ECSQL – a text based command language for EC content

Contents

Introduction and Motivation

This paper introduces **ECSQL** as a **text-based command language** for CRUD (create, read, update, delete) operations **against ECInstances in an EC repository**.

As we move to a world where the three most important data repositories are SQLite, Enterprise databases, and cloud storage (like SQL Azure), it makes sense to think of EC as standard way to express extended metadata for a SQL repository.

A text-based command language is also advantageous in the context of portability where we'd want our users to query or edit EC data from different platforms with different languages (e.g. Java on Android). We avoid the need to port the ECQuery or command object model for each supported language.

Additionally, text-based command languages are very common used in DB APIs. Any well-used APIs to access database content uses a text based command language (SQL in fact), e.g. ADO.NET, JDBC, ODBC, SQLite, MySQL, Oracle OCI. Bentley's own eQL (for eB) is another precedent.

The first use case for ECSQL is its usage in ECDb. But ECSQL is repository agnostic and can therefore be used with any ECRepository. The long-term goal is to make ECSQL commonly available in the ECFramework, too.

The latter point is another way of expressing the original primary mission of the ECFramework of supporting repository abstraction (at a time when the three most important types of repositories were deemed to be DGN, XML, and relational databases.)

The focus of ECSQL for now is the DML portion of SQL (data manipulation language). It is still a bit in the air whether ECSQL will also support DDL (data definition language) and meta-queries (SQL to query an ECSchema).

What is ECSQL?

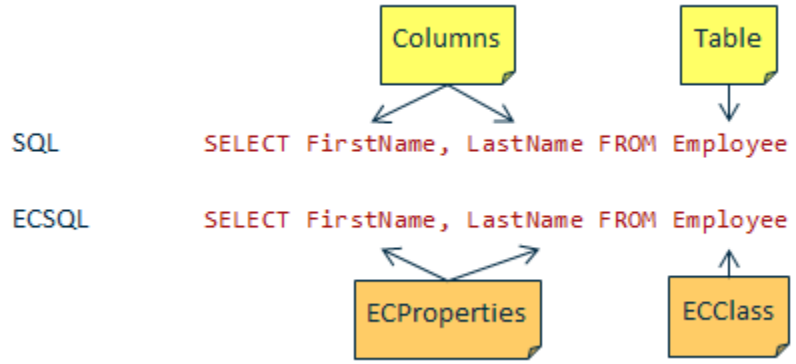
ECSQL is a **text-based command language** for CRUD (create, read, update, delete) operations **against ECInstances in an EC repository**.

ECSQL is an implementation of SQL—a proven, well-adopted text-based command language. It sticks to standard SQL (SQL-92 and SQL-99) wherever possible.

Especially the SQL-99 standard came with a lot of features ECObjects has too: boolean, date time, binary data types, structs, arrays, polymorphism. This allows ECSQL to deviate only in very few exceptions from standard SQL.

Anyone familiar with SQL should intuitively understand ECSQL.

The key difference between ECSQL and SQL is that ECSQL targets the logical schema, and not the underlying database's persistence schema.



In particular this means that ECSQL is repository agnostic (like SQL).

ECSQL in detail

This document will only list the exceptions to standard SQL and the cases where less known features of the standard are used. Standard SQL refers to SQL-92 (aka SQL 2), and to SQL-99 (aka SQL 3) whenever SQL-92 is not sufficient.

Basic data types in ECSQL

In addition to the common numeric and string data types ECSQL supports data types like date, date time, boolean and binary.

Boolean

For Boolean types ECSQL supports the literals `True` and `False`.

SQL compliance: SQL-99 with exception

Note: SQL-99 also supports the UNKNOWN literal for Booleans. This is not supported by ECSQL as there is no matching counterpart in ECObjects.

Examples

```
SELECT Prop1, Prop2 FROM myschema.Foo WHERE HasWarranty = True
SELECT Prop1, Prop2 FROM myschema.Foo WHERE HasWarranty <> False
```

DateTime

ECSQL supports `DATE` for dates without time and `TIMESTAMP` for dates with time.

SQL compliance: SQL-99 with exceptions

Note: SQL-99 also supports a TIME type (time in the day). ECSQL does not support that as ECObjects doesn't support that.
Likewise the SQL-99 features for local times and time zones are not supported because they imply implicit time zone conversions which are tricky to do right in general and portable way. Therefore time zone conversions are to be handled by the application.

Literals

```
DATE 'yyyy-mm-dd'
TIMESTAMP 'yyyy-mm-dd hh:mm:ss[.n[nnnnn]]'
TIME 'hh:mm:ss[.n[nnnnn]]'
```

Basic functions

`CURRENT_DATE`	returns the current date
`CURRENT_TIMESTAMP`	returns the current timestamp **in UTC.**
`CURRENT_TIME`	returns the current time of the day **in UTC.**

Note

This is a deviation from SQL-99 which returns a timestamp in local time. As local times can imply implicit time zone conversions which are hard to implement genericly, ECSQL chose UTC.

Examples

```
SELECT Prop1 FROM myschema.Foo WHERE LastMaintenanceDate > DATE '2010-03-31'
SELECT Prop1 FROM myschema.Foo WHERE LastModDateTime > TIMESTAMP '2010-01-01 12:00:51.123456Z'
SELECT Prop1 FROM myschema.Foo WHERE StartTime > TIME '14:15'

UPDATE myschema.Foo SET LastModDateTime = CURRENT_TIMESTAMP WHERE …
UPDATE myschema.Foo SET LastMaintenanceDate = CURRENT_DATE WHERE …
```

Points

Although there is no SQL-99 equivalent, points are a system primitive type in ECObjects and are therefore supported in ECSQL.

SQL compliance: none

In the context of ECSQL Point2d/Point3d ECProperties are interpreted as structs made up of the following system properties:

Point2d ECProperty structure in ECSQL

Property	Description
X	X coordinate of the point
Y	Y coordinate of the point

Point3d ECProperty structure in ECSQL

Property	Description
X	X coordinate of the point
Y	Y coordinate of the point
Z	Z coordinate of the point

Examples

```
SELECT ECInstanceId FROM myschema.Foo WHERE SrsOrigin.X>=3500000.0 AND SrsOrigin.Y>=5700000.0
UPDATE myschema.FOO SET Srs.Origin.X=3600000.0 WHERE ECInstanceId=?
```

Blobs

ECSQL supports the data type `BLOB` (as in SQL-99) which maps to the ECObjects type `Binary`.

SQL compliance: SQL-99

Predicates

Predicates are functions or expressions that return true or false. When used in Boolean expressions (as in the where clause), it is not needed to compare them to true or false as they return a Boolean value already. (See SQL-99)

Examples

Suppose that the ECClass `Foo` has the ECProperties `Diameter` of type double and `HasWarranty` of type boolean:

```
SELECT * FROM myschema.Foo WHERE Diameter > 0 AND HasWarranty
```

Suppose that a custom function `Contains` was defined that returns true if the first string argument contains the second string (see also section CUSTOM FUNCTIONS):

```
SELECT * FROM myschema.Foo WHERE Diameter > 0 AND Contains(Name, 'bla')
```

Note: SQLite supports that, too.

The NOT operator

`NOT` is a standard SQL keyword that negates any Boolean expression. That said, `NOT` can be used with any predicate to negate its meaning.

Examples

```
SELECT * FROM myschema.Foo WHERE Diameter > 0 AND NOT HasWarranty
SELECT * FROM myschema.Foo WHERE Diameter > 0 AND NOT Contains(Name, 'bla')
```

ECSQL Parameters

To bind values to an ECSQL statement after preparation, the following parameter placeholders are supported.

?	Refers to a parameter whose index is one greater than the previous parameter in the ECSQL statement.
:aaa	Named parameter. This allows to bind the same value to more than one placeholder.

Example

```
SELECT Id FROM myschema.Pump WHERE State = ?
SELECT Id FROM myschema.Pump WHERE State = :state OR (Material = :mat AND State <> :state)
```

Fully qualifying ECClasses in ECSQL

The class used in an ECSQL has to be fully qualified by the schema.

Syntax: `<Schema name or alias>.<Class name>`

SQL compliance: SQL-92

Note: Instead of the "." you can also use ":" as delimiter between schema and class name.

Example

Suppose ECClass Pump resides in the ECSchema OpenPlant (schema alias *op*)

```
SELECT Pump.* FROM OpenPlant.Pump
```

or

```
SELECT Pump.* FROM op.Pump
```

LIMIT and OFFSET

One way for a client to implement paging is to use the LIMIT and OFFSET clauses with an ECSQL statement.

The LIMIT clause is used to limit the number of results returned from an ECSQL statement. Using LIMIT together with OFFSET allows specifying a range of rows to be returned. The OFFSET hereby specifies the first M instances to be omitted from the result set. The LIMIT specifies the next N instances to be returned.

If the ECSQL statement would return less than M+N instances, then the first M rows are skipped and the remaining rows (if any) are returned.

Examples:
```
SELECT p.* FROM myschema.Pump p WHERE p.State = 'IsOn' LIMIT 50
```
returns the first 50 pumps of the result set.

```
SELECT p.* FROM myschema.Pump p WHERE p.State = 'IsOn' LIMIT 50 OFFSET 100
```
returns the pumps 101 through 150 of the result set.

ECRelationships in ECSQL

Defining an ECRelationship in the ECSchema primarily means to specify the ECClasses that can be related through that relationship. The two ends of the ECRelationship are called **source** and **target** constraint. See *ECObjects* documentation for details on ECSchemas and ECRelationships.

Example

```
<ECRelationshipClass typeName="PersonsOwnHouses" modifier="Sealed" strength="referencing">
    <Source multiplicity="(0..*)" roleLabel="owns">
        <Class class="Person" />
    </Source>
    <Target multiplicity ="(0..*)" roleLabel="is owned by">
        <Class class="House" />
    </Target>
</ECRelationshipClass>
```

In the context of ECSQL you can therefore think of ECRelationships as virtual **link tables**. Just like link tables they are used to relate two classes to each other. They are virtual because they do not have to exist in the underlying DB.

In ECSQL an ECRelationship has the following system properties – in addition to any other properties defined by users on the ECRelationship:

ECRelationship structure in ECSQL

Property	Description
ECInstanceId	ECInstanceId of the relationship instance (inherited from ECClass)
ECClassId	ECClassId of ECRelationshipClass (inherited from ECClass)
SourceECInstanceId	ECInstanceId of the instance on the source end of the ECRelationship
SourceECClassId	ECClassId of the instance on the source end of the ECRelationship
TargetECInstanceId	ECInstanceId of the instance on the target end of the ECRelationship
TargetECClassId	ECClassId of the instance on the target end of the ECRelationship

Note: If a navigation property is defined for an ECRelationshipClass, it must be inserted, update or deleted via its navigation property.

Examples

Returning the source and target constraints of all PersonsOwnHouses relationships translates to:

```
SELECT SourceECInstanceId, SourceECClassId, TargetECInstanceId, TargetECCClassId
FROM ONLY myschema.PersonsOwnHouses
```

Establishing a relationship between the company with ECInstanceId 12345 and the employee with ECInstanceId of 523323 translates to:

```
INSERT INTO myschema.PersonsOwnHouses(SourceECInstanceId, SourceECClassId, TargetECInstanceId,
TargetECClassId)
VALUES (12345, 1001, 523323, 1002)
```

Deleting the above relationship would be achieved by:

```
DELETE FROM ONLY myschema.PersonsOwnHouses
WHERE SourceECInstanceId = 12345 AND SourceECClassId = 1001 AND
      TargetECInstanceId = 23323 AND TargetECClassId = 1002
```

or if the ECInstanceId of the relationship was known:

```
DELETE FROM ONLY myschema.PersonsOwnHouses WHERE ECInstanceId = 31234
```

Joins

The ECSQL join support is a combination of leveraging the power of ECRelationships and the flexibility of regular SQL joins.

The key keywords are

- `JOIN`: specifies the other end point of the join, i.e. the related class ("*What to join*")
- `ON / USING`: specifies the join condition (*"How to join"*)

JOIN … ON … / Theta style

The `JOIN ON` syntax and its equivalent, the *theta* style, are the standard and general form for joins in ECSQL. The syntax is standard SQL-92 and can therefore be used without limitation.

When used in conjunction with ECRelationships, the syntax builds upon the semantics of ECRelationships being virtual link table with well-defined system properties (see above).

SQL compliance: SQL-92

Example

Taking the example ECRelationship from above, querying for "all employees of company ACME which joined the company before January 1st, 2000" would translate to the following ECSQL statement:

JOIN ON syntax

```
SELECT e.* FROM ONLY myschema.Employee e
JOIN ONLY myschema.CompanysEmployees rel
ON e.ECInstanceId = rel.TargetECInstanceId AND
   e.ECClassId = rel.TargetECClassId
JOIN ONLY myschema.Company c
ON c.ECInstanceId = rel.SourceECInstanceId AND
   c.ECClassId = rel.SourceECClassId
WHERE c.Name = 'ACME' AND e.JoinDate < DATE '2000-01-01'
```

Theta style

```
SELECT e.* FROM ONLY myschema.Employee e,
                ONLY myschema.CompanysEmployees rel,
                ONLY myschema.Company c
WHERE e.ECInstanceId = rel.TargetECInstanceId AND
      e.ECClassId = rel.TargetECClassId AND
      c.ECInstanceId = rel.SourceECInstanceId AND
      c.ECClassId = rel.SourceECClassId AND
      c.Name = 'ACME' AND e.JoinDate < DATE '2000-01-01'
```

JOIN … USING …

The ECRelationship **implies** the actual SQL join condition. In many cases it therefore is sufficient to just specify the ECRelationship instead of the rather verbose ordinary join conditions via the JOIN ON or theta syntax.

Syntax: `JOIN <joined ECClass> USING <ECRelationshipClass>`

SQL compliance: deviation from SQL-92

Every JOIN … USING … clause can be translated into a set of JOIN … ON … clauses (see examples below).

Rules

- The class in the JOIN clause is either the source or target end of the relationship class in the USING clause.
- One of all other classes (except the class in JOIN) in the ECSQL is the other end of the relationship class

This implies that

- the USING clause is dependent on the JOIN clause
  Note: This is a difference to the JOIN ON / theta syntax where the ON clause is **in**dependent of JOIN clause,
- a JOIN USING clause is never dependent on any other JOIN clause in the ECSQL (same as for JOIN ON / theta),
- the order of multiple join clauses is irrelevant (same as for JOIN ON / theta).

For more complex joins like join types other than inner joins, or joins on nested select statements, the `JOIN USING` syntax is not unambiguous anymore. In those cases, the more general form of `JOIN ON` or the *theta* style has to be used (see section JOIN … ON … / THETA STYLE).

Note on terminology: In plain SQL the **`USING`** keyword indicates that the join condition can be implied from what comes after the `USING` – here the ECRelationship class. In ECSQL the semantic is the analog, but the syntax deviates from standard SQL.

Example

Transforming the ECSQL JOIN ON example from the previous section to using the JOIN USING syntax looks like this:

JOIN ON syntax

```
SELECT e.* FROM ONLY myschema.Employee e
JOIN ONLY myschema.CompanysEmployees rel
ON e.ECInstanceId = rel.TargetECInstanceId AND
   e.ECClassId = rel.TargetECClassId
JOIN ONLY myschema.Company c
ON c.ECInstanceId = rel.SourceECInstanceId AND
   c.ECClassId = rel.SourceECClassId
WHERE c.Name = 'ACME' AND e.JoinDate < DATE '2000-01-01'
```

JOIN USING syntax

```
SELECT e.* FROM ONLY myschema.Employee e
JOIN ONLY myschema.Company c USING myschema.CompanysEmployees
WHERE c.Name = 'ACME' AND e.JoinDate < DATE '2000-01-01'
```

Resolving ambiguity in a JOIN … USING … clause

The JOIN USING syntax is a convenient shortcut for the more verbose JOIN ON syntax. JOIN USING implies that the *source* and *target* of the relationship specified in the USING clause can unambiguously be determined from all classes used in the ECSQL.
However, in some special cases, this is not possible. In those cases the ECSQL needs to specify special keywords to resolve the ambiguity.

To resolve a JOIN USING clause, an ECSQL interpreter has to **find out which of the classes in the ECSQL**

- **is the source,**
- **is the target**

in the relationship class in the USING clause.

If source and target cannot be determined unambiguously, the keywords described in the following sections have to be used to resolve ambiguity.

Note: Alternatively, the JOIN ON syntax can be used. It does not need the special keywords, as it is always unambiguous in this respect.

FORWARD / BACKWARD

If a class in the ECSQL can either be the source or the target of the relationship in the USING clause, **FORWARD** or **BACKWARD** is used to resolve the ambiguity:

- `FORWARD`: indicates that the join goes from source to target class, i.e. the **class in the JOIN clause is the target constraint** of the relationship.
- `BACKWARD`: indicates that a join goes from target to source, i.e. the **class in the JOIN clause is the source constraint** of the relationship.

Example

Assume an ECClass `Folder` and an ECRelationship `FolderHasSubfolders` relating the `Folder` class to itself:

```
<ECRelationshipClass typeName="FolderHasSubfolders" modifier=="Sealed" strength="embedding">
    <Source multiplicity="(0..1)" roleLabel="Parent">
        <Class class="Folder" />
    </Source>
```

```
    <Target multiplicity="(0..*)" roleLabel="Subfolder">
        <Class class="Folder" />
    </Target>
</ECRelationshipClass>
```

Querying the parent folder of a given folder would translate to

```
SELECT parent.Name FROM ONLY myschema.Folder parent
JOIN ONLY myschema.Folder subfolder USING myschema.FolderHasSubfolders FORWARD
WHERE subfolder.Name = 'My Documents'
```

Querying all subfolders of a given folder would translate to

```
SELECT subfolder.Name FROM ONLY myschema.Folder subfolder
JOIN ONLY myschema.Folder parent USING FolderHasSubfolders BACKWARD
WHERE parent.Name = 'My Pictures'
```

Summary: JOIN USING Resolution Logic

The resolution logic for a specific JOIN USING clause looks like this:
JOIN class: class in JOIN clause
Relationship: Relationship class in USING clause

1. Does *JOIN class* match source or target constraint of *relationship*?
   Yes: continue
   No: abort. ECSQL is invalid.
2. Does *JOIN class* match both source and target constraints?
   Yes: Is FORWARD or BACKWARD specified?
      Yes: continue
      No: abort. ECSQL is invalid
   No: continue

➔ One end of the *relationship* is resolved.

3. Do any of the other classes in the ECSQL match the other end of the *relationship*?
   Yes: continue
   No: abort. ECSQL is invalid
4. Does more than one class in the ECSQL match the other end of the *relationship*?
   Yes: abort. ECSQL is invalid.
   No: continue

➔ Both ends of the *relationship* are resolved successfully.

Ad-hoc joins

Ad-hoc joins or on-the-fly joins are not defined by an ECRelationship but by a regular SQL join condition. They are called ad-hoc because they do not require to be predefined in the ECSchema, thus can be established at any time.

For ad-hoc joins, the regular SQL join syntax can be used, e.g. `JOIN ON` or the *theta* style.

Example

Suppose there is an ECClass `City` and an ECClass `State` for which no ECRelationship has been defined. We can still join the two classes via an ad-hoc join. Querying for all cities that are located in the state of Alaska translates to the following ECSQL:

JOIN ON Syntax

```
SELECT c.* FROM City c
JOIN State s ON c.StateId = s.ECInstanceId
WHERE s.Name = 'Alaska'
```

Theta style

```
SELECT c.* FROM City c, State s
WHERE c.StateId = s.ECInstanceId and
      s.Name = 'Alaska'
```

Notes

Further features which come from standard SQL, but may not be obvious:

- As many `JOIN … ON / USING …` clauses as needed can be specified in a statement, e.g. when more than one relationship is involved
- Other SQL join features, like inner joins are implicitly available in ECSQL, too..

Navigation Properties

Navigation ECProperties are ECProperties that point to a related object.

Example

```
<ECEntityClass typeName="Employee" modifier="Sealed">
       <ECProperty propertyName="Name" typeName="string" />
       <ECNavigationProperty propertyName="Company" relationshipName="CompanyEmployees"
                             direction="Backward" />
</ECEntityClass>

<ECRelationshipClass typeName="CompanysEmployees" modifier="Sealed" strength="embedding">
    <Source multiplicity="(1..1)" roleLabel="Company">
        <Class class="Company" />
    </Source>
    <Target multiplicity ="(0..*)" roleLabel="Employee">
        <Class class="Employee" />
    </Target>
</ECRelationshipClass>
```

In the context of ECSQL Navigation ECProperties are interpreted as structs made up of the following system properties:

Navigation ECProperty structure in ECSQL

Property	Description
Id	ECInstanceId of the related instance
RelECClassId	ECClassId of the ECRelationshipClass backing the Navigation ECProperty. It is mainly relevant when the ECRelationshipClass has subclasses.

Note: Navigation ECProperties are a convenient short-cut for JOINs.

Examples

Returns the Company related to the Employee with the given name:
```
SELECT Company FROM myschema.Employee WHERE Name='Mary Smith'
```
As noted above ECSQL returns Company as a struct with the two system properties **Id** and **RelECClassId**.

Consequently, this ECSQL returns the same information:
```
SELECT Company.Id, Company.RelECClassId FROM myschema.Employee WHERE Name='Mary Smith'
```

Or if you are not interested in the ECRelationshipClass, this just returns the ECInstanceId of the related Company:
```
SELECT Company.Id FROM myschema.Employee WHERE Name='Mary Smith'
```

As navigation properties are a convenience short-cuts for JOINs the last ECSQL above can also be written with a JOIN:
```
SELECT c.ECInstanceId FROM myschema.Employee e JOIN myschema.Company c USING
myschema.CompanysEmployees WHERE e.Name='Mary Smith'
```

Structs (Embedded types)

SQL compliance: SQL-99

The straightforward operator for referencing structs, i.e. members in the structs, is the '.'. This is a known token in standard SQL for referencing columns in tables.

Examples
Selecting all plants that are located in cities that start with 'San An' translates to:
```
SELECT * FROM myschema.Plant p
WHERE p.Address.City like 'San An%'
```

Updating the ZIP code of the plant's address would translate to:
```
UPDATE myschema.Plant p
SET p.Address.Zip = 13423
WHERE p.Id = 42
```

Any nesting depth can theoretically occur:
```
SELECT c.AStructProp.A.B.C FROM myschema.MyClass c
WHERE AnotherStructProp.M.N.O.Diameter > 50.0
```

Arrays

Like structs, arrays are covered by SQL-99, but not by SQL-92. ECSQL follows the SQL-99 standard for arrays.

Type operations and Polymorphism

ECObjects supports inheritance of ECClasses and polymorphic queries. SQL-99 does so, too (SQL-92 does not). Only the subset of the SQL-99 type functionality is included in ECSQL which is considered required in the EC world. If need be, more could be added later.

Polymorphic queries

As in SQL-99 the ECSQL syntax of polymorphic queries and non-polymorphic queries is as follows:

- `SELECT * FROM myschema.BaseClass` returns all instances from BaseClass and all its subclasses.
- `SELECT * FROM ONLY myschema.BaseClass` returns all instances from BaseClass but none from its subclasses.

ECClassId Property

In the context of ECSQL each ECClass has a built-in system ECProperty called **`ECClassId`**. It refers to the ECClassId of the respective ECClass in an ECSQL statement.

It can be referenced in ECSQL like any other ECProperty of the class, too. As it is a built-in property, the property is not needed to be defined in the ECSchema.

The ECClassId property is read-only, i.e. it cannot be set or modified via ECSQL.

Note: The ECClassId (like the ECInstanceId) is implicitly included when doing a SELECT * FROM.

Examples

```
SELECT ECClassId FROM myschema.Employee
SELECT e.ECClassId, c.ECClassId FROM myschema.Employee e
       JOIN myschema.Company c USING myschema.CompanyHasEmployees rel
```

Instance identification concepts

Like in ECObjects, ECSQL provides a generic abstract concept to refer to the primary key and the foreign keys of an instance. ECSQL users therefore don't need to know what columns a primary key or foreign key is made up of in the underlying database.

ECInstanceId

The ECInstanceId is the equivalent of ECObjects' InstanceId. It is the equivalent concept of a primary key in a database.

ECInstanceId Property

In the context of ECSQL each ECClass has a built-in system ECProperty called **`ECInstanceId`**. It can be referenced in ECSQL like any other ECProperty of the class, too. As it is a built-in property, the property is not needed to be defined in the ECSchema.

Note: The ECInstance (like the ECClassId) is implicitly included when doing a SELECT * FROM.

Examples

```
SELECT ECInstanceId FROM myschema.Foo WHERE

SELECT Name, ECInstanceId FROM myschema.Foo ORDER BY Owner ASC, ECInstanceId DESC
```

ECInstanceId Data Type

The ECInstanceId can either be an integral value or a string – and implicit conversions exist between the two.

The string type is mainly there for compatibility with ECObjects (as its InstanceId is always a string) or for future cases where the primary key is not a single numeric column.

So the following statements are both valid:

```
SELECT * FROM myschema.Foo WHERE ECInstanceId = 123424
SELECT * FROM myschema.Foo WHERE ECInstanceId = '123424'
```

Note: It is up to the implementation how or whether the implicit conversion between string and number is implemented.

Functions

ECSQL supports any function call. Of course, implementations of ECSQL must provide the implementation of the functions called.

The following functions are ECSQL core functions:

- CURRENT_DATE, CURRENT_TIMESTAMP, CURRENT_TIME (see BASIC FUNCTIONS in section DATETIME)

It is up to the ECSQL implementations to provide built-in functions and/or APIs to register custom functions.
Likewise, any SQL function exposed by the underlying database can be used in ECSQL, too.

For example, all SQL functions in SQLite, whether built in or custom functions, can be used in ECSQL (see also http://www.sqlite.org/lang_corefunc.html).

Extending ECSQL

ECSQL provides a couple of extensibility points.

Custom ECSchemas

Anything that can be expressed through ECClasses or other entities of an ECSchema is implicitly available in ECSQL.

Custom Functions

Functions are a powerful mean to extend the functionality of ECSQL. As described in section FUNCTIONS ECSQL implementations can provide APIs to register custom ECSQL functions or custom functions for the underlying database. Both are immediately available in ECSQL.

Miscellaneous

ECSQLOPTIONS clause

ECSQL comes with an extension to the SQL-99 specification that allows users to append **options** to the ECSQL statement. The options are defined by the implementation. Their goal is to modify the default way of how the ECSQL statement is interpreted.

Syntax: `ECSQLOPTIONS <OptionName1>[=True|False|<Value>] [<OptionName2> [=True|False|<Value>]…]`

The option names are case-insensitive.

SQL compliance: none

Note: The options should not be necessary for most use cases and should therefore only be needed in rare and special cases where the default behavior is not appropriate.

Examples
Note, the options used in the examples are not part of the specification. The ECSQL implementation defines the options.

The following two examples are equivalent:
```
UPDATE ONLY Foo SET CreationDate=? ECSQLOPTIONS ReadonlyPropertiesAreUpdatable
UPDATE ONLY Foo SET CreationDate=? ECSQLOPTIONS ReadonlyPropertiesAreUpdatable=True
```

The following expample is equivalent to omitting the option entirely.
```
UPDATE ONLY Foo SET CreationDate=? ECSQLOPTIONS ReadonlyPropertiesAreUpdatable=False
```

Specifying multiple options:
```
UPDATE ONLY Foo SET CreationDate=? WHERE ECInstanceId=? ECSQLOPTIONS
ReadonlyPropertiesAreUpdatable NoECClassIdFilter
```