TPC BENCHMARK ™ DI

(Data Integration)

Standard Specification

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Transaction Processing Performance Council (TPC)

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Legal Notice

No Warranty

Trademarks

Acknowledgments

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TPC Membership

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February 18, 2014	1.0.1	Editorial Change 1: Change to clarify Clause 7.2.2.2 .
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April 22, 2014	1.0.1	Editorial Change 3: Fixed bad clause reference.
November 11, 2014	1.1.0	Changes to Data Visibility queries (Clause 7.3)

Typographic Conventions

The following typographic conventions are used in this specification:

Convention	Description
Bold	Bold type is used to highlight terms that are defined in this document
Italics	Italics type is used to highlight a variable that indicates some quantity whose value can be assigned in one place and referenced in many other places.
UPPERCASE	Uppercase letters names such as tables and column names. In addition, most acronyms are in uppercase.

Contents

Clause 0: Preamble

0.1 Introduction

TPC Benchmark™ DI (TPC-DI) is a performance test of tools that move and integrate data between various systems. Data Integration (DI) tools are available from a number of vendors, but until now there has been no standard way to compare them. Such tools have also been referred to as Extract, Transform and Load (ETL) tools at times. The benchmark workload manipulates a defined volume of data, preparing the data for use in a Data Warehouse. The benchmark model includes data representing an extract from an On-Line Transaction Processing (OTLP) system being transformed along with data from ancillary data sources (including tabular and hierarchical structures), and loaded into a Data Warehouse. The source and destination schemas, data transformations and implementation rules have been designed to be broadly representative of modern data integration requirements.

The benchmark exercises a breadth of system components associated with DI environments, which are characterized by:

- The manipulation and loading of large volumes of data,
- A mixture of transformation types including error checking, surrogate key lookups, data type conversions, aggregation operations, data updates, etc.,
- Historical loading and incremental updates of a destination Data Warehouse using the transformed data,
- Consistency requirements ensuring that the integration process results in reliable and accurate data,
- Multiple data sources having different formats,
- Multiple data tables with varied data types, attributes and inter-table relationships.

The TPC-DI operations are modeled as follows:

- Source data is generated using TPC provided code. The data is provided in flat files, similar to the output of many extraction tools.
- Transformation of the data begins with the System Under Test (SUT) reading the Source Data.
- The transformations validate the Source Data and properly structure the data for loading into a Data Warehouse.
- The process concludes when all Source Data has been transformed and is available in the Data Warehouse.

0.1.1 Model for the TPC-DI Benchmark

The data model for the TPC-DI benchmark represents a retail brokerage. The focus of the TPC-DI benchmark is on the processes involved in transforming data from an OLTP environment and other relevant sources, and populating a data warehouse.

The mixture and variety of transformations being executed on the SUT is designed to capture the variety and complexity involved in a realistic data integration application. It is not the

intent of the TPC-DI benchmark to exercise all possible transformation types, but rather a representative set as needed for the brokerage scenario.

The benchmark defines:

- Multiple data source schemas and file formats,
- The Source Data generation requirements and data placement,
- The destination data warehouse schema,
- A collection of transformation rules describing how the destination data warehouse is populated with data from the data sources,
- Specific rules for the Historical Load and for Incremental Updates,
- Requirements for the execution, timing and reporting of the metrics,
- Methodology for the verification of the resulting data in the data warehouse,
- Disclosure and auditing requirements for the implementation and execution of the workload.

The performance metric reported for TPC-DI is a throughput measure, the number of Source Data rows processed per second. Conceptually, it is calculated by dividing the total rows processed by the elapsed time of the run. The rules for calculating DI throughput are given in Clause 7.

0.1.2 Restrictions and Limitations

Despite the fact that this benchmark offers a rich environment that represents many DI applications, this benchmark does not reflect the entire range of DI requirements. In addition, the extent to which a customer can achieve the Results reported by a vendor is highly dependent on how closely TPC-DI approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to any other environments are not recommended.

Benchmark results are highly dependent upon workload, specific application requirements, and systems design and implementation. Relative system performance will vary because of these and other factors. Therefore, TPC-DI should not be used as a substitute for specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.

Benchmark sponsors are permitted various possible implementation designs, insofar as they adhere to the model described and pictorially illustrated in this specification. A Full Disclosure Report (FDR) of the implementation details, as specified in Clause 10, must be made available along with the reported Results.

0.2 General Implementation Guidelines

The purpose of the TPC-DI benchmark is to provide relevant, objective performance data to industry users. To achieve that purpose, the TPC-DI benchmark specification requires benchmark tests be implemented with systems, products, technologies and pricing that:

- Are generally available to users;
- Are relevant to the market segment that the TPC-DI benchmark models or represents (e.g., TPC-DI models and represents environments that move and integrate data between various systems);
- Would plausibly be implemented by a significant number of users in the market segment modeled or represented by the benchmark.

The use of new systems, products, technologies (hardware or software) and pricing (hereafter referred to as "TPC-DI implementations") is encouraged so long as they meet the requirements above. Specifically prohibited are benchmark systems, products, technologies or pricing whose primary purpose is performance optimization of TPC-DI benchmark results without any corresponding applicability to real-world applications and environments. In other words, all "benchmark special" TPC-DI implementations, which improve benchmark results but not real-world performance or pricing, are prohibited.

A number of characteristics shall be evaluated in order to judge whether a particular TPC-DI implementation is a benchmark special. It is not required that each point below be met, but that the cumulative weight of the evidence be considered to identify an unacceptable TPC-DI implementation. Absolute certainty or certainty beyond a reasonable doubt is not required to make a judgment on this complex issue. The question that must be answered is: "Based on the available evidence, does the clear preponderance (the greater share or weight) of evidence indicate this TPC-DI implementation is a benchmark special?"

The following characteristics shall be used to judge whether a particular TPC-DI implementation is a benchmark special:

- Does the TPC-DI implementation have significant restrictions on its use or applicability that limits its use beyond the TPC-DI benchmark?
- Is the TPC-DI implementation or part of the TPC-DI implementation poorly integrated into the larger product?
- Does the TPC-DI implementation take special advantage of the limited nature of the TPC-DI benchmark (e.g., data transformations, data transformation mix, concurrency and/or contention, isolation requirements, etc.) in a manner that would not be generally applicable to the environment the benchmark represents?
- Is the use of the TPC-DI implementation discouraged by the vendor? (This includes failing to promote the TPC-DI implementation in a manner similar to other products and technologies.)
- Does the TPC-DI implementation require uncommon sophistication on the part of the end-user, programmer, or system administrator?
- Is the pricing unusual or non-customary for the vendor or unusual or non-customary compared to normal business practices? The following pricing practices are suspect:
    - Availability of a discount to a small subset of possible customers;
    - Discounts documented in an unusual or non-customary manner;
    - Discounts that exceed 25% on small quantities and 50% on large quantities;
    - Pricing featured as a close-out or one-time special;

    - Unusual or non-customary restrictions on transferability of product, warranty or maintenance on discounted items.
- Is the TPC-DI implementation (including beta-release components) being purchased or used for applications in the market segment the benchmark represents? How many sites implemented it? How many end-users benefit from it? If the TPC-DI implementation is not currently being purchased or used, is there any evidence to indicate that it will be purchased or used by a significant number of end-user sites?

0.3 General Measurement Guidelines

TPC-DI benchmark results are expected to be accurate representations of system performance. Therefore, there are specific guidelines that are expected to be followed when measuring those results. The approach or methodology to be used in the measurements are either explicitly described in the specification or left to the discretion of the test sponsor.

The use of new methodologies and approaches is encouraged when not described in the specification. However, these methodologies and approaches must meet the following requirements:

- The approach is an accepted engineering practice or standard;
- The approach does not enhance the result;
- Equipment used in measuring the results is calibrated according to established quality standards;
- Fidelity and candor is maintained in reporting any anomalies in the results, even if not specified in the benchmark requirements.

0.4 Definitions

Throughout the body of this document, defined terms (see Clause 12) are formatted in bold to indicate that the term has a precise meaning. For example, “Rationale” specifically denotes an explanatory statement that is not part of the standard, whereas “rationale” should be interpreted simply using the typical definition of the word.

Clause 1: Benchmark Overview

1.1 Business and Application Environment

The data model for the TPC-DI benchmark represents a retail brokerage. OLTP data is combined with data from additional sources to create the data warehouse. Figure 1.1-1 illustrates the conceptual model of the brokerage DI system.

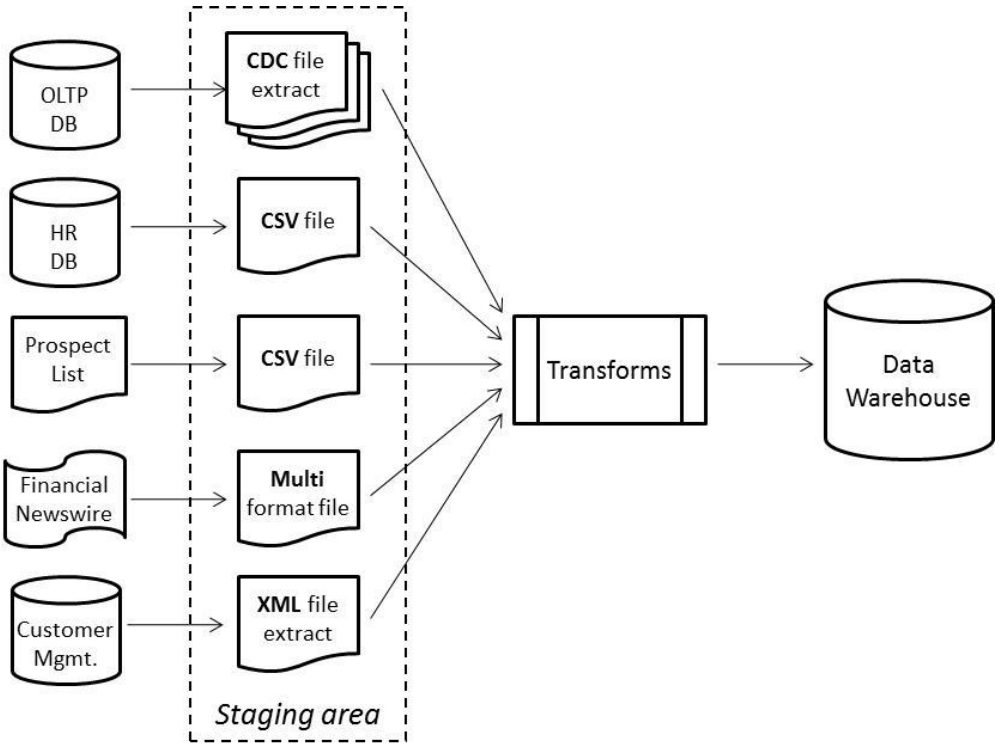


Figure 1.1-1: Conceptual Overview

There are multiple tables in the OLTP system that are extracted into a staging area; the OLTP system contains data on customers, accounts, brokers, securities, trade details, account balances, market information, and so on. Extracts from these tables are represented as flat files in the Staging Area. For Incremental Updates the extracts are Changed Data Capture (CDC) extracts of changes to the tables since the last extract while for the Historical Load the extract is modeled as a full dump of the tables.

The HR database has one table with employee data that is represented as a full table extract into the Staging Area formatted comma separated value (CSV) file.

The Prospects file contains names, addresses and demographic data for prospective customers, such as a company might purchase from a syndicated data provider. This data arrives in a comma separated value (CSV) file format, this being the lowest common denominator of information exchange. The DI process must determine what changes have occurred since the last update.

In the Historical Load phase of the benchmark, two other sources are used to provide information that is not directly available from the OLTP system. Financial information about companies and securities is obtained from a financial newswire (FINWIRE) service that has been archived over an extended period of time. This data comes in variable-format records in files saved in the Staging Area. Customer and account information is retrieved from a Customer Management System. Historical CMS information is saved in the Staging Area as an XML-formatted extract.

1.2 Summary of Operations

1.2.1 Scope of the benchmark

In many real world systems, it is necessary to integrate data from different types of source systems, including different database vendors. While it would be desirable to include the extraction from these often heterogeneous source systems in the benchmark, it is simply an intractable problem from a benchmark logistics point of view. Hence, TPC-DI models an environment where all source system data has been extracted to flat files in a staging area before the remainder of the DI process begins. TPC-DI does not attempt to represent the wide range of data sources available in the marketplace, but models abstracted data sources and measures all systems involved in moving and transforming data from the Staging Area to the Data Warehouse.

The use of a staging area in TPC-DI does not limit its relevance as it is common in real world DI applications to use staging areas for allowing extracts to be performed on a different schedule from the rest of the DI process, for allowing backups of extracts that can be returned to in case of failures, and for potentially providing an audit trail.

Figure 1.2-1 shows what parts of the conceptual model are implemented in the benchmark.

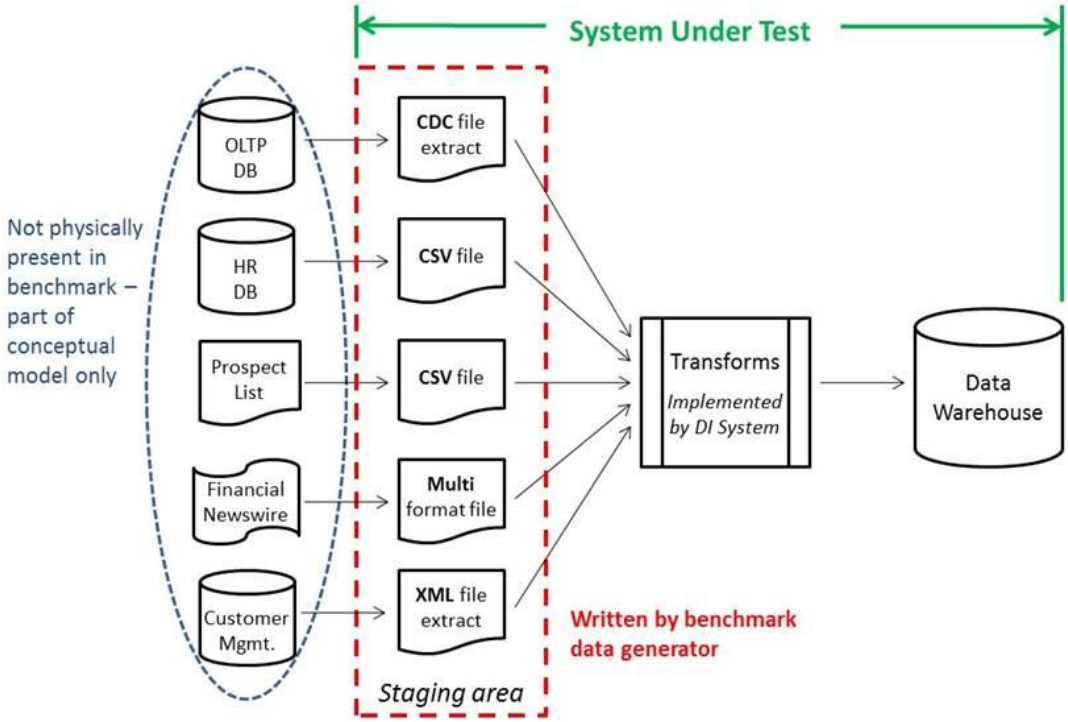


Figure 1.2-1: The System Under Test

1.2.2 Phases of operation

In many real world DI applications, there are two variants of the DI process. One variant performs an historical load, at times when the data warehouse is initially created or when it is recreated from historical records such as when the data warehouse schema is restructured. The second variant performs incremental updates, representing the load of new data into an existing data warehouse. There are many different rates at which incremental updates may occur, from rarely to near real-time. Daily updates are common, and are the model for the TPC-DI benchmark.

Many DI applications have a constrained time window in which they must perform their regular updates. Updates are often done as an overnight operation and must fit with backups and other activities. At the same time, modern DI systems must deal with large volumes of historical data. The benchmark models both large historical data and constrained timing. The benchmark consists of several phases which are executed in sequence.

1.2.2.1 Preparation phase

1.2.2.1.1 Data Generation

Data generation is performed using the data generator described in Clause 6. The data may be generated directly in the Staging Area or it may be generated in a different location and copied to the Staging Area before the Historical Load. Generating data and copying it to the Staging Area are not timed for the benchmark.

1.2.2.1.2 Data Warehouse Creation

Creation of the Data Warehouse database and tables, including allocation of disk space, is not a DI operation and is not timed for the benchmark.

1.2.2.1.3 Data Integration Preparation

The data integration software may require additional preparation and configuration to perform the benchmark operations. The work performed in this step will vary among implementations, and is not timed for the benchmark.

1.2.2.2 Historical Load phase

The Historical Load includes different transformations than the Incremental Updates. Destination tables are initially empty and being populated with new data, and the source files may have different ordering properties (an unload of the data from an OLTP table might be in primary key order, while a CDC extract would be in order of the time that changes occurred). In addition, there are sources of data that are different from the Incremental Updates. The Historical Load naturally uses a larger set of data than an Incremental Update. Following the Historical Load, the Validation Query collects certain information that will be used to check for correctness in the automated audit phase.

The Historical Load phase may run for as much time as needed to completely process the data and is timed for use in the computation of the benchmark metric.

1.2.2.3 Incremental Update phase

An Incremental Update includes different transformations than the Historical Load. The input files from the OLTP database are modeled as CDC extracts, which show the changes in the table data since the last extract. The Prospect file is a full data set (not CDC), so it is up to the DI application to determine what changes have occurred.

Two Incremental Update phases are required in a TPC-DI benchmark run. By requiring more than one Incremental Update, the benchmark ensures repeatability. Following each Incremental Update, the Validation Query collects certain information that will be used to check for correctness in the automated audit phase.

The Incremental Update phases are each required to complete in 30-60 minutes, and are timed for use in the computation of the benchmark metric.

1.2.2.4 Automated Audit phase

After all of the other phases are complete, the automated audit queries the Data Warehouse to perform extensive tests on the resulting data and creates a simple report of the results. The automated audit phase is not timed, but all tests must pass for the run to be valid.

1.3 Source Data Models

1.3.1 Section 1.1 introduced the concept of the OLTP, HR, Prospects, FINWIRE and Customer Management data sources. In addition, there are a small number of reference files that

contain data that is loaded only once during the Historical Load and not modified again in the benchmark. The fields in each source file are described in Clause 2.

1.3.2 The OLTP database represents a database with transactional information about securities market trading and the entities involved, i.e. customers, accounts, brokers, securities, trade details, account balances, market information, and so on. Files used in the Historical Load are full extracts containing all the rows in the table. Files used as input to an Incremental Update are CDC extracts, and as such they contain additional "CDC_FLAG" and "CDC_DSN" columns at the beginning of each row. The CDC_FLAG is a single character I, U or D that tells whether the row has been inserted, updated or deleted since the last change. For updates there is no indication as to what in the row has been changed. Rows that have not changed since the last extract will not appear in the CDC extract file at all. A row may change multiple times in the course of a day. The CDC_DSN is a sequence number, a value whose exact definition is meaningful only to the source database, but will be monotonically increasing in value throughout the rows in a file. The rows in a file will be ordered by the CDC_DSN value, which also reflects the time order in which the changes were applied to the database. Files from the OLTP system are:

- Account.txt (Incremental Update)
- Customer.txt (Incremental Update)
- Trade.txt (Historical Load and Incremental Update)
- TradeHistory.txt (Historical Load)
- CashTransaction.txt (Historical Load and Incremental Update)
- HoldingHistory.txt (Historical Load and Incremental Update)
- DailyMarket.txt (Historical Load and Incremental Update)
- WatchItem.txt (Historical Load and Incremental Update)

1.3.3 The HR database is represented by a single extract file, HR.csv. This file contains information about the employees of the company and the employee reporting hierarchy. There is no CDC on this data source; it is modeled as a full table extract for the Historical Load.

1.3.4 The Prospect.csv represents data that is obtained from an external data provider. The file contains names, contact information and demographic data on potential customers, some of whom are already customers of the brokerage. This file is modeled as a full daily extract from the data provider, i.e. there is no indication in the data as to what has changed from the previous extract.

1.3.5 There is a FINWIRE file for each quarter of historical data. There are three types of records that may appear in a FINWIRE file, each with a different format. Within a record type the fields are fixed-width. The various record types will provide data for the tables DimCompany, DimSecurity and Financial in the Historical Load phase. One would normally expect updates to company and security data while maintaining a data warehouse. However, the number of these changes is too small to have a performance impact in this benchmark, so they are not considered in the Incremental Update phases.

1.3.6 The CustomerMgmt.xml file represents data extracted from a Customer Management System (CMS). The CMS handles new and updated customer and account information. The data in the file is transactional in nature and uses a hierarchical structure to represent data

relationships. This source provides the data for the DimAccount and DimCustomer tables in the Historical Load phase.

1.3.7 Reference data is loaded only during the Historical Load and not modified again in the course of the benchmark. The following files represent the set of reference data for the benchmark:

- Date.txt
- Time.txt
- Industry.txt
- StatusType.txt
- TaxRate.txt
- TradeType.txt

Although some of these tables would be expected to change in the lifetime of a real-world system, they will not change over the lifetime of a benchmark run.

1.4 Destination Data Model

The destination of the TPC-DI workload is a dimensional data warehouse, such as described in The Data Warehouse Toolkit (Ralph Kimball and Margy Ross, Wiley, April 2002). Dimensional models are designed to enable efficient responses to a variety of business questions and are common practice in the industry. There are other ways to define a data warehouse, but this format provides a well understood structure in the benchmark Data Warehouse while also allowing for an appropriate variety of data transformations to be exercised in the TPC-DI workload.

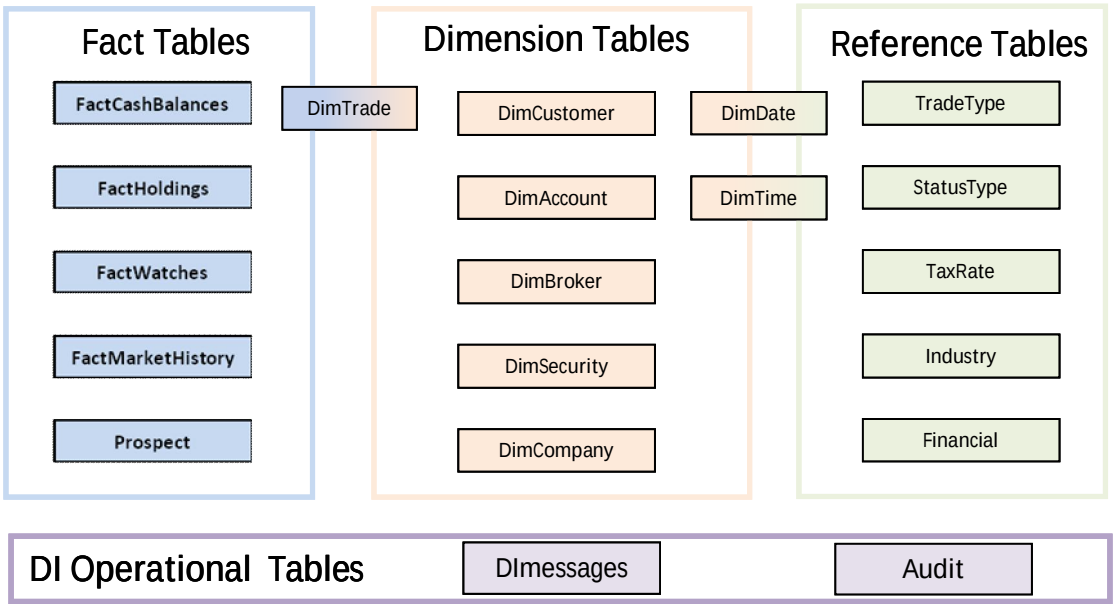


Figure 1.4-1: Pictorial overview of the Data Warehouse Tables

In a dimensional model, “dimension tables” describe the business entities of interest. In the TPC-DI benchmark they are dates (in the DimDate table), times (DimTime), customers (DimCustomer), accounts (DimAccount), brokers (DimBroker), securities (DimSecurity),

companies (DimCompany), and trades (DimTrade). "Fact tables" give measurement information describing what occurred, such as the price and volume of a transaction, or the status of something, such as the number of shares held on a certain date. In the TPC-DI benchmark the fact tables describe holdings (FactHoldings), trades (DimTrade), cash balances (FactCashBalances), the market history (FactMarketHistory), and customer watches on securities (FactWatches). Note that is it possible for certain tables to serve more than one role: The DimTrade table is both a dimension table and a fact table, depending on how it is being used.

1.5 Transformations

The term "transformations" in this benchmark includes everything that must be done to prepare and load data into the Data Warehouse. This can include:

- Conversion of data from character representations to data types compatible with the Data Warehouse specification
- Lookups of business keys to obtain surrogate keys for the Data Warehouse
- Merging or formatting multiple fields into one, or splitting one field into multiple
- Checking data for errors or for adherence to business rules
- Detecting changes in dimension data, and applying appropriate tracking mechanisms (retaining history or overwriting)
- Detecting changes in fact data, and journaling updates to reflect current state

1.5.1 Clause 4 gives the detailed transformation rules for both the Historical Load and for Incremental Updates.

1.6 Result Reporting Classes

1.6.1 In basic data warehousing applications, the data warehouse is used for data analysis and reporting. Data is initially loaded into the data warehouse and then periodically updated with more current information. The data warehouse might also be rebuilt and reloaded from time to time. Typically the data warehouse is 'offline' (i.e. unavailable to end users) during initial loads and reloads. Loading and updating the data warehouse is controlled by a data integration process. The end users access the data warehouse only for querying the data, not for updating. Whether or not full ACID database properties are required in a data warehouse is a choice unique to each organization.

1.6.2 To reflect the variety of systems used to implement data warehouses, TPC-DI defines two data warehouse classes, called ACID and OPEN. The ACID data warehouse class requires the Data Warehouse system to be ACID compliant, while the OPEN class allows the Data Warehouse system to adhere to a minimal set of concurrency requirements.

1.6.3 Data Warehouses eligible to run the TPC-DI benchmark must meet at least the OPEN class criteria. Test sponsors may choose to subject their implementations to additional criteria to establish eligibility for the ACID class.

1.6.4 Benchmark Results from different classes are not comparable and will be listed separately on the TPC website.

Clause 2: Source Data Files

2.1 Introduction

This section describes the formats of files created by the data generator. The number of rows in the files are variable, determined by the data generator based on the Scale Factor chosen by the test sponsor.

Throughout this benchmark, input date values are written as YYYY-MM-DD unless a specific alternate format is given.

2.2 File format definitions

2.2.1 General Formatting definitions

2.2.1.1 The file format definitions refer to a common set of data types, defined in Table 2.2.1, and meta-types defined in Table 2.2.2. The DI System needs to be able to parse the base data types. The meta-types are all defined in terms of base data types, with names that indicate their function and possibly value restrictions.

Rationale: The input data all comes from text files, and in that context all values are character sequences. These are not "native data types" in the sense that a database has native data types that it can store, but are abstractions that describe the character sequences. These types do however correlate to the data types used in section 3.2 to define the Data Warehouse tables.

Table 2.2.1: Common data type definitions for source data files

Base Type	Input formatting
BOOLEAN	"0" for False and "1" for True.
CHAR(n)	Character string of up to n single-byte characters.
DATE	Formatted as "YYYY-MM-DD", were YYYY is the year, MM is the month number and DD is the day number. MM and DD will have leading zeroes when appropriate.
DATETIME	Formatted as "YYYY-MM-DD HH:MM:SS", were YYYY is the year, MM is the month number, DD is the day number, HH is the hour, MM is the minute, and SS is the second in 24-hour format. Each part of the value will have leading zeroes when appropriate.
NUM(m[,n])	Unsigned numeric value with at most m total Digits, of which up to n Digits are to the right (after) the decimal point. The length does not exceed m+1 characters, including the decimal point.
SNUM(m[,n])	Signed numeric value with an optional "+" or "-" followed by at most m total Digits, of which up to n Digits are to the right (after) the decimal point. The length does not exceed m+2 characters, including the sign and decimal point. If there is no sign, the value is positive.

Table 2.2.2: Meta-type definitions for source data files

Meta Type	Base Type	Usage / Restrictions
BALANCE_T	SNUM(12,2)	Aggregate account and transaction related values such as

		account balances, total commissions, etc.
CDC_FLAG_T	CHAR(1)	"I", "U" or "D" for insert, update or delete
CDC_DSN_T	NUM(12)	Database Sequence Number, a monotonically increasing value
IDENT_T	NUM(11)	Numeric identifiers
S_COUNT_T	NUM(12)	Aggregate count of shares
S_PRICE_T	SNUM(8,2)	Share prices
S_QTY_T	NUM(6)	Quantity of shares for an individual trade
TRADE_T	NUM(15)	Trade identifiers
VALUE_T	SNUM(10,2)	Non-aggregated transaction and security related values such as cost, dividend, etc.

2.2.1.2 The character set encoding for all generated source data files is single-byte UTF-8.

2.2.1.3 Unless specifically mentioned, the rows in all generated files are not sorted in any particular order.

2.2.2 Specific file format definitions

2.2.2.1 Account.txt

2.2.2.1.1 The Account.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between vertical bars.

2.2.2.1.2 Rows are ordered by the CDC_DSN field.

Table 2.2.3: Account.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	'I' or 'U'	Denotes insert or update
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
CA_ID	IDENT_T	Not NULL	Customer account identifier
CA_B_ID	IDENT_T	Not NULL	Identifier of the managing broker
CA_C_ID	IDENT_T	Not NULL	Owning customer identifier
CA_NAME	CHAR(50)		Name of customer account
CA_TAX_ST	NUM(1)	0, 1 or 2	Tax status of this account
CA_ST_ID	CHAR(4)	'ACTV' or 'INAC'	Customer status type identifier

2.2.2.2 BatchDate.txt

2.2.2.2.1 This file has a single row with a single field containing the date of extraction of the data files in the Staging Area, formatted as YYYY-MM-DD. This date will be referred to as the Batch Date elsewhere in the specification.

Table 2.2.4: BatchDate.txt file field

Field Name	Type	Restrictions	Description / Explanation
BatchDate	DATE	Not NULL	Date of the data batch in the Staging Area

2.2.2.3 CashTransaction.txt

The CashTransaction.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under

Test. The CDC_FLAG and CDC_DSN fields are not present in the data set used by the Historical Load.

2.2.2.3.1 For Incremental Updates this file is ordered by CDC_DSN.

Table 2.2.5: CashTransaction.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	'I'	Denotes insert
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
CT_CA_ID	IDENT_T	Not Null	Customer account identifier
CT_DTS	DATETIME	Not Null	Timestamp of when the trade took place
CT_AMT	VALUE_T	Not Null	Amount of the cash transaction.
CT_NAME	CHAR(100)	Not Null	Transaction name, or description: e.g. "Cash from sale of DuPont stock".

2.2.2.4 Customer.txt

The Customer.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. This file is not used by the Historical Load. Null values, where allowed, are indicated by there being no characters between vertical bars.

2.2.2.4.1 Customer.txt is ordered by CDC_DSN.

Table 2.2.6: Customer.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	'I' or 'U'	Denotes insert or update
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
C_ID	IDENT_T	Not NULL	Customer identifier
C_TAX_ID	CHAR(20)	Not NULL	Customer's tax identifier
C_ST_ID	CHAR(4)	'ACTV' or 'INAC'	Customer status type identifier
C_L_NAME	CHAR(25)	Not NULL	Primary Customer's last name.
C_F_NAME	CHAR(20)	Not NULL	Primary Customer's first name.
C_M_NAME	CHAR(1)		Primary Customer's middle initial
C_GNDR	CHAR(1)		Gender of the primary customer
C_TIER	NUM(1)		Customer tier
C_DOB	DATE	Not NULL	Customer's date of birth, as YYYY-MM-DD.
C_ADLINE1	CHAR(80)	Not NULL	Address Line 1
C_ADLINE2	CHAR(80)		Address Line 2
C_ZIPCODE	CHAR(12)	Not NULL	Zip or postal code
C_CITY	CHAR(25)	Not NULL	City
C_STATE_PROV	CHAR(20)	Not NULL	State or province
C_CTRY	CHAR(24)		Country
C_CTRY_1	CHAR(3)		Country code for Customer's phone 1.
C_AREA_1	CHAR(3)		Area code for customer's phone 1.
C_LOCAL_1	CHAR(10)		Local number for customer's phone 1.
C_EXT_1	CHAR(5)		Extension number for Customer's phone 1.
C_CTRY_2	CHAR(3)		Country code for Customer's phone 2.

C_AREA_2	CHAR(3)		Area code for Customer's phone 2.
C_LOCAL_2	CHAR(10)		Local number for Customer's phone 2.
C_EXT_2	CHAR(5)		Extension number for Customer's phone 2.
C_CTRY_3	CHAR(3)		Country code for Customer's phone 3.
C_AREA_3	CHAR(3)		Area code for Customer's phone 3.
C_LOCAL_3	CHAR(10)		Local number for Customer's phone 3.
C_EXT_3	CHAR(5)		Extension number for Customer's phone 3.
C_EMAIL_1	CHAR(50)		Customer's e-mail address 1.
C_EMAIL_2	CHAR(50)		Customer's e-mail address 2.
C_LCL_TX_ID	CHAR(4)	Not NULL	Customer's local tax rate
C_NAT_TX_ID	CHAR(4)	Not NULL	Customer's national tax rate

2.2.2.5 CustomerMgmt.xml

CustomerMgmt.xml is an XML document, i.e. an XML formatted file, representing actions resulting in new or changed customer and account information. This file is only used in the Historical Load to populate the DimAccount and DimCustomer tables. The data in the document is ordered in time sequence.

2.2.2.5.1 The document consists of a set of Action data elements. Each Action specifies an ActionType and is related to an Account and/or a Customer. All Actions have at least a related Customer, and all Accounts are associated with a single Customer. The document uses a hierarchical structure to represent the relationship between these data elements.

2.2.2.5.2 The data fields and properties of their values are provided in the table below. In the XML document, these data fields are manifested as attributes or contained (nested) elements. The table describes the characteristics of the values supplied in these data fields. Empty elements are expressed as an empty XML tag, e.g. <Element />.

Table 2.2.7: CustomerMgmt element properties

Field Name	Type	Restrictions	Description / Explanation
Action	XML Element		XML element containing the following attributes and elements
Action Attributes:			
ActionType	CHAR(9)	'NEW', 'ADDACCT', 'UPDCUST', 'UPDACCT', 'CLOSEACCT', 'INACT'	One of: NEW – A new customer. A new customer is always created with 1 or more accounts. ADDACCT – One or more new accounts for an existing customer. UPDACCT – Changes to one or

			more existing accounts. UPDCUST – A change to an existing customer. CLOSEACCT – Close one or more existing accounts. INACT – An existing customer has become inactive.
ActionTS	CHAR	Not empty	Date and time of the action as YYYY-MM-DDTHH:MM:SS . Note the 'T' is a literal value.
Action Contained Element:			
Customer	XML Element		XML element contained by Action, and containing the following attributes and elements
Customer Attributes:			
C_ID	IDENT_T	Not empty, Required	Customer identifier
C_TAX_ID	CHAR(20)	Not empty, Required on 'NEW'	Customer's tax identifier
C_GNDR	CHAR(1)	Not empty	Gender of the customer
C_TIER	NUM(1)	Not empty	Customer tier
C_DOB	DATE	Not empty, Required on 'NEW'	Customer's date of birth as YYYY-MM-DD
C_ID	IDENT_T	Not empty, Required	Customer identifier
Customer Contained Elements:			
Name	XML Element		XML element contained by Customer, and containing the following attributes
Name Attributes:			
C_L_NAME	CHAR(25)	Not empty, Required on 'NEW'	Customer's last name.
C_F_NAME	CHAR(20)	Not empty, Required on 'NEW'	Customer's first name.
C_M_NAME	CHAR(1)		Customer's middle initial
Address	XML Element		XML element contained by Customer, and containing the

			following attributes
Address Attributes:			
C_ADLINE1	CHAR(80)	Not empty, Required on 'NEW'	Address Line 1
C_ADLINE2	CHAR(80)		Address Line 2
C_ZIPCODE	CHAR(12)	Not empty, Required on 'NEW'	Zip or postal code
C_CITY	CHAR(25)	Not empty, Required on 'NEW'	City
C_STATE_PROV	CHAR(20)	Not empty, Required on 'NEW'	State or province
C_CTRY	CHAR(24)		Country
ContactInfo	XML Element		XML element contained by Customer, and containing the following attributes
ContactInfo Attributes:			
C_PRIM_EMAIL	CHAR(50)		Customer's primary e-mail address
C_ALT_EMAIL	CHAR(50)		Customer's alternate e-mail address
C_PHONE_1	PhoneNumber*		Customer's primary phone number
C_PHONE_2	PhoneNumber*		Customer's secondary phone number
C_PHONE_3	PhoneNumber*		Customer's third phone number
TaxInfo	XML Element		XML element contained by Customer, and containing the following attributes
TaxInfo Attributes:			
C_LCL_TX_ID	CHAR(4)		Customer's local tax rate
C_NAT_TX_ID	CHAR(4)		Customer's national tax rate
Account	XML Element		XML element contained by Customer, and containing the following attributes and elements
Account Attributes:			
CA_ID	IDENT_T	Not empty,	Customer account identifier

		Required	
CA_TAX_ST	NUM(1)	Not empty, Required on 'NEW'	Tax status of this account
Account Contained Elements:			
CA_B_ID	IDENT_T	Not empty, Required on 'NEW'	Identifier of the managing broker
CA_NAME	CHAR(50)		Name of customer account

2.2.2.5.3 The PhoneNumber data type is defined within the scope of the CustomerMgmt XML Schema and used to define Action.Customer.ContactInfo.C_PHONE_1, Action.Customer.ContactInfo.C_PHONE_2, and Action.Customer.ContactInfo.C_PHONE_3.

PhoneNumber	XML Type	Defined within the scope of the CustomerMgmt schema.
PhoneNumber Contained Elements:		
C_CTRY_CODE	CHAR(3)	Country code for Customer's phone
C_AREA_CODE	CHAR(3)	Area code for customer's phone
C_LOCAL	CHAR(10)	Local number for customer's phone
C_EXT	CHAR(5)	Extension number for Customer's phone

2.2.2.5.4 For each action, only required properties are supplied. For example, a ‘NEW’ action will contain customer identifying information, many properties (e.g. name, address), and one or more sets of account information. In contrast, an update action may update one or more customer or account properties. For that action, only the properties used to identify the account and/or customer, and the updated properties will be supplied, the other properties will be omitted from the XML document.

2.2.2.5.5 The structure of the XML document is described by an XML Schema (xsd). The XML schema can be used to parse and validate the XML document. Note that the XML schema may not enforce all of the data constraints defined in table 2.2.7. While the XML schema definition allows for more variation in the data values, the data used by the benchmark will conform to the characteristics described in table 2.2.8.

2.2.2.5.6 The formal XML Schema definition is provided here:

CustomerMgmt XML schema definition

```
<xsd:schema targetNamespace="http://www.tpc.org/tpc-di"
xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:TPCDI="http://www.tpc.org/tpc-di">
  <xsd:element name="Action" type="TPCDI:ActionDef" />
  <xsd:element name="Actions">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element ref="TPCDI:Action" maxOccurs="unbounded" />
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>
  <xsd:complexType name="ActionDef">
    <xsd:all>
      <xsd:element name="Customer" minOccurs="1" maxOccurs="1">
        <xsd:complexType>
          <xsd:sequence>
            <xsd:element name="Name" minOccurs="0" >
              <xsd:complexType>
                <xsd:all>
                  <xsd:element name="C_L_NAME" type="xsd:string" />
                  <xsd:element name="C_F_NAME" type="xsd:string" />
                  <xsd:element name="C_M_NAME" type="xsd:string" minOccurs="0" />
                </xsd:all>
              </xsd:complexType>
            </xsd:element>
            <xsd:element name="Address" minOccurs="0">
              <xsd:complexType>
                <xsd:all>
                  <xsd:element name="C_ADLINE1" type="xsd:string" />
                  <xsd:element name="C_ADLINE2" type="xsd:string" minOccurs="0" />
                  <xsd:element name="C_ZIPCODE" type="xsd:string" />
                  <xsd:element name="C_CITY" type="xsd:string" />
                  <xsd:element name="C_STATE_PROV" type="xsd:string" />
                  <xsd:element name="C_CTRY" type="xsd:string" />
                </xsd:all>
              </xsd:complexType>
            </xsd:element>
            <xsd:element name="ContactInfo" minOccurs="0">
              <xsd:complexType>
                <xsd:all>
                  <xsd:element name="C_PRIM_EMAIL" type="xsd:string" minOccurs="0" />
                  <xsd:element name="C_ALT_EMAIL" type="xsd:string" minOccurs="0" />
                  <xsd:element name="C_PHONE_1" type="TPCDI:PhoneNumber" minOccurs="0" />
                  <xsd:element name="C_PHONE_2" type="TPCDI:PhoneNumber" minOccurs="0" />
                  <xsd:element name="C_PHONE_3" type="TPCDI:PhoneNumber" minOccurs="0" />
                </xsd:all>
              </xsd:complexType>
            </xsd:element>
```

```
            <xsd:element name="TaxInfo" minOccurs="0">
              <xsd:complexType>
                <xsd:all>
                  <xsd:element name="C_LCL_TX_ID" type="xsd:string" />
                  <xsd:element name="C_NAT_TX_ID" type="xsd:string" />
                </xsd:all>
              </xsd:complexType>
            </xsd:element>
            <xsd:element name="Account" minOccurs="0" maxOccurs=”unbounded”>
              <xsd:complexType>
                <xsd:all>
                  <xsd:element name="CA_B_ID" type="xsd:string" minOccurs="0" />
                  <xsd:element name="CA_NAME" type="xsd:string" minOccurs="0" />
                </xsd:all>
                <xsd:attribute name="CA_ID" type="xsd:string" use="required" />
                <xsd:attribute name="CA_TAX_ST" type="xsd:string" />
              </xsd:complexType>
            </xsd:element>
          </xsd:sequence>
          <xsd:attribute name="C_ID" type="xsd:string" use="required" />
          <xsd:attribute name="C_TAX_ID" type="xsd:string" />
          <xsd:attribute name="C_GNDR" type="xsd:string" />
          <xsd:attribute name="C_TIER" type="xsd:unsignedByte" />
          <xsd:attribute name="C_DOB" type="xsd:date" />
        </xsd:complexType>
      </xsd:element>
    </xsd:all>
    <xsd:attribute name="ActionType" type="xsd:string" />
    <!-- restrict to certain values? -->
    <xsd:attribute name="ActionTS" type="xsd:dateTime" />
    <!-- yyyy-mm-dd -->
  </xsd:complexType>
  <xsd:complexType name="PhoneNumber">
    <xsd:sequence>
      <xsd:element name="C_CTRY_CODE" type="xsd:string" minOccurs="0" />
      <xsd:element name="C_AREA_CODE" type="xsd:string" />
      <xsd:element name="C_LOCAL" type="xsd:string" />
      <xsd:element name="C_EXT" type="xsd:string" minOccurs="0" />
    </xsd:sequence>
  </xsd:complexType>
</xsd:schema>
```

2.2.2.6 DailyMarket.txt

The DailyMarket.txt file is a plain-text file with variable length fields separated by a vertical bar (“|”). Records have a terminator character appropriate for the System Under Test. The CDC_FLAG and CDC_DSN fields are not present in the data set used by the Historical Load.

2.2.2.6.1 This file is ordered by CDC_DSN for Incremental Updates.

Table 2.2.10: DailyMarket.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	‘I’	Denotes insert
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
DM_DATE	DATE	Not Null	Date of last completed trading day.
DM_S_SYMB	CHAR(15)	Not Null	Security symbol of the security
DM_CLOSE	S_PRICE_T	Not Null	Closing price of the security on this day.
DM_HIGH	S_PRICE_T	Not Null	Highest price for the secuirity on this day.
DM_LOW	S_PRICE_T	Not Null	Lowest price for the security on this day.
DM_VOL	S_COUNT_T	Not Null	Volume of the security on this day.

2.2.2.7 Date.txt

The Date.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between vertical bars.

2.2.2.7.1 This file is ordered by the SK_DateID field.

Table 2.2.11: Date file fields

Field Name	Type	Restrictions	Description / Explanation
SK_DateID	IDENT_T	Not NULL	Surrogate key for the date
DateValue	CHAR(20)	Not NULL	The date as text, e.g. "2004-07-07"
DateDesc	CHAR(20)	Not NULL	The date Month Day, YYYY, e.g. July 7, 2004
CalendarYearID	NUM(4)	Not NULL	Year number as a number
CalendarYearDesc	CHAR(20)	Not NULL	Year number as text
CalendarQtrID	NUM(5)	Not NULL	Quarter as a number, e.g. 20042
CalendarQtrDesc	CHAR(20)	Not NULL	Quarter as text, e.g. "2004 Q2"
CalendarMonthID	NUM(6)	Not NULL	Month as a number, e.g. 20047
CalendarMonthDesc	CHAR(20)	Not NULL	Month as text, e.g. "2004 July"
CalendarWeekID	NUM(6)	Not NULL	Week as a number, e.g. 200428
CalendarWeekDesc	CHAR(20)	Not NULL	Week as text, e.g. "2004-W28"
DayOfWeekNum	NUM(1)	Not NULL	Day of week as a number, e.g. 3
DayOfWeekDesc	CHAR(10)	Not NULL	Day of week as text, e.g. "Wednesday"
FiscalYearID	NUM(4)	Not NULL	Fiscal year as a number, e.g. 2005
FiscalYearDesc	CHAR(20)	Not NULL	Fiscal year as text, e.g. "2005"
FiscalQtrID	NUM(5)	Not NULL	Fiscal quarter as a number, e.g. 20051
FiscalQtrDesc	CHAR(20)	Not NULL	Fiscal quarter as text, e.g. "2005 Q1"
HolidayFlag	BOOLEAN		Indicates holidays

2.2.2.8 FINWIRE

Data from a "financial newswire" has been recorded over time, and stored in files with a new file being created each quarter using names like FINWIRE2003Q1, FINWIRE2003Q2, etc. The formatting of records in the file depends on the type of record, as indicated by three characters of each record starting at column 16. Records of any type may appear in any order in the file. Records have a terminator character appropriate for the System Under Test.

There are three record types in FINWIRE files: 'CMP', 'SEC', and 'FIN'. There are no field separators in these files; each of the record types contains fixed-width fields with the exception that in some cases the last field may contain a company name (60 characters) or a CIK number (10 digits). Where dates appear, they are formatted as YYYYMMDD. Each record begins with a Posting Time Stamp (PTS) showing when the record was originally posted on the FINWIRE; the format of a PTS is YYYYMMDD-HHMMSS using 24-hour time. Records in each FINWIRE file are in increasing order of the PTS.

All fields listed in the table below will be as wide as given in the Type column. Text fields will be padded with spaces on the right and numeric fields will be padded with spaces on the left.

Where CIK numbers appear, they are padded with leading zeroes on the left to fill out the 10-character width. An "empty" field is padded with all spaces.

Table 2.2.8: FINWIRE file fields

Field Name	Type	Restrictions	Description / Explanation
CMP records			
PTS	CHAR(15)	Not empty	Posting date & time as YYYYMMDD-HHMMSS
RecType	CHAR(3)	Not empty	"CMP"
CompanyName	CHAR(60)	Not empty	Name of the company
CIK	CHAR(10)	Not empty	Company identification code from SEC
Status	CHAR(4)	Not empty	'ACTV' for Active company, 'INAC' for inactive
IndustryID	CHAR(2)	Not empty	Code for industry segment
SPrating	CHAR(4)	Not empty	S&P rating
FoundingDate	CHAR(8)		A date as YYYYMMDD
AddrLine1	CHAR(80)	Not empty	Mailing address
AddrLine2	CHAR(80)		Mailing address
PostalCode	CHAR(12)	Not empty	Mailing address
City	CHAR(25)	Not empty	Mailing address
StateProvince	CHAR(20)	Not empty	Mailing address
Country	CHAR(24)		Mailing address
CEOname	CHAR(46)	Not empty	Name of company CEO
Description	CHAR(150)	Not empty	Description of the company
SEC records			
PTS	CHAR(15)	Not empty	Posting date & time as YYYYMMDD-HHMMSS
RecType	CHAR(3)	Not empty	"SEC"
Symbol	CHAR(15)	Not empty	Security symbol
IssueType	CHAR(6)	Not empty	Issue type
Status	CHAR(4)	Not empty	'ACTV' for Active security, 'INAC' for inactive
Name	CHAR(70)	Not empty	Security name
ExID	CHAR(6)	Not empty	ID of the exchange the security is traded on
ShOut	CHAR(13)	Not empty	Number of shares outstanding
FirstTradeDate	CHAR(8)	Not empty	Date of first trade as YYYYMMDD
FirstTradeExchg	CHAR(8)	Not empty	Date of first trade on exchange as YYYYMMDD
Dividend	CHAR(12)	Not empty	Dividend as VALUE_T
CoNameOrCIK	CHAR(60 or 10)	Not empty	Company CIK number (if only digits, 10 chars) or name (if not only digits, 60 chars)
FIN records			
PTS	CHAR(15)	Not empty	Posting date & time as YYYYMMDD-HHMMSS
RecType	CHAR(3)	Not empty	"FIN"
Year	CHAR(4)	Not empty	Year of the quarter end.
Quarter	CHAR(1)	Not empty	Quarter number: valid values are '1', '2', '3', '4'
QtrStartDate	CHAR(8)	Not empty	Start date of quarter, as YYYYMMDD
PostingDate	CHAR(8)	Not empty	Posting date of quarterly report as YYYYMMDD
Revenue	CHAR(17)	Not empty	Reported revenue for the quarter
Earnings	CHAR(17)	Not empty	Net earnings reported for the quarter

EPS	CHAR(12)	Not empty	Basic earnings per share for the quarter
DilutedEPS	CHAR(12)	Not empty	Diluted earnings per share for the quarter
Margin	CHAR(12)	Not empty	Profit divided by revenues for the quarter
Inventory	CHAR(17)	Not empty	Value of inventory on hand at end of quarter
Assets	CHAR(17)	Not empty	Value of total assets at the end of quarter
Liabilities	CHAR(17)	Not empty	Value of total liabilities at the end of quarter
ShOut	CHAR(13)	Not empty	Average number of shares outstanding
DilutedShOut	CHAR(13)	Not empty	Average number of shares outstanding (diluted)
CoNameOrCIK	CHAR(60 or 10)	Not empty	Company CIK number (if only digits, 10 chars) or name (if not only digits, 60 chars)

2.2.2.9 HoldingHistory.txt

The HoldingHistory.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. The CDC_FLAG and CDC_DSN fields are not present in the data set used by the Historical Load.

2.2.2.9.1 This file is ordered by CDC_DSN for Incremental Updates.

Table 2.2.9: HoldingHistory.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	'I'	Denotes insert
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
HH_H_T_ID	TRADE_T	Not Null	Trade Identifier of the trade that originally created the holding row.
HH_T_ID	TRADE_T	Not Null	Trade Identifier of the current trade
HH_BEFORE_QTY	S_QTY_T	Not Null	Quantity of this security held before the modifying trade.
HH_AFTER_QTY	S_QTY_T	Not Null	Quantity of this security held after the modifying trade.

2.2.2.10 HR.csv

The HR.csv file is a plain-text file with variable length fields separated by a comma (","). Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between commas.

2.2.2.10.1 This file is ordered by EmployeeID.

Table 2.2.10: HR.csv file fields

Field Name	Type	Restrictions	Description / Explanation
EmployeeID	IDENT_T	Not NULL	ID of employee
ManagerID	IDENT_T	Not NULL	ID of employee's manager
EmployeeFirstName	CHAR(30)	Not NULL	First name
EmployeeLastName	CHAR(30)	Not NULL	Last name
EmployeeMI	CHAR(1)		Middle initial
EmployeeJobCode	NUM(3)		Numeric job code
EmployeeBranch	CHAR(30)		Facility in which employee has office

EmployeeOffice	CHAR(10)	Office number or description
EmployeePhone	CHAR(14)	Employee phone number

2.2.2.11 Industry.txt

The Industry.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test.

Table 2.2.11: Industry.txt file fields

Field Name	Type	Restrictions	Description / Explanation
IN_ID	CHAR(2)	Not NULL	Industry code
IN_NAME	CHAR(50)	Not NULL	Industry description
IN_SC_ID	CHAR(4)	Not NULL	Sector identifier

2.2.2.12 Prospect.csv

The Prospect.csv file is a plain-text file with variable length fields separated by a comma (","). Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between commas.

Table 2.2.12: Prospect.csv file fields

Field Name	Type	Restrictions	Description / Explanation
AgencyID	CHAR(30)	Not NULL	Unique identifier from agency
LastName	CHAR(30)	Not NULL	Last name
FirstName	CHAR(30)	Not NULL	First name
MiddleInitial	CHAR(1)		Middle initial
Gender	CHAR(1)		'M' or 'F' or 'U'
AddressLine1	CHAR(80)		Postal address
AddressLine2	CHAR(80)		Postal address
PostalCode	CHAR(12)		Postal code
City	CHAR(25)	Not NULL	City
State	CHAR(20)	Not NULL	State or province
Country	CHAR(24)		Postal country
Phone	CHAR(30)		Telephone number
Income	NUM(9)		Annual income
NumberCars	NUM(2)		Cars owned
NumberChildren	NUM(2)		Dependent children
MaritalStatus	CHAR(1)		'S' or 'M' or 'D' or 'W' or 'U'
Age	NUM(3)		Current age
CreditRating	NUM(4)		Numeric rating
OwnOrRentFlag	CHAR(1)		'O' or 'R' or 'U'
Employer	CHAR(30)		Name of employer
NumberCreditCards	NUM(2)		Credit cards
NetWorth	NUM(12)		Estimated total net worth

2.2.2.13 StatusType.txt

The StatusType.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test.

Table 2.2.13: StatusType.txt file fields

Field Name	Type	Restrictions	Description / Explanation
ST_ID	CHAR(4)	Not NULL	Status code
ST_NAME	CHAR(10)	Not NULL	Status description

2.2.2.14 TaxRate.txt

The TaxRate.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test.

Table 2.2.14: TaxRate.txt file fields

Field Name	Type	Restrictions	Description / Explanation
TX_ID	CHAR(4)	Not NULL	Tax rate code
TX_NAME	CHAR(50)	Not NULL	Tax rate description
TX_RATE	NUM(6,5)	Not NULL	Tax rate

2.2.2.15 Time.txt

The Time.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between vertical bars.

2.2.2.15.1 This file is ordered by the SK_TimeID field. Hour values are based on 24-hour time.

Table 2.2.12: Time.txt file fields

Field Name	Type	Restrictions	Description / Explanation
SK_TimeID	IDENT_T	Not NULL	Surrogate key for the time
TimeValue	CHAR(20)	Not NULL	The time as text, e.g. "01:23:45"
HourID	NUM(2)	Not NULL	Hour number as a number, e.g. 01
HourDesc	CHAR(20)	Not NULL	Hour number as text, e.g. "01"
MinuteID	NUM(2)	Not NULL	Minute as a number, e.g. 23
MinuteDesc	CHAR(20)	Not NULL	Minute as text, e.g. "01:23"
SecondID	NUM(2)	Not NULL	Second as a number, e.g. 45
SecondDesc	CHAR(20)	Not NULL	Second as text, e.g. "01:23:45"
MarketHoursFlag	BOOLEAN		Indicates a time during market hours
OfficeHoursFlag	BOOLEAN		Indicates a time during office hours

2.2.2.16 TradeHistory.txt

The TradeHistory.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. This file is used only in the Historical Load.

2.2.2.16.1 This file is ordered by the TH_T_ID field.

Table 2.2.15: TradeHistory file fields

Column Name	Data Type	Constraints	Description
TH_T_ID	TRADE_T	Not Null	Trade identifier. Corresponds to T_ID in the Trade.txt file
TH_DTS	DATETIME	Not Null	When the trade history was updated.

TH_ST_ID	CHAR(4)	Not Null	Status type identifier.

2.2.2.17 Trade.txt

The Trade.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. The CDC_FLAG and CDC_DSN fields are not present in the data set used by the Historical Load. Null values, where allowed, are indicated by there being no characters between vertical bars.

2.2.2.17.1 Rows in Historical Load files are ordered by the T_ID field; rows in the Incremental Update files are ordered by CDC_DSN.

Table 2.2.16: Trade.txt file fields

Column Name	Data Type	Constraints	Description
CDC_FLAG	CDC_FLAG_T	'I', 'U'	Denotes insert, update
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
T_ID	TRADE_T	Not Null	Trade identifier.
T_DTS	DATETIME	Not Null	Date and time of trade.
T_ST_ID	CHAR(4)	Not Null	Status type identifier
T_TT_ID	CHAR(3)	Not Null	Trade type identifier
T_IS_CASH	BOOLEAN	'0' or '1'	Is this trade a cash ('1') or margin ('0') trade?
T_S_SYMB	CHAR(15)	Not Null	Security symbol of the security
T_QTY	S_QTY_T	> 0	Quantity of securities traded.
T_BID_PRICE	S_PRICE_T	> 0	The requested unit price.
T_CA_ID	IDENT_T	Not Null	Customer account identifier.
T_EXEC_NAME	CHAR(49)	Not Null	Name of the person executing the trade.
T_TRADE_PRICE	S_PRICE_T	Null except in CMPT records, then > 0	Unit price at which the security was traded.
T_CHRG	VALUE_T	Null except in CMPT records, then >= 0	Fee charged for placing this trade request.
T_COMM	VALUE_T	Null except in CMPT records, then >= 0	Commission earned on this trade
T_TAX	VALUE_T	Null except in CMPT records, then >= 0	Amount of tax due on this trade

2.2.2.18 TradeType.txt

The TradeType.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test.

Table 2.2.17: TradeType.txt file fields

Field Name	Type	Restrictions	Description / Explanation
TT_ID	CHAR(3)	Not NULL	Trade type code
TT_NAME	CHAR(12)	Not NULL	Trade type description
TT_IS_SELL	NUM(1)	Not NULL	Flag indicating a sale
TT_IS_MRKT	NUM(1)	Not NULL	Flag indicating a market order

2.2.2.19 WatchHistory.txt

The WatchHistory.txt file is a plain-text file with variable length fields separated by a vertical bar ("|"). Records have a terminator character appropriate for the System Under Test. The CDC_FLAG and CDC_DSN fields are not present in the data set used by the Historical Load.

2.2.2.19.1 Rows in the Historical Load files are ordered by the W_DTS field; rows in the Incremental Update files are ordered by CDC_DSN.

Table 2.2.18: WatchHistory.txt file fields

Field Name	Type	Restrictions	Description / Explanation
CDC_FLAG	CDC_FLAG_T	'I'	Rows are only added
CDC_DSN	CDC_DSN_T	Not NULL	Database Sequence Number
W_C_ID	IDENT_T	Not Null	Customer identifier
W_S_SYMB	CHAR(15)	Not Null	Symbol of the security to watch
W_DTS	DATETIME	Not Null	Date and Time Stamp for the action
W_ACTION	CHAR(4)	'ACTV' or 'CNCL'	Whether activating or canceling the watch

2.2.2.20 Audit Data

A number of files used for auditing are generated in all directories of the Staging Area. Each file contains information about a component of the generated data. The files use a naming convention, <name>_audit.csv, where <name> corresponds to the component the data is associated with.

2.2.2.20.1 All audit files are of the same format; a text file with variable length fields separated by a comma (","). The first record in each file contains the field names. Records have a terminator character appropriate for the System Under Test. Null values, where allowed, are indicated by there being no characters between commas, or between a comma and the record delimiter.

Table 2.2.19: Audit files fields

Field Name	Type	Restrictions	Description / Explanation
DataSet	CHAR(20)	Not Null	Component the data is associated with
BatchID	NUM(5)		BatchID the data is associated with
Date	DATE		Date value corresponding to the Attribute
Attribute	CHAR(50)	Not Null	Attribute this row of data corresponds to
Value	SNUM(15)		Integer value corresponding to the Attribute
DValue	SNUM(15,5)		Decimal value corresponding to the Attribute

2.3 Structure of the Staging Area

The Staging Area contains one directory or folder (as appropriate for the System Under Test) for each batch of data to be loaded. DIGen will generate data directly into these directories:

- Batch1 contains all files used for the Historical Load.
- Batch2 contains all files used for Incremental Update 1.

- Batch3 contains all files used for Incremental Update 2.

2.4 Staging Area Implementation Rules

2.4.1 The Staging Area must guarantee durability. Once the Source Data has been generated or copied into the Staging Area, the consistency of the Source Data must be preserved when presented with all of the following failures:

- Permanent irrecoverable failure of any single Durable Medium containing data of the Staging Area. The media to be failed is to be chosen at random by the auditor, and cannot be specially prepared.
- Staging Area Server Power Failure: Loss of all external power to the Staging Area Server for an indefinite time period.

Note: No system provides complete durability (i.e., durability under all possible types of failures). The specific set of single failures addressed above is deemed sufficiently significant to justify demonstration of durability across such failures.

2.4.2 Access to the Source Data files in the Staging Area must be maintained despite any single media failure.

2.4.3 The Source Data may be generated directly into the Staging Area or generated elsewhere and copied into the Staging Area.

2.4.4 The directory and file structure in the Staging Area must be as described in Clause 2.3. Modifications to the structure including creating additional files are not allowed.

2.4.5 The Source Data files must be those generated by DIGen or exact copies. Changes to file contents are not allowed.

Rationale: The intent is to disallow changes that add, remove, replace, modify, or restructure data to aid in the execution of the benchmark, while allowing copying to a file system appropriate for the SUT.

Clause 3: Data Warehouse

3.1 Introduction

3.1.1 Data Structures

The Data Warehouse is defined only in terms of the tables it contains. This specification does not specify the storage structures to be used or the presence or absence of indices on the structures.

3.2 Table Definitions

The Data Warehouse table definitions refer to a common set of data types, defined in Table 3.2.1, and meta-types defined in Table 3.2.2. The Data Warehouse implementation must be able to store the base data types using publicly documented native or built-in data types provided by the Data Warehouse. Storage must accommodate exact values for any number in the input range.

Note: Real or floating-point representations that store approximate values are not allowed unless it can be demonstrated that all possible valid values can be stored and retrieved exactly.

Table 3.2.1: Common data type definitions for Data Warehouse tables

Base Type	Storage Requirement
BOOLEAN	Holds at least two distinct values that represent FALSE and TRUE or 0 and 1.
CHAR(n)	Holds a character string of up to n single-byte characters.
DATE	Represents a unique day in the range of January 1, 1800 to December 31, 9999, inclusive.
DATETIME	Represents a time value with a precision of 1 millisecond in the range of January 1, 1800 to December 31, 2199, inclusive.
NUM(m[,n])	Unsigned exact numeric value with at most m total Digits, of which n Digits are to the right (after) the decimal point.
SNUM(m[,n])	Signed exact numeric value with at most m total Digits, of which n Digits are to the right (after) the decimal point.
TIME	Represents a time of day value to a precision of 1 millisecond. The range is 00:00:00.000 to 23:59:59.999.

The meta-types are all defined in terms of base data types, with names that indicate their function and possibly value restrictions. There is no requirement to implement the meta-types as user-defined types in the Data Warehouse. A meta-type may be implemented using a user-defined type in the Data Warehouse as long as the user-defined type encorporates a native data type.

Table 3.2.2: Meta-type definitions for Data Warehouse tables

Meta Type	Base Type	Usage / Restrictions
BALANCE_T	SNUM(12,2)	Aggregate account and transaction related values such as account balances, total commissions, etc.

FIN_AGG_T	SNUM(15,2)	Aggregated financial data such as revenue figures, valuations, and asset values
IDENT_T	NUM(11)	Numeric identifiers from several OLTP system tables
S_COUNT_T	NUM(12)	Aggregate count of shares
S_PRICE_T	SNUM(8,2)	Share prices
SK_T	NUM(11)	Surrogagte key; identifies a row in a dimension table
TRADE_T	NUM(15)	Trade identifiers
VALUE_T	SNUM(10,2)	Non-aggregated transaction and security related values such as cost, dividend, etc.

DIT- 3-1: Definitions of all tables (e.g. DDL)

3.2.1 DimAccount

Table 3.2.3: DimAccount table fields

Field Name	Type	Restrictions	Description / Explanation
SK_AccountID	SK_T	Not NULL	Surrogate key for AccountID
AccountID	IDENT_T	Not NULL	Customer account identifier
SK_BrokerID	SK_T	Not NULL	Surrogate key of managing broker
SK_CustomerID	SK_T	Not NULL	Surrogate key of customer
Status	CHAR(10)	Not NULL	Account status, active or closed
AccountDesc	CHAR(50)		Name of customer account
TaxStatus	NUM(1)	0, 1 or 2	Tax status of this account
IsCurrent	BOOLEAN	Not NULL	True if this is the current record
BatchID	NUM(5)	Not NULL	Batch ID when this record was inserted
EffectiveDate	DATE	Not NULL	Beginning of date range when this record was the current record
EndDate	DATE	Not NULL	Ending of date range when this record was the current record. A record that is not expired will use the date 9999-12-31.

3.2.2 DimBroker

Table 3.2.4: DimBroker table fields

Field Name	Type	Restrictions	Description / Explanation
SK_BrokerID	SK_T	Not NULL	Surrogate key for broker
BrokerID	IDENT_T	Not NULL	Natural key for broker
ManagerID	IDENT_T		Natural key for manager's HR record
FirstName	CHAR(50)	Not NULL	First name
LastName	CHAR(50)	Not NULL	Last Name
MiddleInitial	CHAR(1)		Middle initial
Branch	CHAR(50)		Facility in which employee has office
Office	CHAR(50)		Office number or description
Phone	CHAR(14)		Employee phone number
IsCurrent	BOOLEAN	Not NULL	True if this is the current record
BatchID	NUM(5)	Not NULL	Batch ID when this record was inserted
EffectiveDate	DATE	Not NULL	Beginning of date range when this record was the current record
EndDate	DATE	Not NULL	Ending of date range when this record was the

	current record. A record that is not expired will use the date 9999-12-31.

3.2.3 DimCompany

Table 3.2.5: DimCompany table fields

Field Name	Type	Restrictions	Description / Explanation
SK_CompanyID	SK_T	Not NULL	Surrogate key for CompanyID
CompanyID	IDENT_T	Not NULL	Company identifier (CIK number)
Status	CHAR(10)	Not NULL	Company status
Name	CHAR(60)	Not NULL	Company name
Industry	CHAR(50)	Not NULL	Company's industry
SPrating	CHAR(4)		Standard & Poor company's rating
isLowGrade	BOOLEAN		True if this company is low grade
CEO	CHAR(100)	Not NULL	CEO name
AddressLine1	CHAR(80)		Address Line 1
AddressLine2	CHAR(80)		Address Line 2
PostalCode	CHAR(12)	Not NULL	Zip or postal code
City	CHAR(25)	Not NULL	City
StateProv	CHAR(20)	Not NULL	State or Province
Country	CHAR(24)		Country
Description	CHAR(150)	Not NULL	Company description
FoundingDate	DATE		Date the company was founded
IsCurrent	BOOLEAN	Not NULL	True if this is the current record
BatchID	NUM(5)	Not NULL	Batch ID when this record was inserted
EffectiveDate	DATE	Not NULL	Beginning of date range when this record was the current record
EndDate	DATE	Not NULL	Ending of date range when this record was the current record. A record that is not expired will use the date 9999-12-31.

3.2.4 DimCustomer

Table 3.2.6: DimCustomer table fields

Field Name	Type	Restrictions	Description / Explanation
SK_CustomerID	SK_T	Not NULL	Surrogate key for CustomerID
CustomerID	IDENT_T	Not NULL	Customer identifier
TaxID	CHAR(20)	Not NULL	Customer's tax identifier
Status	CHAR(10)	Not NULL	Customer status type
LastName	CHAR(30)	Not NULL	Customer's last name.
FirstName	CHAR(30)	Not NULL	Customer's first name.
MiddleInitial	CHAR(1)		Customer's middle name initial
Gender	CHAR(1)		Gender of the customer
Tier	NUM(1)		Customer tier
DOB	DATE	Not NULL	Customer's date of birth.
AddressLine1	CHAR(80)	Not NULL	Address Line 1
AddressLine2	CHAR(80)		Address Line 2
PostalCode	CHAR(12)	Not NULL	Zip or Postal Code
City	CHAR(25)	Not NULL	City
StateProv	CHAR(20)	Not NULL	State or Province

Country	CHAR(24)		Country
Phone1	CHAR(30)		Phone number 1
Phone2	CHAR(30)		Phone number 2
Phone3	CHAR(30)		Phone number 3
Email1	CHAR(50)		Email address 1
Email2	CHAR(50)		Email address 2
NationalTaxRateDesc	CHAR(50)		National Tax rate description
NationalTaxRate	NUM(6,5)		National Tax rate
LocalTaxRateDesc	CHAR(50)		Local Tax rate description
LocalTaxRate	NUM(6,5)		Local Tax rate
AgencyID	CHAR(30)		Agency identifier
CreditRating	NUM(5)		Credit rating
NetWorth	SNUM(10)		Net worth
MarketingNameplate	CHAR(100)		Marketing nameplate
IsCurrent	BOOLEAN	Not NULL	True if this is the current record
BatchID	NUM(5)	Not NULL	Batch ID when this record was inserted
EffectiveDate	DATE	Not NULL	Beginning of date range when this record was the current record
EndDate	DATE	Not NULL	Ending of date range when this record was the current record. A record that is not expired will use the date 9999-12-31.

3.2.5 DimDate

Table 3.2.7: DimDate table fields

Field Name	Type	Restrictions	Description / Explanation
SK_DateID	SK_T	Not NULL	Surrogate key for the date
DateValue	DATE	Not NULL	The date stored appropriately for doing comparisons in the Data Warehouse
DateDesc	CHAR(20)	Not NULL	The date in full written form, e.g. "July 7, 2004"
CalendarYearID	NUM(4)	Not NULL	Year number as a number
CalendarYearDesc	CHAR(20)	Not NULL	Year number as text
CalendarQtrID	NUM(5)	Not NULL	Quarter as a number, e.g. 20042
CalendarQtrDesc	CHAR(20)	Not NULL	Quarter as text, e.g. "2004 Q2"
CalendarMonthID	NUM(6)	Not NULL	Month as a number, e.g. 20047
CalendarMonthDesc	CHAR(20)	Not NULL	Month as text, e.g. "2004 July"
CalendarWeekID	NUM(6)	Not NULL	Week as a number, e.g. 200428
CalendarWeekDesc	CHAR(20)	Not NULL	Week as text, e.g. "2004-W28"
DayOfWeekNum	NUM(1)	Not NULL	Day of week as a number, e.g. 3
DayOfWeekDesc	CHAR(10)	Not NULL	Day of week as text, e.g. "Wednesday"
FiscalYearID	NUM(4)	Not NULL	Fiscal year as a number, e.g. 2005
FiscalYearDesc	CHAR(20)	Not NULL	Fiscal year as text, e.g. "2005"
FiscalQtrID	NUM(5)	Not NULL	Fiscal quarter as a number, e.g. 20051
FiscalQtrDesc	CHAR(20)	Not NULL	Fiscal quarter as text, e.g. "2005 Q1"
HolidayFlag	BOOLEAN		Indicates holidays

3.2.6 DimSecurity

Table 3.2.8: DimSecurity table fields

Field Name	Type	Restrictions	Description / Explanation
SK_SecurityID	SK_T	Not NULL	Surrogate key for Symbol
Symbol	CHAR(15)	Not NULL	Identifies security on "ticker"
Issue	CHAR(6)	Not NULL	Issue type
Status	CHAR(10)	Not NULL	Status type
Name	CHAR(70)	Not NULL	Security name
ExchangeID	CHAR(6)	Not NULL	Exchange the security is traded on
SK_CompanyID	SK_T	Not NULL	Company issuing security
SharesOutstanding	S_COUNT_T	Not NULL	Shares outstanding
FirstTrade	DATE	Not NULL	Date of first trade
FirstTradeOnExchange	DATE	Not NULL	Date of first trade on this exchange
Dividend	VALUE_T	Not NULL	Annual dividend per share
IsCurrent	BOOLEAN	Not NULL	True if this is the current record
BatchID	NUM(5)	Not NULL	Batch ID when this record was inserted
EffectiveDate	DATE	Not NULL	Beginning of date range when this record was the current record
EndDate	DATE	Not NULL	Ending of date range when this record was the current record. A record that is not expired will use the date 9999-12-31.

3.2.7 DimTime

Table 3.2.9: DimTime table fields

Field Name	Type	Restrictions	Description / Explanation
SK_TimeID	SK_T	Not NULL	Surrogate key for the time
TimeValue	TIME	Not NULL	The time stored appropriately for doing comparisons in the Data Warehouse
HourID	NUM(2)	Not NULL	Hour number as a number, e.g. 01
HourDesc	CHAR(20)	Not NULL	Hour number as text, e.g. "01"
MinuteID	NUM(2)	Not NULL	Minute as a number, e.g. 23
MinuteDesc	CHAR(20)	Not NULL	Minute as text, e.g. "01:23"
SecondID	NUM(2)	Not NULL	Second as a number, e.g. 45
SecondDesc	CHAR(20)	Not NULL	Second as text, e.g. "01:23:45"
MarketHoursFlag	BOOLEAN		Indicates a time during market hours
OfficeHoursFlag	BOOLEAN		Indicates a time during office hours

3.2.7.1 DimTrade

Unlike other dimension tables in the Data Warehouse, DimTrade is not maintained as a history-tracking dimension. There are two state changes of concern for a trade: When it was initiated and when it was completed or cancelled. Therefore the record has date and time fields for the starting and ending states.

Rationale: This design is friendlier for users querying DimTrade as a fact table, because there won't be multiple records to consider for the same trade.

Table 3.2.10: DimTrade table fields

Field Name	Type	Restrictions	Description / Explanation
TradeID	IDENT_T	Not NULL	Trade identifier
SK_BrokerID	SK_T		Surrogate key for BrokerID
SK_CreateDateID	SK_T	Not NULL	Surrogate key for date created
SK_CreateTimeID	SK_T	Not NULL	Surrogate key for time created
SK_CloseDateID	SK_T		Surrogate key for date closed
SK_CloseTimeID	SK_T		Surrogate key for time closed
Status	CHAR(10)	Not NULL	Trade status
Type	CHAR(12)	Not NULL	Trade type
CashFlag	BOOLEAN	Not NULL	Is this trade a cash (1) or margin (0) trade?
SK_SecurityID	SK_T	Not NULL	Surrogate key for SecurityID
SK_CompanyID	SK_T	Not NULL	Surrogate key for CompanyID
Quantity	NUM(6,0)	Not NULL	Quantity of securities traded.
BidPrice	NUM(8,2)	Not NULL	The requested unit price.
SK_CustomerID	SK_T	Not NULL	Surrogate key for CustomerID
SK_AccountID	SK_T	Not NULL	Surrogate key for AccountID
ExecutedBy	CHAR(64)	Not NULL	Name of person executing the trade.
TradePrice	NUM(8,2)		Unit price at which the security was traded.
Fee	NUM(10,2)		Fee charged for placing this trade request
Commission	NUM(10,2)		Commission earned on this trade
Tax	NUM(10,2)		Amount of tax due on this trade
BatchID	NUM(5)	Not Null	Batch ID when this record was inserted

3.2.8 DImessages

There are five types of messages defined in the benchmark:

- "Status" messages give information about the DI processing.
- "Alert" messages provide information that certain conditions were detected which may need attention, but do not warrant excluding the data from the data warehouse. For example, customer tiers have the value 1, 2 or 3. If a different value appeared in a customer record, the record would be fully processed and an alert message would be written.
- Phase Complete Records ("PCR") are written at the end of each phase and are used to calculate the phase elapsed times.
- "Validation" messages are written by the Batch Validation query (see Clause 7.4)
- "Visibility_1" and "Visibility_2" messages are written by the Data Visibility query (see Clause 7.3)

3.2.8.1 Test Sponsors may include other messages in the DImessages table, as long as they use a MessageType value that is not one of types defined above.

Rationale: The DImessages table provides one place where the DI system places any messages to the operator in response to various conditions encountered during execution of DI jobs.

Table 3.2.11: DImessages table fields

Field Name	Type	Restrictions	Description / Explanation

MessageDateAndTime	DATETIME	Not NULL	Date and time of the message
BatchID	NUM(5)	Not NULL	DI run number; see the section "Overview of BatchID usage"
MessageSource	CHAR(30)		Typically the name of the transform that logs the message
MessageText	CHAR(50)	Not NULL	Description of why the message was logged
MessageType	CHAR(12)	Not NULL	"Status" or "Alert" or "Reject"
MessageData	CHAR(100)		Varies with the reason for logging the message

3.2.9 FactCashBalances

Table 3.2.12: FactCashBalances table fields

Field Name	Type	Restrictions	Description / Explanation
SK_CustomerID	SK_T	Not Null	Surrogate key for CustomerID
SK_AccountID	SK_T	Not Null	Surrogate key for AccountID
SK_DateID	SK_T	Not Null	Surrogate key for the date
Cash	SNUM(15,2)	Not Null	Cash balance for the account after applying changes for this day
BatchID	NUM(5)	Not Null	Batch ID when this record was inserted

3.2.10 FactHoldings

Table 3.2.13: FactHoldings table fields

Field Name	Type	Restrictions	Description / Explanation
TradeID	IDENT_T	Not NULL	Key for Orignial Trade Indentifier
CurrentTradeID	IDENT_T	Not Null	Key for the current trade
SK_CustomerID	SK_T	Not NULL	Surrogate key for Customer Identifier
SK_AccountID	SK_T	Not NULL	Surrogate key for Account Identifier
SK_SecurityID	SK_T	Not NULL	Surrogate key for Security Identifier
SK_CompanyID	SK_T	Not NULL	Surrogate key for Company Identifier
SK_DateID	SK_T	Not NULL	Surrogate key for the date associated with the current trade
SK_TimeID	SK_T	Not NULL	Surrogate key for the time associated with the current trade
CurrentPrice	S_PRICE_T	> 0	Unit price of this security for the current trade
CurrentHolding	SNUM(6)	Not NULL	Quantity of a security held after the current trade. The value can be a positive or negative integer
BatchID	NUM(5)	Not Null	Batch ID when this record was inserted

3.2.11 FactMarketHistory

Table 3.2.14: FactMarketHistory table fields

Field Name	Type	Restrictions	Description / Explanation
SK_SecurityID	SK_T	Not Null	Surrogate key for SecurityID
SK_CompanyID	SK_T	Not Null	Surrogate key for CompanyID
SK_DateID	SK_T	Not Null	Surrogate key for the date

PERatio	NUM(10,2)		Price to earnings per share ratio
Yield	NUM(5,2)	Not Null	Dividend to price ratio, as a percentage
FiftyTwoWeekHigh	NUM(8,2)	Not Null	Security highest price in last 52 weeks from this day
SK_FiftyTwoWeekHighDate	SK_T	Not Null	Earliest date on which the 52 week high price was set
FiftyTwoWeekLow	NUM(8,2)	Not Null	Security lowest price in last 52 weeks from this day
SK_FiftyTwoWeekLowDate	SK_T	Not Null	Earliest date on which the 52 week low price was set
ClosePrice	NUM(8,2)	Not Null	Security closing price on this day
DayHigh	NUM(8,2)	Not Null	Highest price for the security on this day
DayLow	NUM(8,2)	Not Null	Lowest price for the security on this day
Volume	NUM(12)	Not Null	Trading volume of the security on this day
BatchID	NUM(5)	Not Null	Batch ID when this record was inserted

3.2.12 FactWatches

Table 3.2.15: FactWatches table fields

Field Name	Type	Restrictions	Description / Explanation
SK_CustomerID	SK_T	Not NULL	Customer associated with watch list
SK_SecurityID	SK_T	Not NULL	Security listed on watch list
SK_DateID_DatePlaced	SK_T	Not NULL	Date the watch list item was added
SK_DateID_DateRemoved	SK_T		Date the watch list item was removed
BatchID	NUM(5)	Not Null	Batch ID when this record was inserted

3.2.13 Industry

Table 3.2.16: Industry table fields

Field Name	Type	Restrictions	Description / Explanation
IN_ID	CHAR(2)	Not NULL	Industry code
IN_NAME	CHAR(50)	Not NULL	Industry description
IN_SC_ID	CHAR(4)	Not NULL	Sector identifier

3.2.14 Financial

Table 3.2.17: Financial table fields

Field Name	Type	Restrictions	Description / Explanation
SK_CompanyID	IDENT_T	Not NULL	Company SK.
FI_YEAR	NUM(4)	Not NULL	Year of the quarter end.
FI_QTR	NUM(1)	Not NULL	Quarter number that the financial information is for: valid values 1, 2, 3, 4.
FI_QTR_START_DATE	DATE	Not NULL	Start date of quarter.
FI_REVENUE	SNUM(15,2)	Not NULL	Reported revenue for the quarter.
FI_NET_EARN	SNUM(15,2)	Not NULL	Net earnings reported for the quarter.
FI_BASIC_EPS	SNUM(10,2)	Not NULL	Basic earnings per share for the quarter.
FI_DILUT_EPS	SNUM(10,2)	Not NULL	Diluted earnings per share for the quarter.
FI_MARGIN	SNUM(10,2)	Not NULL	Profit divided by revenues for the quarter.
FI_INVENTORY	SNUM(15,2)	Not NULL	Value of inventory on hand at the end of quarter.

FI_ASSETS	SNUM(15,2)	Not NULL	Value of total assets at the end of the quarter.
FI_LIABILITY	SNUM(15,2)	Not NULL	Value of total liabilities at the end of the quarter.
FI_OUT_BASIC	SNUM(12)	Not NULL	Average number of shares outstanding (basic).
FI_OUT_DILUT	SNUM(12)	Not NULL	Average number of shares outstanding (diluted).

3.2.15 Prospect

Table 3.2.18: Prospect table fields

Field Name	Type	Restrictions	Description / Explanation
AgencyID	CHAR(30)	Not NULL	Unique identifier from agency
SK_RecordDateID	SK_T	Not NULL	Last date this prospect appeared in input
SK_UpdateDateID	SK_T	Not NULL	Latest change date for this prospect
BatchID	NUM(5)	Not Null	Batch ID when this record was last modified
IsCustomer	BOOLEAN	Not NULL	True if this person is also in DimCustomer, else False
LastName	CHAR(30)	Not NULL	Last name
FirstName	CHAR(30)	Not NULL	First name
MiddleInitial	CHAR(1)		Middle initial
Gender	CHAR(1)		M / F / U
AddressLine1	CHAR(80)		Postal address
AddressLine2	CHAR(80)		Postal address
PostalCode	CHAR(12)		Postal code
City	CHAR(25)	Not NULL	City
State	CHAR(20)	Not NULL	State or province
Country	CHAR(24)		Postal country
Phone	CHAR(30)		Telephone number
Income	NUM(9)		Annual income
NumberCars	NUM(2)		Cars owned
NumberChildren	NUM(2)		Dependent children
MaritalStatus	CHAR(1)		S / M / D / W / U
Age	NUM(3)		Current age
CreditRating	NUM(4)		Numeric rating
OwnOrRentFlag	CHAR(1)		O / R / U
Employer	CHAR(30)		Name of employer
NumberCreditCards	NUM(2)		Credit cards
NetWorth	NUM(12)		Estimated total net worth
MarketingNameplate	CHAR(100)		For marketing purposes

3.2.16 StatusType

Table 3.2.19: StatusType table fields

Field Name	Type	Restrictions	Description / Explanation
ST_ID	CHAR(4)	Not NULL	Status code
ST_NAME	CHAR(10)	Not NULL	Status description

3.2.17 TaxRate

Table 3.2.20: TaxRate table fields

Field Name	Type	Restrictions	Description / Explanation
TX_ID	CHAR(4)	Not NULL	Tax rate code
TX_NAME	CHAR(50)	Not NULL	Tax rate description
TX_RATE	NUM(6,5)	Not NULL	Tax rate

3.2.18 TradeType

Table 3.2.21: TradeType table fields

Field Name	Type	Restrictions	Description / Explanation
TT_ID	CHAR(3)	Not NULL	Trade type code
TT_NAME	CHAR(12)	Not NULL	Trade type description
TT_IS_SELL	NUM(1)	Not NULL	Flag indicating a sale
TT_IS_MRKT	NUM(1)	Not NULL	Flag indicating a market order

3.2.19 Audit

Table 3.2.23: Audit table fields

Field Name	Type	Restrictions	Description / Explanation
DataSet	CHAR(20)	Not Null	Component the data is associated with
BatchID	NUM(5)		BatchID the data is associated with
Date	DATE		Date value corresponding to the Attribute
Attribute	CHAR(50)	Not Null	Attribute this row of data corresponds to
Value	SNUM(15)		Integer value corresponding to the Attribute
DValue	SNUM(15,5)		Decimal value corresponding to the Attribute

3.3 Data Warehouse Properties

3.3.1 The Data Warehouse must be implemented using a commercially available product, as defined by the TPC-Pricing specification.

DIT- 3-2: Name, optional components, and version number that uniquely identifies the product that implements the Data Warehouse

3.3.2 The Data Warehouse must provide access to data using logical structures (i.e. tables, columns).

3.3.3 The Data Warehouse must allow concurrent Data Warehouse sessions.

3.3.4 The Data Warehouse must provide a means for Data Warehouse sessions to commit data. In the context of this specification, to commit data means the data is made permanent in the Data Warehouse and visible to other Data Warehouse sessions. Committed data must meet the data durability requirements specified in Clause 3.4.6.

3.4 Data Warehouse Implementation Rules

3.4.1 The benchmark does not give requirements for the Data Warehouse internal implementation. Various techniques, including vertical partitioning, horizontal partitioning, replication and the use of various storage mechanisms, are allowed as long as they do not

rely on any knowledge of the Source Data other than date ranges, total record counts, source file sizes, or information provided in this specification.

3.4.2 No ill-formed rows may exist in any data that is available to all Data Warehouse sessions. An ill-formed row occurs when the value of any column cannot be determined. In the context of this specification, NULL is considered a value that can be determined. For example, in the case of a vertically partitioned table, a row must exist in all the partitions.

3.4.3 The surrogate key of any table must not directly represent the physical disk addresses of the row or any offsets thereof. Queries are not allowed to reference rows using relative addressing since they are simply offsets from the beginning of the storage space.

3.4.4 The Data Warehouse must allow for insertion of arbitrary data values that conform to the datatype of columns of the tables.

3.4.5 The columns within a given table may be implemented in any order, but all columns listed in the table definition shall be implemented and there shall be no columns added to or removed from the tables.

3.4.6 Data Durability

3.4.6.1 The Data Warehouse must guarantee durability. The Data Warehouse must preserve committed data and ensure database consistency after recovery from all of the following failures:

- Permanent irrecoverable failure of any single Durable Medium containing data of the Data Warehouse. The media to be failed is to be chosen at random by the auditor, and cannot be specially prepared.
- Data Warehouse Server Power Failure: Loss of all external power to the Data Warehouse Server for an indefinite time period.

Note: No system provides complete durability (i.e., durability under all possible types of failures). The specific set of single failures addressed above is deemed sufficiently significant to justify demonstration of durability across such failures.

3.4.7 Data Visibility

Data visibility is the ability for all Data Warehouse sessions to operate on data that was committed by another Data Warehouse session. The following are the rules governing data visibility:

3.4.7.1 The Data Warehouse may automatically commit data or allow the DI application to control when data is committed.

3.4.7.2 Once data has been committed, it must remain visible at all times.

3.4.8 Auxiliary data structures

3.4.8.1 Auxiliary data structures are allowed to be created and maintained in the Data Warehouse.

3.4.8.2 Data modifications performed during a Benchmark Run phase (see Clause 7.2) must be reflected in associated auxiliary data structures before the phase is completed.

3.4.9 Execution rules

3.4.9.1 Data Warehouse tables must not exist at the start of the Benchmark Run.

3.4.9.2 At the end of each phase, all transformations must have completed successfully and their output data must be committed in the Data Warehouse.

3.4.9.3 While inserts, updates and deletes are not performed on all tables, the system must not be configured to take special advantage of this fact during the test.

3.4.9.4 Although inserts are inherently limited by the storage space available on the configured system, there must be no restriction preventing the execution of seven more incremental updates. To determine the number of rows added to each table in an incremental update, row counts from Batch2 may be used.

3.4.9.5 It is required that the space for the additional seven incremental updates (and corresponding growth in associated auxiliary data structures, such as indices) be configured for the Benchmark Run and priced accordingly, as per Clause 9.2.1.

3.4.10 Data Warehouse classification

3.4.10.1 A TPC-DI benchmark Result will be listed either under the TPC-DI ACID class or the TPC-DI OPEN class. Only TPC-DI benchmark Results listed in the same class are comparable.

DIT- 3-3: Data Warehouse class (must be either ACID or OPEN)

3.4.10.2 In order for a benchmark Result to be listed in the ACID class of TPC-DI, the Data Warehouse must demonstrate ACID compliance. ACID compliance can be demonstrated using any of the two following procedures. It is under the discretion of the Test Sponsor to choose the procedure. The FDR must clearly state which procedure was followed:

1. The version of the software that implements the Data Warehouse has demonstrated ACID compliance as part of one or more published TPC-C, TPC-E, TPC-H, TPC-DS, or TPC-DI Result, hereafter referred to as ACID Benchmark Proof (ABP). The same mechanisms that were enabled to demonstrate ACID compliance in the ABP must also be enabled during both Incremental Update phases of TPC-DI. If this software relied on any hardware or software features of the server or storage areas or devices to pass the ACID tests, e.g. RAID, the Data Warehouse Server must implement these features and have them enabled during both Incremental Update phases of TPC-DI. If, for any reason, the benchmark publication listed in the ABP is withdrawn, then the TPC-DI Result must be withdrawn.

2. The version of the software that implements the Data Warehouse has demonstrated ACID compliance using any of the ACID tests required for TPC-C, TPC-E, TPC-H or TPC-DS, hereafter referred to as AT. The Test Sponsor is required to build all necessary database objects for the AT on the SUT and demonstrate ACID compliance to the auditor following the rules in the AT specification. The same mechanisms that were enabled to demonstrate ACID compliance during the AT must also be enabled during both Incremental Update phases of TPC-DI. If this software relied on any hardware or software features of the server or storage areas or devices to pass the ACID tests, e.g. RAID, the Data Warehouse Server must have them enabled during both Incremental Update phases of TPC-DI.

DIT- 3-4: Method use to demonstrate ACID compliance and details of ABP or AT

3.4.10.3 If ACID compliance is not demonstrated, then the Result must be listed in the TPC-DI OPEN class.

3.4.11 SQL Compliance

SQL statements in this specification must be executed as provided by this specification unless a Data Warehouse implementation requires modified versions of the SQL statements to be able run them. If modifications are necessary, they must fall under one of the following categories:

- Minor query modifications
- Major query modifications

3.4.11.1 Minor query modifications

SQL statements provided in this specification may be modified applying minor query modifications as defined in this clause. They do not need approval by the auditor or the TPC. The application of minor query modifications to SQL statements must be applied consistently to all SQL statements. For example, if a particular vendor-specific date expression or table name syntax is used in one query, it must be used in all other queries involving date expressions or table names.

OID 3-1: The use of minor query modifications must be disclosed and justified.

3.4.11.1.1 The following modifications are considered minor query modifications

a) Table names - The table names found in the FROM clause of each query may be modified to reflect the customary naming conventions of the system under test.
b) Select-list expression aliases - For queries that include the definition of an alias for a SELECT-list item (e.g., “AS” clause), vendor-specific syntax may be used instead of the specified syntax. Replacement syntax must have equivalent semantic behavior. Examples of acceptable implementations include "TITLE <string>", or "WITH HEADING <string>".

c) Date expressions - For queries that include an expression involving manipulation of dates (e.g., adding/subtracting days/months/years, or extracting years from dates), vendor-specific syntax may be used instead of the specified syntax. Replacement syntax must have equivalent semantic behavior. Examples of acceptable implementations include "YEAR(<column>)" to extract the year from a date column or "DATE(<date>) + 3 MONTHS" to add 3 months to a date.
d) GROUP BY and ORDER BY - For queries that utilize a nested table-expression or select-list alias solely for the purposes of grouping or ordering on an expression, vendors may replace the view, nested table-expression or select-list alias with a vendor-specific SQL extension to the GROUP BY or ORDER BY clause. Examples of acceptable implementations include "GROUP BY <ordinal>", "GROUP BY <expression>", "ORDER BY <ordinal>", and "ORDER BY <expression>".
e) Command delimiters - Additional syntax may be inserted at the end of the executable query text for the purpose of signaling the end of the query and requesting its execution. Examples of such command delimiters are a semicolon or the word "GO".
f) Output formatting functions - Scalar functions whose sole purpose is to affect output formatting may be applied to items in the outermost SELECT list of the query.
g) Correlation names – Table-name aliases may be added to the executable query text. The keyword "AS" before the table-name alias may be omitted.
h) Explicit ASC - ASC may be explicitly appended to columns in an ORDER BY clause.
i) In cases where identifier names conflict with reserved words in a given implementation, delimited identifiers may be used.
j) Relational operators - Relational operators used in queries such as "<", ">", "<>", "<=", and "=", may be replaced by equivalent vendor-specific operators, for example ".LT.", ".GT.", "!=" or "^=", ".LE.", and "==", respectively.
k) Nested table-expression aliasing - For queries involving nested table-expressions, the nested keyword "AS" before the table alias may be omitted.
l) At large scale factors, the aggregates may exceed the range of the values supported by an integer. The aggregate functions AVG and COUNT may be replaced with equivalent vendor-specific functions to handle the expanded range of values (e.g., AVG_BIG and COUNT_BIG).
m) Outer Join – For outer join queries, vendor specific syntax may be used instead of the specified syntax. Replacement syntax must have equivalent semantic behavior. For example, the join expression “CUSTOMER LEFT OUTER JOIN ORDERS ON C_CUSTKEY = O_CUSTKEY” may be replaced by adding CUSTOMER and ORDERS to the from clause and adding a specially-marked join predicate (e.g., C_CUSTKEY *= O_CUSTKEY).
n) String concatenation operator: For queries which use string concatenation operators, vendor specific syntax can be used (e.g. || can be substituted with +). Replacement syntax must have equivalent semantic behavior.
o) Table-less Queries - Queries that do not require any tables may be modified to select from a system defined table, e.g. sysibm.sysdummy for DB2 or dual for Oracle.

3.4.11.2 Major query modifications

All query modifications that do not fall under Clause 3.4.11.1.1 are considered major query modifications, which includes queries not expressed in SQL. The Test Sponsor must prove to the auditor that statements containing major query modifications are functionally equivalent to the SQL statements provided by the specification.

OID 3-2: The use of major query modifications must be disclosed and justified.

Clause 4: Transformations

4.1 Introduction

Data Integration (DI) Systems provide capabilities to specify data sources and destinations, and actions to be taken to move and transform data from sources to destinations. Typically a DI System provides a design time environment for specifying data transformation logic, and a runtime environment for executing the specified data transformations.

4.2 Data Integration System Properties

4.2.1 The Data Integration (DI) System must be a commercially available product, as defined by the TPC-Pricing specification.

DIT- 4-1: The name, options and version number that uniquely identifies the product implementing the Data Integration System

4.2.2 The Data Integration System must provide the ability to read and write data to and from more than one data store and provide data transformation capabilities that can be applied to general data integration tasks.

4.2.3 The DI System may require additional software to access particular data stores. For example, database client software provided by a database system vendor may be required for the DI System to access the particular database system. If additional software is required, the software must be generally available.

4.2.4 The DI System must translate the DI specification into the DI application format, which can be executed in the DI System's runtime environment or other general purpose program execution system.

DIT- 4-2: The translation of the DI specification into the DI aplication format

4.3 Transformation Implementation Rules

4.3.1 Data Integration (DI) System

4.3.1.1 Implementation of the benchmark transformations must be created using a DI System.

4.3.1.2 The benchmark transformations may be transcribed in the optimal form for the DI System.

4.3.1.3 Creation of the DI specification on a different installation of the DI System is allowed, however the translation into the DI application must be done on the benchmark DI System.

4.3.1.4 The DI application may not be altered from the form generated by the DI System.

4.3.1.5 If the DI System uses the same format for the DI specification and the DI application, e.g. the DI System interprets the DI specification at run time, it is permissible to create this application on a DI System that is not part of the SUT, provided:

- All software components that are required by the DI System to create the DI specification are installed and included in the priced configuration, as described in Clause 9.
- The DI specification is not altered from the form generated by the DI System.

4.3.2 Use of extension mechanisms provided by the DI System for extending base capabilities is allowed, with the following rules:

- The extension is generally available as software, or provided as source in the FDR.
- If charged for, included in the priced configuration as described in Clause 9.

4.3.3 Data Dependencies

There are dependencies between tables in the Data Warehouse that require data from some tables to be processed before data in the dependent tables, within the scope of a Benchmark Run phase. When a dependent table column refers to a column in a source table, any rows in the source table that would change the outcome of processing of a row in the dependent table must be processed before the dependent row.

Table 4.3: Table and column dependencies

Dependent		Source	
Table	Column	Table	Column
DimAccount	SK_BrokerID	DimBroker	SK_BrokerID
DimAccount	SK_CustomerID	DimCustomer	SK_CustomerID
DimSecurity	SK_CompanyID	DimCompany	SK_CompanyID
DimTrade	SK_BrokerID	DimBroker	SK_BrokerID
DimTrade	SK_CreateDateID	DimDate	SK_DateID
DimTrade	SK_CreateTimeID	DimTime	SK_TimeID
DimTrade	SK_CloseDateID	DimDate	SK_DateID
DimTrade	SK_CloseTimeID	DimTime	SK_TimeID
DimTrade	SK_SecurityID	DimSecurity	SK_SecurityID
DimTrade	SK_CompanyID	DimCompany	SK_CompanyID
DimTrade	SK_CustomerID	DimCustomer	SK_CustomerID

DimTrade	SK_AccountID	DimAccount	SK_AccountID
FactCashBalances	SK_CustomerID	DimCustomer	SK_CustomerID
FactCashBalances	SK_AccountID	DimAccount	SK_AccountID
FactCashBalances	SK_DateID	DimDate	SK_DateID
FactCashBalances	SK_TimeID	DimTime	SK_TimeID
FactHoldings	SK_TradeID	DimTrade	SK_TradeID
FactHoldings	SK_CurrentTradeID	DimTrade	SK_CurrentTradeID
FactHoldings	SK_CustomerID	DimCustomer	SK_CustomerID
FactHoldings	SK_AccountID	DimAccount	SK_AccountID
FactHoldings	SK_SecurityID	DimSecurity	SK_SecurityID
FactHoldings	SK_CompanyID	DimCompany	SK_CompanyID
FactHoldings	SK_DateID	DimDate	SK_DateID
FactHoldings	SK_TimeID	DimTime	SK_TimeID
FactMarketHistory	SK_SecurityID	DimSecurity	SK_SecurityID
FactMarketHistory	SK_CompanyID	DimCompany	SK_CompanyID
FactMarketHistory	SK_DateID	DimDate	SK_DateID
FactWatches	SK_CustomerID	DimCustomer	SK_CustomerID
FactWatches	SK_SecurityID	DimSecurity	SK_SecurityID
FactWatches	SK_DateID_DatePlaced	DimDate	SK_DateID
FactWatches	SK_DateID_DateRemoved	DimDate	SK_DateID
Prospect	SK_UpdateDateID	DimDate	SK_DateID

Rationale: When there are dependencies between data in tables (whether declared or not) it is common in developing DI applications to process tables in order of their dependencies; e.g., DimCustomer is fully processed before DimAccount because the account records refer to customer records. The benchmark specification does not require that certain tables must be processed before others. However, data dependencies do exist, and must be honored: An account record cannot be processed until related customer records have been processed. How the application accomplishes this is not specified.

4.3.4 If the DI System requires additional software to interact with the Data Warehouse, the software must be installed on the SUT and included in the priced configuration.

4.3.5 Execution Phases

The benchmark is executed in a series of phases, as described in Clause 7. The following are the rules associated with execution of the phases:

4.3.5.1 At the end of each phase, all transformations must have completed successfully and their output data must be committed into the Data Warehouse.

4.3.5.2 A subset of the transformed data may be committed into the Data Warehouse during the execution of any phase as long as all of the transformations on the subset have been completed, the rows are not ill-formed as described in clause 3.4.2.2, and the data dependencies described in Clause 4.3.3 are honored.

4.3.5.3 The DI application is allowed to perform the transformations defined within each phase in any order, provided the data dependencies described in clause 4.3.3 are honored.

4.3.5.4 The DI application must determine the Staging Area directory from which to read the Source Data based on an input parameter or calculation.

4.3.5.5 The DI application must not access data from a Staging Area directory associated with a subsequent execution phase.

4.3.5.6 While executing the Historical Load phase, the DI application may assume it has exclusive access to the Data Warehouse tables.

4.3.5.7 The same DI application must be used to perform all Incremental Update phases.

4.3.5.8 Starting from the first Incremental Update phase, the Data Warehouse must be operational and accessible to Data Warehouse sessions that are not managed by the DI application.

- The DI application may assume the Data Warehouse sessions that it manages are the only sessions that may be updating or inserting data into the Data Warehouse.
- Data that has been committed in the Data Warehouse must remain visible to other Data Warehouse sessions. DI applications may not temporarily remove data from the Data Warehouse tables.

4.3.6 Various techniques, including partitioning, are allowed as long as they do not rely on any prior knowledge of the Source Data other than date ranges, total record counts, source file sizes, or information provided in this specification.

4.3.7 Auxiliary data structures are allowed to be created and maintained by the DI System, with the following rules:

- No Auxiliary data structures from previous Benchmark Runs may be present on the SUT at the start of a Benchmark Run.
- Data modifications performed during a benchmark execution phase must be reflected in associated auxiliary data structures before the execution phase is completed.

4.4 Data Manipulation Details

4.4.1 History-tracking Dimension tables

History-tracking dimension tables retain information about changes to the data over time, while also allowing users to easily query for current information. This is accomplished using both the primary (or “natural”) key for a record in the source system, which is constant over time, and a surrogate key that is updated for each recorded change. Fact tables that

reference a history-tracking dimension include a foreign key reference to the surrogate key, not the natural key.

When data that matches an existing record in a history-tracking dimension table is processed, i.e. the natural keys match, updates to the dimension table record are not made in-place. Instead, the record is marked as not current and the EndDate is set, and a new record is inserted with the same natural key but a new surrogate key value. This new record contains all the current field values. After this, any new records introduced into fact tables corresponding to this natural key reference the new surrogate key value.

Rationale: The concept of a history tracking dimension is common in the industry, and is sometimes referred to as a "type 2 changing dimension" or a "type 2 slowly changing dimension."

4.4.1.1 History tracking updates are used on the following tables:

- DimAccount
- DimBroker
- DimCompany
- DimCustomer
- DimSecurity

4.4.1.2 When a record with a natural key that does not exist in the dimension table is processed, the following transformations are performed:

1. A unique surrogate key value must be assigned and included in the inserted record.
2. The current indicator field, IsCurrent, is set to TRUE to indicate that this is the current record corresponding to the natural key.
3. The EffectiveDate field is set to a value specified by the transformation, or Batch Date if no value is specified.
4. The EndDate field is set to December 31, 9999.

Rationale: The EndDate of the 'current' record is not yet determined. The actual EndDate is set when a new record is inserted and this record is expired. When querying a dimension to find the valid record for a given time, a condition like EffectiveDate <= my_time < EndDate could be used. Using a NULL value for EndDate complicates these sorts of queries as these conditions will be UNKNOWN on current records, so additional logic would need to be added to account for that. To avoid this complication, a date far off into the future is used as the EndDate for current records, which allows a basic date range search to work for all records.

4.4.1.3 When a record with a natural key already present in the dimension table is processed, the following transformations are performed:

1. Update the existing dimension table record for that natural key where IsCurrent is set to TRUE (these updates are known as 'Expiring' the record):

    - The current indicator field, IsCurrent, is set to FALSE to indicate that this is no longer the current record corresponding to the natural key.
    - The EndDate field is set to the EffectiveDate of the new record.

2. After expiring the existing record in the dimension table, a new record is inserted into the dimension table, as described in Clause 4.4.1.2.

4.4.1.4 Natural keys are not deleted in the Source Data, therefore no processing of deleted records is required.

Rationale: In the brokerage application modeled by this benchmark, the source systems that are used to populate the dimension tables do not delete records. Rather, some indication of the state (active or inactive) of an object is updated. Note: A different update strategy is used on the DimTrade table due to its dual role as both a dimension table and a fact table.

Note: DimDate and DimTime are static dimension tables; they do not receive updates.

4.4.1.5 Dimension table granularity

The level of precision (e.g. hours, days, months) that updates are tracked in the dimension table is known as the granularity (or grain) of the dimension. The granularity of all dimensions in this benchmark is daily. This means that there must be at most 1 update to a natural key record on any given day, even when the Source Data contains more than 1 update to a natural key.

4.4.1.5.1 The DI System must accumulate the changes that occur relative to a single natural key on a daily basis, and apply a single update record per day per natural key value, for those keys that have changed on that day.

4.4.1.5.2 If a field changes more than once per day, the latest value is used as determined by the time stamps on the incoming data. If the time stamps are the same, the sequence the records appear in the file determines the order, i.e. the latest value appears last.

4.4.1.6 Data dependencies and history-tracking updates

4.4.1.6.1 When a history-tracking dimension table contains a surrogate key reference to another dimension table and an update occurs to the referenced dimension table, the referencing table must be updated as well. Specifically, this situation exists for:

- DimAccount, which contains a surrogate key for DimCustomer
- DimSecurity, which contains a surrogate key for DimCompany

Note: DimAccount also contains a surrogate key for DimBroker, but DimBroker will not be updated according to the benchmark specification.

4.4.1.6.2 When a history-tracking dimension table depends on data from multiple source files, changes in either source can cause it to be updated. For example, DimCustomer depends on data from Customer.txt and Prospect.csv; data in either of these sources can cause an update to the DimCustomer table.

4.4.1.6.3 Regardless of the number of causes of an update to a record in a history tracking dimension, only one change record must be produced per natural key value per Incremental Update. Likewise, in the Historical Load, exactly one historical record should be produced per natural key value for each day that has an update to that key. See Clause 4.4.1.5.

4.4.2 BatchID

The BatchID is a numeric value that is used to mark data that is added to the Data Warehouse so that it can be associated with a particular benchmark phase. The BatchID is

used when logging events to the DImessages table and is also included in rows of data being added to most Data Warehouse tables.

4.4.2.1 A unique BatchID is associated with each execution phase of the benchmark. When the BatchID is required by the specification, the following values must be used:

- Initialization, BatchID = 0
- Historical Load, BatchID = 1
- Incremental Update 1, BatchID = 2
- Incremental Update 2, BatchID = 3

Rationale: In practice, the BatchID concept is commonly used as part of an audit trail for data in the warehouse, and also can be used to help identify data that should be cleaned up in the event of an unrecoverable system issue during a run.

4.4.3 Error handling

4.4.3.1 The detection and handling of various data errors is a normal part of data integration processing. Accordingly, the generated data will contain certain values that are defined in the specification to be errors.

4.4.3.2 The transformation rules specified in Clauses 4.5 and 4.6 define the error conditions that must be checked and the action to take when those conditions are met.

4.4.3.3 Additional error checks are not required, but may be implemented at the discretion of the Test Sponsor.

4.4.3.4 Implementations may assume the Source Data is self-consistent, e.g. an account record will not contain a customer key that does not reference a valid customer record.

4.4.3.5 All records, including those meeting error conditions must be fully processed as described by the transformation rules.

4.5 Transformation Details for the Historical Load

DIT- 4-3: Implementation of each transformation of the Historical Load

4.5.1 DimAccount

4.5.1.1 DimAccount data is obtained from the data file CustomerMgmt.xml. Account data is stored as a contained element to the related Action and Customer elements. The possible ActionType values are shown in table 4.5.1.1:

Table 4.5.1.1

ActionType	Description
NEW	A new customer. A new customer is always created with 1 or more new accounts.
ADDACCT	One or more new accounts for an existing customer.
UPDACCT	Updates to the information in one or more existing accounts.
UPDCUST	One or more updates to an existing customer. When updating customer information, no account information is supplied. Note that since DimAccount contains a surrogate key to DimCustomer, a change to a customer record will require a history-tracking change to update the SK_CustomerID field of the current

	associated account records in DimAccount as described in clause 4.4.1.
CLOSEACCT	Close one or more existing accounts as described in 4.5.1.3
INACT	Make an existing customer and that customer's currently active accounts inactive. No specific account information is supplied in the Source Data.

NOTE: The descriptions below use XPath notation (http://www.w3.org/TR/xpath) to identify specific data elements of the XML document. All references are relative to the context of the associated Action (/Action) data element.

4.5.1.2 Customer/Account/@CA_ID is the natural key for the Account data. When Account information is new, field values may be missing from the XML or included as an empty element (e.g. <Element />). In both cases the value should be processed as a NULL value. When Account information is updated, only the natural key and the updated fields are given a value in the record, i.e. all properties that are missing values retain their current values in the DimAccount table. Fields with an empty value (e.g. <Element />) must be processed as a NULL value. All changes to DimAccount are implemented in a history-tracking manner as specified in Clause 4.4.1.

4.5.1.3 When populating fields of the DimAccount table, for each account identified in the record:

- When ./@ActionType is 'NEW' or 'ADDACCT'
- AccountID, AccountDesc and TaxStatus fields are copied from Customer/Account/@CA_ID, Customer/Account/CA_NAME and Customer/Account/@CA_TAX_ST respectively.
- SK_BrokerID and SK_CustomerID are set by obtaining the associated surrogate keys by matching Customer/Account/CA_B_ID with DimBroker.BrokerID and Customer/@C_ID (from the parent Customer element) with DimCustomer.CustomerID where the date portion of ./@ActionTS >= EffectiveDate and the date portion of ./@ActionTS <= EndDate. The BrokerID and CustomerID matches are guaranteed to succeed.
- Status is set to 'ACTIVE'.
- When ./@ActionType is 'UPDACCT'
- Fields that exist in the Source Data should be transformed to the target fields as described above.
- Fields that do not exist in the Source Data retain their values from the current record in DimAccount.
- When ./@ActionType is 'CLOSEACCT'
- Status is set to 'INACTIVE'
- When ./@ActionType is 'UPDCUST'
- For each account held by the customer being updated, perform an update to:
- Set SK_CustomerID to the associated customer's DimCustomer current record after it has been updated.
- When ./@ActionType is 'INACT'
- For each account held by the customer being marked as inactive, perform an update to:
- Set SK_CustomerID to the associated customer's DimCustomer record after it has been marked 'INACTIVE'.

- Set Status to 'INACTIVE'.
- IsCurrent, EffectiveDate, and EndDate are set as described in section 4.4.1, with EffectiveDate being assigned the date value from the date portion of ./@ActionTS.
- BatchID is set as described in section 4.4.2.

4.5.1.4 There are no messages written to the DImessages table by this transformation.

4.5.2 DimBroker

4.5.2.1 Data for DimBroker comes from the HR extract file HR.csv. Those employees from the HR file that are brokers (as indicated by the EmployeeJobCode) will have data copied to the Broker table.

The Broker table is structured as a history tracking dimension table. However, nothing in the input file will provide any history of changes over time; it is simply a snapshot of the current state of the HR data.

Rationale: Although changes to DimBroker might be expected in a "real world" brokerage warehouse, the rate of change in this table is so low as to be inconsequential to benchmark results.

When inserting records from HR.csv into DimBroker:

- Records where EmployeeJobCode is not 314 are not broker records, and are ignored. The remaining steps are for records where the job code is 314.
- BrokerID, ManagerID, FirstName, LastName, MiddleInitial, Branch, Office and Phone are obtained from these fields of the HR.csv file: EmployeeID, ManagerID, EmployeeFirstName, EmployeeLastName, EmployeeMI, EmployeeBranch, EmployeeOffice and EmployeePhone.
- SK_BrokerID is set appropriately for new records as described in section 4.4.1.3.
- IsCurrent is set to true
- EffectiveDate is set to the earliest date in the DimDate table and EndDate is set to 9999-12-31.
- BatchID is set as described in section 4.4.2.

4.5.3 DimCompany

4.5.3.1 DimCompany data is obtained from the FINWIRE files. All FINWIREyyyyQq files are processed in ascending year and quarter order, and records of type CMP are used. CMP records may have content that is unchanged from prior CMP records, except for the PTS field. Changes to DimCompany are implemented in a history-tracking manner, but unchanged records are not recorded. CIK is the natural key for the Company data.

4.5.3.2 When populating fields of the DimCompany table:

- CompanyID is copied from CIK.
- Name, SPRating, CEO, Description and FoundingDate are copied from CompanyName, SPrating, CEOname, Description, and FoundingDate respectively. In cases where the input data is all blanks, a NULL value is used in the target.
- AddressLine1, AddressLine2, PostalCode, City, State_Prov, and Country are copied from AddrLine1, AddrLine2, PostalCode, City, StateProvince, and Country. In cases where the input data is all blanks, a NULL value is used in the target.

- Status is obtained from the FINWIRE Status by matching Status with ST_ID from the StatusType.txt file.
- Industry is obtained from IndustryID by matching IndustryID with IN_ID from the Industry.txt file.
- isLowGrade is set to False if SPrating begins with 'A' or 'BBB' otherwise set to True
- IsCurrent, EffectiveDate and EndDate are set as described in section 4.4.1, with EffectiveDate being the date indicated by the PTS field.
- BatchID is set as described in section 4.4.2.

4.5.3.3 A record will be inserted in the DImessages table if a company's SPRating is not one of the valid values for Standard & Poor long-term credit-ratings. The MessageSource is "DimCompany", the MessageType is "Alert" and the MessageText is "Invalid SPRating". The MessageData field is "CO_ID = " followed by the key value of the record, then ", CO_SP_RATE = " and the CO_SP_RATE value. The SPRating and isLowGrade columns will be set to NULL in this case. The valid values are: AAA, AA[+/-], A[+/-], BBB[+/-], BB[+/-], B[+/-], CCC[+/-], CC, C, D.

4.5.4 DimCustomer

4.5.4.1 DimCustomer data is obtained from the data file CustomerMgmt.xml. Customer data is stored as a sub-element to the related Action element. Every Action will have a related Customer, but not all actions require modifying the DimCustomer table. The possible ActionTypes are shown in table 4.5.4.1:

Table 4.5.4.1

ActionType	Description
NEW	A new customer. A new customer is always created with 1 or more new accounts.
ADDACCT	One or more new accounts for an existing customer. This does not require any change to DimCustomer.
UPDACCT	Updates to the information in one or more existing accounts. No change to DimCustomer is required.
UPDCUST	One or more updates to existing customer's information. Only the identifying data and updated property values are supplied in the Source Data.
CLOSEACCT	Close one or more existing accounts. This does not require any change to DimCustomer.
INACT	Make an existing customer and that customer's currently active accounts inactive. No specific account information is supplied in the Source Data.

NOTE: The descriptions below use XPath notation (http://www.w3.org/TR/xpath) to identify specific data elements of the XML document. All references are relative to the context of the associated Action (/Action) data element.

4.5.4.2 The TaxRate and Prospect tables will be referenced in the transformation. Customer/@C_ID is the natural key for the Customer data. When a Customer is new, unknown field values may be missing from the XML or included as an empty element (e.g. <Element />). In both cases

the value should be processed as a NULL value. When Customer information is updated, only the updated fields are supplied a new value, i.e. all missing values retain their current values. Fields with empty values (e.g. <Element />) should be processed as NULL values. Changes to DimCustomer are implemented in a history-tracking manner.

4.5.4.3 When populating fields of the DimCustomer table:

- When ./@ActionType is 'NEW'
- CustomerID, TaxID, LastName, FirstName, MiddleInitial, Tier, DOB, Email1 and Email2 are copied from Customer/@C_ID, Customer/@C_TAX_ID, Customer/Name/C_L_NAME, Customer/Name/C_F_NAME, Customer/Name/C_M_NAME, Customer/@C_TIER, Customer/@C_DOB, Customer/ContactInfo/C_PRIM_EMAIL, Customer/ContactInfo/C_ALT_EMAIL, respectively.
- Gender is obtained from Customer/@C_GNDR, and is uppercased. Values other than 'M' or 'F' are replaced with 'U'.
- AddressLine1, AddressLine2, PostalCode, City, State_Prov, and Country are copied from Customer/Address/C_ADLINE1, Customer/Address/C_ADLINE2, Customer/Address/C_ZIPCODE, Customer/Address/C_CITY, Customer/Address/C_STATE_PROV, and Customer/Address/C_CTRY.
- Status is set to 'ACTIVE'.
- Phone1, Phone2 and Phone3 are created by concatenating fields from the corresponding input data. The input data contains 3 contact phone number elements, Customer/ContactInfo/C_PHONE_1, Customer/ContactInfo/C_PHONE_2, and Customer/ContactInfo/C_PHONE_3, which correspond to Phone1, Phone2, and Phone3 respectively. The transformation for each of the these fields is as follows:
- For each Phone*n*, where *n* = {1,2,3}
- If Customer/ContactInfo/C_PHONE_n/C_CTRY_CODE, Customer/ContactInfo/C_PHONE_n/C_AREA_CODE and Customer/ContactInfo/C_PHONE_n/C_LOCAL are not null, Phone*n* is:
  '+' + Customer/ContactInfo/C_PHONE_n/C_CTRY_CODE
  + ' (' + Customer/ContactInfo/C_PHONE_n/C_AREA_CODE + ') '
  + Customer/ContactInfo/C_PHONE_n/C_LOCAL
- If Customer/ContactInfo/C_PHONE_n/C_CTRY_CODE is null while Customer/ContactInfo/C_PHONE_n/C_AREA_CODE and Customer/ContactInfo/C_PHONE_n/C_LOCAL are not null, Phone*n* is:
  '(' + Customer/ContactInfo/C_PHONE_n/C_AREA + ') '
  + Customer/ContactInfo/C_PHONE_n/C_LOCAL
- If Customer/ContactInfo/C_PHONE_n/C_AREA_CODE is null while Customer/ContactInfo/C_PHONE_n/C_LOCAL is not null, Phone*n* is:
  Customer/ContactInfo/C_PHONE_n/C_LOCAL
- If any of the above rules has been applied and Customer/ContactInfo/C_PHONE_n/C_EXT is not null, Phone*n* is:
  Phone*n* + Customer/ContactInfo/C_PHONE_n/C_EXT
- If none of the above rules has been applied,

- Phone*n* is null
- NationalTaxRateDesc and NationalTaxRate are copied from TX_NAME and TX_RATE respectively by matching Customer/TaxInfo/C_NAT_TX_ID with TX_ID. The match is guaranteed succeed.
- LocalTaxRateDesc and LocalTaxRate are copied from TX_NAME and TX_RATE respectively by matching Customer/TaxInfo/C_LCL_TX_ID with TX_ID. The match is guaranteed to succeed.
- AgencyID, CreditRating, NetWorth, MarketingNameplate: If demographic data for this customer is present in the Prospect file and there are no newer 'UPDCUST' or 'INACT' records for this Customer/@C_ID, the AgencyID, CreditRating and NetWorth values will be copied to DimCustomer and the MarketingNameplate will be set according to the latest values using the same process defined for the data warehouse Prospect table. A Prospect record is deemed to match a DimCustomer record if the LastName, FirstName, AddressLine1, AddressLine2 and PostalCode fields all match the corresponding DimCustomer fields when upper-cased. If the demographic data for this customer is not present in the Prospect file or there are newer 'UPDCUST' or 'INACT' records for this customer, these fields should be set to NULL.

Rationale: Only current demographic information is available, and it corresponds to the Batch Date of the Historical Load. It does not make sense to apply that information retroactively to older customer records. It will only be applied to the latest version of the customer record.

- When ./@ActionType is 'UPDCUST'
- Fields that exist in the Source Data should be transformed to the target fields as described above.
- Fields that do not exist in the Source Data retain their values from the current record in DimCustomer.
- AgencyID, CreditRating, NetWorth, MarketingNameplate: If demographic data for this customer is present in the Prospect file and there are no newer 'UPDCUST' or 'INACT' records for this customer, these values should be obtained as described above. If the demographic data for this customer is not present in the Prospect file or there are newer 'UPDCUST' or 'INACT' records for this customer, these fields should be not be changed.
- A history-tracking update to all current accounts for this customer in the DimAccount table is also required, as described in clause 4.4.1.6
- When ./@ActionType is 'INACT'
- Status is set to 'INACTIVE'
- AgencyID, CreditRating, NetWorth, MarketingNameplate: If demographic data for this customer is present in the Prospect file, these values should be obtained as described above. If the demographic data for this customer is not present in the Prospect file these fields should be not be changed.
- All current accounts for this customer must also be made inactive, as described in clause 4.5.1.3 (when ActionType is 'INACT').
- IsCurrent, EffectiveDate, and EndDate are set as described in section 4.4.1 except that EffectiveDate is assigned the date value in the date portion of ./@ActionTS.
- BatchID is set as described in section 4.4.2.

4.5.4.4 A record will be inserted in the DImessages table if a customer's Tier is not one of the valid values (1,2,3). The MessageSource is "DimCustomer", the MessageType is "Alert" and the MessageText is "Invalid customer tier". The MessageData field is "C_ID = " followed by the natural key value of the record, then ", C_TIER = " and the C_TIER value.

4.5.4.5 A record will be reported in the DImessages table if a customer's DOB is invalid. A customer's DOB is invalid if DOB < Batch Date – 100 years or DOB > Batch Date (customer is over 100 years old or born in the future). The MessageSource is "DimCustomer", the MessageType is "Alert" and the MessageText is "DOB out of range". The MessageData field is "C_ID = " followed by the natural key value of the record, then ", C_DOB = " and the C_DOB value.

4.5.5 DimDate

4.5.5.1 DimDate is a static table: It is loaded from the Date.txt in the Historical Load and not modified again.

4.5.5.2 During the Historical Load, all rows and columns of the Date.txt file must be loaded into the corresponding columns of the DimDate table, with no modifications.

4.5.6 DimSecurity

4.5.6.1 DimSecurity data is obtained from the FINWIRE files. All FINWIREyyyyQq files are processed in ascending year and quarter order, and records of type SEC are used. The surrogate key of the associated company must be obtained for the Company dimension reference. Changes to DimSecurity are implemented in a history-tracking manner. Symbol is the natural key for the Security data.

4.5.6.2 When populating fields of the DimSecurity table:

- Symbol, Issue, Name, ExchangeID, SharesOutstanding, FirstTrade, FirstTradeOnExchange and Dividend are copied from Symbol, IssueType, Name, ExID, ShOut, FirstTradeDate, FirstTradeExchg and Dividend respectively from the SEC record.
- SK_CompanyID is obtained from the DimCompany table by matching CoNameOrCIK with Name or CIKcode (depending on the characters found in CoNameOrCIK), where PTS >= EffectiveDate and PTS < EndDate, to return the SK_CompanyID. The match is guaranteed to succeed due to the integrity of the FINWIRE data. This dependency of DimSecurity on DimCompany requires that any update to a company's DimCompany records must be completed before updates to that company's DimSecurity records.
- Status is obtained from the StatusType table by matching Status from the FINWIRE record with ST_ID to return the ST_NAME.
- IsCurrent, EffectiveDate, and EndDate are set as described in section 4.4.1, where the EffectiveDate is the date indicated by the PTS field.
- BatchID is set as described in section 4.4.2.

4.5.7 DimTime

4.5.7.1 DimTime is a static table: It is loaded from a file once in the Historical Load and not modified again.

During the Historical Load, all rows and columns of the Time.txt file must be loaded into the corresponding columns of the DimTime table, with no modifications.

4.5.8 DimTrade

4.5.8.1 DimTrade data is obtained from the Trade.txt and TradeHistory.txt files. The incoming files may be thought of as logically joined on the T_ID field. When a T_ID encountered does not match a TradeID from the DimTrade table, a new DimTrade record is inserted. When a T_ID is encountered that matches an existing TradeID in the DimTrade table, the DimTrade record is updated.

4.5.8.2 When populating fields of the DimTrade table:

- If TH_ST_ID is "SBMT" and T_TT_ID is either "TMB" or "TMS", or TH_ST_ID is "PNDG", then SK_CreateDateID and SK_CreateTimeID must be set based on TH_DTS, with time truncated to 1-second resolution. SK_CloseDateID and SK_CloseTimeID must be set to NULL if a new DimTrade record is being inserted.
- If TH_ST_ID is "CMPT" or "CNCL", SK_CloseDateID and SK_CloseTimeID must be set based on TH_DTS, with time truncated to 1-second resolution. SK_CreateDateID and SK_CreateTimeID must be set to NULL if a new DimTrade record is being inserted.
- TradeID, CashFlag, Quantity, BidPrice, ExecutedBy, TradePrice, Fee, Commission and Tax are copied from T_ID, T_IS_CASH, T_QTY, T_BID_PRICE, T_EXEC_NAME, T_TRADE_PRICE, T_CHRG, T_COMM and T_TAX respectively.
- Status is copied from ST_NAME of the StatusType table by matching T_ST_ID with ST_ID.
- Type is copied from TT_NAME of the TradeType table by matching T_TT_ID with TT_ID.
- SK_SecurityID and SK_CompanyID are copied from SK_SecurityID and SK_CompanyID of the DimSecurity table by matching T_S_SYMB with Symbol where TH_DTS is in the range given by EffectiveDate and EndDate. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that these surrogate key values must reference the dimension record that is current at the earliest time this TradeID is encountered. If an update to a record is required in order to set the SK_CloseDateID and SK_CloseTimeID, these fields must not be updated. This dependency of DimTrade on DimSecurity requires that any update to a security's DimSecurity records must be completed before updates to that security's DimTrade records.
- SK_AccountID, SK_CustomerID, and SK_BrokerID are copied from the SK_AccountID, SK_CustomerID, and SK_BrokerID fields of the DimAccount table by matching T_CA_ID with AccountID where TH_DTS is in the range given by EffectiveDate and EndDate. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that these surrogate key values must reference the dimension record that is current at the earliest time this TradeID is encountered. If an update to a record is required in order to set the SK_CloseDateID and SK_CloseTimeID, these fields must not be updated. This dependency of DimTrade on DimAccount requires that any update to an account's DimAccount records must be completed before updates to that account's DimTrade records.
- BatchID is set as described in section 4.4.2 at the time the record is initially created.

4.5.8.3 A record will be reported in the DImessages table if a trade's Commission is not null and exceeds TradePrice * Quantity. The MessageSource is "DimTrade", the MessageType is

"Alert" and the MessageText is "Invalid trade commission". The MessageData field is "T_ID = " followed by the key value of the record, then ", T_COMM = " and the T_COMM value.

4.5.8.4 A record will be reported in the DImessages table if a trade's Fee is not null and exceeds TradePrice * Quantity. The MessageSource is "DimTrade", the MessageType is "Alert" and the MessageText is "Invalid trade fee". The MessageData field is "T_ID = " followed by the key value of the record, then ", T_CHRG = " and the T_CHRG value.

4.5.9 FactCashBalances

4.5.9.1 FactCashBalances data is obtained from the data file CashTransaction.txt. The net effect of all cash transactions for a given account on a given day is totaled, and only a single record is generated per account that had changes per day.

4.5.9.2 When populating fields of the FactCashBalances table:

- SK_CustomerID and SK_AccountID are obtained from DimAccount by matching CT_CA_ID with AccountID, where CT_DTS is in the range given by EffectiveDate and EndDate.
- SK_DateID is obtained from DimDate by matching just the date portion of CT_DTS with DateValue to return the SK_DateID. The match is guaranteed to succeed because DimDate has been populated with date information for all dates relevant to the benchmark.
- Cash is calculated as the sum of the prior Cash amount for this account plus the sum of all CT_AMT values from all transactions in this account on this day. If there is no previous FactCashBalances record for the associated account, zero is used.

Note: The procedure used to determine the new Cash total must account for the possibility that a new surrogate key is created in DimAccount since the last cash transaction.

- BatchID is set as described in section 4.4.2.

4.5.10 FactHoldings

4.5.10.1 Data for FactHoldings comes from the HoldingHistory.txt file and the DimTrade table. The quantity and price values reflect the holdings for a particular security after the most recent trade. The customer can have a positive or negative position (Quantity) as a result of a trade

4.5.10.2 When populating fields of the FactHoldings table:

- Retrieve the following values from DimTrade where HH_T_ID (current trade identifier) from the HoldingHistory.txt file matches the TradeID from DimTrade:
- SK_CustomerID, SK_AccountID, SK_SecurityID, SK_CompanyID and CurrentPrice
- SK_DateID is set to the value of SK_CloseDateID and SK_TimeID is set to the value of SK_CloseTimeID
- TradeId and CurrentTradeID values are supplied by HH_H_T_ID and HH_T_ID
- CurrentHolding – this value is supplied by HH_AFTER_QTY
- BatchID is set as described in section 4.4.2.

4.5.11 FactMarketHistory

4.5.11.1 FactMarketHistory data is primarily obtained from the file DailyMarket.txt.

4.5.11.2 When populating fields of the FactMarketHistory table:

- ClosePrice, DayHigh, DayLow, and Volume are copied from DM_CLOSE, DM_HIGH, DM_LOW, and DM_VOL respectively.
- SK_SecurityID is obtained from DimSecurity by matching the associated security's current record DM_S_SYMB with Symbol, for the date indicated by DM_DATE, to return the SK_SecurityID. The match is guaranteed to succeed due to the referential integrity of the OLTP database. The dependency of FactMarketHistory on DimSecurity requires that any update to a company's DimSecurity records must be completed before updates to the FactMarketHistory records.
- SK_CompanyID is obtained from DimSecurity by matching DM_S_SYMB with Symbol, for the date indicated by DM_DATE, to return the SK_CompanyID. The match is guaranteed to succeed due to the referential integrity of the OLTP database. The dependency of FactMarketHistory on DimSecurity requires that any update to a company's DimSecurity records must be completed before updates to the FactMarketHistory records.
- SK_DateID is obtained from DimDate by matching DM_DATE with DateValue to return the SK_DateID. The match is guaranteed to succeed because DimDate has been populated with date information for all dates relevant to the benchmark.
- FiftyTwoWeekHigh and SK_FiftyTwoWeekHighDate are determined by finding the highest price over the last year (approximately 52 weeks) for a given security. The FactMarketHistory table itself can be used for this comparison. FiftyTwoWeekHigh is set to the highest DM_HIGH value for any date in the range from DM_DATE back to but not including the same date one year earlier. SK_FiftyTwoWeekHighDate is assigned the earliest date in the date range upon which this DM_HIGH value occurred.

Note: Over the course of the year, the surrogate key value for a security may have changed. It is not sufficient to simply compare records that share the same SK_SecurityID value.

Rationale: The terms "52 week high" and "52 week low" are common in financial reporting, and in general practice seem to mean "over the last year". This benchmark follows the one-year interpretation. Therefore in a summary generated on July 4, 2014, the date range to use is 2013-07-05 to 2014-07-04.

- FiftyTwoWeekLow and SK_FiftyTwoWeekLowDate are determined by finding the lowest price over the last year (approximately 52 weeks) for a given security. The FactMarketHistory table itself can be used for this comparison. FiftyTwoWeekLow is set to the lowest DM_LOW value for any date in the range from DM_DATE back to but not including the same date one year earlier. SK_FiftyTwoWeekLowDate is assigned the earliest date in the date range upon which this DM_LOW value occurred.

Note: Over the course of the year, the surrogate key value for a security may have changed. It is not sufficient to simply compare records that share the same SK_SecurityID value.

- PERatio is calculated by dividing DM_CLOSE (the closing price for a security on a given day) by the sum of the company's quarterly earnings per share ("eps") over the previous 4 quarters prior to DM_DATE. Company quarterly earnings per share data is provided by

the FINWIRE data source in the EPS field of the 'FIN' record type. If there are no earnings for this company, NULL is assigned to PERatio and an alert condition is raised as described below.

Note: Over the course of the previous 4 quarters, attributes of securities and companies may have changed. As a result, there may be more than one surrogate key value used for a security and/or company in the target data warehouse tables during that time period.

- Yield is calculated by dividing the security's dividend by DM_CLOSE (the closing price for a security on a given day), then multiplying by 100 to obtain the percentage. The dividend is obtained from DimSecurity by matching DM_S_SYMB with Symbol, where DM_DATE is in the range given by EffectiveDate and EndDate, to return the Dividend field.
- BatchID is set as described in section 4.4.2.

4.5.11.3 A record will be reported in the DImessages table if there are no earnings found for a company. The MessageSource is "FactMarketHistory", the MessageType is "Alert" and the MessageText is "No earnings for company". The MessageData field is "DM_S_SYMB = " followed by the DM_S_SYMB value of the record.

4.5.12 FactWatches

4.5.12.1 Data for FactWatches comes from the WatchHistory.txt file. Surrogate keys must be obtained for the Customer, Security and Date dimension references. The date keys show the dates the watch was set and removed.

4.5.12.2 Securities can either be added to or removed from a watch list; there is no notion of updating a security on a watch list.

4.5.12.3 When a security is added to a watch list, as indicated by W_ACTION = "ACTV", surrogate keys from the DimCustomer, DimSecurity and DimDate are inserted based on the following:

- SK_CustomerID – each watch list is associated with a customer. W_C_ID can be used to match the associated DimCustomer record (W_C_ID = C_ID) that is current at the time indicated by W_DTS, to obtain SK_CustomerID.
- SK_SecurityID – W_S_SYMB can be used to match the current associated DimSecurity record (W_SYMB = Symbol) that is current at the time indicated by W_DTS, to obtain SK_SecurityID.
- SK_DateID_DatePlaced – set based on W_DTS.
- SK_DateID_DateRemoved – set to NULL.
- BatchID is set as described in section 4.4.2.

4.5.12.4 When a security is removed from a watch list, as indicated by W_ACTION = "CNCL", the FactWatches record to update is located by finding the surrogate keys corresponding to W_C_ID and W_S_SYMB, bearing in mind that the customer SK value or the company SK value many have changed since the watch was set; then the following action is required:

- SK_DateID_DateRemoved – set based on W_DTS.
- BatchID is set as described in section 4.4.2.

4.5.13 Industry

4.5.13.1 Industry is a static table: It is loaded from a file once in the Historical Load and not modified again.

4.5.13.2 During the Historical Load, all rows and columns of the Industry.txt file are loaded into the corresponding columns of the Industry table, with no modifications.

4.5.14 Financial

4.5.14.1 Financial data is obtained from the FINWIRE files. All FINWIREyyyyQq files are processed in ascending year and quarter order, and records of type FIN are used. The surrogate key of the associated company must be obtained for the Company dimension reference.

Note: In reality, companies sometimes "restate" earnings in special situations. The benchmark data will not contain more than one FIN record for any company for a single quarter.

4.5.14.2 When populating fields of the Financial table:

- FI_YEAR, FI_QTR, FI_QTR_START_DATE, FI_REVENUE, FI_NET_EARN, FI_BASIC_EPS, FI_DILUT_EPS, FI_MARGIN, FI_INVENTORY, FI_ASSETS, FI_LIABILITY, FI_OUT_BASIC, and FI_OUT_DILUT are copied from Year, Quarter, QtrStartDate, Revenue, Earnings, EPS, DilutedEPS, Margin, Inventory, Assets, Liabilities, ShOut, and DilutedShOut.
- SK_CompanyID is obtained from the DimCompany table by matching CoNameOrCIK with Name or CIKcode (depending on the characters found in CoNameOrCIK), where EffectiveDate <= PTS < EndDate, to return the SK_CompanyID. The match is guaranteed to succeed due to the integrity of the FINWIRE data. This dependency of Financial on DimCompany requires that any update to a company's DimCompany records must be completed before updates to that company's Financial records.

4.5.15 Prospect

4.5.15.1 Prospect table data is obtained from the Prospect file. AgencyID is a unique identifier assigned by the agency providing the data feed. An AgencyID value will not be repeated within one data batch.

- The following fields are copied from the Prospect file: AgencyID, LastName, FirstName, MiddleInitial, Gender, AddressLine1, AddressLine2, PostalCode, City, State, Country, Phone, Income, NumberCars, NumberChildren, MaritalStatus, Age, CreditRating, OwnOrRentFlag, Employer, NumberCreditCards, NetWorth.
- SK_RecordDateID is set to the DimDate SK_DateID field that corresponds to the Batch Date.
- SK_UpdateDateID is set to the DimDate SK_DateID field that corresponds to the Batch Date.
- IsCustomer is set to True or False depending on whether the prospective customer record matches a current customer record in DimCustomer whose status is 'ACTIVE' after all customer records in the batch have been processed. A Prospect record is deemed to match a DimCustomer record if the FirstName, LastName, AddressLine1, AddressLine2 and PostalCode fields all match when upper-cased.

- MarketingNameplate is set based on other fields. Zero or more tags are concatenated with a "+" character between them if multiple tags apply to a given customer. For example, a prospect that qualifies for both the "Boomer" tag and the "Spender" tag would be assigned the MarketingNameplate value "Boomer+Spender". If multiple tags are used they must be in the order given below, and if no tags apply the nameplate is NULL. The tags are defined as:
    - HighValue: NetWorth > 1000000 or Income > 200000
    - Expenses: NumberChildren > 3 or NumberCreditCards > 5
    - Boomer: Age > 45
    - MoneyAlert: Income < 50000 or CreditRating < 600 or NetWorth < 100000
    - Spender: NumberCars > 3 or NumberCreditCards > 7
    - Inherited: Age < 25 and NetWorth > 1000000
- BatchID is set as described in section 4.4.2.

4.5.15.2 As the Prospect file is processed, a count is kept of new Prospect table rows created. After the last row, a "Status" message is written to the DImessages table, with the MessageSource "Prospect", MessageText "Inserted rows" and the MessageData field containing the number of rows.

4.5.16 StatusType

4.5.16.1 StatusType is a static table: It is loaded from a file once in the Historical Load and not modified again.

4.5.16.2 During the Historical Load, all rows and columns of the StatusType.txt file are loaded into the corresponding columns of the StatusType table, with no modifications.

4.5.17 TaxRate

4.5.17.1 TaxRate is a static table: It is loaded from a file once in the Historical Load and not modified again.

4.5.17.2 During the Historical Load, all rows and columns of the TaxRate.txt file are loaded into the corresponding columns of the TaxRate table, with no modifications.

4.5.18 TradeType

4.5.18.1 TradeType is a static table: It is loaded from a file once in the Historical Load and not modified again.

4.5.18.2 During the Historical Load, all rows and columns of the TradeType.txt file are loaded into the corresponding columns of the TradeType table, with no modifications.

4.6 Transformation Details for Incremental Updates

4.6.1 DimAccount

4.6.1.1 DimAccount data is obtained from the data file Account.txt. CA_ID is the natural key for the Account data. The StatusType table will be referenced in the transformation.

4.6.1.2 When CDC_FLAG is "I", a new DimAccount record is inserted. When CDC_FLAG is "U", the updates to DimAccount are implemented in a history-tracking manner as described in 4.4.1.

4.6.1.3 Updates to associated customer records require history-tracking updates to all of the customer's accounts where IsCurrent=1. The value of SK_CustomerID must be set to the value of DimCustomer.SK_CustomerID in the newest customer record. If the customer's status has changed to inactive, then the Status of all associated accounts must be set to 'INACTIVE'.

Note: More than one update to the same Account may occur during this phase (i.e. on the same day) and should be handled as described in 4.4.1.5.

4.6.1.4 When populating fields of the DimAccount table:

- AccountID, AccountDesc and TaxStatus fields are copied from CA_ID, CA_NAME and CA_TAX_ST respectively.
- SK_BrokerID and SK_CustomerID are set by obtaining surrogate keys by matching CA_B_ID with DimBroker.BrokerID where IsCurrent = 1 and CA_C_ID with

DimCustomer.CustomerID where IsCurrent = 1. The BrokerID and CustomerID matches are guaranteed to succeed due to the referential integrity of the OLTP database. This dependency of DimAccount on DimCustomer requires that any update to a customer's DimCustomer records must be completed before updates to that customer's DimAccount records.

- Status is copied from ST_NAME of the StatusType table by matching CA_ST_ID with ST_ID of the StatusType table.
- IsCurrent, EffectiveDate, and EndDate are set as described in section 4.4.1.
- BatchID is set as described in section 4.4.2.

4.6.2 DimBroker

4.6.2.1 No changes to DimBroker will occur during Incremental Updates.

Rationale: Although changes to DimBroker might be expected in a "real world" brokerage warehouse, the rate of change in this table is so low as to be inconsequential to benchmark results.

4.6.3 DimCompany

4.6.3.1 No changes to DimCompany will occur during Incremental Updates.

Rationale: Although changes to DimCompany might be expected in a "real world" brokerage warehouse, the rate of change in this table is so low as to be inconsequential to benchmark results.

4.6.4 DimCustomer

4.6.4.1 DimCustomer data is obtained from the data file Customer.txt. The TaxRate, StatusType, and Prospect tables will be referenced in the transformation. C_ID is the natural key for the Customer data. Changes to DimCustomer are implemented in a history-tracking manner.

4.6.4.2 New Customer records in the input data are indicated by CDC_FLAG set to "I". Existing customer records are indicated by CDC_FLAG set to "U".

Note: More than one update to the same Customer may occur during this phase (i.e. on the same day) and should be handled as described in 4.4.1.5.

4.6.4.3 When populating fields of the DimCustomer table:

- CustomerID, TaxID, LastName, FirstName, MiddleInitial, Tier, DOB, Email1 and Email2 are copied from C_ID, C_TAX_ID, C_L_NAME, C_F_NAME, C_M_NAME, C_TIER, C_DOB, C_EMAIL_1, C_EMAIL_2 respectively.
- Gender is obtained from C_GNDR, which is uppercased. Values other than 'M' or 'F' are replaced with 'U'.
- AddressLine1, AddressLine2, PostalCode, City, StateProv, and Country are copied from C_ADLINE1, C_ADLINE2, C_ZIPCODE, C_CITY, C_STATE_PROV, and C_CTRY.
- Status is copied from ST_NAME of the StatusType table by matching C_ST_ID with ST_ID of the StatusType table.
- Phone1, Phone2 and Phone3 are created by concatenating fields. For each *n* in {1, 2, 3}:
- If C_CTRY_*n*, C_AREA_*n* and C_LOCAL_*n* are not null, Phone*n* is:
  '+' + C_CTRY_*n* + ' (' + C_AREA_*n* + ') ' + C_LOCAL_*n*
- If C_CTRY_*n* is null while C_AREA_*n* and C_LOCAL_*n* are not null, Phone*n* is:
  '(' + C_AREA_*n* + ') ' + C_LOCAL_*n*

- If C_AREA_*n* is null while C_LOCAL_*n* is not null, Phone*n* is:
  C_LOCAL_*n*
- If any of the above rules has been applied and C_EXT_*n* is not null, Phone*n* is:
  Phone*n* + C_EXT_*n*
- If none of the above rules has been applied, Phone*n* is null
- NationalTaxRateDesc and NationalTaxRate are copied from TX_NAME and TX_RATE respectively by matching C_NAT_TX_ID with TX_ID.
- LocalTaxRateDesc and LocalTaxRate are copied from TX_NAME and TX_RATE respectively by matching C_LCL_TX_ID with TX_ID.
- AgencyID, CreditRating, NetWorth, MarketingNameplate: If demographic data for this customer has been present in the Prospect file for this DI batch or for any previous batch, the latest AgencyID, CreditRating and NetWorth values will be copied to DimCustomer and the MarketingNameplate will be set according to the latest values using the same process defined for the data warehouse Prospect table. A Prospect record is deemed to match a DimCustomer record if the FirstName, LastName, AddressLine1, AddressLine2 and PostalCode fields all match the corresponding fields in DimCustomer when upper-cased. The IsCustomer field in the Prospect table needs to be updated to reflect the current state for the corresponding prospect record, as defined in Clause 4.6.14
- IsCurrent, EffectiveDate, and EndDate are set as described in section 4.4.1.
- BatchID is set as described in section 4.4.2.

4.6.4.4 A record will be reported in the DImessages table if a customer's Tier is not one of the valid values (1,2,3). The MessageSource is "DimCustomer", the MessageType is "Alert" and the MessageText is "Invalid customer tier". The MessageData field is "C_ID = " followed by the key value of the record, then ", C_TIER = " and the C_TIER value.

4.6.4.5 A record will be reported in the DImessages table if a customer's DOB is invalid. A customer's DOB is invalid if DOB < Batch Date – 100 years or DOB > Batch Date (customer over 100 years old or born in the future). The MessageSource is "DimCustomer", the MessageType is "Alert" and the MessageText is "DOB out of range". The MessageData field is "C_ID = " followed by the key value of the record, then ", C_DOB = " and the C_DOB value.

4.6.5 DimDate

4.6.5.1 The DimDate table is not altered by Incremental Updates.

4.6.6 DimSecurity

4.6.6.1 No changes to DimSecurity will occur during Incremental Updates.

Rationale: Although changes to DimSecurity might be expected in a "real world" brokerage warehouse, the rate of change in this table is so low as to be inconsequential to benchmark results.

4.6.6.2 The DimTime table is not altered by Incremental Updates.

4.6.7 DimTrade

4.6.7.1 DimTrade data is obtained from the Trade.txt file. When CDC_FLAG is "I", a new DimTrade record is inserted. When CDC_FLAG is "U", the existing DimTrade record whose TradeID matches the incoming T_ID is updated.

4.6.7.2 When populating fields of the DimTrade table:

- If this is a new Trade record (CDC_FLAG = "I") then SK_CreateDateID and SK_CreateTimeID must be set based on T_DTS. SK_CloseDateID and SK_CloseTimeID must be set to NULL.
- If T_ST_ID is "CMPT" or "CNCL", SK_CloseDateID and SK_CloseTimeID must be set based on T_DTS.
- TradeID, CashFlag, Quantity, BidPrice, ExecutedBy, TradePrice, Fee, Commission and Tax are copied from T_ID, T_IS_CASH, T_QTY, T_BID_PRICE, T_EXEC_NAME, T_TRADE_PRICE, T_CHRG, T_COMM and T_TAX respectively.
- Status is copied from ST_NAME of the StatusType table by matching T_ST_ID with ST_ID.
- Type is copied from TT_NAME of the TradeType table by matching T_TT_ID with TT_ID.
- SK_SecurityID and SK_CompanyID are copied from SK_SecurityID and SK_CompanyID of the DimSecurity table by matching T_S_SYMB with Symbol where IsCurrent = 1. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that these surrogate key values should reference the dimension record that is current at the earliest time this TradeID is encountered. If an update to a record is required in order to set the SK_CloseDateID and SK_CloseTimeID, these fields must not be updated. This dependency of DimTrade on DimSecurity requires that any update to a security's DimSecurity records must be completed before updates to that security's DimTrade records.
- SK_AccountID, SK_CustomerID, and SK_BrokerID are copied from the SK_AccountID, SK_CustomerID, and SK_BrokerID fields of the DimAccount table by matching T_CA_ID with AccountID where IsCurrent = 1. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that these surrogate key values must reference the dimension record that is current at the earliest time this TradeID is encountered. If an update to a record is required in order to set the SK_CloseDateID and SK_CloseTimeID, these fields must not be updated. This dependency of DimTrade on DimAccount requires that any update to an account's DimAccount records must be completed before updates to that account's DimTrade records.
- BatchID is set as described in section 4.4.2 at the time the record is initially created.

4.6.7.3 A record will be reported in the DImessages table if a trade's Commission is not null and exceeds TradePrice * Quantity. The MessageSource is "DimTrade", the MessageType is "Alert" and the MessageText is "Invalid trade commission". The MessageData field is "T_ID = " followed by the key value of the record, then ", T_COMM = " and the T_COMM value.

4.6.7.4 A record will be reported in the DImessages table if a trade's Fee is not null and is larger than TradePrice * Quantity. The MessageSource is "DimTrade", the MessageType is "Alert" and

the MessageText is “Invalid trade fee”. The MessageData field is “T_ID = ” followed by the key value of the record, then “, T_CHRG = ” and the T_CHRG value.

4.6.8 FactCashBalances

4.6.8.1 FactCashBalances data is obtained from the data file CashTransaction.txt. The net effect of all cash transactions for a given account on a given day is totaled, and only a single record is generated per account that had changes per day.

4.6.8.2 When populating fields of the FactCashBalances table:

- SK_CustomerID and SK_AccountID are obtained from DimAccount by matching CT_CA_ID with AccountID, where IsCurrent = 1.
- SK_DateID is set to the DimDate SK_DateID field that corresponds to the Batch Date.
- Cash is calculated as the sum of the prior Cash amount for this account plus the sum of all CT_AMT values from all transactions in this account on this day. If there is no previous FactCashBalances record for the associated account, zero is used.

Note: The procedure used to determine the new Cash total must account for the possibility that a new surrogate key is created in DimAccount since the last cash transaction.

4.6.8.3 BatchID is set as described in section 4.4.2.

4.6.9 FactHoldings

4.6.9.1 Data for FactHoldings comes from the HoldingHistory.txt file and the DimTrade table. The quantity and price values reflect the holdings for a particular security after the most recent trade. The customer can have a positive or negative position (Quantity) as a result of a trade.

4.6.9.2 When populating fields of the FactHoldings table:

- Retrieve the following values from DimTrade where HH_T_ID (current trade identifier) from the HoldingHistory.txt file matches the TradeID from DimTrade: SK_CustomerID, SK_AccountID, SK_SecurityID, SK_CompanyID, SK_DateID, SK_TimeID, and CurrentPrice
- TradeId and CurrentTradeID values are supplied by HH_H_T_ID and HH_T_ID
- CurrentHolding – this value is supplied by HH_AFTER_QTY
- BatchID is set as described in section 4.4.2.

4.6.10 FactMarketHistory

4.6.10.1 FactMarketHistory data is primarily obtained from the file DailyMarket.txt. When populating fields of the FactMarketHistory table:

- ClosePrice, DayHigh, DayLow, and Volume are copied from DM_CLOSE, DM_HIGH, DM_LOW, and DM_VOL respectively.
- SK_SecurityID is obtained from DimSecurity by matching the associated security’s current record DM_S_SYMB with Symbol, where IsCurrent = 1, to return the SK_SecurityID. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that the surrogate key value will reference the current security dimension record at the time the record from DailyMarket.txt is processed. This dependency of FactMarketHistory on DimSecurity requires that any update to a company’s DimSecurity records must be completed before updates to the FactMarketHistory records.

- SK_CompanyID is obtained from DimSecurity by matching DM_S_SYMB with Symbol, where IsCurrent = 1, to return the SK_CompanyID. The match is guaranteed to succeed due to the referential integrity of the OLTP database. Note that the surrogate key value will reference the current company dimension record at the time the record from DailyMarket.txt is processed. This dependency of FactMarketHistory on DimSecurity requires that any update to a company's DimSecurity records must be completed before updates to the FactMarketHistory records.
- SK_DateID is obtained from DimDate by matching DM_DATE with DateValue to return the SK_DateID. The match is guaranteed to succeed because DimDate has been populated with date information for all dates relevant to the benchmark.
- FiftyTwoWeekHigh and SK_FiftyTwoWeekHighDate are determined by finding the highest price over the last year (approximately 52 weeks) for a given security. The FactMarketHistory table itself can be used for this comparison. FiftyTwoWeekHigh is set to the highest DM_HIGH value for any date in the range from DM_DATE back to but not including the same date one year earlier. SK_FiftyTwoWeekHighDate is assigned the earliest date in the date range upon which this DM_HIGH value occurred.

Note: Over the course of the year, the surrogate key value for a security may have changed. It is not sufficient to simply compare records that share the same SK_SecurityID value.

- FiftyTwoWeekLow and SK_FiftyTwoWeekLowDate are determined by finding the lowest price over the last year (approximately 52 weeks) for a given security. The FactMarketHistory table itself can be used for this comparison. FiftyTwoWeekLow is set to the lowest DM_LOW value for any date in the range from DM_DATE back to but not including the same date one year earlier. SK_FiftyTwoWeekLowDate is assigned the earliest date in the date range upon which this DM_LOW value occurred.

Note: Over the course of the year, the surrogate key value for a security may have changed. It is not sufficient to simply compare records that share the same SK_SecurityID value.

- PERatio is calculated by dividing DM_CLOSE (the closing price for a security on a given day) by the sum of the company's quarterly earnings per share ("eps") over the previous 4 quarters prior to DM_DATE. Company quarterly earnings per share data was provided by the FINWIRE data source in the EPS field of the 'FIN' record type in the Historical Load phase data, and should exist in the data warehouse FINANCIAL table as a result of the Historical Load transformation desribed in 4.5.14. If there are no earnings for this company, NULL is assigned to PERatio and an alert condition is raised as described below.

Note: Over the course of the previous 4 quarters, attributes of securities and companies may have changed. As a result, there may be more than one surrogate key value used for a security and/or company in the target data warehouse tables during that time period.

- Yield is calculated by dividing the security's dividend by DM_CLOSE (the closing price for a security on a given day), then multiplying by 100 to obtain the percentage. The dividend is obtained from DimSecurity by matching DM_S_SYMB with Symbol, where IsCurrent = 1, to return the Dividend field
- BatchID is set as described in section 4.4.2.

4.6.10.2 A record will be reported in the DImessages table if there are no earnings found for a company. The MessageSource is "FactMarketHistory", the MessageType is "Alert" and the MessageText is "No earnings for company". The MessageData field is "DM_S_SYMB = " followed by the DM_S_SYMB value of the record.

4.6.11 FactWatches

4.6.11.1 Data for FactWatches comes from the WatchHistory.txt file. Surrogate keys must be obtained for the Customer, Security and Date dimension references. The date keys show the dates the watch was set and removed.

4.6.11.2 Securities can either be added to or removed from a watch list; there is no notion of updating a security on a watch list.

4.6.11.3 When a security is added to a watch list, as indicated by W_ACTION = "ACTV", surrogate keys from the DimCustomer, DimSecurity and DimDate are inserted based on the following:

- SK_CustomerID – each watch list is associated with a customer. W_C_ID can be used to match the associated DimCustomer record, W_C_ID = C_ID where IsCurrent=1, to obtain SK_CustomerID.
- SK_SecurityID – W_S_SYMB can be used to match the current associated DimSecurity record, W_SYMB = Symbol where IsCurrent=1, to obtain SK_ SecurityID.
- SK_DateID_DatePlaced – set based on W_DTS.
- SK_DateID_DateRemoved – set to NULL.
- BatchID is set as described in section 4.4.2.

4.6.11.4 When a security is removed from a watch list, as indicated by W_ACTION = "CNCL", the FactWatches record to update is located by finding the surrogate keys corresponding to W_C_ID and W_S_SYMB, bearing in mind that the customer SK value or the company SK value many have changed since the watch was set; then the following action is required:

- SK_DateID_DateRemoved – set based on W_DTS.
- BatchID is set as described in section 4.4.2.

4.6.12 Industry

4.6.12.1 The Industry table is not altered by Incremental Updates.

4.6.13 Financial

4.6.13.1 No changes to the Financial table will occur during Incremental Updates.

Rationale: Although changes to Financial might be expected in a "real world" brokerage warehouse, the rate of change in this table is so low as to be inconsequential to benchmark results.

4.6.14 Prospect

4.6.14.1 Prospect table data is obtained from the Prospect file. AgencyID is a unique identifier assigned by the agency providing the data feed. Because it is a unique identifier, the AgencyID alone is sufficient to determine whether this prospective customer has been seen in the input file in a previous batch. If so, the corresponding record in the Prospect table is updated with the new values; if not, a new record is created. An AgencyID value will not be repeated within one data batch.

- The following fields are copied from the Prospect file: AgencyID, LastName, FirstName, MiddleInitial, Gender, AddressLine1, AddressLine2, PostalCode, City, State, Country, Phone, Income, NumberCars, NumberChildren, MaritalStatus, Age, CreditRating, OwnOrRentFlag, Employer, NumberCreditCards, NetWorth.
- SK_RecordDateID is set to the DimDate SK_DateID field that corresponds to the Batch Date.
- SK_UpdateDateID is set to the DimDate SK_DateID field that Batch Date if this is the first time this AgencyID value has appeared in the Prospect file or if this AgencyID value has appeared before and the values of any of the following fields are different from prior saved values for the same AgencyID value in the Prospects table: LastName, FirstName, MiddleInitial, Gender, AddressLine1, AddressLine2, PostalCode, City, State, Country, Phone, Income, NumberCars, NumberChildren, MaritalStatus, Age, CreditRating, OwnOrRentFlag, Employer, NumberCreditCards, NetWorth. Otherwise, SK_UpdateDateID retains its prior saved value.
- IsCustomer is set to True or False depending on whether the prospective customer record matches a current customer record in DimCustomer whose status is 'ACTIVE' after all customer records in the batch have been processed. A Prospect record is deemed to match a DimCustomer record if the FirstName, LastName, AddressLine1, AddressLine2 and PostalCode fields all match when upper-cased.
- MarketingNameplate is set based on other fields. Zero or more tags are concatenated with a "+" character between them if multiple tags apply to a given customer. For example, a prospect that qualifies for both the "Boomer" tag and the "Spender" tag would be assigned the MarketingNameplate value "Boomer+Spender". If multiple tags are used they must be in the order given below, and if no tags apply the nameplate is NULL. The tags are defined as:
  - HighValue: NetWorth > 1000000 or Income > 200000
  - Expenses: NumberChildren > 3 or NumberCreditCards > 5
  - Boomer: Age > 45
  - MoneyAlert: Income < 50000 or CreditRating < 600 or NetWorth < 100000
  - Spender: NumberCars > 3 or NumberCreditCards > 7
  - Inherited: Age < 25 and NetWorth > 1000000
- BatchID is set as described in section 4.4.2.

4.6.14.2 Three messages are written to the DImessages table by this transformation.

- As the Prospect file is processed, the number of source rows is counted. After the last row, a "Status" message is written to the DImessages table, with the MessageSource "Prospect", MessageText "Source rows" and the MessageData field containing the number of rows.
- As the Prospect file is processed, a count is kept of new Prospect table rows created. After the last row, a "Status" message is written to the DImessages table, with the MessageSource "Prospect", MessageText "Inserted rows" and the MessageData field containing the number of rows.
- As the Prospect file is processed, a count is kept of the number or rows in the Prospect table updated due to changed values from the Prospect file. (These are the same rows that cause SK_UpdateDateID to be updated.) This count does not include rows updated because the IsCustomer status changed while no input values changed. Newly inserted rows are also excluded from this count. After the last row, a "Status" message is written to the DImessages table, with the MessageSource "Prospect", MessageText "Updated rows" and the MessageData field containing the number of rows.

4.6.15 StatusType

4.6.15.1 The StatusType table is not altered by Incremental Updates.

4.6.16 TaxRate

4.6.16.1 The TaxRate table is not altered by Incremental Updates.

4.6.17 TradeType

4.6.17.1 The TradeType table is not altered by Incremental Updates.

Clause 5: Description of the System Under Test

5.1 Overview

The DI benchmark uses data in a Staging Area as a starting point and places transformed data into a Data Warehouse. The guiding principle is that anything that has an effect on the processes involved in moving and transforming the data from the Staging Area to the Data Warehouse is part of the System Under Test and is defined in the following sections.

5.2 Definition of the System Under Test

5.2.1 The System Under Test (SUT) consists of all hardware and software that supports the function of the Staging Area, DI System and Data Warehouse. Any Network that is used for the communication between the Staging Area, DI System and Data Warehouse is part of the SUT.

Note: The intent of this section is to ensure that everything used in the measured phases of the benchmark is included in the SUT. Data generation is not a measured phase of the benchmark.

5.2.2 There are many possible configurations of the SUT. The Staging Area, DI System, and Data Warehouse may run on a physical server or servers, or virtual servers. Supporting functions may include storage, network, communications, bridges, routers, etc. used in the measured phases of the benchmark.

Rationale: The following diagrams are examples of possible configurations, not a comprehensive list.

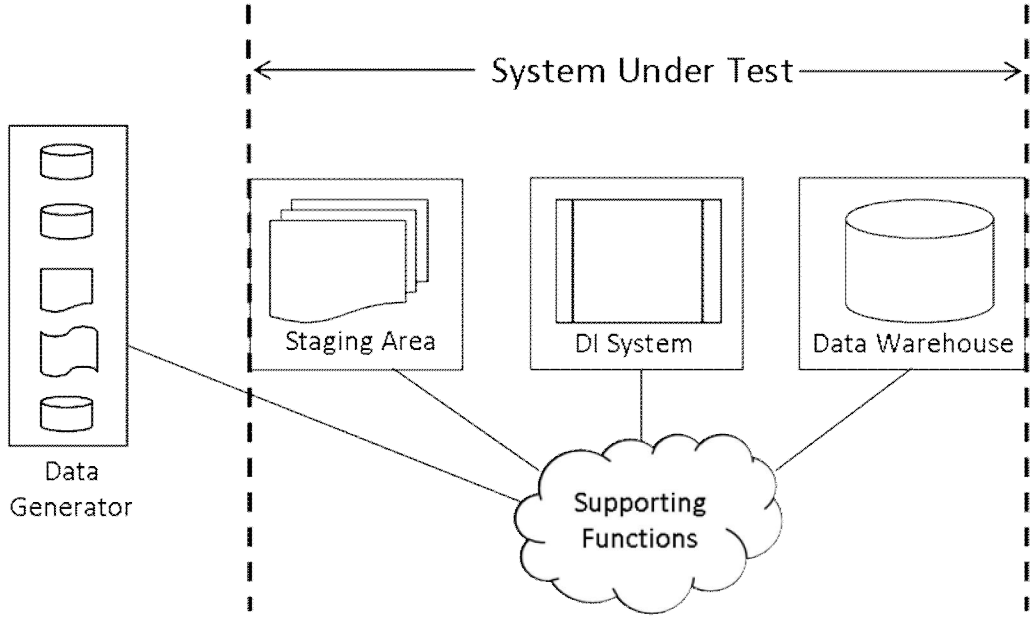


Figure 5.2-1: SUT configuration using separate environments for each function

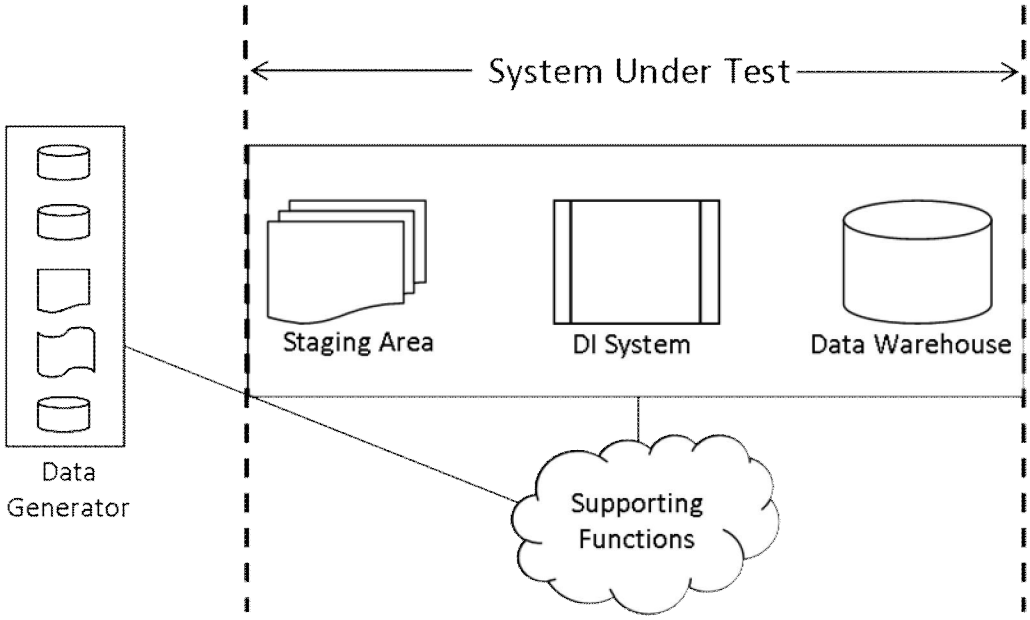


Figure 5.2-2: SUT configuration using a single environment for all functions

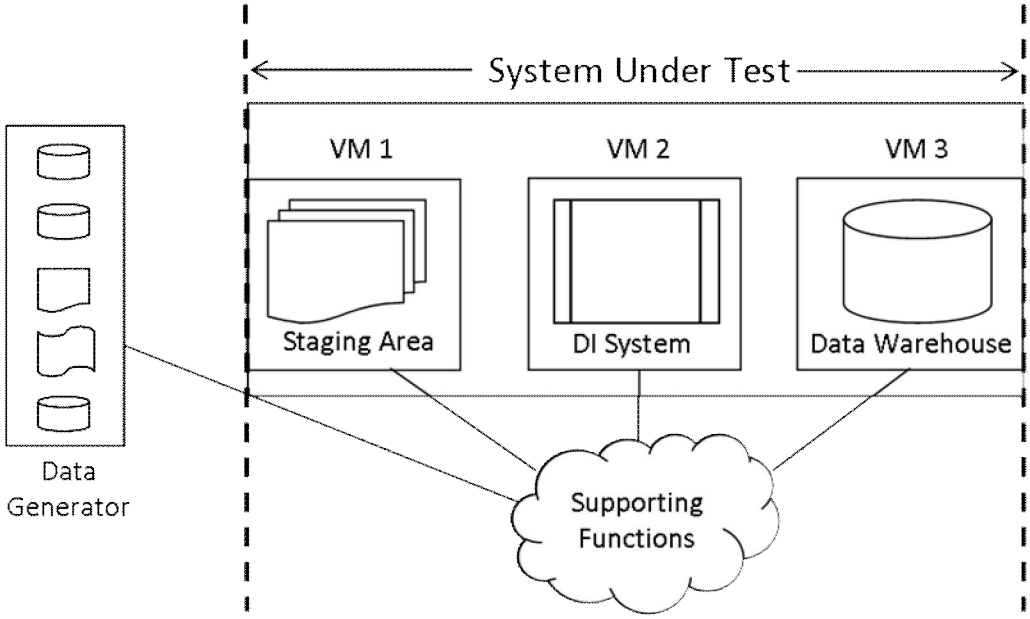


Figure 5.2-3: SUT configuration using a single physical environment and multiple virtual environments.

Clause 6: DIGen

6.1 Overview

DIGen is the data generator program provided by the TPC for creating Source Data and audit information. The Source Data and audit information used for this benchmark must be created using DIGen.

DIGen is a specific implementation built on top of the Parallel Data Generation Framework (PDGF), which is provided and maintained by *Bankmark* (www.bankmark.de). PDGF is a generic data generation framework that provides a core set of data generation capabilities that were extended to generate data with the specific characteristics required by TPC-DI.

6.2 Compliant DIGen Versions

6.2.1 The Source Data used for the benchmark must be generated by DIGen.

6.2.2 Modifications to DIGen are not allowed.

6.2.3 The version of the specification and DIGen must match.

DIT- 6-1: Version of the data generator

6.2.4 The version of PDGF that is included with DIGen must be used.

6.2.5 Any error in a compliant version of DIGen, as provided by the TPC, is deemed to be in compliance with the specification. Therefore, any such errors may not serve as the basis for a compliance challenge.

6.2.6 A Java Virtual Machine (JVM) compliant to a minimum of Java SE 7 must be used with DIGen to create the Source Data.

6.2.7 DIGen has been tested on a variety of platforms. None-the-less, it is impossible to guarantee that DIGen is functionally correct in all aspects or will run correctly on all platforms. It is the test sponsor's responsibility to ensure DIGen runs correctly in their environment(s).

6.2.8 To submit an issue (bugs or enhancements), the test sponsor must:

1. Document the exact nature of the issue.
2. Document the exact nature of the proposed fix.
3. Contact the TPC Administrator with the above specified documentation (hard or soft copy is acceptable). The Sponsor must provide return contact information (e.g. Name, Address, Phone number, Email)

6.3 Data Generation Statistics

6.3.1 DIGen will produce a data generation statistics file named “digen_report.txt” as part of the data generation process. The statistics file is used to calculate the metric and for auditing. The file contains:

- General information about the data generation process
- Options used during the generation process
- Row counts generated for each batch.

6.3.2 The data generation statistics file must not be modified.

Clause 7: Execution Rules & Metrics

7.1 Introduction

This clause defines the execution rules and the methods for calculating the benchmark metric.

A general principle for this benchmark is that all information used to perform the transformations or populate the Data Warehouse tables must be read from the Source Data in the Staging Area. No other sources of data are allowed, including data structures or caches that might be leftover from prior runs of the benchmark, whether maintained by the database, operating system, or any other facility.

7.1.1 Wherever timing is called for, timing to a precision of 0.1 second is required (rounded up), e.g. 0.01 is reported as 0.1.

7.1.2 There is no interaction permitted between the SUT and any outside system during the performance of the benchmark, except for

- Keeping login sessions open. A login session may only be used to start the benchmark and to monitor its progress.
- Maintaining the system in a network domain.
- Other interactions that clearly do not have a performance impact, as long as they are disclosed in the FDR under miscellaneous tasks and/or miscellaneous observations.

7.2 Execution phases and measurements

7.2.1 Preparation Phase

The preparation phase consists of one time tasks needed to prepare the SUT for execution of the benchmark. These steps are not included as part of the benchmark metric, however they must be reported as tasks in the FDR (see Clause 10.2.2).

7.2.1.1 Staging Area Preparation Step

In this step, Source Data is prepared in the Staging Area for use in the Benchmark Run.

7.2.1.1.1 The Test Sponsor chooses a Scale Factor value to be used in data generation. This value determines the sizes of the source files as described in Section 2.1. Scale Factor values must be chosen that result in an elapsed time of each Incremental Update phase of 3600 seconds or less (see Clause 7.2.2).

DIT- 7-1: Scale Factor (SF)

7.2.1.1.2 Data generation is performed using the DIGen data generator described in Clause 6. The Source Data may be generated directly in the Staging Area or it may be generated in a different location and copied to the Staging Area.

DIT- 7-2: DIGen command line parameters used to generate the Source Data

7.2.1.1.3 The same Scale Factor must be used when generating Source Data for all phases of a Benchmark Run.

7.2.1.2 Data Warehouse Preparation Step

7.2.1.2.1 In this step, tasks are performed that are needed to prepare the environment hosting the Data Warehouse for execution of the benchmark. Depending on the needs of the SUT, the following are examples of tasks included in this step:

- Changes to system settings of the Data Warehouse environment, e.g. BIOS, OS, and driver options.

DIT- 7-3: Non default system settings

- Installation of the product running the Data Warehouse

DIT- 7-4: Non default installation settings

- Allocation of space on disk

DIT- 7-5: Instructions to allocate space on disk

- Creation of user accounts on the product hosting the Data Warehouse

DIT- 7-6: Instructions to create user accounts in product hosting the Data Warehouse

- Allocation of space for Data Warehouse tables

DIT- 7-7: Instructions on how to allocate space for Data Warehouse tables

7.2.1.3 DI System Preparation Step

7.2.1.3.1 In this step, tasks are performed that are needed to prepare the DI System for execution of the benchmark. Depending on the needs of the SUT, the following are examples of tasks included in this step:

- Changes to system settings of the DI System environment, e.g. BIOS, OS, and driver options

DIT- 7-8: Non default system settings

- Installation of the data integration product performing the transformations

DIT- 7-9: Non default installation settings

- Allocation of space on disk

DIT- 7-10: Commands/Scripts to allocate space on disk

- Creating user accounts

DIT- 7-11: Commands/scripts to create user accounts

- Importing the DI specification into the DI System

DIT- 7-12: Commands/scripts to import the DI specification

7.2.2 Benchmark Run

A valid Benchmark Run consists of the following phases, which must be performed in the following sequence:

1. Initialization Phase (Clause 7.2.3)
2. Historical Load Phase (Clause 7.2.4)
3. Incremental Update 1 Phase with an elapsed time less than or equal to 3600 seconds (Clause 7.2.5)
4. Incremental Update 2 Phase with an elapsed time less than or equal to 3600 seconds (Clause 7.2.5)
5. Automated Audit Phase (Clause 7.2.6)

It is not permitted to begin processing of a phase until the previous phase has completed.

7.2.2.1 A Benchmark Run may be initiated using an any method for the System Under Test, e.g. manual (command lines, graphical interfaces) or automated task execution.

7.2.2.2 Once initiated, a Benchmark Run must complete all phases without interruption or manual intervention.

Rationale: By having each phase start immediately upon completion of the prior phase, work cannot be performed without being timed.

7.2.3 Initialization Phase

The initialization phase provides a "clean" SUT for each Benchmark Run, with no artifacts remaining from previous runs.

7.2.3.1 The Data Warehouse must be created as defined in Clause 3.

7.2.3.2 Auxiliary Data Structures may be added at the discretion of the Test Sponsor.

7.2.3.3 Tasks specific to the SUT may be performed at the discretion of the Test Sponsor.

7.2.3.4 Tasks that require accessing any Source Data in the Staging Area are not allowed.

7.2.3.5 After all initialization steps have been performed, the batch validation described in Clause 7.4 is executed. Upon completion of the batch validation query, a phase completion record (PCR) is written to the DImessages table.

7.2.3.6 The initialization phase is not timed.

7.2.4 Historical Load Phase

7.2.4.1 The Historical Load phase populates Data Warehouse tables with data by performing the transformations specified in Clause 4.5, using data from the Batch1 directory of the Staging Area.

7.2.4.2 After all transformations specified in section 4.5 have been completed, the batch validation query given in Clause 7.4 is executed. Upon completion of the batch validation query, a phase completion record (PCR) is written to the DImessages table.

7.2.4.3 The Historical Load phase is timed as described in Clause 7.5.2.

7.2.5 Incremental Update Phases

7.2.5.1 Two Incremental Update phases, Update1 and Update2, must be performed in sequence.

7.2.5.2 Update1 and Update2 each perform the transformations specified in Clause 4.6, using data from the Batch2 and Batch3 directories of the Staging Area, respectively.

7.2.5.3 After all transformations have been performed, the batch validation query described in Clause 7.4 is executed to complete each phase. Upon completion of the batch validation query, a phase completion record (PCR) is written to the DImessages table.

7.2.5.4 Incremental Updates are timed as described in Clause 7.5.3.1

7.2.6 Automated Audit Phase

7.2.6.1 The automated audit phase begins immediately upon completion of the last Incremental Update phase.

7.2.6.2 Audit data is generated as part of the Source Data as defined in Clause 2.2.2.20. All audit data must be loaded into the Audit table defined in Clause 3.2.19 using the following rules:

- The first row in every audit data file contains only the field names, not audit data. This record may be used to aid in the load process, but must not be loaded into the Audit table.
- Each field in the audit data must be loaded into the cooresponding column (the column of the same name) of the Audit table.

7.2.6.3 It is permissible to create Auxiliary Data Structures to aid in the performance of the automated audit during this phase.

7.2.6.4 It is not permissible to modify the contents of the Data Warehouse during this phase other than loading the Audit table as described in Clause 7.2.6.2 and 7.2.6.3.

7.2.6.5 At the beginning of the automated audit phase, a final execution of the data visibility 1 query (Appendix C) must be executed.

7.2.6.6 The audit query must be executed, which will perform a set of tests on the Data Warehouse to confirm the validity of the result set. The audit query is given in Appendix A.

7.2.6.7 A valid Benchmark Run must report “OK” status for every test.

OID- 7-1: Output of the audit query

7.2.6.8 The audit query is written to be compatible with most databases that can run SQL queries. For systems that cannot run the query as supplied, the Test Sponsor must follow the rules for SQL compliance, outlined in Clause 3.4.11.

7.3 Data Visibility Queries

7.3.1 The data visibility queries are used to verify the visibility of the data written to the Data Warehouse (see Clauses 4.3.5.1 and 4.3.5.2). Data collected by the data visibility queries is stored in the DImessages table and will be examined in the Automated Audit phase. The data visibility queries are given in Appendix C.

7.3.2 Beginning at the start of the Incremental Update 1 phase and ending at the conclusion of the Incremental Update 2 phase, the data visibility queries must be executed at regular intervals against the Data Warehouse.

7.3.3 The interval between the start of the Incremental Update 1 phase and the start of the data visibility 1 query must not exceed five minutes.

7.3.4 The interval between the start of the first data visibility 2 query and the start of the data visibility 1 query (7.3.3) must not exceed five minutes.

7.3.5 The interval between starts of successive executions of the data visibility 2 query must not exceed five minutes

7.3.6 The interval between the start of the last data visibility 2 query and the conclusion of the Incremental Update 2 phase must not exceed five minutes.

7.3.7 The data visibility queries must be executed using a different Data Warehouse Session than the session(s) used by the DI System.

7.3.8 The data visibility queries may be initiated using any method for the System Under Test.

7.4 Batch Validation Query

7.4.1 The batch validation query is used to capture information for the purpose of timing and validating the correctness of each execution phase. The batch validation query is given in Appendix B.

7.4.2 The batch validation query is executed multiple times as part of a Benchmark Run. When executed as part of a timed phase, the time to execute the query is included as defined in Clause 7.2.

7.4.3 The batch validation query writes results into the DImessages table defined in Clause 3.2.8, which are used in the automated audit phase to validate the transformed data in the Data Warehouse.

7.4.4 The batch validation query is written to be compatible with most databases that can run SQL queries. For systems that cannot run SQL queries, the Test Sponsor must follow the rules for SQL compliance, outlined in Clause 3.4.11.

7.5 Calculating Throughput

7.5.1 The completion timestamp (CT) of each phase identified by BatchID, $CT_{BatchID}$ (see Clause 4.4.2) is the value in the MessageDateAndTime field of the record in the DImessages table where the MessageType field is 'PCR' and the BatchID field is equal to the BatchID for the phase. For example, the following query could be used to retrieve the CT for the Historical Load phase:

```
select MessageDateAndTime from DImessages where BatchID = 1 and MessageType = 'PCR'
```

7.5.2 Historical Load Throughput

7.5.2.1 The elapsed time, expressed in units of seconds, for the Historical Load is $E_H = CT_1 - CT_0$

OID- 7-2: Elapsed time of the Historical Load

7.5.2.2 The total number of rows of Source Data in the Historical Load data set is R_H and is reported by DIGen as the row count for Batch1 (see Clause Error! Reference source not found.).

OID- 7-3: Total number of rows of input data in the Historical Load (Batch 1) data set as reported by DIGen

7.5.2.3 The throughput of the Historical Load is $T_H = R_H / E_H$

OID- 7-4: The throughput of the Historical Load

7.5.3 Incremental Update Throughput

7.5.3.1 The elapsed times, expressed in units of seconds, for the Incremental Updates are $E_{I1} = CT_2 - CT_1$ and $E_{I2} = CT_3 - CT_2$.

OID- 7-5: The elapsed times for the Incremental Updates

7.5.3.2 The total number of rows of Source Data in the Incremental Update data sets are R_{I1} and R_{I2}, and are reported by DIGen as the row count for Batch2 and Batch3, respectively (see Clause Error! Reference source not found.) .

OID- 7-6: Total number of rows of source data in the Incremental Update data sets

7.5.3.3 The throughputs of the Incremental Updates are:

$T_{I1} = R_{I1} / \text{Max}(E_{I1}, 1800)$ and $T_{I2} = R_{I2} / \text{Max}(E_{I2}, 1800)$

OID- 7-7: Throughputs of the Incremental Updates

Rationale: To encourage that a sufficient amount of data is processed, the benchmark targets Incremental Update elapsed times of a minimum of 1800 seconds. The above formula allows the Test Sponsor to use a Benchmark Run with elapsed times less than 1800 seconds and avoid doing another complete run, if they are willing to accept the impact of calculating the throughput using a value larger than the actual elapsed time. The impact is minimized as the elapsed time gets closer to 1800 seconds.

7.6 Primary Metrics

7.6.1 Performance Metric

The performance metric for the benchmark is a combined metric using the three throughput calculations from the timed phases, and is computed as follows:

$$TPC\_DI\_RPS = Trunc(GeoMean(T_H, Min(T_{I1}, T_{I2})))$$

where:

T_H is the throughput of the Historical Load (see Clause 7.5.2)
T_{I1} is the throughput of Incremental Update 1 (see Clause 7.5.3)
T_{I2} is the throughput of Incremental Update 2 (see Clause 7.5.3)
GeoMean() is the geometric mean of the arguments.
Min() is the argument with the least value.
Trunc() is the whole number portion of the argument.

7.6.2 Price/Performance Metric

The Price/Performance is computed using the performance metric TPC_DI_RPS as follows:

Price-per-TPC_DI_RPS = $ / TPC_DI_RPS

where:

$ is the total 3-year pricing as described in the effective version of the TPC Pricing specification in the reported currency. The list of components to be priced is described in Clause 9.1 of this specification.

TPC_DI_RPS is the combined throughput metric defined in Clause 7.6.1

7.6.2.1 The units of Price-per-TPC_DI_RPS are expressed as in the effective version of the TPC Pricing Specification. For example, in the United States, the system price must be reported in whole dollars and the Price-per-TPC_DI_RPS may be reported in dollars and cents. Any fraction of a unit must be raised to the next highest unit (e. g., $12.123 must be shown as $12.13USD.

7.6.3 Availability Date

7.6.3.1 The Availability Date is the date in which all components of the SUT are generally available, as defined in the effective version of the TPC Pricing Specification.

Clause 8: System and Implementation Qualification

The following set of qualification tests must be performed to demonstrate compliance of the SUT.

8.1 Qualification Environment

8.1.1 The qualification tests must be performed on the SUT using the same hardware and software components as the performance test. No aspect of the SUT (e.g., system parameters, hardware configuration, software releases, etc.), other than the Source Data may differ between this demonstration of compliance and the performance test, unless it is directly related to the difference in size of the data being processed.

8.1.2 The components must be configured identically to the performance test configuration, with the exception of adjustments made for the size of the qualification Source Data. For example, if the Data Warehouse employs partitioning, then the qualification Data Warehouse must also employ partitioning in a similar manner, although the number of partitions may differ in each case.

8.1.3 The Source Data for the qualification tests must be generated by DIGen using Scale Factor (SF) = 5.

8.1.4 The DI application must be the same as that used in the performance test.

8.2 Verifying accuracy and consistency

8.2.1 It is the responsibility of the Test Sponsor to demonstrate that the Data Warehouse was implemented as specified and all transformations were performed completely and accurately.

8.2.1.1 The TPC provides a comparison tool and expected result data that is used to verify the accuracy and consistency of test result data. The comparison tool can be obtained from the download section of the TPC web site. Detailed usage information is provided with the comparison tool.

8.2.1.2 Some fields are expected to be different from implementation to implementation or run to run. In these cases the exact values are not required to match the expected result set, however the semantics of the field must be correct. The following variances are allowed:

- Fields with meta-type SK_T (surrogate keys) represent unique identifiers for dimension table rows. These may be generated differently from system to system, but key-foreign key references must be correct.
- The field MessageDateAndTime of the DImessages table is set using the current timestamp of the run.
- Fields with meta-type BOOLEAN must match the Boolean state, but may use different values to indicate True and False.

Note: The comparison tool allows for these variances.

8.2.2 Preparing Test Result Data

8.2.2.1 In order to compare the results of a run with the expected result data, the data must be extracted from the Data Warehouse into a set of files to produce the test result data. All files must be pipe ("|") delimited text files with the fields in the order specified by the associated extract query. The following formatting must be used:

- Fields containing NULL must be expressed as an empty field, e.g. a row with 3 fields where the second field is NULL would be written as "A||B"
- DATE fields must be formatted as YYYY-MM-DD
- TIME fields must be formatted as hh.mm.ss

8.2.2.2 Files must be created as defined below, with contents defined by the associated SQL query:

File Name	Extract Query
DimAccount.txt	select SK_AccountID, AccountID, SK_BrokerID, SK_CustomerID, Status, AccountDesc, TaxStatus, IsCurrent, BatchID, EffectiveDate, EndDate from DimAccount order by AccountID, EffectiveDate
DimBroker.txt	select SK_BrokerID, BrokerID, ManagerID, FirstName, LastName, MiddleInitial, Branch, Office, Phone, IsCurrent, BatchID, EffectiveDate, EndDate from DimBroker order by BrokerID, EffectiveDate
DimCompany.txt	select SK_CompanyID, CompanyID, Status, Name, Industry, SPrating, isLowGrade, CEO, AddressLine1, AddressLine2, PostalCode, City, StateProv, Country, Description, FoundingDate, IsCurrent, BatchID, EffectiveDate, EndDate from DimCompany order by CompanyID, EffectiveDate
DimCustomer.txt	select SK_CustomerID, CustomerID, TaxID, Status, LastName, FirstName, MiddleInitial, Gender, Tier, DOB, AddressLine1, AddressLine2, PostalCode, City, StateProv, Country, Phone1, Phone2, Phone3, Email1, Email2, NationalTaxRateDesc, NationalTaxRate, LocalTaxRateDesc, LocalTaxRate, AgencyID, CreditRating, NetWorth, MarketingNameplate, IsCurrent, BatchID, EffectiveDate, EndDate from DimCustomer order by CustomerID, EffectiveDate
DimDate.txt	select SK_DateID, DateValue, DateDesc, CalendarYearID, CalendarYearDesc, CalendarQtrID, CalendarQtrDesc, CalendarMonthID, CalendarMonthDesc, CalendarWeekID, CalendarWeekDesc, DayOfWeekNum, DayOfWeekDesc, FiscalYearID, FiscalYearDesc, FiscalQtrID, FiscalQtrDesc, HolidayFlag from DimDate order by DateValue
DimSecurity.txt	select SK_SecurityID, Symbol, Issue, Status, Name, ExchangeID, SK_CompanyID, SharesOutstanding, FirstTrade, FirstTradeOnExchange, Dividend, IsCurrent, BatchID, EffectiveDate, EndDate from DimSecurity order by Symbol, EffectiveDate
DimTime.txt	select SK_TimeID, TimeValue, HourID, HourDesc, MinuteID, MinuteDesc, SecondID, SecondDesc, MarketHoursFlag, OfficeHoursFlag from DimTime order by TimeValue

DimTrade.txt	select TradeID, SK_BrokerID, SK_CreateDateID, SK_CreateTimeID, SK_CloseDateID, SK_CloseTimeID, Status, Type, CashFlag, SK_SecurityID, SK_CompanyID, Quantity, BidPrice, SK_CustomerID, SK_AccountID, ExecutedBy, TradePrice, Fee, Commission, Tax, BatchID from DimTrade order by TradeID, Status
FactCashBalances.txt	select FCB.SK_CustomerID, FCB.SK_AccountID, FCB.SK_DateID, FCB.Cash, FCB.BatchID from FactCashBalances as FCB left outer join DimAccount as DA on FCB.SK_AccountID=DA.SK_AccountID left outer join DimCustomer as DC on FCB.SK_CustomerID=DC. SK_CustomerID left outer join DimDate as DD on FCB.SK_DateID=DD.SK_DateID order by DA.AccountID, DD.DateValue
FactHoldings.txt	select FH.TradeID, FH.CurrentTradeID, FH.SK_CustomerID, FH.SK_AccountID, FH.SK_SecurityID, FH.SK_CompanyID, FH.SK_DateID, FH.SK_TimeID, FH.CurrentPrice, FH.CurrentHolding, FH.BatchID from FactHoldings as FH left outer join DimTrade as DT on FH.TradeID=DT.TradeID left outer join DimAccount as DA on FH.SK_AccountID=DA. SK_AccountID left outer join DimCustomer as DC on FH. SK_CustomerID = DC. SK_CustomerID left outer join DimSecurity as DS on FH.SK_SecurityID=DS.SK_SecurityID left outer join DimCompany as DCo on FH.SK_CompanyID=DCo.SK_CompanyID left outer join DimDate as DD on FH.SK_DateID=DD.SK_DateID left outer join DimTime as DT on FH.SK_TimeID=DT.SK_TimeID order by FH.TradeID, DD.DateValue, DT.TimeValue
FactMarketHistory.txt	select FM.SK_SecurityID, FM.SK_CompanyID, FM.SK_DateID, FM.PERatio, FM.Yield, FM.FiftyTwoWeekHigh, FM.SK_FiftyTwoWeekHighDate, FM.FiftyTwoWeekLow, FM.SK_FiftyTwoWeekLowDate, FM.ClosePrice, FM.DayHigh, FM.DayLow, FM.Volume, FM.BatchID from FactMarketHistory as FM left outer join DimSecurity as DS on FM.SK_SecurityID=DS.SK_SecurityID left outer join DimCompany as DCo on FM.SK_CompanyID=DCo.SK_CompanyID left outer join DimDate as DD on FM.SK_DateID=DD.SK_DateID order by DS.Symbol, DD.DateValue
FactWatches.txt	select FW.SK_CustomerID, FW.SK_SecurityID, FW.SK_DateID_DatePlaced, FW.SK_DateID_DateRemoved, FW.BatchID from FactWatches as FW left outer join DimSecurity as DS on FW.SK_SecurityID=DS.SK_SecurityID left outer join DimCustomer as DC on FW.SK_CustomerID=DC.SK_CustomerID left outer join DimDate as DD on FW.SK_DateID_DatePlaced=DD.SK_DateID order by DC.CustomerID, DS.Symbol, DD.DateValue
Financial.txt	select FIN.SK_CompanyID, FIN.FI_YEAR, FI_QTR, FIN.FI_QTR_START_DATE, FIN.FI_REVENUE, FI_NET_EARN, FIN.FI_BASIC_EPS, FIN.FI_DILUT_EPS, FIN.FI_MARGIN, FIN.FI_INVENTORY, FIN.FI_ASSETS, FIN.FI_LIABILITY, FIN.FI_OUT_BASIC, FIN.FI_OUT_DILUT from Financial as FIN left outer join DimCompany as DC on FIN.SK_CompanyID=DC.SK_CompanyID order by DC.CompanyID, FIN.FI_QTR_START_DATE
Prospect.txt	select P.AgencyID, P.SK_RecordDateID, P.SK_UpdateDateID, P.BatchID, P.IsCustomer, P.LastName, P.FirstName, P.MiddleInitial, P.Gender, P.AddressLine1, P.AddressLine2, P.PostalCode, P.City, P.State, P.Country,

	P.Phone, P.Income, P.NumberCars, P.NumberChildren, P.MaritalStatus, P.Age, P.CreditRating, P.OwnOrRentFlag, P.Employer, P.NumberCreditCards, P.NetWorth, P.MarketingNameplate from Prospect as P left outer join DimDate as DD on P.SK_UpdateDateID=DD.SK_DateID order by P.LastName, P.FirstName, DD.DateValue
DImessages.txt	select MessageDateAndTime, BatchID, MessageSource, MessageText, MessageType, MessageData from DImessages where MessageType <> 'Visibility' order by BatchId, MessageSource, MessageText, MessageData

Note: The extract queries are written to be compatible with most databases that can run SQL queries. For systems that cannot run these SQL queries, the test sponsor must follow the rules for SQL compliance, outlined in Clause 3.4.11.

8.3 Transformation Accuracy

8.3.1 To validate the compliance of the DI application, a complete Benchmark Run must be executed by the Test Sponsor using the qualification environment.

8.3.2 The qualification run test results must be created and verified for accuracy and consistency as described in Clause 8.2.

8.3.3 The qualification run test result data must match the expected results; otherwise, the DI application is not compliant.

8.4 Durability

The Test Sponsor is required to guarantee that the Staging Area and the Data Warehouse will preserve the data integrity and consistency after recovery from each of the failures listed below, see Clauses 2.4.1 and 3.4.6.

8.4.1 Durability tests
For each of the failure conditions defined below, the Test Sponsor will perform a Benchmark Run using the qualification environment.

8.4.1.1 Staging Area failures

8.4.1.1.1 Access to the Source Data files must be maintained throughout a permanent irrecoverable failure of any single Durable Medium containing Source Data of the Staging Area. To demonstrate compliance the following procedure must be followed:

1. Start a Benchmark Run using the qualification environment.
2. Induce the failure prior to the run completing. The run must continue to completion.
3. Create and verify the test result data as described in Clause 8.2.

The test result data must match the expected results; otherwise, the Staging Area is not compliant.

8.4.1.1.2 In the event of a loss of all external power to the Staging Area for an indefinite period of time, the Source Data must be preserved. To demonstrate compliance the following procedure must be followed:

1. Induce the failure and recover the Staging Area Server.
2. Start a Benchmark Run using the qualification environment.
3. Create and verify the test result data as described in Clause 8.2.

The test result data must match the expected results; otherwise, the Staging Area is not compliant.

8.4.1.2 Data Warehouse failures

If ACID compliance is demonstrated per Clause 3.4.10.2, it is not necessary to perform these tests.

8.4.1.2.1 The Data Warehouse must maintain consistency after a permanent irrecoverable failure of any single Durable Medium containing data of the Data Warehouse. To demonstrate compliance the following procedure must be followed:

1. Start a Benchmark Run using the qualification environment.
2. Wait until the second Incremental Update phase is executing and ensure the DI application has committed some data to the Data Warehouse but has not completed all transformations.
3. Induce the failure. If necessary, recover the Data Warehouse.
4. Create and verify the test result data as described in Clause 8.2.

Depending on the implementation and the time the failure is induced, there may be some transformations that have been completed entirely, some that have been partially completed, and others that have not yet been performed. Therefore, the test result data must be a subset of the expected result data. All data that exists in the test result data must match the expected result data, i.e. differences in the files can only be due to records that are missing entirely from the test result data.

The following files must match completely:

- DimBroker
- DimCompany
- DimDate
- DimSecurity
- DimTime
- Financial
- Files containing only data produced by transformations indicated by the DI System as complete

Files that contain only a subset of the expected result data must be verified to contain the correct number of records. The number of records that have been created or modified in

the second incremental update phase (i.e. where BatchID = 3) must match the number of records that the DI System indicates have been committed to the Data Warehouse during this phase.

Note: Various methods can be used by the DI System to indicate the status of the transformations, e.g. log files or DI application created audit files.

If the above conditions are not met, the Data Warehouse is not compliant.

8.4.1.2.2 The Data Warehouse must maintain consistency after loss of all external power to the Data Warehouse Server for an indefinite time period. To demonstrate compliance the following procedure must be followed:

1. Start a Benchmark Run using the qualification environment.
2. Wait until the second Incremental Update phase is executing and ensure the DI application has committed some data to the Data Warehouse but has not completed all transformations in the phase.
3. Induce the failure. Recover the Data Warehouse.
4. Create and verify the test result data as described in Clause 8.2.

Depending on the implementation and the time the failure is induced, there may be some transformations that have been completed entirely, some that have been partially completed, and others that have not yet been performed. Therefore, the test result data must be a subset of the expected result data. All data that exists in the test result data must match the expected result data, i.e. differences in the files can only be due to records that are missing entirely from the test result data.

The following files must match completely:

- DimBroker
- DimCompany
- DimDate
- DimSecurity
- DimTime
- Financial
- Files containing only data produced by transformations indicated by the DI System as complete

Files that contain only a subset of the expected result data must be verified to contain the correct number of records. The number of records that have been created or modified in the second incremental update phase (i.e. where BatchID = 3) must match the number of records that the DI System indicates have been committed to the Data Warehouse during this phase.

Note: Various methods can be used by the DI System to indicate the status of the transformations, e.g. log files or DI application created audit files.

If the above conditions are not met, the Data Warehouse is not compliant.

Clause 9: Pricing

Rules for pricing the Priced Configuration and associated software and maintenance are included in the effective version of the TPC Pricing Specification, located at www.tpc.org. The following requirements are intended to supplement the Pricing Specification:

9.1 Priced Configuration

9.1.1 The system to be priced shall include the hardware and software Components present in the System Under Test (SUT), additional operational Components configured on the test system, DI application development software, and maintenance on all of the above.

9.1.2 Specifically, the Priced Configuration consists of:

1. All software and hardware components of the SUT, as tested and defined in Clause 5.
2. The on-line storage for the Staging Area, DI System, and Data Warehouse as described in Clause 9.2 and storage for all software included in the Priced Configuration.
3. Additional products (software or hardware) required for customary operation, administration and maintenance of the SUT.
4. All software required to execute and administer the DI application.
5. Software required to create or modify, prepare, and translate DI specifications into a DI application format for a minimum of 5 concurrent users.

9.1.2.1 Specifically excluded from the priced system are:

1. End-user communication devices and related cables, connectors, and concentrators.
2. Equipment and tools used exclusively for the execution of DIGen.
3. Hardware used exclusively to develop the DI application.
4. Equipment and tools used exclusively in the production of the full disclosure report.

9.2 On-line Storage Requirement

9.2.1 Continuous Operation Requirement

Within the Priced Configuration, there must be sufficient on-line storage to support:

- The Staging Area with generated Source Data for the Historical Load run and two Incremental Update runs.
- The required data transformations, including temporary and intermediate storage used by the DI System and DI Application.
- The fully populated Data Warehouse after completing all benchmark execution steps defined in Clause 7, plus an additional 7 Incremental Update runs as required by Clause 3.4.9.4.

9.2.2 Archive Operation Requirement
TPC-DI has no requirements for pricing additional archive storage.

9.2.3 Back-up Storage Requirements
TPC-DI has no requirements for on-line back-up data capabilities in the Priced Configuration.

9.3 TPC-DI Specific Pricing Requirements

9.3.1 Additional Operational Components

9.3.1.1 Additional products that might be included on a customer installed configuration, such as operator consoles and magnetic tape drives, are also to be included in the priced system if explicitly required for the operation, administration, or maintenance, of the priced system.

9.3.1.2 Copies of the software, on appropriate media, and a software load device, if required for initial load or maintenance updates, must be included.

9.3.1.3 Uninterruptible Power Supply specifically contributing to a Data Durability solution, must be included (see Clause 3.4.6).

9.3.1.4 All components, including cables, used to interconnect components of the SUT must be included.

9.3.2 Additional Software

9.3.2.1 All software required to create or modify, prepare, and translate DI specifications into a DI application format for a minimum of 5 concurrent users, must be included. This includes the DI System development software, compilers, database client libraries, etc.

9.4 Component Substitution

9.4.1 Substitution is defined as a deliberate act to replace components of the Priced Configuration by the Test Sponsor as a result of failing the availability requirements of the TPC Pricing Specification or when the Part Number for a component changes.

9.4.2 Hardware or Software product Substitutions within the SUT, with the exceptions noted below require the benchmark to be re-run with the new Components in order to reestablish compliance.

9.4.3 Corrections or "fixes" to components of the Priced Configuration are often required during the life of products. These changes are not considered Substitutions so long as the Part Number of the priced component does not change. Suppliers of hardware and software may update the components of the Priced Configuration, but these updates must not impact the Reported Throughput. The following are not considered Substitutions:

- software patches to resolve a security vulnerability
- silicon revision to correct errors

- new supplier of functionally equivalent components (i.e. memory chips, disk drives, ...)

9.4.4 Some hardware components of the Priced Configuration may be substituted after the Test Sponsor has demonstrated to the Auditor's satisfaction that the substituting components do not negatively impact the Reported Throughput. All Substitutions must be reported in the FDR and noted in the Auditor's Attestation Letter. The following hardware components may be substituted:

- Durable Medium
- Durable Medium Enclosure
- Network interface card
- Router
- Bridge
- Repeater

9.4.5 Substitutions will be open to challenge for a 60-day period.

Clause 10: Full Disclosure Report

10.1 Full Disclosure Report Requirements

10.1.1 A Full Disclosure Report (FDR) is required. This section specifies the requirements for the FDR. The FDR is a zip file of a directory structure containing the following:

- A Report in Adobe Acrobat PDF format,
- An Executive Summary Statement in Adobe Acrobat PDF format,
- A Supporting Files Archive consisting of various source files, scripts, and listing files.

10.2 General Requirements

10.2.1 The FDR must include all information of all steps necessary to i) configure the SUT as it was configured during the benchmark execution, ii) modify the system, user, and application environments, iii) run the TPC-DI benchmark according to the TPC-DI specification, iv) verify that the benchmark execution was conducted according to the TPC-DI specification, and v) compute all benchmark metrics. Configuring the SUT is defined as the process of modifying the priced configuration to implement TPC-DI and to achieve the reported performance.

10.2.2 Each step in the process of configuring the SUT and running the TPC-DI benchmark corresponds to one or more tasks. Each step in the process of verifying the benchmark execution and computing all benchmark metrics correspond to one or more observations. Definitions of tasks and observations are listed throughout the specification.

10.2.2.1 Tasks are entitled DIT_<clause number>_<sequence number>. If configuration steps are necessary to satisfy Clause 10.2.1 that are not defined in this specification, they must be given a unique task name in format DIT_M_<sequence number> and included in the FDR under miscellaneous tasks. The implementation of each task must be presented in programs, configuration files, screenshot sequences, user manual, or human readable text.

10.2.2.2 Observations are entitled OID_<clause number>_<sequence number>. If configuration steps are necessary to satisfy Clause 10.2.1 that are not defined in this specification, they must be given a unique observation name in format OID_M_<sequence number> and included in the FDR under miscellaneous observations. An observation must be presented in the form of human readable text or screenshot sequences.

10.2.3 The reader of the FDR must be able to understand the semantics of human readable text, programs, configuration files and screenshots, either by accompanied explanation or by referring to documentation.

10.2.4 Programs

10.2.4.1 Programs are the preferred format to specify tasks.

10.2.4.2 All instructions of programs that control functions of components listed in the priced configuration must be fully explained in a user manual. This manual must be made available

by the benchmark sponsor for download upon request on the availability date without any license, NDA or fee.

10.2.4.3 All instructions of programs that control functions of components that are not listed in the priced configuration must adhere to a publically available standard i.e. a programming language whose definition is publically available. They must be presented in their source code. For each of these programs the version of their programming language, any input and output data and the way it is translated to be machine executable must be disclosed. For each program that needs to be compiled to be machine executable, the compiler version and compile invocation needs to be disclosed. For each program that needs to be interpreted to be machine executable, the version of the interpreter and any non-default parameter need to be disclosed.

10.2.4.4 All programs must be accompanied by a short description of what part of the TPC-DI specification they implement. For all non-GUI driven programs a call tree must be provided that shows which program calls which. If a non-GUI driven program calls a GUI driven program, it needs to name the GUI-driven program. If a GUI-driven program calls a non-GUI driven program it needs to name the non-GUI driven program.

10.2.5 Configuration files

10.2.5.1 Each configuration file must be accompanied with a short description of its usage and when it is used.

10.2.5.2 If a configuration file changes the default behavior of one or more components that are listed in the priced configuration, the syntax of the configuration file must be fully explained in a user manual. This manual must be made available by the benchmark sponsor upon request on the Availability Date.

10.2.5.3 If a configuration file changes the default behavior of one or more components that are not listed in the priced configuration, the syntax of the configuration file must adhere to a publically available standard i.e. a programming language whose definition is publically available or the syntax must be explained in the FDR.

10.2.6 Screenshot Sequences

10.2.6.1 The use of screenshot sequences to specify a task is allowed if a graphical user interface was used to implement it for the SUT.

10.2.6.2 The actions that cause the transition from one screenshot to the next screenshot of a screenshot sequence must be documented in English text, e.g. click on the button <OK> or Enter file name foo and click on <continue>.

10.2.6.3 The order in which screenshots appear must be disclosed.

10.2.6.4 Screenshots must be labeled with SS followed by a hierarchy of numbers where each level is separated with "_", e.g. SS_1_4_5. If screenshots follow each other, then they should be listed in ascending order.

10.2.6.5 Screenshot sequences that are used more than once can be given a unique name and referred to by this name in other screenshot sequences.

10.2.7 User Manuals

Tasks can be described using user manuals and English descriptions as long as all of the following criteria are met:

Links to downloadable versions of the user manuals are provided with page numbers of the page explaining the feature. In case the manual has no page numbering (e.g. html or xml documents), a hyperlink that links directly to the position in the document explaining the feature must be provided.

All manuals are downloadable without any fees or license restrictions.

All manuals are downloadable by the Availability Date.

A user can perform the task reading the instructions in the manual and the English description.

10.2.8 The order and titles of sections in the Report and Supporting Files must correspond with the order and titles of sections from the TPC-DI Standard Specification (i.e., this document). The intent is to make it as easy as possible for readers to compare and contrast material in different FDRs.

10.2.9 The content of each page of the Report and Executive Summary must fit on a 8.5 by 11 inches sheet. The content of each page must be printed either in portrait or in landscape orientation.

10.2.10 All text sections of the report, including appendices, must be printed using font sizes of a minimum of 8 points.

10.2.11 All text on any screenshots must be legible and all graphical elements must be clearly identifiable. The largest screen resolution on which screenshots are allowed to be taken is 1440 by 900. At most two screenshots are allowed to be printed on one page of the Report and ES.

10.3 Executive Summary Statement

The executive summary is meant to be a high level overview of a TPC-DI implementation. It should provide the salient characteristics of a benchmark execution (metrics, configuration, pricing, etc.) without the exhaustive detail found in the FDR.

The executive summary has two components:

Implementation Overview

Pricing Spreadsheet

10.3.1 Page Layout

Each component of the executive summary should appear on a page by itself. Each page should use a standard header and format, including

1/2 inch margins, top and bottom;

3/4 inch left margin, 1/2 inch right margin;

2 pt. frame around the body of the page. All interior lines should be 1 pt;

Test Sponsor identification and System identification, each set apart by a 1 pt. rule, in 16-20 pt. Times Bold font.

TPC-DI and TPC-Pricing with three tier versioning (e.g., 1.2.3), and report date, separated from other header items and each other by a 1 pt. Rule, in 9-12 pt. Times font.

Note: It is permissible to use or include company logos when identifying the sponsor.

Note: The report date must be disclosed with a precision of 1 day. The precise format is left to the test sponsor.

Note: An example executive summary is provided to help clarify the reporting requirements.

10.3.2 Implementation Overview

The implementation overview page contains four sets of data, each laid out across the page as a sequence of boxes using 1 pt. rule, with a title above the required quantity. Both titles and quantities should use a 9-12 pt. Times font unless otherwise noted.

10.3.2.1 The first section contains the results that were obtained from the reported runs of the Performance test.

Title	Quantity	Precision	Units	Font
TPC-DI Throughput	TPC_DI_RPS	1	TPC_DI_RPS	16-20 pt. Bold
Scale Factor	Scale Factor	1		16-20 pt. Bold
Price/Performance	$/TPC_DI_RPS	$0.01	$/TPC_DI_RPS	16-20 pt. Bold
Availability Date	System Availbility Date	1 day		16-20 pt. Bold
Total System Cost	3 yr. Cost of ownership (See Clause 7)	1	$	16-20 pt. Bold

10.3.2.2 The second section of the page must contain a performance summary of the phases of the measured run in tabular format. The table must have the following columns: “Rows Processed”, “Elapsed Time”, and “Throughput”, and have rows for the three phases of the measured run (“Historical Load”, “Update 1”, and “Update 2”).

10.3.2.3 The next section of the Implementation Overview shall contain a synopsis of each of the SUT’s major components, including:

Functional Scope (e.g. Staging Area, Data Integration, Data Warehouse);

Software, including both O/S and Tool(s);

Storage, including total space and redundancy level;

Processors/Cores/Threads

Memory [GB].

10.3.2.4 The final section of the Implementation Overview shall contain a diagram of the various SUT components, including quantity and model of processors, memory, and storage.

10.3.3 Pricing Spreadsheet

A pricing spreadsheet must be included in the executive summary. Refer to the TPC-Pricing specification for spreadsheet requirements.

Logo	My Super System	TPC-DI 1.0.0 TPC-Pricing 1.6.0 Report Date: July 4, 2017

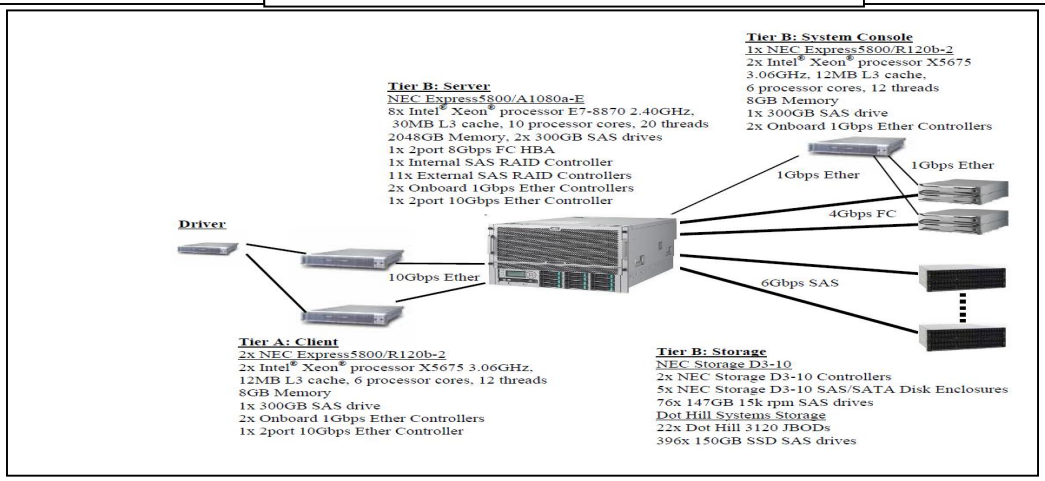
Scale Factor 100,000	TPC-DI Throughput 12,345 TPC_DI_RPS	Data Warehouse Class OPEN class
Availability Date July 7, 2017	Price/Performance $123.45 USD per TPC_DI_RPS	Total System Cost 12,345.67 USD

Performance Summary

	Rows Processed	Elapsed Time	Throughput
Historical Load	123,456 (R_H)	12:34:56(E_H)	12,345 (T_H)
Update 1	12,345 (R_{I1})	32:10 (E_{I1})	12,345 (T_{I1})
Update 2	12,345 (R_{I2})	32:10 (E_{I2})	12,345 (T_{I2})
Overall		--- TPC_DI_RPS --->	12,345

System Summary

Functional Scope	Software		Storage		Processors/ Cores/Threads	Memory [GB]
	OS	Tool	Storage	Redundancy		
Data Integration	D	MyDI	50	Level1	8/80/160	8
Staging Area	S		5,000	Level5	1/2/2	8
Data Warehouse	D	MyDB	10,000	Level5	16/160/320	1000
Total Storage= 15,050		Total processor/Cores/Threads=25/242/482			Total Memory = 1016	



Logo	My Super System	TPC-DI 1.0.0 TPC-Pricing 1.6.0 Report Date: July 4, 2017

Pricing Summary

Description	Part Number	Pricing	Unit Price	Quantity	Extended Price	3 year Maintenance price
My Super server	2109857	12,000	1	10,000	20,000	included

Results independently audited by: Mr. Audit

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that the stated prices are not available according to these terms please inform the TPC at pricing@tpc.org. Thank you.

10.4 Availability of the Full Disclosure Report

10.4.1 The full disclosure report must be readily available to the public at a reasonable charge, similar to charges for comparable documents by that test sponsor. The report must be made available when results are made public. In order to use the phrase "TPC Benchmark DI", the full disclosure report must have been submitted electronically to the TPC using the procedure described in the TPC Policies document.

10.4.2 The official full disclosure report must be available in English but may be translated to additional languages.

10.5 Revisions to the Full Disclosure Report

10.5.1 Full disclosure report revisions may be required as specified in the TPC Policies and Guidelines document, and must be submitted using the mechanisms described therein.

10.5.2 If the Availability Date is after the Report Date of the Result and the performance of the SUT as of the Availabilty Date has decreased by more than 2% from the reported value, then the Test Sponsor is required to withdraw the benchmark result.

10.5.3 A report may be revised to add or delete Clause 9 related items for country-specific priced configurations.

10.6 Rebadged Results

10.6.1 TPC-DI results may be rebadged. For the rules governing rebadging results, see the TPC Policies.

10.7 Supporting Files Index Table

A supporting files index for all files corresponding to tasks, observations and screenshots must be provided in the Full Disclosure Report. The supporting files index is presented in a tabular format where the columns specify the following:

- The first column denotes the label of the task, observation or screenshot as required by the TPC-DI Specification
- The second column provides a short description of the file contents
- The third column contains the path name for the file starting at the SupportingFiles directory.

If there are no Supporting Files provided, e.g. in case documentation is used to fulfill the disclosure requirements then path name column must clearly identify the location of the documentation.

The following table is an example of the Supporting Files Index Table that must be reported in the Report.

Clause	Description	Pathname
Clause 2	TBD	TBD

Clause 11: Independent Audit

11.1 Overview

11.1.1 Prior to its publication, a TPC-DI Result must be audited by a TPC-Certified, independent Auditor.

11.1.2 The audit must assure that the Result is in compliance with all clauses of the effective version of the TPC-DI specification.

11.1.3 All audit requirements specified in the effective version of the TPC Pricing Specification, located at www.tpc.org must be followed. For clarity and readability the TPC Pricing Specification requirements may be repeated in the TPC-DI Specification.

11.1.4 To document that a Result passed the audit, the Attestation Letter must be included in the Report and made readily available to the public.

11.1.5 A Test Sponsor can demonstrate compliance of a new Result produced without running any performance test by referring to the Attestation Letter of another Result, if the following conditions are all met:

- The referenced Result has already been published by the same or by another Test Sponsor.
- The new Result must have the same hardware and software architecture and configuration as the referenced Result. The only exceptions allowed are for elements not involved in the processing logic of the SUT (e.g., number of peripheral slots, power supply, cabinetry, fans, etc.)
- The Test Sponsor of the already published Result gives written approval for its use as referenced by the Test Sponsor of the new Result.
- The Auditor verifies that there are no significant functional differences between the priced components used for both Results (i.e., differences are limited to labeling, packaging and pricing.)
- The Auditor reviews the FDR of the new Result for compliance. The Auditor delivers a new Attestation Letter to be included in the Report of the new Result.

Note: The intent of this clause is to allow publication of benchmarks for systems with different packaging and model numbers that are considered to be identical using the same Benchmark Run. For example, a rack mountable system and a freestanding system with identical electronics can use the same Benchmark Run for publication, with appropriate changes in pricing.

Note: Although it should be apparent to a careful reader that the FDR for the two Results are based on the same set of performance tests, the FDR for the new Result is not required to explicitly state that it is based on the performance tests of another published Result.

Note: When more than one Result is published based on the same set of performance tests, only one of the Results from this group can occupy a numbered slot in each of the benchmark Result "Top Ten" lists published by the TPC. The Test Sponsors of this group of Results must

all agree on which Result from the group will occupy the single slot. In case of disagreement among the Test Sponsors, the decision will be made by the Test Sponsor of the earliest publication from the group.

Clause 12: Definitions of Terms

Auxiliary Data Structure: Any persistent or volatile data structures used by the Data Warehouse or the Data Integration System other than the Tables defined in the Data Warehouse in Clause 3. Auxiliary Data Structures may include temporary tables or files, intermediate tables, indices on tables or caches, among other things.

Batch Date: Date value representing the date of extaction of the data being processed in each Batch.

Component: Defined in Clause 0.1.2 of the TPC Pricing Specification.

Configuration File: A configuration file is a file containing parameters and values that specify settings for a program or environment.

Data Generation Server: The server machine (or machines) used to generate the data (using DIGen). This may be a server that is not involved in running the benchmark.

Data Integration (DI) DI application: The executable form of the data transformation logic. Typically this is generated by the DI System based on the DI specification

Data Integration (DI) Server: The server machine (or machines) that supports the DI System and any Auxiliary Data Structures used by the DI System. This server is part of the SUT, including all hardware and software on the machine.

Data Integration (DI) specification: The input provided to the DI System which describes the data transformations that need to be performed.

Data Integration (DI) System: The DI System performs the moving and transforming of data described in Clause 4.

Data store: A durable repository of data. A data store may consist of one or more collections of data which may or may not be related. The data store provides interfaces for users and applications to manipulate the data. Data stores include files, and relational and non-relational databases.

Data transformation: Operations on data for the purpose of creating a new context in which processing and analysis of the data can be performed. Examples include grouping or regrouping data, combining data from different data sources, reformatting, decoding, and data value substitution.

Data Warehouse: The Data Warehouse is the set of tables defined in Clause 3 and the software that implements the concurrency controls, and the data definition, access and update mechanisms. The tables can be read using a query language or API. In this specification, the SQL query language is used to express some queries that will be performed, but other languages or APIs are allowed in cases where the Test Sponsor obtains a waiver by submitting documentation showing that the proposed queries are functionally equivalent to the specified SQL.

Data Warehouse Server: The server machine (or machines) that supports the Data Warehouse database and any Auxiliary Data Structures used by the Data Warehouse. Any

software, storage areas or devices that support the Data Warehouse or its use in the benchmark are included. This server is part of the SUT, including all hardware and software on the machine.

Data Warehouse Session: The process context capable of supporting the execution of a DDL, DML, queries, e.g. SQL 'create table' and 'select' statements.

Effective Version: The effective version of the TPC Pricing Specification is the most recent version of the pricing specification published by the TPC. The TPC Pricing Specification is available at www.tpc.org.

Extension mechanism: Functionality provided by the Data Integration System to extend the base capabilities of the DI System with reusable custom logic.

Historical Load: Execution phase of the benchmark in which the Data Warehouse is initially loaded with transformed Source Data. The Data Warehouse is presumed to be 'non-operational' during the Historical Load, i.e. only Data Warehouse Sessions directly related to performing the Historical Load are active. Historical Load is a timed phase.

Human readable text: Text using printable characters

Incremental Update: Execution phase of the benchmark in which the Data Warehouse is updated with additional transformed Source Data. The Data Warehouse is presumed to be 'operational' during Incremental Update, i.e. Data Warehouse Sessions not related to updating the Data Warehouse may be active. Incremental Update is a timed phase.

Network: If the Staging Area Server, DI Server or Data Warehouse Server are on separate machines, then the Network is whatever communication facilities are used to communicate between machines, including hardware and software. Any network equipment, network interfaces and cabling used are part of the SUT.

Note: Some statements in the specification are designated as notes for purposes of clarification. While separated from the main text for readability, notes are a part of the standard and must be enforced.

Observation: A disclosure is output obtained from the implementation of the benchmark

Part Number: Defined in Clause 0.1.2 of the TPC Pricing Specification.

Priced Configuration: Defined in Clause 0.1.2 of the TPC Pricing Specification.

Program: A program is a sequence of instructions to automate a task for a computer program.

Rationale: Rationale statements may be provided to explain design decisions related to the benchmark. Rationale statements may be used for understanding the intent of the specification, but are not part of the standard. Rationale statements are given a shaded background to clearly delineate their boundaries.

Report: The Adobe Acrobat PDF file in the Report folder in the FDR. The contents of the Report are defined in Clause 10.

Reported Throughput: The performance metric reported by TPC-DI, as specified in Clause 7.6.1.

Result: Defined in Clause 0.2.39 of the TPC Policies as follows: A performance test submitted to the TPC, documented by an FDR and Executive Summary submitted to the TPC, and attested to meet the requirements of a TPC Benchmark Standard at the time of submission.

Scale Factor: Parameter supplied to DIGen to control the amount of Source Data generated. A larger Scale Factor will produce a proportionally larger set of source data. The same Scale Factor must be used to generate all source data.

Screenshot Sequence: A screenshot sequence is an ordered list of one or more screenshots.

Screenshot: A screen shot is an image of a computer screen.

Staging Area: The Staging Area holds the Source Data, described in Clause 2, that will be read by the DI System. No manipulations are allowed on the files after they are generated or copied to the Staging Area.

Staging Area Server: The server machine (or machines) that supports the Staging Area. This server is part of the SUT, including all hardware and software on the machine.

System Under Test: The system of hardware and software components used to perform the TPC-DI benchmark operations. The System Under Test is specifically defined in Clause 5.

Source Data: Data files that are generated by DIGen or exact copies, and the data contained within. Source data is read from the Staging Area and used as input to the benchmark transformations.

Table: A data structure that is populated with data that can be read by users or applications, including the Data Integration process. A table has a structure with a name given in Clause 3 and pre-determined columns having names and defined types as given in Clause 3, and a variable number or rows depending on the number of records placed in the table. In this benchmark, tables are populated by the data integration process.

Task: A task is a configuration step

Clause 13: Definitions of Tasks to be disclosed

Clause 14: Definitions of Observations to be disclosed

The content for the appendices can be obtained from the download section of the TPC web site. The Appendices are stored in a single archive file with directories containing the supporting files for each Appendix.

Appendix A: Audit Query

The audit query is used to validate the results of a benchmark run and is contained in the file tpcdi_audit.sql

Appendix B: Batch Validation Query

The batch vaildation query is used to capture the state of the Data Warehouse at the end of a benchmark phase and is contained in the file tpcdi_validation.sql

Appendix C: Data Visibility Queries

The data visibility queries are used to verify the visibility of data during a benchmark run and are contained in the file tpcdi_visibility_1.sql and tpcdi_visibility_2.sql