

DBControl Online™ for Oracle

Ensuring Modern Database Service Standards with Online Reorganizations



Introduction

With e-commerce driving the design and demands of modern business applications, high performance and high availability database computing is now the service standard. This modern performance standard is associated with a high cost of downtime. Administration techniques developed for this type environment demand negligible impact on the system while performing standard maintenance tasks.

The ability to perform online data reorganization in these environments would greatly assist in maintaining the overall database availability, and potentially reduce or eliminate planned downtime. This, in turn would increase the application return on investment (ROI) and lower the total cost of ownership (TCO). Online reorganizations would also lend an administrator unprecedented flexibility to modify table physical attributes and transform both data and table structure with users having complete access to the database.

The standard method for reorganizing tables is to develop sophisticated O/S and database scripts to either automate reorganizations or squeeze them in during a scheduled maintenance downtime. While this is the common method, there are associated downtime, administrative, and development costs. Additionally, if this method of reorganization fails, it is a waiting game until the next opportunity arises.

Conventional wisdom dictates correct initial table sizing to prevent the need to reorganize, but even the most meticulously sized tables can require storage parameter modifications to make optimal use of space under evolving conditions.

Reasons to Reorganize

Tables and their dependant objects are subject to reorganization in order to make the most efficient use of space, prevent performance issues, or conform to new hardware architecture.

Consider the following conditions.

Archiving

The purpose of archiving is to reduce online space requirements of data and improve the performance of applications by shrinking data sets. Archiving alone, however, does not produce these benefits. A reorganization is the critical next step in order to realize the space savings and performance benefits of the archiving process.

Large delete operations, such as archiving, leave holes in table segments. Even though a significant portion of the data has been removed from a table, the internal free space is not returned to the database for use by other objects. A reorganization compacts the data segment, and the internal free space is returned to the database.

After archiving, the high-water mark (HWM) for a table remains unchanged. Full table scan operations, such as reporting, are still traversing the entire table segment, even if most of it is empty. A reorganization lowers the high-water mark, which increases the performance of these operations and reaps the full benefit of the data reduction.

Space Reclamation

When free space in a tablespace is located at the end of a data file, the data file can be resized, and that free space can be returned to the operating system for other uses. If the free space is in the middle of a tablespace, however, reorganizations are needed in order to compact data and shift that free space to the end of the data file. Returning free space to the operating system allows for more efficient use of expensive disk systems, and it extends the life of hardware purchases.

Table Deviation from Initial Storage Parameter Design

When a table is initially created, the DBA must estimate the following storage parameters.

Block Space Utilization Parameters

PCTFREE	Specifies the amount of space available for updates on existing rows in a block.
PCTUSED	Sets threshold for space used to prevent updates from occurring on the block. If the data block usage falls below this specified parameter, the block will be subject to updates.
INITRANS	Specifies the initial number of transactions that can concurrently update the rows in a data block.
MAXTRANS	Specifies the maximum number of transactions that can concurrently update the rows in a data block.

Extent Allocation Parameters

INITIAL	Sets the size for the initial table extent.
NEXT	Specifies the size of allocated extents until PCTINCREASE parameter is applied.
MINEXTENTS	Minimum number of extents a table should allocate.
MAXEXTENTS	Maximum number of extents a table can allocate.
PCTINCREASE	The third and each consecutive extent are subject to a compounding space increment determined as a product of the NEXT storage parameter and the pctincrease value.

Since the previous parameters are estimated at the creation of a table, they are subject to correction. Once production data is introduced to the table, the true behavior of the data concerning update size and frequency can be established. From this analysis, storage parameters can be optimized to meet actual performance demands requiring a reorganization.

Adherence to Industry “Best Practices”

As of Oracle 8i, best practices include the use of locally managed tablespaces. This allows for automatic sizing of all new extents with standard sizing, removing any concern with free extent fragmentation. The local method keeps track of extents with the use of bitmaps, removing the need to access the data dictionary. Storage, performance, and administration efficiency are gained from locally managed tables. A second method to prevent inefficient use of space apart from using locally managed tables is accomplished by setting the extent storage parameter PCTINCREASE =0 and the INITIAL and NEXT parameters equal to one another. This allows for allocation of uniform extents and predictable sizing requirements. Tables with like-size extents can share a tablespace designed for a standard extent allocation requirement. This segregation allows for equal extent allocation per tablespace depending whether the table is considered small, medium, or large.

Removal of Row Chaining and Row Migration

Row chaining occurs when a row is inserted or updated, and the row size becomes greater than the original data block size. When this occurs, Oracle splits the data for the row in a chain of data blocks reserved for that segment. Row chaining is a complication resulting from data block sizing incompatibilities. Row migration occurs when a row is updated, and will not fit in the originating data block. Oracle migrates the row to a new block.

Oracle must link the original row to the new block containing the migrated row. Both row chaining and row migration decrease performance and potentially waste database space.

Partitioning of Large Tables

Partitioning of large tables greatly improves table manageability by enabling DBAs to split tables and indexes into smaller, independent units. This divides the maintenance process, such as table analysis and online backups, into efficient, manageable tasks.

Traditional Reorganization Method

Transformation to Index Organized Table (IOT)

An Index Organized Table (IOT) is a table that has its contents organized as a B-tree index. There are no separate storage requirements for the index and table, as they are now consolidated into one database object. Index organized tables save space, consolidate query efforts into one object, and increase performance on primary key-based queries. The performance gain and storage space saved are worth the reorganization.

All of the prior examples are justifiable reasons to reorganize a table. The trade-off comes about when the potential negative impact of the reorganization is weighed against the performance benefit gained from it. Traditional methods of reorganization come with some risk and time considerations in which minor performance issues may be neglected. The general guidelines of traditional table reorganizations follow.

Offline reorganizations must be carefully orchestrated, particularly if the maintenance window is very small, as it is in many OLTP environments. Any mistake is associated with a large financial burden if it is not quickly remedied, adding additional stresses to an already regimented time frame. Today's databases with large table sizes and high availability requirements create a critical need for online table reorganization capabilities to maximize uptime and performance.

The process of taking a tablespace offline:

- *Create a new temporary table (TT1) with optimal storage parameters.*
- *Copy data from original table (T1) to the temporary table (TT1).*
- *Drop the original table.*
- *Rename (TT1) to (T1). Recreate indexes and apply constraints.*
- *Recreate dependencies.*
- *Bring tablespace online.*

Online Reorganization Benefits

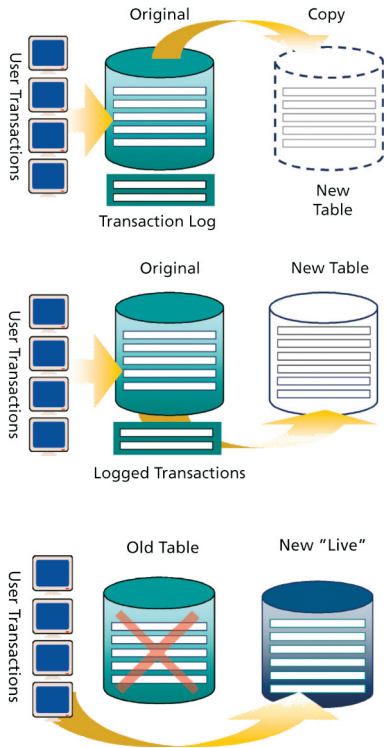
Enterprise class business applications must be available to all users in all time zones. Being able to perform most reorganization tasks online provides the unprecedented advantage of time, as there is no interruption of data flow. Most service level agreements for SAP and financial environments demand 99.9% uptime, with an obviously negligible maintenance window.

The cost of downtime is such that online reorganizations are as valuable service as online backups. With online reorganization, there is no time constraint to consider for table reorganization.

Bradmark's **DBControl Online** provides the capability to reorganize a table and its respective objects while transactions are running against it. Application of this technology includes online capability to:

- ***Add, modify, and drop indexes***
- ***Add, modify, and drop partitions and their respective attributes***
- ***Add, modify, and drop sub-partitions***
- ***Partition and de-partition tables***
- ***Modify a table for index organization, or vice versa***

Online Reorganization Methods



Competitive Advantages

DBControl Online provides a method that drastically reduces the downtime usually associated with table reorganizations. Tables can be augmented online to help achieve availability requirements. Standard methods of offline reorganization do not provide the efficient, fault-tolerant environment required to meet high availability standards.

The general DBControl Online method to online reorganization and structural change follows.

Setup Phase

From the appropriate Online Reorganization dialog box, the changed table information serves as the template in which a new table is created with the modified parameters.

Replication Phase

Incoming DML statements running against the table are recorded into a log table, and data stored in the original table is loaded into the newly reorganized table.

Synchronization Phase

DBControl Online will optionally apply transactions to keep the original and reorganized tables in synch until the Active Refresh or Switchover phase begins. The Active Refresh aggressively applies transactions to the reorganized table just prior to the Switchover.

Switchover Phase

Several criteria can be set, such as a threshold on table activity, to control when Switchover begins. At Switchover, the newly reorganized table assumes the identity of the original table and the original table is either deleted, or kept depending on user settings.

Compatibility

DBControl Online offers the widest range of support for Oracle versions and features:

- Databases:** DBControl Online provides support for all versions of Oracle databases from 8.0.6 to 10.2
- Data types:** DBControl Online supports LONG and LONG RAW data types without data length restrictions
- Compressed tables:** DBControl Online provides complete support for the compressed table feature introduced in Oracle 9.2.0.3

Based on Oracle Technology

Using Oracle's own technology provides Bradmark with a number of key advantages:

Reliability	All the procedures used in the replication and refresh phases are based on Oracle approved methods and procedures, not proprietary technology. DBControl Online is as reliable as Oracle's technology.
Speed	The use of internalized triggers rather than external triggers or redo-log accesses makes the product faster than competitors' products. Using Oracle's replication technology minimizes the transactions replicated, thereby improving both speed of replication and database performance overhead.
Robustness	The architecture of the product is ideally suited to large tables with heavy transaction loads. There is extensive protection against "ORA-1555: Snapshot too old" errors during the online reorg/structure change process.
Ease of management	Unlike products that are dependent on redo logs, there is no burden of planning a redo log strategy or significantly increasing redo log sizes to accommodate the demands of a reorganization. DBControl Online uses rollback segments which are less intrusive and easier to tune. The product accommodates small rollback segments and only requires one large rollback segment per reorganization.

Additional Online Functionality**Integrated Alert and Dispatch Capabilities**

When used in conjunction with Bradmark's Surveillance product, DBControl Online provides integrated alerting mechanisms, providing the DBA with real-time feedback on the progress of the reorganization process. These alerts generate standard pop-up messages, send emails or SNMP traps, send Tivoli or OpenView events, or generate external scripts. Multiple alerts and actions can be generated, as well as being time-delayed.

Online Job History

The Online Job History window gives you the ability to view previous runs of online jobs. This feature is useful for planning future reorganizations, or estimating the time of a reorg and other online jobs.

Multi-Object Online Reorg

DBControl Online provides the ability to select multiple tables and reorganize them. Depending on the desired performance, you can reorganize all of the tables in a tablespace or set any number of tables to reorganize at one time.

Additional Database Administration Functionality

In addition to the main online reorganization and partition management functionality, DBControl Online provides a rich set of database management features that will ease or eliminate error-prone or time-consuming tasks.

Additional Database Administration Functionality

(continued)

Tablespace Map

The Tablespace Map can help the DBA identify objects with incorrect storage parameters, while reorganization features are used to correct and prevent space allocation problems. Once the objects in need of reorganization have been identified, DBControl can reorganize or restructure by either traditional or online methods.

Offline Reorganization

For a traditional Object Reorganization, DBControl uses an unload/reload facility that employs the Oracle Import and Export Utilities, which ensures that all referential integrity, privileges, indexes, and dependent objects are intact upon completion of the reorganization. The Tablespace Reorganization feature provides fast, traditional reorganizations when the majority of the objects in a tablespace need reorganizing. Utilizing DBControl's unload/reload facility, all objects in the tablespace are unloaded, dropped, recreated, and reloaded as a group rather than one at a time. The DBA may specify new storage parameters for any tablespace, table, index or cluster. DBControl rebuilds the tablespace and associated objects, either immediately or by creating a script file, or, it can be scheduled to perform the reorganization in the future.

Diagnostics

Is space being used efficiently? DBControl's Diagnostics can spot problems such as inefficient indexes, row chaining in tables that can cause significant performance degradation, and tables and indexes that have never had the "Analyze Statistics" command run on them, leading to poor query plans with the cost-based optimizer. Diagnostics can be run for a table, index, or entire tablespace.

Trend Analysis

The Trend Analysis feature can be used to increase space efficiency and performance by enabling DBAs to highlight current space utilization problems, make accurate estimates for future space requirements, and identify index inefficiencies. To accomplish this, DBControl stores the statistics from Oracle's ANALYZE statement in a table-based repository that provides a powerful graphical interface to graph these statistics over time. The DBA can then use these statistics as a basis for new storage parameters; including when to reorganize an object with the Object Reorganization feature, determine when rebuilding or coalescing an index is needed, determine if an index is the right type, or if the database block size needs to be increased.

Schema Object Administration

The power to administer all schema objects within the Oracle environment using a GUI that eases the efforts required to manage these objects. Use the Schema Object Administration option to reduce the requirement for the DBA to have a complete mastery of the Oracle Data Dictionary Language by providing the DBA a graphical user interface to create, alter, and drop schema objects.

Schema Comparison

Schema Comparison quickly pinpoints differences between test and production environments, avoiding availability problems when differences prevent users from entering data. A comparison of the schema object's structure is performed, which includes identifying missing columns with different data types, missing constraints and/or different storage parameters. The Initialization File Comparison feature is used to detect differences between parameter settings, which could contribute to availability and/or performance problems.

Business Case Study: **Bertelsmann Book Club**

SQL Tuning

Tuning an Oracle database should be a holistic approach that includes tuning the application and database design, the SQL, memory allocation, I/O, and resource contention. With the SQL Tuning feature, statements can be tuned during the application development phase, or problem statements can be isolated during the testing or production phases.

Security Administration

Administering Oracle security is one of the most tedious tasks faced by DBAs. DBControl provides an easy-to-use method for administering Oracle security, which includes creating, altering, and dropping users, roles, and profiles, in addition to granting and revoking system or object privileges.

Scheduler

Some DBA tasks can be time-consuming so it is preferable to schedule these tasks and run them automatically during off-peak hours, resulting in tremendous gains in DBA and database productivity. The flexible scheduling system allows administrators to submit jobs immediately or on a regular or repeated schedule, such as a day of the month or on a specific date.

When you run a book club, the database that tracks your customers' orders is the lifeblood of your business. If you are the biggest book club in Europe, with more than 3.7 million members, that database is very big and very busy. With data getting constantly added, changed, and deleted, this SAP system and the underlying Oracle database at the heart of Bertelsmann's Book Club becomes more and more fragmented. This fragmentation in turn leads to degradations in performance, as well as increased storage requirements.

In a previous 12 month period, the Book Club took the database down 12 times to do table reorganizations. Each time, the database was down for between 12 and 20 hours. Even though these downtimes took place on Sundays, it meant that the telephone sales operation could not access all information needed by the customer purchase order system. With the rate of growth of the database, and the added fragmentation caused by archiving, it was clear that a product was needed that would allow the company to carry out all these reorganizations online.

Finding a solution

This decision of the online reorganization tool involved multiple parties. Arvato Systems host and manage the database servers, and would be using the product on a daily basis, so it was important to have their buy-in. Sun, the hardware partners, had implemented a mirrored database solution, and it was important to ensure that any reorganization product did not conflict with this mirroring capability. As well as finding the right product, Bertelsmann Book Club also needed to find a partner who could provide multiple levels of support to the different organizations involved.

The first product that was considered was BRSPACE, the SAP utility. While BRSPACE handled most situations well, it couldn't reorganize any tables with LONG and LONGRAW data types. Although less than 5% of the tables have LONG and LONGRAW data types, they are among the biggest and busiest tables in the database. The time Bertelsmann would need to reorganize these tables would mean 150 hours of downtime. In addition, two of these tables become too big to reorganize even in the longest downtime period during the year. As a result, Bertelsmann looked for a tool that could handle all their tables.

One of the most important criteria for us was that the tool had to be SAP approved. Bradmark's DBControl Online product had not only been given a positive endorsement through the SAP Integration Assessment from SAP Labs in Walldorf, but SAP Packaged Services in the UK had decided to use the product for the Oracle Online Reorganization Packaged Service. This gave Bertelsmann a lot of confidence that the product was robust, which was undoubtedly the most important criterion in the decision process.

Another key criterion for the product selection was the compatibility with the mirroring tool, as this provided the backup and recovery solution. The mirroring tool, Libelle, relies on the redo log to recreate the mirror image. As a result, Bertelsmann were hesitant to consider any tool that relied on the redo logs for synchronization, as there would have been a great deal of additional testing required to ensure full compatibility between the two products. Fortunately, the Bradmark product uses Oracle's materialized view to synchronize the tables, which not only did not conflict with the mirroring tool, but is also the methodology that is endorsed by Oracle and SAP.

Benefits

Together with Arvato and Bertelsmann Book Club, Bradmark proved the value of the DBControl Online product in the QA environment. While the standard settings proved fine for most of the tables being reorganized, there were a number of very large tables with LONGRAW values where the standard settings were not giving the optimum performance. Bertelsmann Club, Arvato and Bradmark worked together to tune the configuration parameters to provide the maximum performance for the different profiles of tables that needed to be reorganized.

Fig. 1

Table	Size before (MB)	Size after (MB)	Savings	% Savings
CCITCTS/SRSTRAT	3632	1679	1953	54%
TST03	7800	4560	3240	42%
VBUP	19101	17560	1541	8%
LIPS	74023	75400	-1377	-2%
CE1Z001	35742	16289	19453	54%
VBFS	31992	30449	1543	5%
QMEL	13789	12812	977	7%
ZYYCS_IF_RETURN	2390	664	1726	72%
CCITCTS/OM_RET1	311	97	214	69%
CCITCTS/OMCTR13	742	195	547	74%
S262	14726	8489	6237	42%
VBPA	58007	36440	21567	37%
MSEG	12656	8720	3936	31%
VEDA	3828	3800	28	1%
LIKP	9882	7720	2162	22%
VRPMA	9335	7240	2095	22%
VAPMA	16562	13200	3362	20%
VLPMA	9179	7080	2099	23%
BSIS	12773	10160	2613	20%
Total	336470	262554	73916	22%

Storage savings

The DBControl Online product proved itself in the QA environment, and was taken into production in March 2005. Since then, they have reorganized many tables online. The reorganization has been carried out on SD, MM, PS, FI, CO modules on the R/3 System, and BW and SEM modules in our BW environment. Although all the reorganization will have some impact, it is of course the large tables where this impact is most visible. Below are some of the initial results seen from the experience with DBControl Online on our SAP R/3 system. (See Fig. 1)

Although the reorganization can be done on any and all of the tables, Bertelsmann Club decided to focus on tables larger than 1 GB, of which there are approximately 300. Since the other tables will be left untouched, the total storage savings expected after a full reorganization of the 300 tables is 750 Gbytes, or 15% of the total database size. Since there is a disaster recovery machine as well as a QA

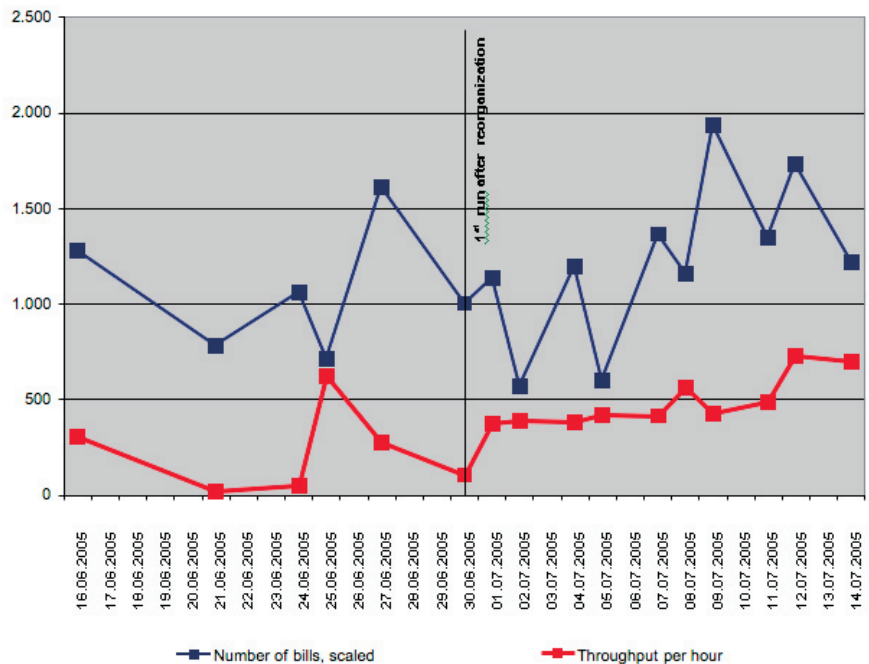
environment, both of which are replicas of the production environment, the total space savings in all 3 environments is expected to be 2.2 Terabytes.

End user response time

The improvement of end-user response time in a production environment is almost impossible to ascertain, mostly because of the many variables that contribute to the end-user response time, including number of transactions, type of transactions, overall CPU load, network performance etc. In the analysis that was carried out at Bertelsmann Club, it became clear that a significant percentage of the response time was being spent in database operations. Part of this was due to SQL statement inefficiencies, which were tuned. Another major improvement carried out was the rebuilding of the indexes. Since the DBControl Online solution recreates the index during the table reorg, the index rebuilds have now been replaced with table reorganisations. Because of the performance improvements, the tables are reorganized on a frequent basis. Of the 300 tables, 50 are reorganized on a weekly basis, 200 on a monthly and 50 on a quarterly basis.

In order to try and factor out the effect of the other parameters, the runtime for a billing process that relied on table VBFA was measured and averaged over 14 days before the reorganization, and over 14 days after the reorganization of the key billing table. The reorganization reduced the storage requirements for this table from 139 GB to 110 GB. The runtime measurements showed the following results:

Throughput for billing run before and after reorganization



Although the throughput varies with the number of bills being processed, one can see that the average throughput after the reorganization was 50% higher than after the reorganization with a similar number of bills being processed. This resulted in shorter batch runtimes overnight and more consistent completion of processing in the timescales allowed.

Conclusion

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DBControl Online Whitepaper
Print Date: 3/08

Uptime improvement

The use of the DBControl Online product for online reorganizations has meant that Bertelsmann have increased their application and database uptime from 99.2% to 99.7%. This is an important difference, as they now feel, having surpassed the 99.5% barrier, that they are in a position to integrate real 24x7 operations into their environment

IT Planning Manpower Savings – One of the less obvious benefits of the online reorganization is the IT man-hour savings in planning and coordinating a period of downtime. Bertelsmann estimate that they spent, on average, 6 man-hours for each downtime period organizing and informing the different parties and issues affected by downtime, including management, users, and the outsourced hosting partner, as well as rescheduling all the batch jobs that were planned for that period. With online reorg, they have none of these costs.

Dr. Torsten Fimmel, Bertelsmann Book Club's IT Director commented "I am very pleased with both the way the product has been performed, and just as importantly, how close the cooperation has been between all the parties involved. We had some performance issues early on in the testing, but these were resolved quickly by the Bradmark team and Arvato Systems working in close cooperation. Today, we feel that we have a product that matches our needs very well. The product allows us to reorganize on a regular basis, which keeps the database compact, and we can address end-user response issues before they affect productivity. DBControl Online allows us to do this without any end-user downtime and without additional hardware spend."

