TECHNICAL SPECIFICATION

ISO/IEC TS 13249-7

First edition
2013-02-15

Information technology — Database languages — SQL multimedia and application packages —

Part 7: History

Technologies de l'information — Langages de bases de données — Multimédia SQL et paquetages d'application —
Partie 7: Historique

Reference number
ISO/IEC TS 13249-7:2013(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, the joint technical committee may decide to publish an ISO/IEC Technical Specification (ISO/IEC TS), which represents an agreement between the members of the joint technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/IEC TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/IEC TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 13249-7 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

ISO/IEC 13249 consists of the following parts, under the general title *Information technology — Database languages — SQL multimedia and application packages*:

- *Part 1: Framework*
- *Part 2: Full-Text*
- *Part 3: Spatial*
- *Part 5: Still image*
- *Part 6: Data mining*
- *Part 7: History* [Technical Specification]

Introduction

The purpose of ISO/IEC 13249 is to define multimedia and application specific types and their associated routines using the user-defined features in ISO/IEC 9075.

ISO/IEC 13249 is based on the content of ISO/IEC International Standard Database Language (SQL).

The organization of this Technical Specification is as follows:

1) Clause 1, "Scope", specifies the scope of this Technical Specification.

2) Clause 2, "Normative references", identifies additional standards that, through reference in this Technical Specification, constitute provisions of this Technical Specification.

3) Clause 3, "Terms, definitions, notations, and conventions", defines the definitions, concepts, notations and conventions used in this Technical Specification.

4) Clause 4, "Concepts", presents concepts used in the definition of this Technical Specification.

5) Clause 5, "History Procedures", defines the history associated routines.

6) Clause 6, "History Types", defines the user-defined types provided for the manipulation of history.

7) Clause 7, "SQL/MM History Information Schema" defines the SQL/MM History Information Schema.

8) Clause 8, "SQL/MM History Definition Schema" defines the SQL/MM History Definition Schema.

9) Clause 9, "Status Codes", defines the SQLSTATE codes used in this Technical Specification.

10) Clause 10, "Conformance", defines the criteria for conformance to this Technical Specification.

In the text of this Technical Specification, clauses begin a new page. Any resulting blank space is not significant.

The history user-defined types and routines defined in this Technical Specification adhere to the following:

a) A history user-defined type and routine are generic to history data handling. History user-defined types and routines provide the means to record changes to the rows of a persistent base table in an SQL database, so that applications using such a persistent base table shall be completely independent of whether there is any recording of changes. This means that, when changes are to be recorded, an application does not need to be modified and its behaviour remains the same.

b) History user-defined types and routines provide the means to query the recorded changes for such a table.

c) A history user-defined type does not redefine the database language SQL directly or in combination with another history data type.

The scope of this Technical Specification is limited to support for history when there are no changes to the definition of the tracked columns of a tracked table. The following operations are not supported in this Technical Specification:

a) DROP COLUMN operation to a tracked column of a tracked table.

b) ALTER COLUMN operation to a tracked column of a tracked table except changes of the default value.

The scope of this Technical Specification is limited to support for history when a tracked table has at least one unique constraint with NOT NULL that is not modified by any ALTER TABLE statements.

If a transaction does not have an isolation level that is SERIALIZABLE, the results in the recorded history are implementation-dependent.

Information technology — Database languages — SQL multimedia and application packages —

Part 7: History

1 Scope

The ISO/IEC 13249 series defines a number of packages of generic data types common to various kinds of data used in multimedia and application areas, to enable that data to be stored and manipulated in an SQL database.

This Technical Specification:

a) defines concepts specific to this Technical Specification;

b) defines history user-defined types and their associated routines.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9075-1:2008, *Information technology — Database languages — SQL — Part 1: Framework (SQL/Framework)*

ISO/IEC 9075-2:2008, *Information technology — Database languages — SQL — Part 2: Foundation (SQL/Foundation)*

ISO/IEC 9075-4:2008, *Information technology — Database languages — SQL — Part 4: Persistent Stored Modules (SQL/PSM)*

ISO/IEC 9075-11:2008, *Information technology — Database languages — SQL — Part 11: Information and Definition Schemas (SQL/Schemata)*

ISO/IEC 13249-1:2007, *Information technology — Database languages — SQL multimedia and application packages — Part 1: Framework*

3 Terms and definitions, concepts, notations and conventions

3.1 Terms and definitions

3.1.1 Terms and definitions provided in ISO/IEC 9075-1

This Technical Specification makes use of the following terms defined in ISO/IEC 9075-1:

a) atomic

b) fully qualified of a name of some SQL object

c) identify

d) object (as in 'x object')

e) persistent

f) SQL-session

3.1.2 Terms and definitions provided in ISO/IEC 9075-2

This Technical Specification makes us of the following terms defined in ISO/IEC 9075-2:

a) distinct (of a pair of comparable values)

b) qual (of a pair of comparable values)

c) dentical (of a pair of values)

d) SQL parameter

e) structured type

f) variable-length

3.1.3 Terms and definition provided in this Technical Specification

For the purposes of this document, the terms and definitions given in ISO/IEC 13249-1 and the following apply:

3.1.3.1
contiguous periods
sequence of two or more periods, such that, for all 1<i<=n (where n is the number of periods), the begin time of the i-th period is greater than the begin time of the (i-1)-th period and is equal to the end time of the (i-1)-th period

3.1.3.2
history row
row in a history table

3.1.3.3
history row set
set of rows in a history table that represent all the changes to a single row of a tracked table

3.1.3.4
history table
table that represents values of the tracked columns of a tracked table and the period during which all the values in each row were present in the tracked table

3.1.3.5
identifier column (of a tracked table)
either the primary key or one of the set of columns defined as UNIQUE and NOT NULL

3.1.3.6
period
duration of time with a begin time and an end time

NOTE In this Technical Specification a period value is a half-open duration that includes the begin time but not the end time.

3.1.3.7
period normalization
operation that makes one or more contiguous periods into a single period

3.1.3.8
period-normalized table
table resulting from selecting one or more columns in a history table, including the column(s) corresponding to the unique constraint columns with NOT NULL of the tracked table, and applying period normalization to rows that are otherwise not distinct

NOTE Each row in a period-normalized table is formed from one or more rows of a history table with the same values in one or more specified columns that relate to a continuous period, which may either be a single period from one row or contiguous periods from many rows.

3.1.3.9
tracked column
column of a tracked table for which changes are to be recorded

NOTE The tracked columns of a tracked table shall include unique constraint columns with NOT NULL of that table.

3.1.3.10
tracked row
row in a tracked table

3.1.3.11
tracked table
persistent base table for which changes are to be recorded for one or more tracked columns

3.1.3.12
transaction timestamp
timestamp value that is within the duration of an SQL-transaction

NOTE This value is implementation-dependent, preferably corresponding to the end of an SQL-transaction

3.2 Concepts

3.2.1 Concepts taken from ISO/IEC 9075-1

This Technical Specification makes use of the following concepts defined in ISO/IEC 9075-1:

a) assertion

b) domain

c) primary key

d) query

e) role

f) SQL-client module

g) SQL-schema

h) SQL-server module

i) SQL-transaction

j) SQLSTATE

k) trigger

l) unique constraint

3.2.2 Concepts taken from ISO/IEC 9075-2

This Technical Specification makes use of the following concepts defined in ISO/IEC 9075-2:

a) applicable role

b) authorization identifier

c) default unqualified schema name

d) default catalog name

e) enabled authorization identifier

f) parameter

g) procedure

h) sequence generator

i) SQL-path

j) SQL-session context

k) transaction timestamp

3.2.3 Syntactic elements taken from ISO/IEC 9075-2

This Technical Specification makes use of the following syntactic elements (BNF non-terminal symbols) defined in ISO/IEC 9075-2:

a) <catalog name>

b) <column name>

c) <comma>

d) <constraint name>

e) <data type or domain name>

f) <delimited identifier body>

g) <delimited identifier>

h) <double quote>

i) <equals operator>

j) <identifier body>

k) <local or schema qualifier>

l) <qualified identifier>

m) <quote>

n) <regular identifier>

o) <rollback statement>

p) <schema definition>

q) <schema name list>

r) <schema name>

s) <space>

t) <table name>

u) <Unicode delimiter body>

v) <Unicode delimiter identifier>

w) <unqualified schema name>

3.2.4 Other concepts

For the purposes of this document, the concepts given in ISO/IEC 13249-1 apply.

3.2.5 Notations

3.2.6 Notations provided in ISO/IEC 13249-1

For the purposes of this document, the notations given in ISO/IEC 13249-1 apply.

3.2.7 Notations provided in ISO/IEC 13249-7

This Technical Specification uses the prefix 'HS_' for view, base table, user-defined type, attribute and SQL-invoked routine names.

This Technical Specification uses the following representation in a figure for a table that includes the column of HS_Hist of the structured type, HS_History.

<column name>	*<column name>*	⋯	*HS_Hist (HS_BeginTime, HS_EndTime)*
Column Value	*Column Value*	⋯	*(Attribute Value, Attribute Value)*
Column Value	*Column Value*	⋯	*(Attribute Value, Attribute Value)*

…	…	…	…

3.3 Conventions

For the purposes of this document, the conventions given in ISO/IEC 9075-4, ISO/IEC 9075-11 and ISO/IEC 13249-1 apply.

4 Concepts

4.1 Overview

This Technical Specification provides user-defined types and routines that enable a user to specify columns of a table to record all changes to these columns and to query recorded changes. The recorded changes include tracking information on inserts, deletes, and updates of those columns of the table.

This part does not specify the means by which recorded changes are maintained. However, the concept of a history table is introduced in this clause, and it has two roles. A history table allows the precise specification of the user-defined types and routines providing the required capabilities, and it determines the way in which the recorded changes are materialised for querying.

4.1.1 Tracked Table and History Table

A tracked table is a persistent base table for which any changes to the current values of specified tracked columns are to be recorded. A history table is a means of virtualising the recording of these changes, even though there is no requirement for it to exist as a persistent base table.

A history table consists of the column of a sequence number, the columns corresponding to all tracked columns of the tracked table and the column of the structured type for the period of a history row.

Example 1:

Tracked Table TT1

ID	Column_A	Column_B	Column_C

History Table for Tracked Table TT1

HS_SEQ	ID	Column_A	Column_B	HS_Hist (HS_BeginTime, HS_EndTime)

Example 2:

Tracked Table TT2

ID	Column_A	Column_B	Column_C	Column_D	Column_E	Column_F	Column_G

History Table for Tracked Table TT2

HS_SEQ	ID	Column_A	Column_B	Column_C	Column_D	HS_Hist (HS_BeginTime, HS_EndTime)

In example 1, the column ID is the unique constraint column of the tracked table TT1. The columns ID, Column_A and Column_B are tracked columns of the tracked table TT1.

In example 2, the column ID is the unique constraint column of the tracked table TT2. The columns ID, Column_A, Column_B, Column_C and Column_D are tracked columns of the tracked table TT2.

The value of a begin time or an end time is automatically set by the system when an insert, update, or delete operation is executed on the tracked table TT1 or the tracked table TT2.

A row in the history table, namely history row, represents the values of the columns (in example 1, ID, Column_A and Column_B, and in example 2, ID, Column_A, Column_B, Column_C and Column_D) that existed from begin time to end time. Once a begin/end time is set to a certain non-NULL timestamp value, the value will not be changed.

The value of the column HS_SEQ is a number which is generated by an external sequence generator that is defined as START WITH 1 INCREMENT BY 1. The value of the column HS_SEQ is set when a history row is inserted into a history table.

4.1.2 Concept of Transaction Timestamp

When an insert operation, an update operation or a delete operation is executed on a tracked table, the values of the tracked columns need to be recorded along with a begin time and possibly an end time for the history period. But if multiple DML operations are executed in the same SQL-transaction, these operations will occur at different times and so using CURRENT_TIMESTAMP the resulted timestamp values may vary and would not allow the multiple changes for a transaction to be related. This is an especially serious problem if more than one table is being tracked. Thus a single time for all changes within a transaction is required. This requirement is provided by the implementation-dependent transaction timestamp for an SQL-transaction.

The value of transaction timestamp is used as the value of a begin time or an end time of a history row (see Section 4.1.3 Operations on Tracked Table).

4.1.3 Operations on Tracked Table

A history table is created automatically for a tracked table by invoking the HS_CreateHistory procedure provided in this Technical Specification.

When the HS_CreateHistory procedure is invoked, a history table is initialized as follows. A history table is created and all rows in the tracked table are inserted into the history table, and the begin times of all history rows are set to the value of transaction timestamp of the execution time of the HS_CreateHistory procedure.

When an insert operation on a tracked table is executed, a history row, which corresponds to the inserted row in the tracked table, is inserted into the history table, and the begin time is set to the value of transaction timestamp of the transaction that executes the insert operation.

When an update operation on a tracked table is executed, for each row that is changed:

1) the end time of the row which has the latest begin time in the history row set for that row is set to the value of transaction timestamp of the transaction that executes the update operation, and

2) a history row which has the new values of the tracked columns for that row and the value of the transaction timestamp as its begin time is inserted into the history table.

When a delete operation on a tracked table is executed, for each row that is deleted, the end time of the row which has the latest begin time in the history row set for that row is set to the value of transaction timestamp of the transaction that executes the delete operation.