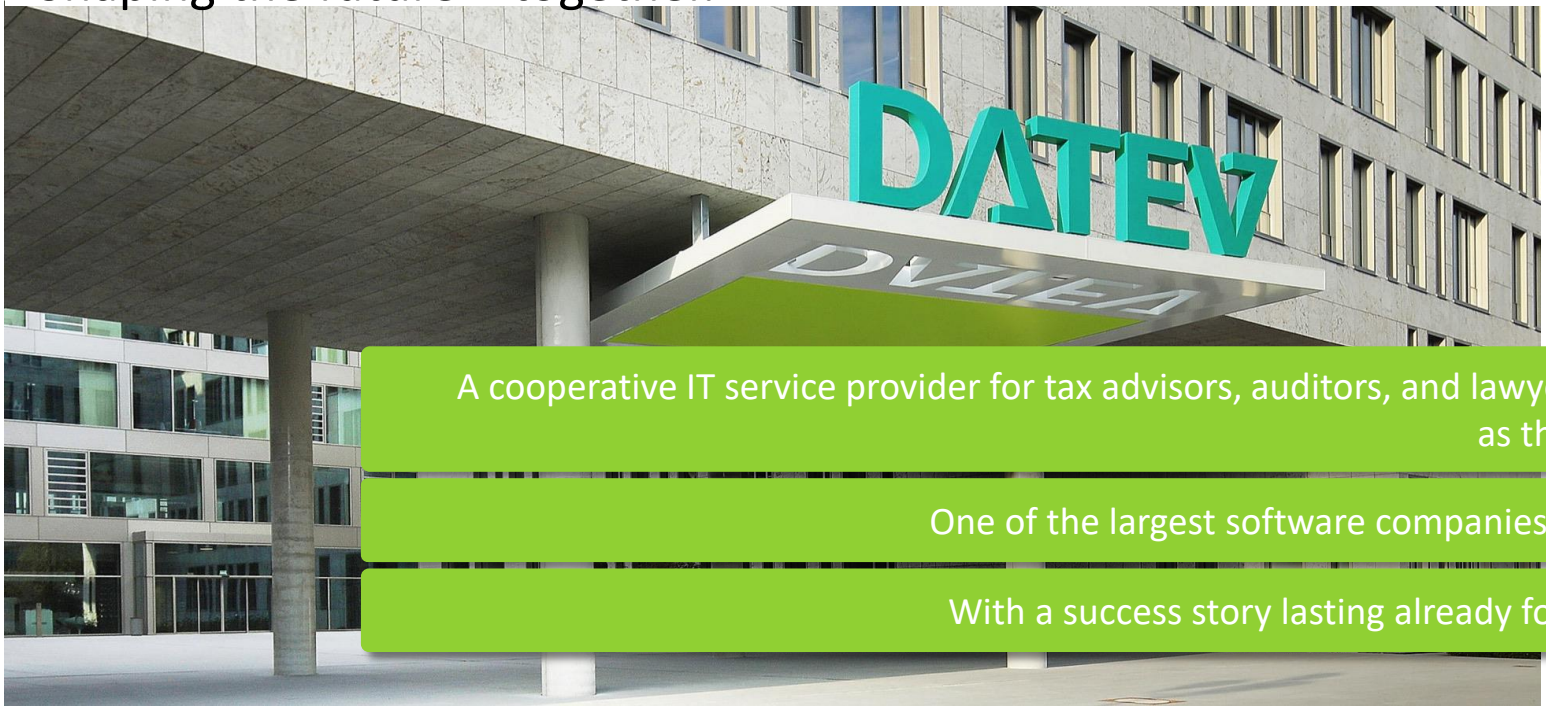
RUNSTATS Rescue @ DATEV

DATEV eG

Shaping the future – together.

DATEV eG

Shaping the future – together.



A cooperative IT service provider for tax advisors, auditors, and lawyers as well as their clients

One of the largest software companies in Europe

With a success story lasting already for 50 years

DATEV eG
Shaping the future – together.

DATEV eG
Our Offer

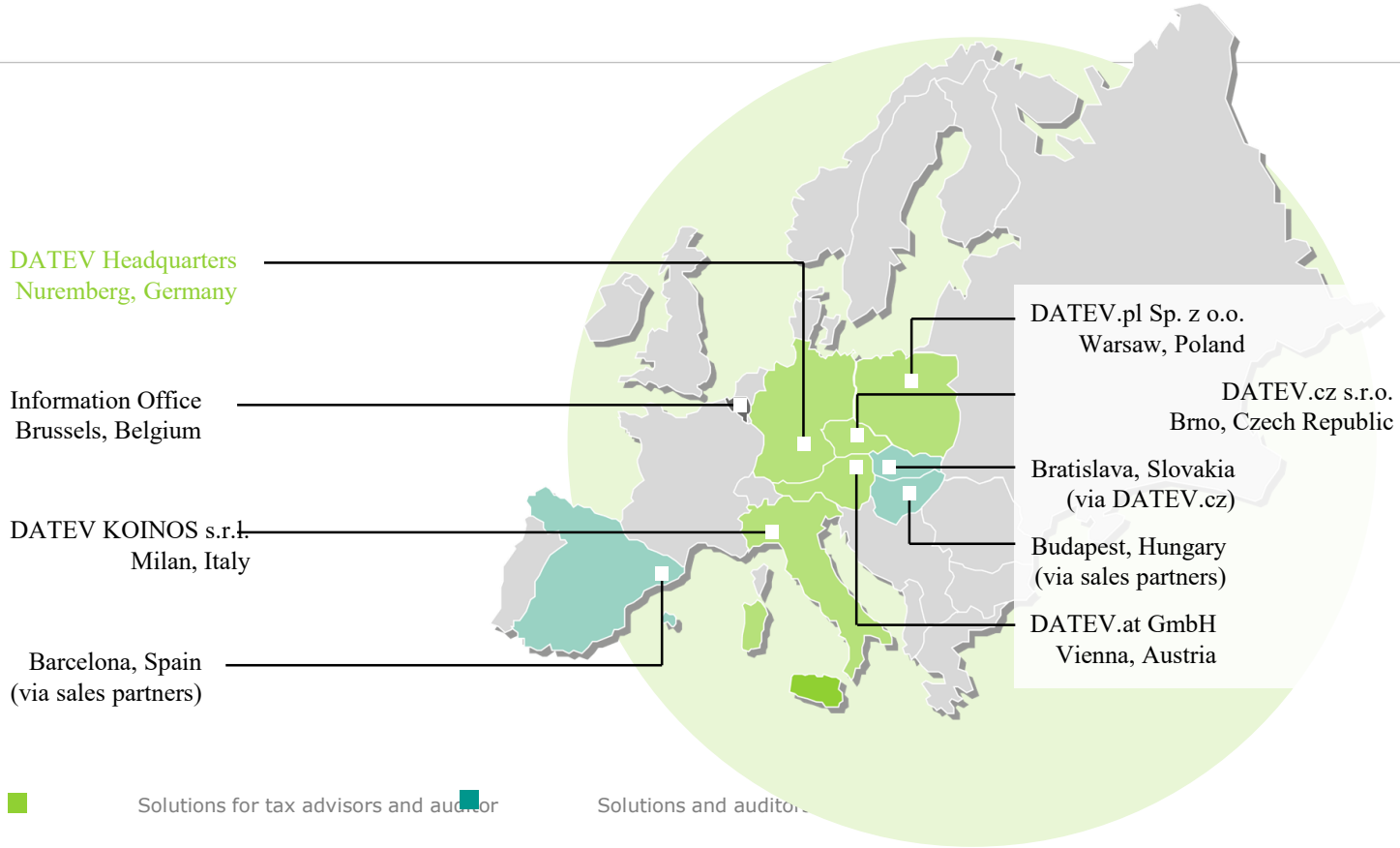
DATEV eG On site throughout Germany

Headquarters and
an Information Center
in Nuremberg

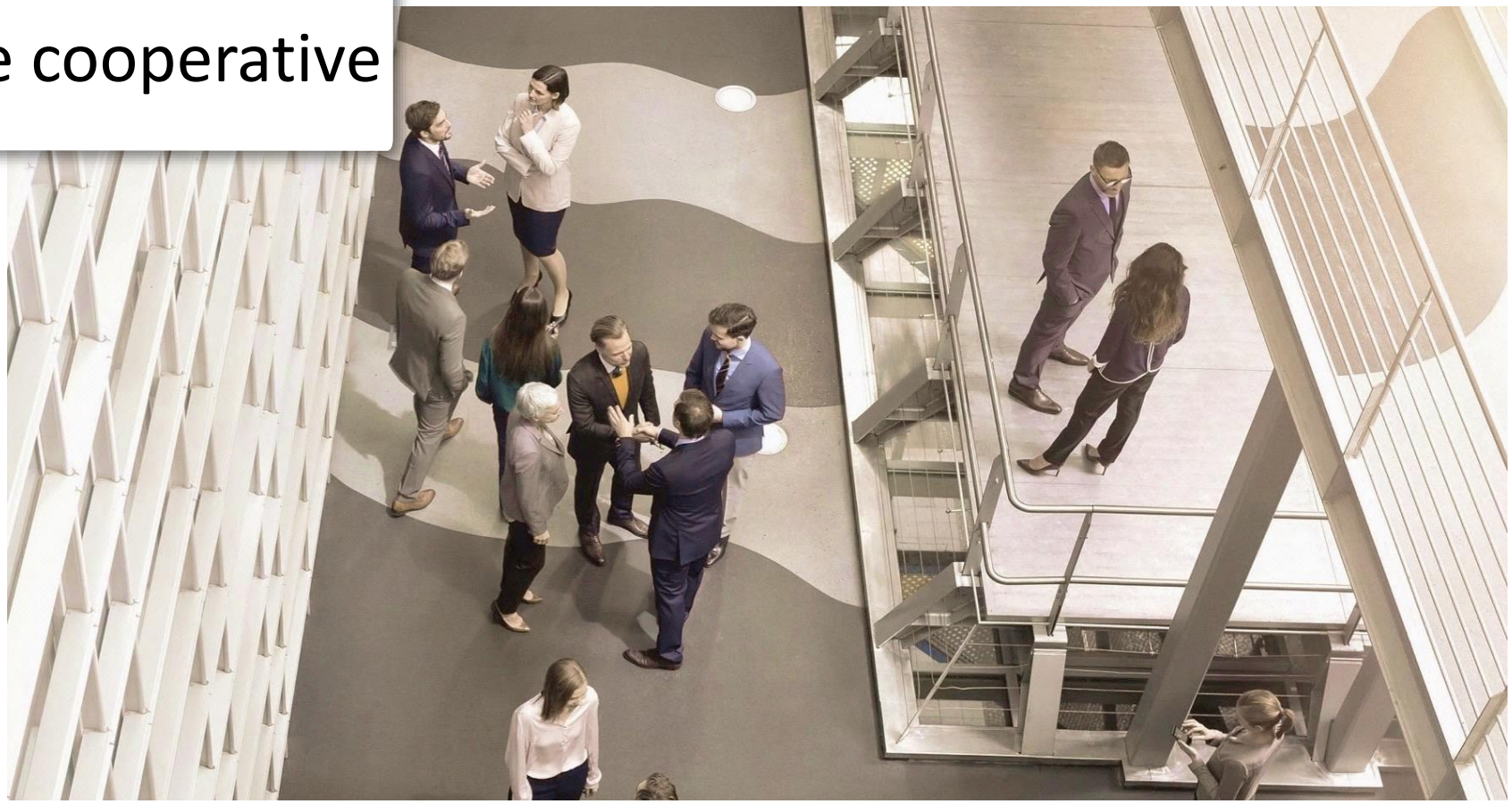
Altogether 26 Company Locations
nationwide

An Information Office
in Berlin

DATEV eG Cooperating throughout Europe



The cooperative



The cooperative

Our members

- Tax advisors
- Auditors
- Lawyers
- Sworn accountants
- Societies owned by members of the profession
- Joint practices and partner companies

The cooperative Our sustainability

The cooperative
funding principle stands for
sustainability instead of short-term profit maximization

Economic	Ecological	Social
		

Why RUNSTATS Rescue?

- 2015: Negative experience with RUNSTATS
  - Performance degradation after RUNSTATS
  - RUNSTATS has no real „reset“ option
- DATEV-Workload: JDBC/dynamic SQL
  - DB objects with a complex topology
  - DATEV did quite some scientific research about RUNSTATS possibilities

Buy or Homegrown?

Market analysis at the end of 2015

- Exactly one tool in the market
- DATEV: not enough people to d it alone

→ Decision: Buy!

Case study RUNSTATS Rescue

- Two cases of RUNSTATS Reset in Membership management/Access control SQLs
  - CPU usage after RUNSTATS increased by a factor of 100
  - New RUNSTATS hat no effect
  - Elapsed time from alarm to reset: **< 1 hour**
- One case of suddenly occurring `SQLCODEs -420`

Lessons Learned

- Fast reset from statistics, especially for dynamic SQL, is very important
- New running of RUNSTATS does not always solve the problem
- Regular RUNSTATS Rescue training
- Exclude the just rescued objects from new RUNSTATS / REORG Jobs – Do not forget!
- RUNSTATS problems are not predictable
- Db2 V12 does not deliver a solution

Zukunft gestalten. Gemeinsam.

Give and Take Program, Germany 2020

What we **GIVE**:

1) 90 days free trial – even in production
2) Two webinars covering installation and all pre-reqs
3) Two days – free of charge – onsite support
4) Offer of two days – free of charge – for potential realization of customer requests and enhancements

What we **TAKE**:

1) Your Real World Experiences
2) Your permission to use the gathered data in our presentations (Anonymous or, if you allow it, with your customer name)

Give and Take Program, Germany 2020

The 2020 Program offers:

January – March	(1Q): Db2 11 + 12 Audit + SIEM (Security Information Event Management) with optional framework Eclipse or ZOWE
April – June	(2Q): Access Path Recovery – The first participant of this program is the FiduciaGAD IT AG
July – September	(3Q): Space Assurance – K-no-w your limits
October – December	(4Q): Zowe and SQL Workload Performance for Db2 11 & 12

Ready for the Future.

The IT Experts in the Cooperative Financial Network.

FIDUCIA GAD
ZUKUNFTSERFAHREN

Diverse Target Markets

More than 1,100 customers and owners in four target markets are the basis of our successful business strategy.

Status: 31 Dec. 2018

Our Customers: Efficient and Effective

Our banking system improves our customers' level of competitiveness.

- **166,690** workstations in banks
- **over 7 m** accounting entries per year
- **82.2 m** active accounts
- **34,185** self-service terminals
- **500 m** ATM cash withdrawals per year

Status: 31 Dec. 2018

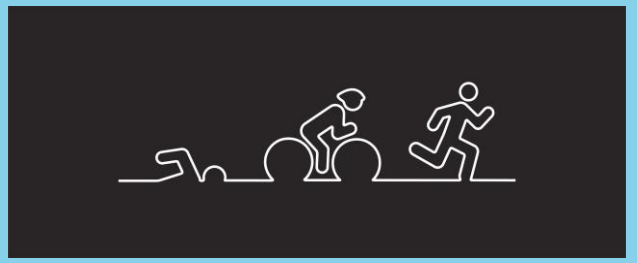
Computer Center Performance

The performance of our four computer centers – More than just zeros and ones.

Performance

- Virtual servers: **42,959**
- Nine mainframe computers: **230,780 MIPS**
- Mainframe transactions: **64,300m per year**
- Utilized cartridge capacity: **53,284 Terabyte**
- Mainframe storage: **4,468 Terabyte** / Open system storage: **21,305 Terabyte**

Status: 31 Dec. 2018



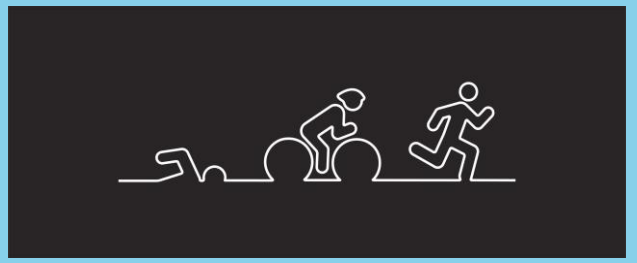
RUNSTATS management: An Iron Man Event?

We have recently had major problems with Access Paths changing after Db2 maintenance or migration. To make it even worse the problems do not appear on all systems so we have used “Dynamic Plan Stability” to stabilize a good access path. Then we copy over all the required data to where there is a bad access path and try to use an OPTHINT to get the good access path back.

These problems, just like history, keep repeating and further when application DBAs do a ROTATE partition we have to start all over again.

All this work is doable, and manageable, but it is a lot of work and there is lots of room for errors and mistakes.

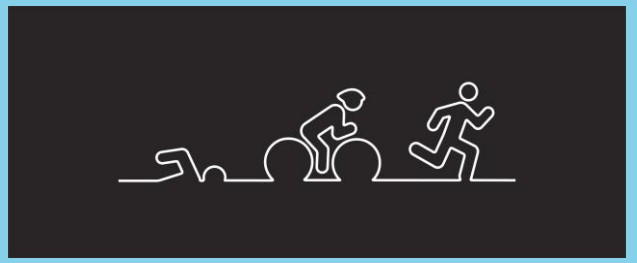
RUNSTATS Rescue could offer us a new, quicker, simpler, faster and more reliable way to get back to good access paths without having to swim 4km, cycle 181km, and run 42km!



RUNSTATS management: An Iron Man Event?

Swim 4km

Dynamic Prefetch and Sequential Prefetch.
One Db2 subsystem completely killed with one SQL statement due to RID list failures.



RUNSTATS management: An Iron Man Event?

Cycle 181km

Dynamic Plan Stability in a very dynamic world! Trying to get “good” access paths and propogating them across Db2 systems is a real trial. It gets worse when the SQL you need is quickly flushed out of the Dynamic Statement Cache by batch jobs running in the background.

RUNSTATS management: An Iron Man Event?

Run 42km

Then you finish the cycling only to see someone ROTATE in front of you… All Your work is destroyed. It can even get worse when using query stability when the creator of the explain and the creator in the SYSQUERYPLAN do not match 100%

Questions???

Many thanks for your attention and now....