



SyncStudio
by HandApps

SyncStudio by HandApps Software

A Complete Mobile Database Synchronization Solution

User Guide

Release 3.x, June 2017

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Document Revision The SyncStudio User Manual, Rev. 3.x, supersedes all previous versions of this manual. Discard any older versions and replace with this version.

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About SyncStudio

SyncStudio is a powerful tool for mobile app developers needing to incorporate offline data with sync functionality into their solutions. With SyncStudio developers can create a complete mobile database synchronization solution in minutes rather than weeks or months.

Built atop a significantly enhanced customized version of the Microsoft Sync Framework™ SyncStudio leverages and expands this reliable SDK with unique patented technology and a user-friendly wizard style interface. With SyncStudio we have taken all the complication and tediousness out of the Microsoft Sync Framework and totally insulate the developer from having to learn anything about it. Sync configuration, database provisioning, automatic code generation, compilation, IIS Deployment, user management and more is all taken care of. Our users don't even need to know C# or how to use Visual Studio.

Completing the solution, we provide our universal sync client class libraries and the sample code developers need to get their apps synchronizing databases fast.

Currently there are SyncStudio universal sync client class libraries for Android Java, Basic4Android, Windows CE/Mobile 6.5, Windows Forms, Universal Windows Platform and Xamarin Android/iOS. Using these class libraries in your application allows you to synchronize data between SQLite, SQL Compact, SQL LocalDB, SQL Express and Microsoft SQL Server.

In addition to the above mobile sync API's are being developed and release every quarter. In the future look for SyncStudio support for native iOS (iPhone/iPad), MAC OS, PhoneGap, LINUX and more. We will also be adding support for other database servers like MySQL, Oracle, and Maria DB and other client side databases.

True Data Synchronization

SyncStudio is a full bi-directional synchronization. Unlike simple data replication or custom created REST web services; SyncStudio only exchanges new and altered records between the client and the server. This means both databases are maintained in a synchronized state with only the minimum needed bytes flowing back and forth. SyncStudio renders custom or home-built sync and custom data transfer code completely unnecessary. Change tracking is handled automatically on the server side and at the client the developer's application has full control to flag records that have been changed, created or deleted so that SyncStudio knows what to do.

Auto-Magic Client Database

The first time a SyncStudio empowered app synchronizes it will download the database schema from the server and create the client-side database file automatically. This local DB file will be complete with all the tables, fields and indexes that were defined at the server. Any server side field types that are not supported in SQLite are automatically translated to the most compatible equivalent.

During subsequent synchronizations SyncStudio will always validate the local database schema against the server. If any schema changes are detected they are automatically applied.

DB Schema Synchronization

Database structures are not static once created. They change over time as new features are added to a solution or due to customer requested modifications. Pushing these schema changes out to 10's or 1000's of mobile clients has always been a nightmare; until now.

SyncStudio delivers Database Schema synchronization out of the box. Any changes made to the database structures at the server will be automatically propagated to all the mobile clients the next time they synchronize. Best of all, these schema changes do not break the synchronization or force the user to lose un-synced data. Tables and fields can be added as needed to the App and these changes seamlessly flow to the devices when they connect. This feature alone will substantially lower the maintenance and upgrade effort required to support a mobile database application.

Large Databases Live Here

SyncStudio was built for mobile database synchronization. It fully understands the physical memory constraints of mobile environments and how to deal with them. By properly managing memory usage SyncStudio can easily sync large databases with tens or even hundreds of thousands of records.

Transaction Commit/Rollback

SyncStudio has full transactional support at the Sync session level (across multiple transmission batches) —all data changes will be applied under a single upload or download transaction, which will either succeed or fail.

Some synchronization solutions ONLY implement commit/roll-back at the batch level. Consequently, any errors during a multi-batch synchronization could leave the databases in a corrupted state. This won't happen with SyncStudio.

Class Libraries (.JAR & .DLL)

The SyncStudio solution includes a device side universal synchronization client (USC) in the form of platform specific API class libraries. Any developer that wants to build database synchronization directly into their application would add these class libraries to their solution.

Once incorporated our USC handles all aspects of the synchronization and frees the developer to focus on building his app.

Stand-Alone Sync Client

SyncStudio also includes free platform specific sample apps that can be used as stand-alone synchronization utilities. Rather than adding our Class Library into their application a developer can choose to use these stand-alone sync clients and leave his app untouched. Also, we provide source code to these apps so the developer could use it as a starting point for adding sync features into his solution. With this approach the total client-side development effort using our free sample sync clients is also zero.

The SyncStudio SMC

The SyncStudio SMC (Sync Management Console) is the Windows application where the developer creates the synchronization project. Here is where they specify the tables and fields to sync with SQLite on the devices. They can set sync direction, conflict resolution, filters and user access privileges. The SMC is an extremely easy to use (wizard like) tool that guides the developer step-by-step through the process. Its features include automated database provisioning, automated code generation and compilation of custom sync component library and automated deployment to IIS.

Sync Schema Configuration

The SyncStudio SMC allows the developer to specifically select which tables and fields he wants to sync with the device. He also has full control (without programming) to define the direction in which data will flow and how conflicts will be handled. The ability to enable data filtering on a table by table basis is also available.

Data Filtering

SyncStudio supports both simple and complex data filtering. Developers and system admins can control which records are synced to each device on a table-by-table basis.

Database Provisioning

The SyncStudio SMC automatically handles the provisioning (and de-provisioning) of the server side SQL database; making all the changes necessary for synchronization to work. The developer simply chooses the tables and fields he wants to sync with SQLite and we take care of the rest. All the needed tracking tables, triggers and other objects are added to the selected SQL DB automatically.

Code Generation

The SyncStudio SMC will automatically generate and compile the .NET code for a custom WPF Synchronization Web Service. The result is a ready to go .NET .DLL that is specific to the selections of tables and fields made by the developer. Once this uniquely created .DLL is deployed to IIS everything is ready to start synchronizing data. With the SyncStudio SMC developers have absolutely ZERO custom coding on the server-side.

Automated IIS Deployment

The SyncStudio SMC will automatically deploy the sync project to IIS. The developer simply chooses the folder where the various files will be copied to and presses one button. IIS is then configured with the appropriate virtual folder, application pool, etc. to enable synchronization.

Reporting and Logging

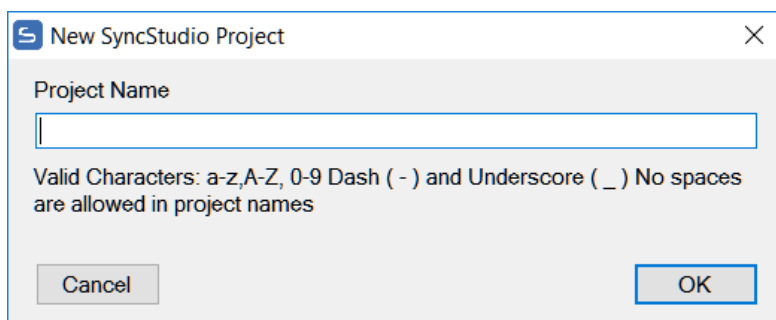
SyncStudio has a full synchronization logging feature, both at the client and the server. Using the Reporting features in the SMC the developer or system admin can review sync stats and other info.

SyncStudio Projects

To get started with SyncStudio you first create a new SyncStudio project. A SyncStudio Project defines the tables, fields and indexes that are to be synchronized between your Database Server and your mobile clients.

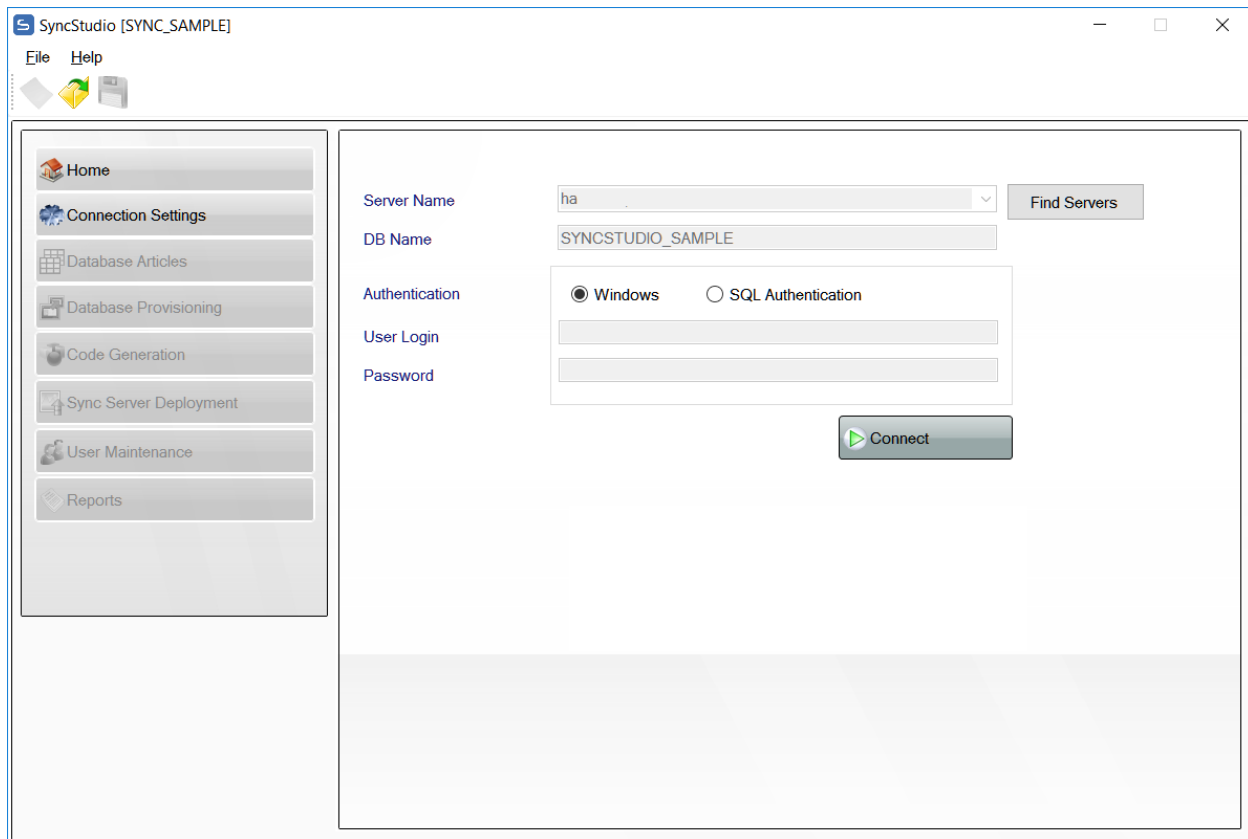


To create a new SyncStudio Project select **File → New Project** in the main menu and enter a Project Name. Project Names cannot have any spaces—use the underscore character instead of a space—and can only contain the characters a-z, A-Z, 0-9 plus the underscore character (_).



SyncStudio Projects are created under the SyncStudio Projects folder, which will be located in `\SyncStudio\Projects` (directly off the root directory of the target drive. Each Project has its own sub-directory, with the name of the directory being the same as the name of the project.

Note: You should never have two SyncStudio Projects target the same database—they will interfere with each other. You can have as many projects as you want targeting the same database **server**, though, so long as each project targets *a different database*.



Once you create your new Project you need to connect to the Database Server. To do this please select the Database Server, enter the Database Name and select either Windows Authentication or SQL Server Authentication and click on the “Connect” button.

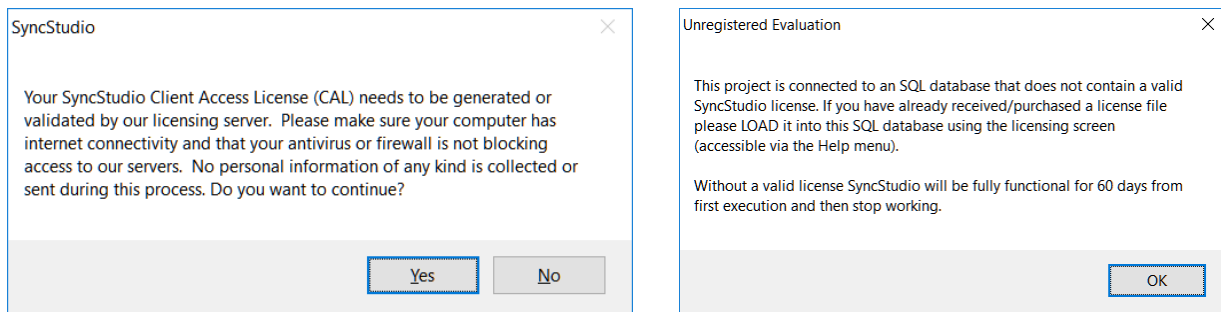
If you select SQL Server Authentication you will need the User ID and Password of your SQL Server user account. Regardless of which authentication method you select the user account needs to be able to modify the Database Schema, as we will need to add a number of tables, triggers and stored procedures to the database structures.

WARNING: PLEASE DO NOT ATTEMPT TO USE AN SQL DATABASE THAT HAS PREVIOUSLY BEEN PROVISIONED OR USED WITH STANDARD MICROSOFT SYNC FRAMEWORK. ONLY USE DATABASES WITH SYNCSTUDIO THAT ARE CLEAR OF THIRD PARTY SYNC RELATED OBJECTS OR ARE NEW AND HAVE NOT ALREADY BEEN ALTERED BY OTHER SYNCHRONIZATION TOOLS. IT IS LIKELY THAT SYNCSTUDIO PROVISIONING WILL FAIL IF ATTEMPTED WITH DB ALREADY PROVISIONED BY SOME OTHER TOOL.

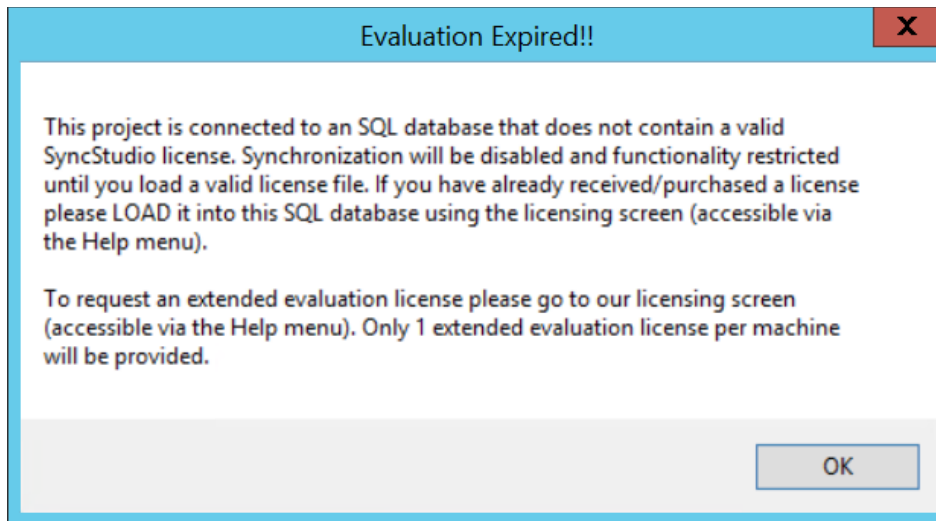
Licensing

When SyncStudio is installed on a machine for the first time it will operate as an unregistered evaluation. In this mode, synchronization will be limited to 3 mobile users for 14 days.

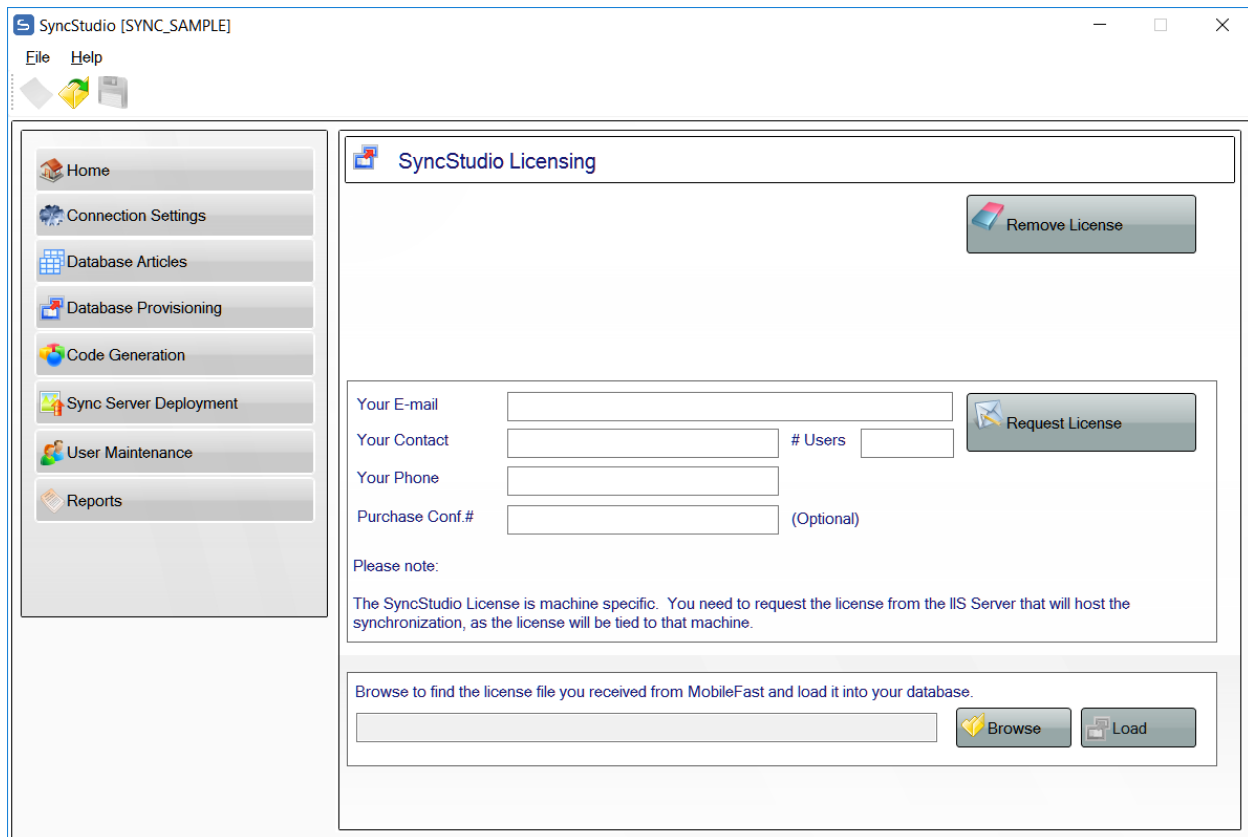
In order for SyncStudio to automatically license itself as an eval it needs to be able to access our Licensing server.



Click “Yes” to allow SyncStudio to attempt to access our license server. If connection fails or you click “No” then you will need to request an evaluation license via the Licensing Screen.



To access the license screen, click “Help” and then “Licensing”



To receive your SyncStudio License file please complete the form in the center of the screen and click “Request License”.

Note about “Your Email” -

If you have purchased a license of SyncStudio please use the same email address you used with the purchase. Otherwise we will not be able to match up the request to a purchase and won’t be able to send a license. Please contact us at sales@handapps.com for prices and purchase options.

Note about “Purchase Conf. #” -

If you have already purchased your license of SyncStudio then you will have received an email confirmation. Depending on if you purchased at our website or from a partner the format of the email might be different. Find the Confirmation number or invoice number and enter it in this field. If you can’t find it, no worries, we’ll figure it out using your email address.

Note about the License File -

The SyncStudio license file is generated on a machine by machine basis. It is specific to the machine for which it is created and will not work on any other machine. Please only perform the “Request License” from the machine which will be used for synchronization with the devices. In other words, the machine / server that will be running Internet Information Server (IIS) and hosting the SyncStudio sync web services.

If in the future, you need to change the machine that is hosting the sync then you will need to request a different license file and the current license will be disabled. SyncStudio licenses are created specific to:

- The machine
- The number of users
- The SQL Server
- The number of SQL databases being synced within the same server
- For a fixed period of time or perpetual.

It is a requirement that the machine hosting the sync services have an Internet connection so that SyncStudio can perform license validation.

Database Sync Configuration

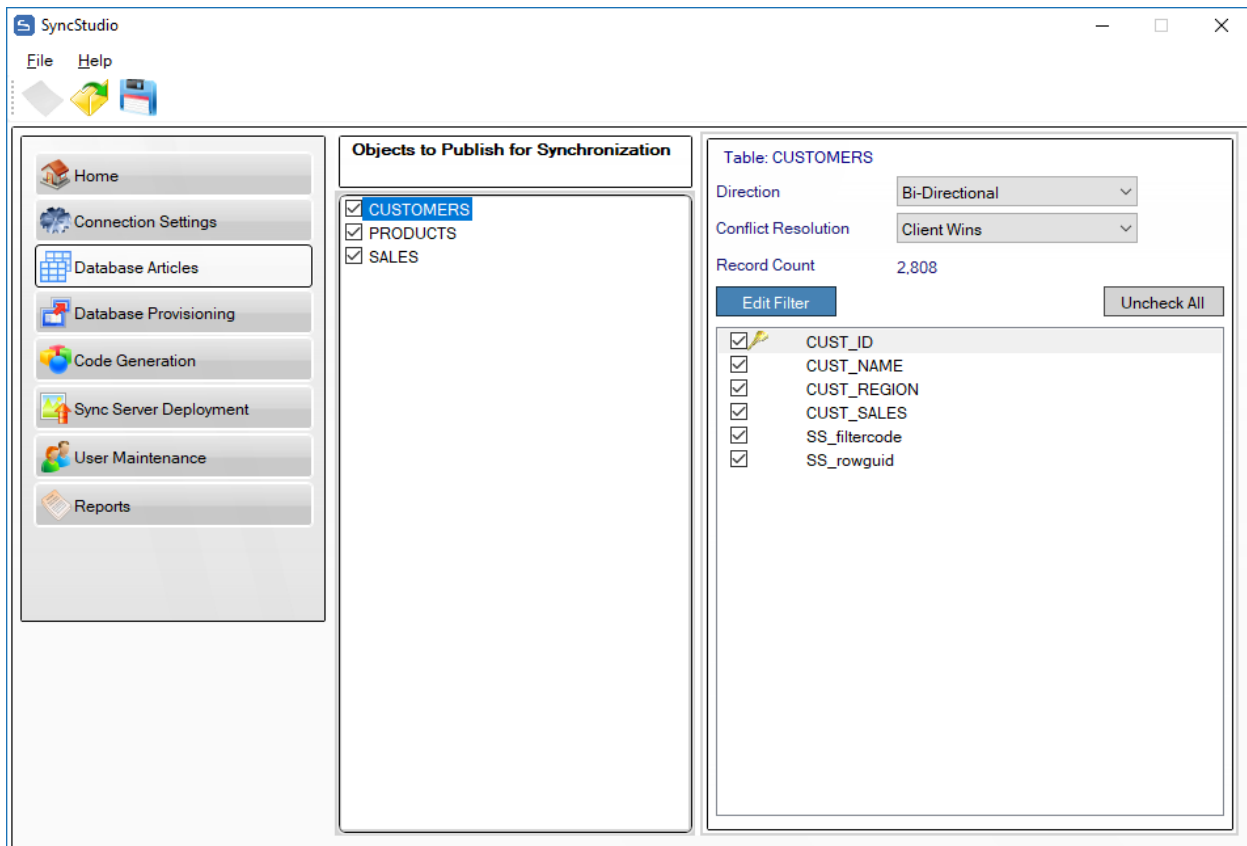
SyncStudio has allows you to select which tables and fields will be synchronized. This information is saved into your Sync Project file. When you select the Database Articles tab on the left-side menu you will see a list of the tables in the database. Select which tables need to be synced by checking them off, as shown in the figure.

By default, when you select a table for the first time only the primary key fields will be selected. You then use the right-hand panel to select additional fields or Check All.

PLEASE NOTE

SyncStudio requires you add the field SS_rowguid to any table that you intend to sync with the client application. The following SQL script can be used to automatically create the ALTER command for each table in your DB.

```
SELECT 'ALTER TABLE ' + T.name + ' ADD SS_rowguid UNIQUEIDENTIFIER DEFAULT newid() NOT null' FROM sys.tables AS T where t.name not like 'SyncStudio%' and t.name not like '%_Tracking' and t.name not like 'scope%' and t.name not like 'schema_info'
```



When you try to leave this section of SyncStudio you will be prompted to save your changes.

Important Notes:

- 1) You **cannot** synchronize a table that does not have a primary key. Tables that do not have a primary key will be shown highlighted in red in the SyncStudio and you will not be able to select them for synchronization.

Please note that having a unique index or a unique constraint is **not** the same thing as having a primary key—if you do not have a primary key the sync will fail, regardless of whether you have unique indexes or constraints or not.

- 2) You do not have to synchronize all the fields in a table, but you **must** synchronize all the fields that make up the primary key. Failure to follow this rule will cause the sync to fail. The same thing goes for any fields that are part of any Index that is being synchronized: you have to synchronize every field that is part of an index that is being synchronized, otherwise the client will not be able to create and maintain the index and the sync will fail.
- 3) Please keep in mind that fields that are **not** selected for synchronization will **not** be present in the client-side table. The client-side version of the tables will have **only** the fields that you select for synchronization in the SyncStudio. Your client-side application needs to know which fields are present in the client-side version of your database.
- 4) Fields that are **not** selected for synchronization should **always** either allow null values or provide a default value for the field or the sync will fail. The reason is that whenever a new record is created at the client and uploaded to the server the client will not be providing values for fields that are not being synced. If you do not allow nulls and do not provide a default value for the field this will trigger a server-side error and abort the sync.
- 5) Client-side data types are **not** guaranteed to be exactly the same as their Server-side equivalents. The reason is that in client-side database systems such as SQLite the set of supported data types will, in general, be very different from the MS SQL Server equivalent. SyncStudio will attempt to find the closest match for each field that is being synchronized, though. For example, all the Integer data types in MS SQL Server will be mapped to the Integer data type in SQLite, regardless of the length of the server-side field; likewise, all the floating-point numeric data types in MS SQL Server will be mapped into the SQLite Real data type, and all character strings in SQL Server will become TEXT data types in SQLite.
- 6) Special data types like geometry and geography can be synchronized. However, timestamp cannot be synchronized as this is a non-editable field data type. You will not be able to select any data type that cannot be supported. In any event, most of the client-side databases such as SQLite simply have no equivalents for these special data types other than storing them as binary objects (blobs).
- 7) Views **cannot** be synchronized.
- 8) Triggers and Stored Procedures are **not** synchronized.

- 9) Foreign keys are fully supported. During database provisioning please be sure to set the sync order for each table so that a child is not inserted before a parent.
- 10) A table cannot have a field that contains the name of the table. For example, a table called "TYPE" cannot have any fields that begin with TYPE. The same thing applies for a primary index that contains the name of the table. Sorry.
- 11) Table names, Field names and Index names **cannot** contain any of the following special characters:

~ ! @ # \$ % ^ & * () { } / ; ' " | \

Please note that some of these characters, \$ for example, are perfectly valid in field names for many database systems, such as MS SQL Server. However, they cannot be used in table, index or field names that are intended for synchronization.

If you have used any of these characters in your database table schema or field names and you need the table synchronized then you really have only two choices: if you have control over the database structures you can always rename the table and/or fields to use only legal characters; otherwise, for tables you could create a "parallel" table with a valid table name, use a trigger to keep the two tables aligned and synchronize only the new table.

You could also do something similar with invalid field names, where you create an additional field in the same table but with a valid name and then use a trigger to copy any changes from the invalid field to the new valid one.

Regardless of the strategy used you need to keep in mind that this is a hard limitation, as invalid table and/or field names will cause your synchronization to fail. The SyncStudio user interface will try to prevent you from selecting tables and/or fields with invalid names whenever possible.

- 12) Tables can be marked as Upload-Only, Download-Only or Bi-Directional (both Upload and Download). The default is Bi-Directional, where any changes in the server will be sent to the client and vice-versa.

Upload-Only tables are meant to be used to collect data from the clients but not to send or replicate any server data back to the client device.

Download-Only tables are meant for data that should never be changed at the client. Some examples of common download-only tables are tax rates and tables with codes, which the client needs to use but should not be able to change.

For all the obvious reasons your client-side code should always be written so as to not allow any changes to download-only tables, to avoid confusion and the possibility of data-dependent errors that are very hard to reproduce and debug.

- 13) Any time that you make changes to either the database structure or to the tables and fields that need to be synchronized you must re-provision your database. There is a complete section of database provisioning later in this document. Please read it carefully, as the provisioning process has the potential for affecting both your application and your users.
- 14) For every Synchronization Project SyncStudio creates a binary file with a .dbp extension that contains all the information about your project configuration. The configuration file is not human-readable; please do not attempt to make any changes to this file outside of SyncStudio—otherwise your project will fail to load.

Database Provisioning

SyncStudio requires that you “Provision” your database for sync operations. Provisioning adds a tracking table to each table that is selected for synchronization, plus a number of triggers and stored procedures.

SyncStudio

File Help

Home

Connection Settings

Database Articles

Database Provisioning

Code Generation

Sync Server Deployment

User Maintenance

Reports

Database Provisioning

Status: Database provisioned.

Provision [haazure1,61395.SYNCSTUDIO_SAMPLE]

De-Provision [haazure1,61395.SYNCSTUDIO_SAMPLE]

Settings

Sync Order

Process Timeout (seconds)

60

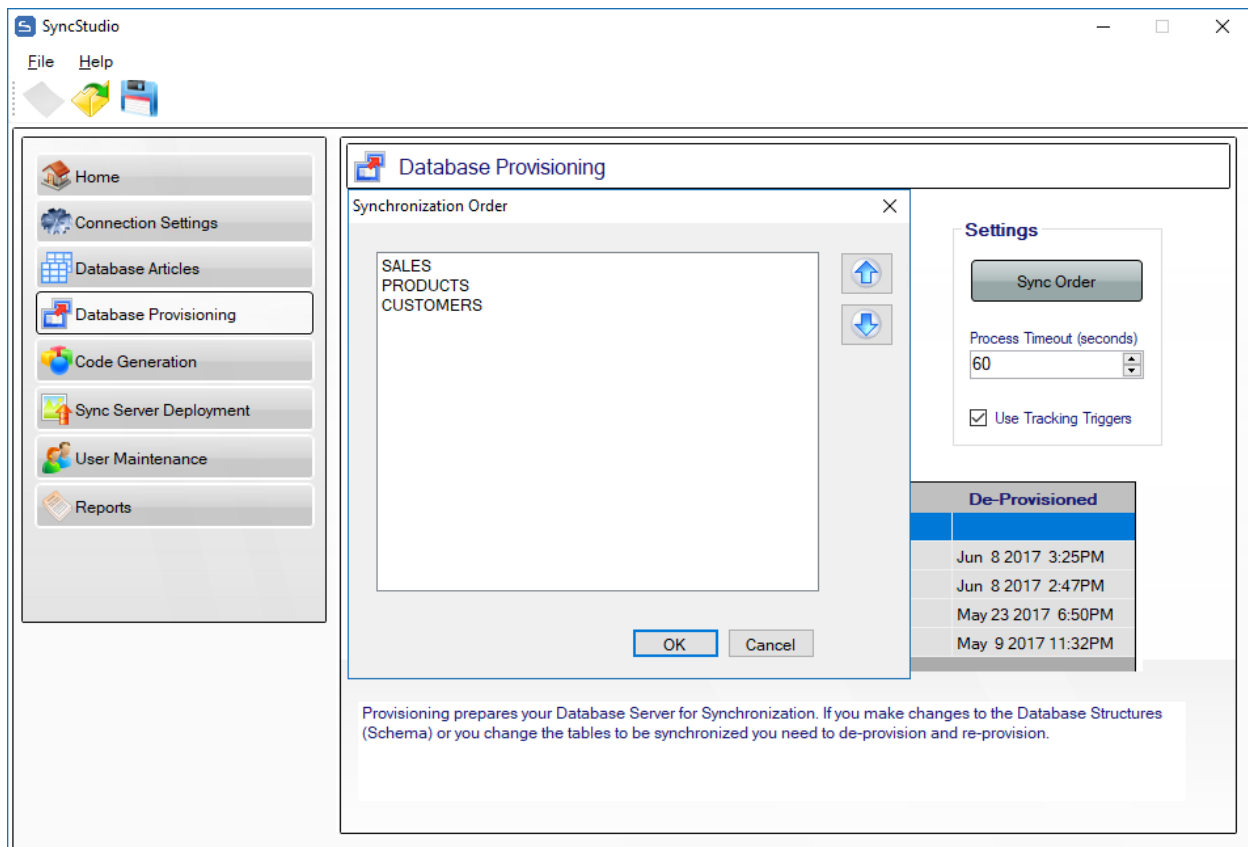
☒ Use Tracking Triggers

Gen.	Provisioned	Active	Project	De-Provisioned
4	Jun 8 2017 3:27PM	<input checked="" type="checkbox"/>	SYNC_SAMP	
3	Jun 8 2017 2:47PM	<input type="checkbox"/>	SYNC_SAMP	Jun 8 2017 3:25PM
2	May 23 2017 6:50PM	<input type="checkbox"/>	HA	Jun 8 2017 2:47PM
1	May 9 2017 11:32PM	<input type="checkbox"/>	SYNC_SAMP	May 23 2017 6:50PM
0	May 9 2017 11:26PM	<input type="checkbox"/>	SYNC_SAMP	May 9 2017 11:32PM

Provisioning prepares your Database Server for Synchronization. If you make changes to the Database Structures (Schema) or you change the tables to be synchronized you need to de-provision and re-provision.

Foreign Keys

If you selected any Database Articles that have Foreign Key's, then before Provisioning the database you MUST review and confirm the Sync Order of the tables. Click the “Sync Order” button to open the control.



You must carefully arrange the tables in the correct sync order so as to not cause a foreign key violation during the sync process. If none of your tables have foreign keys then the sync order does not matter. However, if you have foreign keys then, for example, a new child record cannot be inserted before the corresponding parent record is inserted first. Be sure you understand the foreign key relationships between selected tables so you can properly set the sync order. Click on a table then use the arrow keys to move it up or down into the order you want.

When done click OK.

Use Tracking Triggers

In SyncStudio version 3 we introduced the option to automatically create change tracking triggers on the client side database. In order to maintain backward compatibility, we do not enable this feature by default. For new SyncStudio projects we strongly recommend enabling this feature. With this feature on the client database will be fully cable of detecting inserts, edits and deletes without the developer needing to make any codes changes.

Process Timeout (seconds)

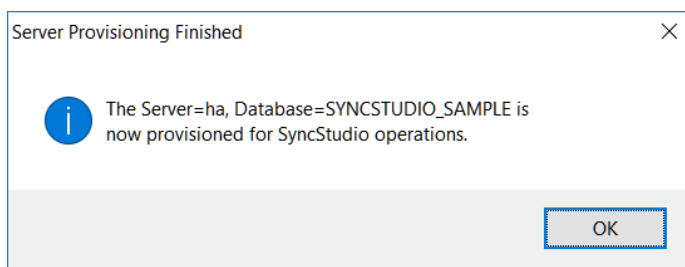
The provisioning of a database with lots of tables or where tables contain considerable amounts of data will naturally take longer than when the database is small with little data. In order to avoid the possibility of an SQL time due to inactivity you have the option of increasing the time out interval. Sixty seconds is usually good for most cases but if more is needed you can increase it here before trying to provision the database.

The Database Provisioning Process

When you are ready to provision your database as per the selections made under Database Articles click the Provision button.

WARNING: PLEASE DO NOT ATTEMPT TO USE AN SQL DATABASE THAT HAS PREVIOUSLY BEEN PROVISIONED OR USED WITH STANDARD MICROSOFT SYNC FRAMEWORK. ONLY USE DATABASES WITH SYNCSTUDIO THAT ARE CLEAR OF THIRD PARTY SYNC RELATED OBJECTS OR ARE NEW AND HAVE NOT ALREADY BEEN ALTERED BY OTHER SYNCHRONIZATION TOOLS. IT IS LIKELY THAT SYNCSTUDIO PROVISIONING WILL FAIL IF ATTEMPTED WITH DB ALREADY PROVISIONED BY SOME OTHER TOOL.

SyncStudio will start processing and making the needed changes to your database. When it's done, it will display the following.



Provisioning prepares your database for synchronization by adding change-tracking tables and the metadata that is required to manage the synchronization process in the form of metadata tables, triggers and stored procedures. After provisioning, every table that is selected for synchronization will have a companion tracking table, plus a set of triggers and stored procedures. SyncStudio has a Database Provisioning feature to simplify the provisioning and de-provisioning of your database, but as a developer you need to be very much aware of the issues involved in re-provisioning databases, particularly large ones. This topic is covered in full this section and you should read it carefully because it may have an impact in your application and your user experience.

The basic concepts that you need to consider are that whenever you make changes to your data structures you will have to first de-provision the database, make whatever changes are needed and then re-provision your database; that de-provisioning and re-provisioning a database is an all-or-nothing process, and that you cannot re-provision a database that is already provisioned—it needs to be de-provisioned first.

You can provision and de-provision a database as often as you need to. However, this is not something that you want to do without understanding the process or consequences. When a database is de-provision it *loses any memory* of the state of the clients and all tracking table information. That means that when the clients sync after a de-provision/re-provision cycle SyncStudio **must** resend **all** the records again, as it does not know which records need to be synced. Essentially, de-provisioning and re-provisioning a database is something that should **only** be done when there are changes to the database structure or filters of tables that are being sync'd via SyncStudio.

Tip: some developers add a number of “reserved” fields and even whole tables to their database structures on the first release of their product, **set them to synchronize** but leave these fields blank or null. So long as you **do not** change the field names, lengths or data types you can then use them later for enhancements, new features, etc. without having to de-provision and re-provision the database.

If you change the schema of your database (i.e., if you add, change or delete tables, fields or indexes) you **must** de-provision and re-provision the server, but **only** if the changes apply to tables that are being synchronized. Adding, changing or deleting tables that are not being synchronized (and which you do not need to synchronize) does not require a de-provision/re-provision cycle.

If you change the tables and/or fields that are being synchronized, you **have** to de-provision and re-provision the database—even if the database structure itself has not changed—and you **must** re-generate and re-deploy the server-side code. Failure to follow this rule will almost certainly break the synchronization process, as the database structures will no longer correspond to the server-side code. Your data should still be protected because of the full transaction support in SyncStudio, but you are running the risk that some synchronization sessions **may not fail** even if the database structures have changed, because of data-dependent factors. To repeat: if you change the database structures or if you change which fields and/or tables are being synchronized you have to de-provision, re-provision, re-generate and re-deploy the server side code.

When you de-provision, change the structure of your database and then re-provision the database using the new database schema you **do not** have to manually make the same modifications on the client side. SyncStudio has an Automated Schema Synchronization feature that will take care of this for you, providing that the changes that you made to the database schema do not break the synchronization. There is a more complete description of which changes will break synchronization in the next section below.

We are aware that some developers do try to manually change the table structures and synchronization-related stored procedures on the server side to avoid having to de-provision a database for minor changes. In our opinion this is such a dangerous process and so prone to failure that we cannot recommend it. SyncStudio has been designed with a Database Schema Synchronization feature precisely to simplify the task of upgrading your database to support new fields and features in your code. Please note that support for problems in a database in which the synchronization data structures and/or stored procedures have been manually altered will be a billable service.

Automatic Schema Synchronization

SyncStudio has a fully automated Database Schema Synchronization feature. Any changes that you make to the server’s database structures will be propagated to the clients the next time that they synchronize their devices.

If the changes that you make to your database structures do not “break” the synchronization process—more on this below—the changes will be handled transparently. However, please do keep in mind that any changes to the server database schema will **always** require a de-provisioning and re-provisioning cycle, which will force your clients to perform a full download.

Avoiding changes that break synchronization

Most changes to your database structure will not “break” the synchronization process. The following kinds of changes **do not** break the synchronization and will be handled transparently by the SyncStudio Schema Synchronization process:

- 1) Add a new table or set an existing table to be synchronized that was not being synced before. In this case the client will first create the new table structure and then download the appropriate records from the server as defined by your data filtering configuration for the table.
- 2) Delete an existing table or change a table that is being synchronized so that it will no longer be synced. The client-side software will automatically delete the client-side table. Please note that in this case any “dirty” or new records that might exist at the client will be lost (silently, the user will not receive any messages). This is necessary because when you drop a table from the sync there will no longer be any code on the server side to receive the changed records from the client.
- 3) Add a new field to a table. This change will not break the synchronization process **providing** that you either allow nulls or that you define the default value for this field.
- 4) Increasing the length of a string-type field.
- 5) Delete an existing field from a table or stop synchronizing an existing field. In this case the client-side table will be modified to omit the field. As with table deletions, whatever data existed in the deleted field will be discarded at the client, including data that had changed at the client but had not yet been sent to the server. The change will be done silently—the user will not be informed or receive any messages.
- 6) Add a new Index to a table. The client-side code will add the new index.
- 7) Delete an existing index from a table. The client side code will delete the index.

Some changes will “break” the automated Database Schema synchronization process, however, and you should always try to avoid making these changes:

- 1) Changing the data type of a field. Changing from a string to a numeric, for example, will likely break the synchronization process. SyncStudio **does not** attempt to perform automatic type coercion. If you absolutely need to change the data type of a field the best solution is to first have all your clients sync, then stop the service, de-provision the database, create a new field with the correct data type and convert the data **yourself**, re-provision the database, re-create the server-side code, re-deploy and restart the service and finally have all the clients sync again so that they get the updated data structures and the converted data. While this might seem somewhat involved it is still much less effort than having to manually convert all the clients, as would be the case with a standard Microsoft Sync Service solution.

- 2) Reducing the length of a string-type field at the server to the point where it is too small for data that is **already** at the client. This will fail at the server-side on a future sync if the record that has the long string is marked as “dirty”. Please note the following: In SQLite, there is no concept of a fixed-length string/text field; string fields can hold string data of any length, regardless of the nominal “size” of the field. Server-side databases like MS SQL Server, however, do have the concept of fixed-length string fields. If you use fixed-length strings at the server side—perhaps the most common database design ever! —**your** client-side application is responsible for making sure that the user does not enter strings that are too long for the server-side field.
- 3) Changing the name of a field may cause problems or not, but it is data-dependent. In this situation, the client-side software will interpret the change not as a rename but as the deletion of the old field plus the addition of a field with the new name—in other words, you will lose the contents of the old field at the client, and the new field values will be nulls, which is probably **not** what you wanted when you renamed the field. If you **really** need to change a field name the best alternative is to first have all your clients sync, then stop the service, de-provision the database, add a new field to the table with the desired name, copy the old values to the new field **yourself**, delete the old field on the server, re-provision the database, re-generate the server code so that it will understand the new field name, re-deploy the service to IIS and then have the clients re-sync.
- 4) Adding a new field to a table or choosing to synchronize an existing field that was not synced before will fail if the field **does not** allow null values and does not provide a server-side default.

Stranded Client Records

Whenever a SyncStudio client performs a synchronization the very first thing that happens is that we have the client compare the data structures at the server with those already at the client. If the data structures are different the client will **attempt** to synchronize the client-side data structures (the Database Schema) with those of the server. If your changes are such that they do not “break” the synchronization, then the following sequence of events will take place under a transaction:

- 1) The client will download the new data structures from the server.
- 2) The client will “save” the contents of any existing tables that have changed—tables that have no changes are not affected—but only if the tables have either “dirty” deleted or new records. Tables that have changed at the server but where the client does not have any un-synced “dirty” records do not need to be saved.
- 3) The client will then create the new tables, fields and indexes for the tables that have changed so as to replicate the same structures received from the server.
- 4) The client will then **attempt** to insert the “saved” records into the new (empty) data structures. As we mentioned before, this will **only** work if your changes are such that

they do not “break” the synchronization. If this process works then the client side ends up with the old data in the new structures, including the “dirty” flags. If the process fails, the client will **attempt** to roll-back the transaction and abort the sync. Please note that not all client-side databases have full support for rolling back changes to data structures, so this feature works on a “best efforts” basis. Again, the best way to avoid this type of issue is to make sure that your database schema changes do not break the synchronization.

- 5) If everything works and the Schema Synchronization phase completes without errors the client will then upload the changed records to the server and commit the transaction. If the upload fails, either because of a communication error or because of a server-side error the client will attempt to roll-back the transaction and the entire sync will fail.
- 6) If the upload completes without errors then the client performs a complete download of all the server records, still under a new transaction—this is required because in order to change your database schema you first had to de-provision the server, which causes it to “forget” all knowledge about the state of the clients.
- 7) Finally, if the download completed without errors the client commits the transaction; otherwise client side changes caused by the server are rolled-back and the sync fails.

Reading through the description above you will understand that the possibility exists of having “stranded” records at the client, which explains the title of this section. Stranded records can happen if you make changes to your database structures that break the synchronization process, and where there are either new records or “dirty” records at the client—still in the old data structures—but where the automated Schema Synchronization process is unable to convert the old records to the new data structures.

Preventing Schema Synchronization Errors

For all the obvious reasons, you should always try to architect your schema changes so as to not break the synchronization process. Aside from following the rules above, a really good way to ensure that the changes will work is to do the following:

- 1) Create a copy of the table that is being modified in your development database. For this example, we will assume you have a table called “TEST” that has three fixed-length character fields: FIELD_1, FIELD_2 and FIELD_3. In your server, you will create a new empty table called “TEST_2” with the same structure plus a new field called “FIELD_4”. Make sure that FIELD_4 either accepts null values or it has a default value defined.
- 2) Run the following SQL Statement in your server:

```
INSERT INTO TEST_2 (FIELD_1, FIELD_2, FIELD_3) SELECT FIELD_1, FIELD_2, FIELD_3
FROM TEST
```

From the statement, above you will see that we are inserting the old records into the new structure. The fields in the INSERT part of the statement need to be only those that are present in both the old and the new data structures; the fields of the SELECT part of the statement follow the same rule. If this statement works in your development server you should be

reasonably safe in making the schema change, providing that there are no data-dependent errors that happen at run-time because of issues such as different field lengths between the two data structures, for example—those you will have to analyze yourself.

You can test deleting a field, for example, with a statement like:

```
INSERT INTO TEST_2 (FIELD_1, FIELD_3) SELECT FIELD_1, FIELD_3 FROM TEST
```

Notice that we left FIELD_2 out. This simulates deleting FIELD_2 from the new table structure.

Some Notes about SQLite

If your client-side database is SQLite (such as in Android, iOS, Win Phone and even Universal Windows Platform clients) please remember that the data typing rules of SQLite are **very** different from those of MS SQL Server. SQLite has a very interesting feature that lets you store **any** type of data into **any** field, **regardless** of the “nominal” field type. Additionally, SQLite has no concept of “fixed” field length for strings, and will do automatic modification of data types as required.

Finally, one more warning about SQLite: this database program has a number of **HARD LIMITS** that need to be respected:

- 1) Maximum number of columns in a table is 2,000. This one is not too bad, as anyone that has more than 2,000 columns in a table should have their head examined. However, if you are considering using a table with many fields, let's say 1,000 or so, please keep this in mind:
“There are places in the SQLite code generator that use algorithms that are $O(N^2)$ where N is the number of columns [...] so with a large number of columns SQLite will run **very slowly**” (see <http://www.SQLite.org/limits.html>)
- 2) Maximum length of a record is 1 Megabyte. This is a bad one, because there are many situations in which you have text/blob type fields where the user supplies some unknown, but possibly large, amount of text or binary data—e.g., images—which will make the SyncStudio client **fail** if the 1 Megabyte limit is exceeded. Please note that this has nothing to do with us, it is a limitation of SQLite that we have **zero** control over. The bottom line is that you have to prevent any situation in which a single row can be longer than 1 Megabyte **yourself**.
- 3) SQLite does not have direct support for date data types (for more information please see <http://www.SQLite.org/datatype3.html>). In SQLite dates, can be stored in one of three ways: as ISO8601 strings (“YYYY-MM-DD HH:MM: SS.SSS”), as Real numbers or as Integers. SyncStudio treats dates as strings, which is the most general representation and allows the largest range of date values—both real and integer representation of dates support only a restricted range. However, if you are going to manipulate or create date values in your client side code you need to ensure that your date strings contain a valid date value in the ISO8601 format (YYYY-MM-DD HH:MM: SS.SSS) to avoid triggering synchronization errors (for more information on the ISO8601 standard please see http://en.wikipedia.org/wiki/ISO_8601). Please note that SyncStudio automatically performs the conversion from the MS SQL Server date data types into the ISO8601 string format and back—you simply use date data types at the server and the ISO8601 string date data types at the client.
- 4) SQLite does not have a Boolean data type. In SQLite, Boolean values are stored as integers, with zero being false and one being true. In SyncStudio we automatically convert the MS SQL Server bit data type to an integer (0=false, 1=true) and back into a bit value for the upload.
- 5) SQLite does not have a data type equivalent for the MS SQL Server **uniqueidentifier** data type (a unique id). In SyncStudio **uniqueidentifier** fields are stored as text.
- 6) A number of special MS SQL Server data types are not supported for synchronization. This limitation is generally imposed by the Microsoft Sync Framework rather than SQLite.

Examples of data types that cannot be synchronized are: geography, geometry, hierarchyid. In any event, these data types have no direct equivalent in SQLite.

- 7) MS SQL Server and other database systems have a rich set of numeric data types for both integer and real numbers. SQLite has only one Integer data type and one Real data type. On the client side SyncStudio will convert all the MS SQL Server integer data types to SQLite Integers and all the data types that can have decimals to SQLite Reals. However, please keep in mind that in SQL Server the various Integer and Real data types have different lengths, and therefore different ranges of valid values. In SQLite Integer fields are stored as 8-byte Long Integers and Real values are 8-byte IEEE floating point numbers. There is simply nothing in SQLite that will stop you from storing a 10-digit number, for example, into a field that is defined as a one-byte “tinyint” data type on the server side, which accepts only integer values from 0 to 255. When you try to upload this 10-digit value SQL Server will most definitely stop you, though—and the sync will fail. The same thing applies with all the other numeric data types—**you** are responsible for keeping track of the minimum and maximum allowed values for every field on the client side.

Tip: developers that have control over their server-side data structures might decide to minimize this issue by using only bigint (8-byte Integers) and either the real or float data types at the server. Developers that do not have control over their server-side data structures will spend long days coding the necessary data validation and very long and anxious nights debugging obscure—and entirely avoidable—data-dependent sync problems.

- 8) SQLite allows you to store any data type into any field, regardless of the “nominal” data type of the field, and will perform automatic type conversions as required. The automatic type conversion rules in SQLite have been very, very carefully crafted so as to maximize the uncertainty regarding the final data type stored in the database (for the details of this coding feat please refer to <http://www.SQLite.org/datatype3.html>). When the Client Database Schema is created SyncStudio will make a valiant and spirited effort to automatically translate from the MS SQL Server data types to the corresponding equivalents in SQLite. So long as **you** choose to behave sensibly and observe the same data typing rules as MS SQL Server in your own client-side code the sync will work just fine. However, if your client-side code uses this feature of SQLite to store mixed data types in the same column you will **for sure** break the synchronization, and in rather interesting and hard to debug ways at that. Your choice.

General Design Considerations

SyncStudio acts as a bridge between your server database system and the database on the Mobile Clients. This means that we need to abide by all the constraints of every component in the sequence, and therefore that we can support only the set of features that will not “break” anything in this chain. When designing your server-side database you need to keep the following limitations in mind:

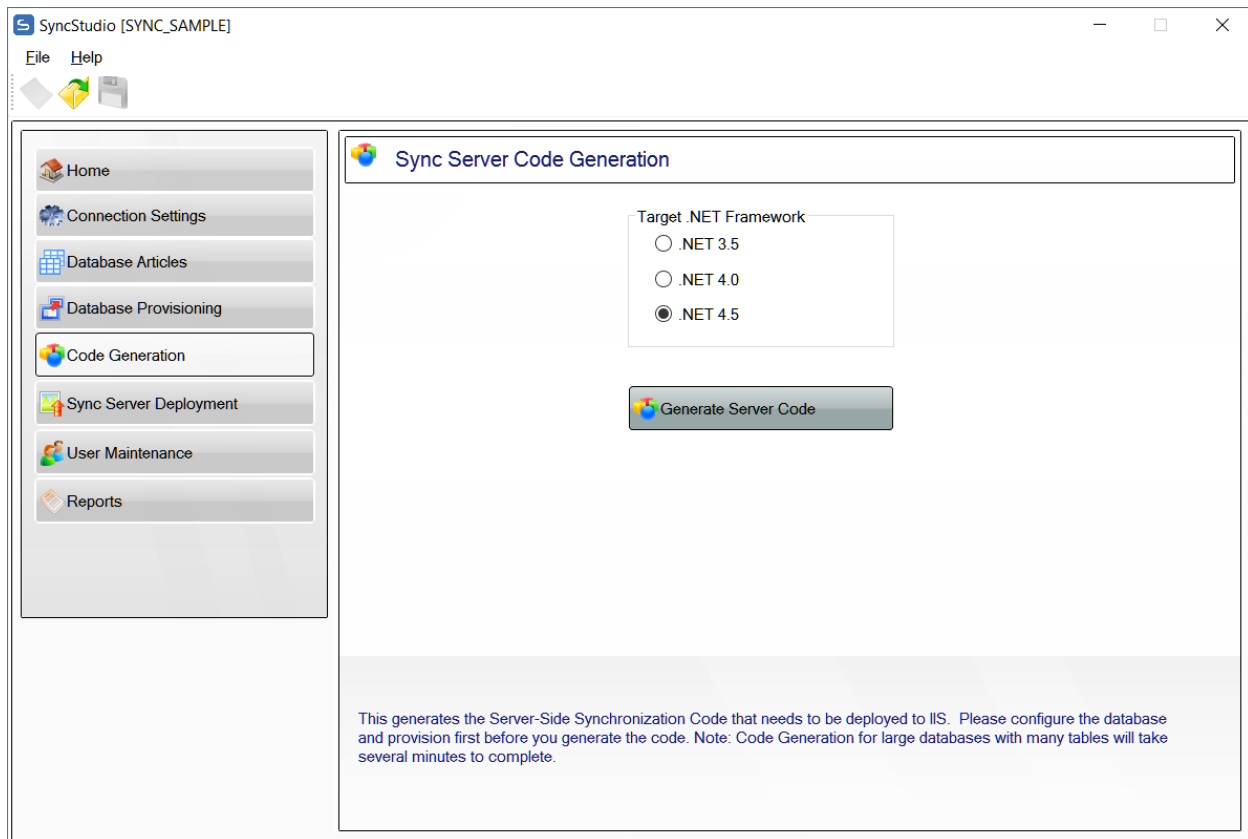
- 1) SyncStudio will create the client-side database schema for you, and will attempt to keep the client database schema aligned with your server. The good news here is that our Automatic Schema Synchronization feature should save you a very substantial amount of maintenance work, that you do not have to invest any time or coding effort in creating and updating the database schema on the clients and that most schema changes will be transparent to the user. The bad news is that any changes that you make to the client-side schema will be overridden whenever the server schema changes, and that the client-side synchronization code depends on a number of custom synchronization tables that are kept by the client—which you should never touch or change in any way.

Whenever we create or update the database schema on the client we will create all the corresponding table structures and indexes; triggers and stored procedures are **not** replicated, however. Additionally, due to the lack of support for the ALTER TABLE statement in SQLite whenever a table structure changes we are forced to drop the old table and re-create the new table structure from scratch. This means that any client-side triggers, constraints and/or indexes that you create manually will be **deleted** when the old table is deleted. **Bottom line:** do not make **any** custom changes to the client-side database schema; in SyncStudio the idea is that you control the structure of the client-side database by making changes to the server-side and setting them to synchronize.

- 2) There are substantial differences between the MS SQL Server data types and the SQLite data types. As a general rule, if you have control over the server-side database design it is always best to stick with a sub-set of data types that is common to both. Otherwise, your client-side code must be aware of the server-side data types on a field-by-field basis. **Bottom line:** if possible try to use only the data types that are defined in SQLite.
- 3) The Microsoft Sync Framework imposes a number of limitations on what characters can be used as part of a table name or a field name. Some table and field names that are perfectly valid in both MS SQL Server and SQLite are **not** valid for synchronization. This is a limitation imposed by the design of the MS Sync Framework and we do not have any way to override it or compensate for it. Your server-side database structure needs to comply with the MS Sync Framework field naming rules or SyncStudio will not be able to operate on your database. **Bottom line:** make sure that your field names are valid Sync Framework Identifiers.

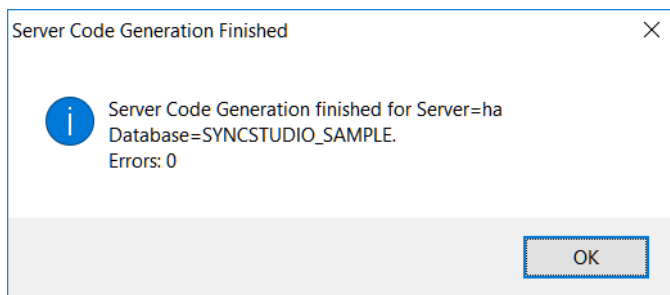
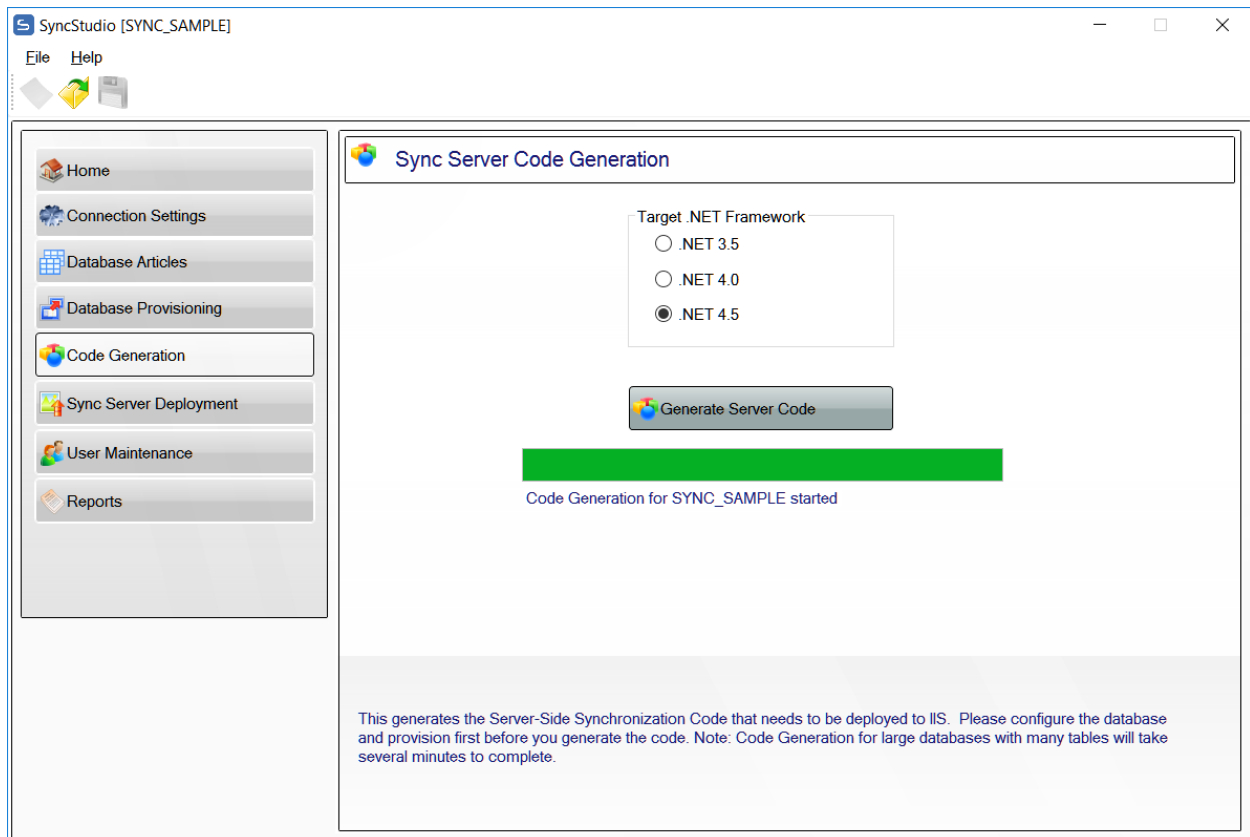
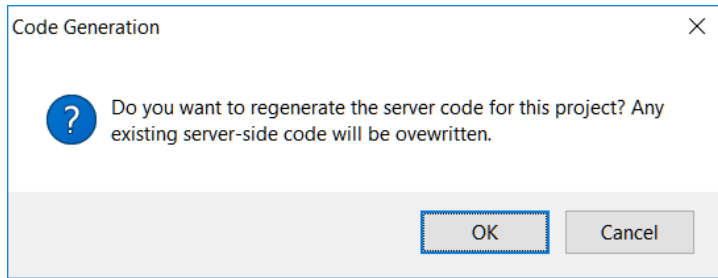
Code Generation

Once you have defined your project configuration and provisioned your database server for synchronization you are ready to have SyncStudio generate all the server-side code for you. Click on the Code Generation button on the left-hand menu to bring up the Sync Server Code Generation screen shown below, and then click on the button labeled “Generate Server Code”:



First select the version of the .NET Framework that it is to be targeted. We currently support 3.5, 4.0 and 4.5 and will add supported targets as new versions of the .NET Framework are released. Note: you need to ensure that the version of the .NET framework you select matches the one in the web server where the synchronization project will be deployed. Once you select the target framework, click on the button labeled Generate Server Code.

When you do this, you will receive a message that alerts you to the fact that the new server-side code will override—and replace—any existing code. If you want to save the previous version of the code, you should copy the contents of the project’s build directory somewhere else before creating the new code.



Note: SyncStudio produces *compiled* code, not source. After you create the server-side code the build directory in your project folder will contain the following directories and files:

```
\bin
\bin\SyncStudioService.dll
\bin\Microsoft.Synchronization.Services.dll
DataScopeSyncService.svc
DefaultScopeSyncService.svc
Web.config
```

All the files above are required for deployment. Please do not make manual changes to any of these files (except for the Web.config database connection, as described below) or your synchronization project will not work correctly.

The project creates a default Web.config file. The connection string to the database is inside this Web.config under the tag "SyncStudioCn".

```
<add name="SyncStudioCn" connectionString="Server=YOURSERVER\YOURDBNAME;
    Database=YOURDBNAME; Integrated Security=SSPI; Connection Timeout=30;"
    providerName="System.Data.SqlClient"/>
```

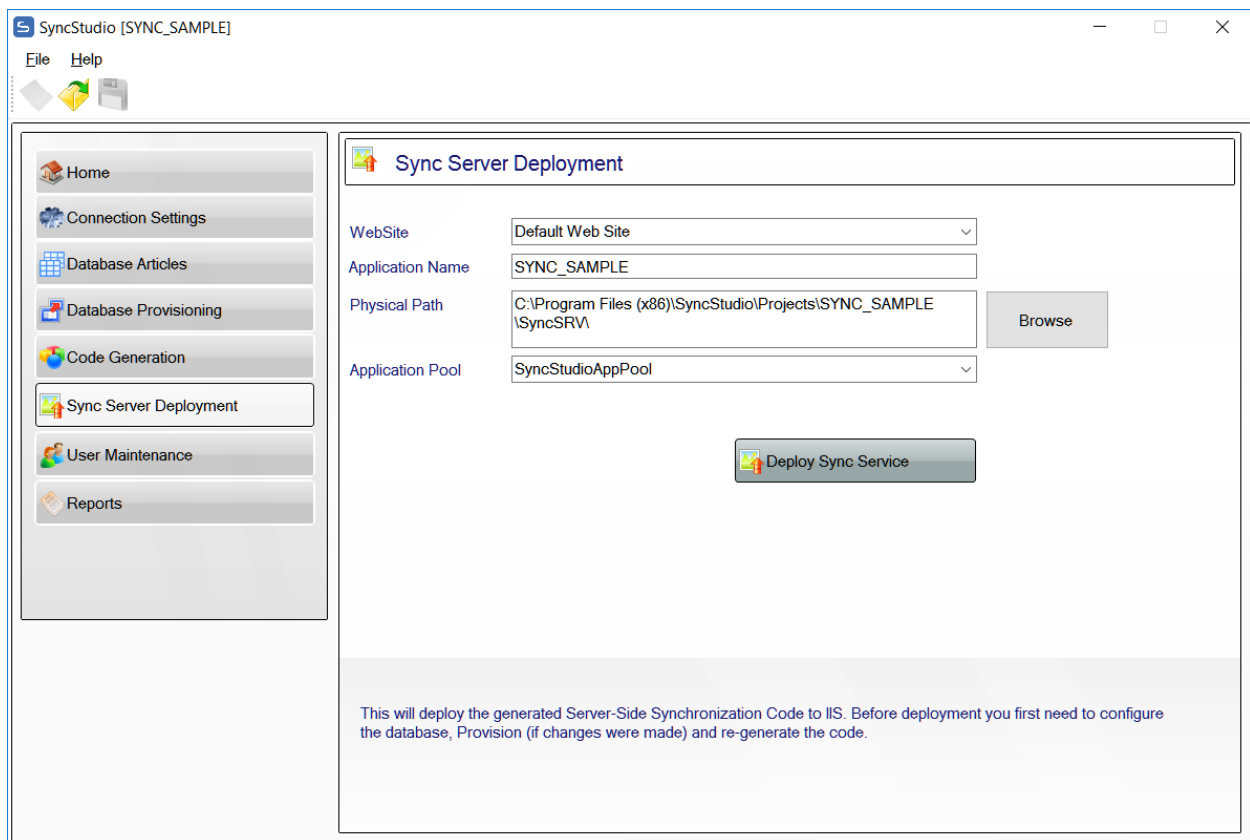
To deploy the new synchronization server code to IIS please click on the "Sync Server Deployment" tab on the left side of the SyncStudio.

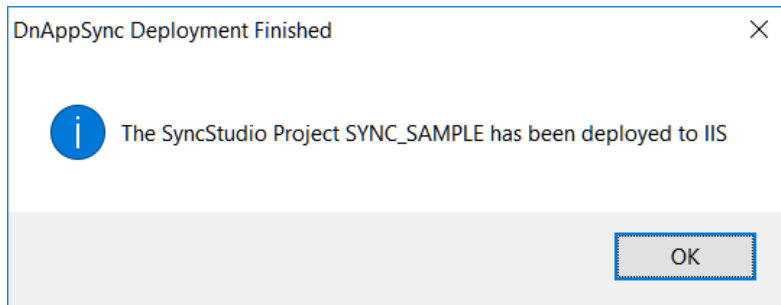
Sync Server Deployment

SyncStudio has an automated deployment feature to move the code and configure your Web Service code to run under IIS. This utility is there for your convenience—you could always copy the contents of the Build directory in your project to a virtual directory that you create in IIS yourself and manually configure IIS.

Notes:

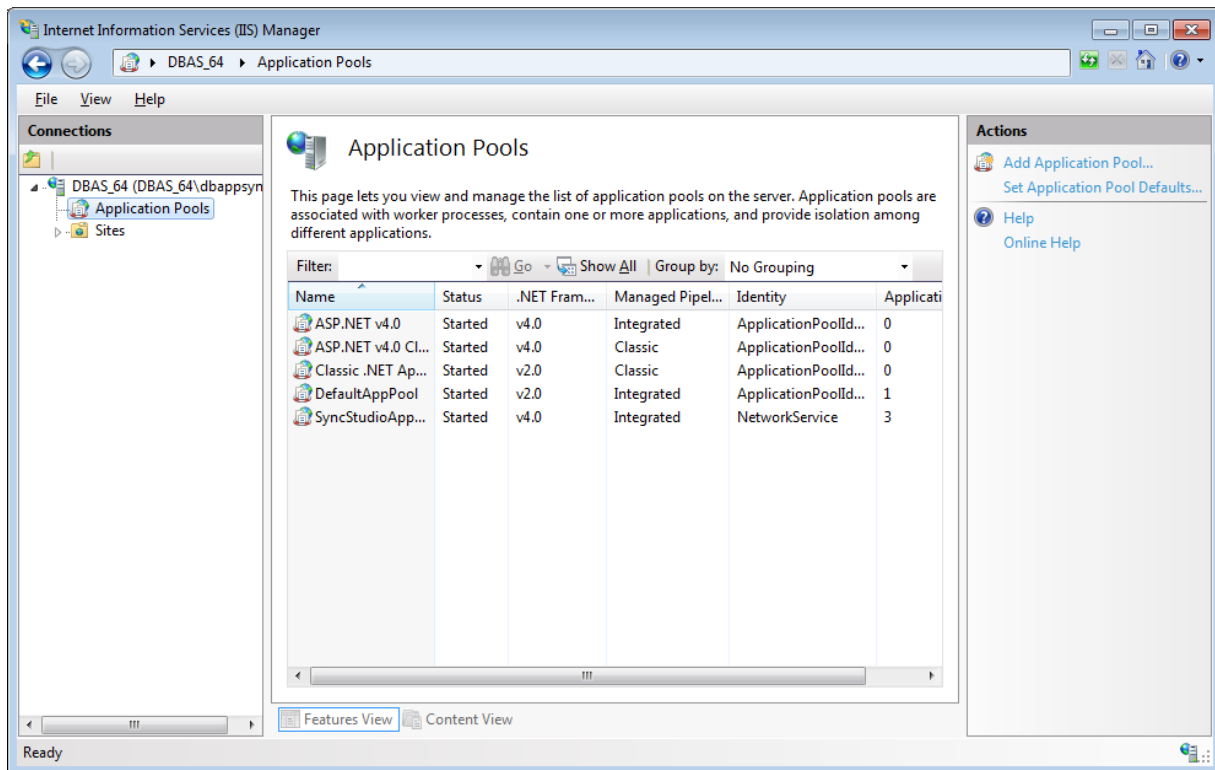
- 1) SyncStudio needs to run in an Application Pool that is configured to use the .NET Framework Version 4.x.
- 2) SyncStudio requires IIS 7 and up to run.
- 3) Deployment is the very last stage in the process. Before you deploy to IIS you must have created a project configuration, provisioned your server and generated the server-side code.





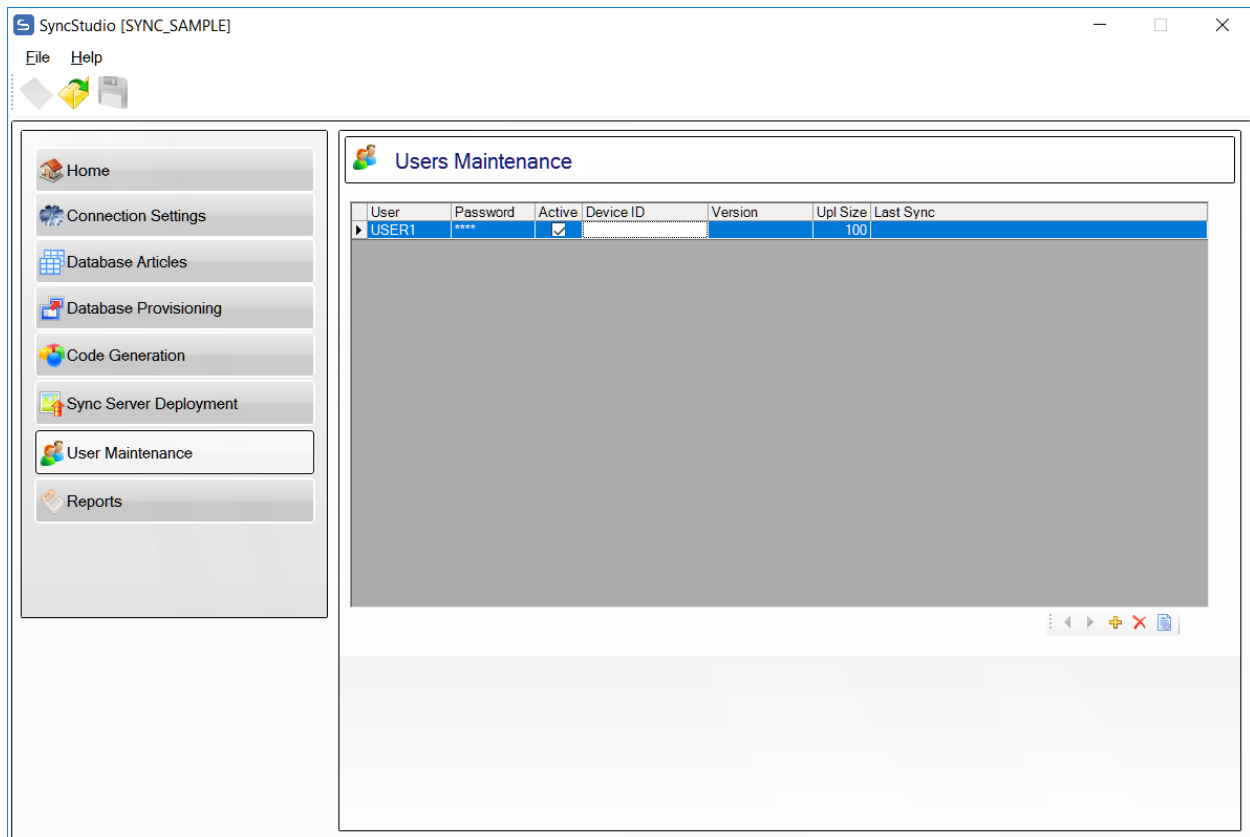
Notes:

- 1) SyncStudio needs to run in an Application Pool that is configured to use the .NET Framework Version 4.x. We create one called "SyncStudioAppPool" and configure as needed.
- 2) SyncStudio requires IIS 7 and up to run.
- 3) The project will be deployed to the Default Web Site (unless you change it).
- 4) The project will be deployed to a directory in wwwroot.




User Maintenance

SyncStudio use the SQL authentication mechanism. Users you setup via SyncStudio are also created as SQL Server users. Every user (i.e., client device) in your system **must** have a valid SQL user id and password with permissions for the target SQL database in order for it to be able to synchronize.



You can configure any number of users via the SMC user maintenance screen, but the system will not operate if there are more users than you are licensed for (**Important:** if your license allows you to have only 10 users and you configure 11 users the sync will stop working for **all** the users, not just the 11th one). Demo Licenses (what you get when you download the SyncStudio demo) allow only 3 users—please do not configure more than 3 users for a demo license or you will receive an error message during the synchronization test.

At a minimum, a user has to have a unique User ID and a non-empty password.

First, click on the tab called “User Maintenance” on the left then click on the  button and fill in the form.

The screenshot shows a dialog box titled "Add/Edit User". It has four input fields: "User Name" with the text "USER1", "Password" with "****", "Re-Type Password" with "****", and "Upload Batch Size" with "100". Below these fields is an "Active" checkbox which is checked. At the bottom right are "Save" and "Cancel" buttons.

The Upload Batch Size determines how many records the remote client will send (new, modified) in a single batch. 100 is the default but the value can be higher or lower depending on your application and what device you are using. 10 is the minimum.

Your users cannot share User Ids. Every user in SyncStudio must have a different User Id, otherwise they will interfere with each other and they will not be able to synchronize.

If two of your users accidentally use the same User Id (and Password) they will interfere with each other and will not be able to synchronize. If this happens the only recourse is to have both of them delete the local database (you will lose any pending transactions), enter the appropriate User Id and Password for each one in their respective devices and re-synchronize, which will require a full download.

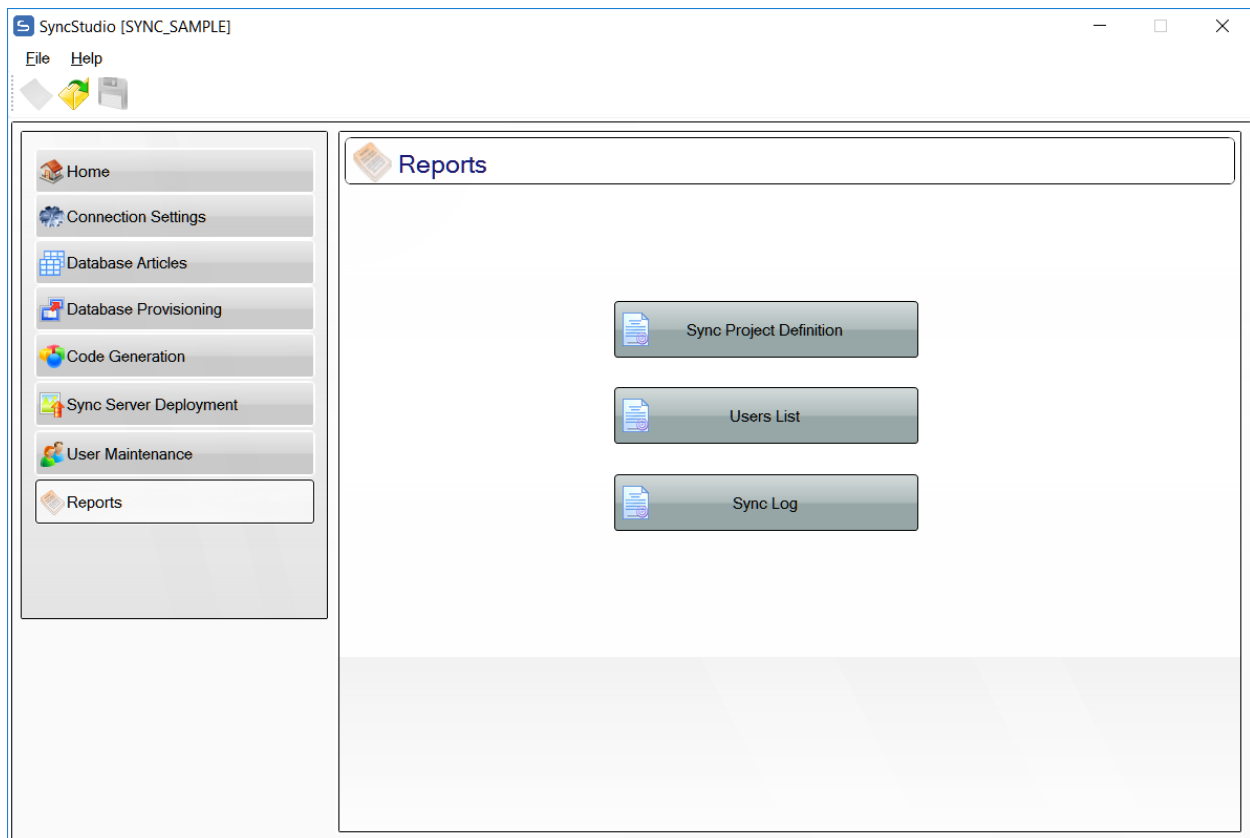
Please note that this should never happen during normal usage because every user should not only have a unique User Id, but also their secret password, which they should never give to anyone else.

Additionally, sharing User Ids is a violation of the SyncStudio licensing terms, since we license this product on a per-user basis. In other words, it is not allowed (or possible) to buy a 5 user license and then have 100 users by giving everyone the same User Id and password—it will fail, your users will lose any transactions that have been entered but not uploaded to the server and will be forced to re-synchronize with a full download.

Reports

SyncStudio has the following reports:

- 1) Sync Project Definition. This report prints all the tables, fields and indexes that are being synchronized.
- 2) User List. A list of all your users.
- 3) Sync Log. A Complete listing of all the synchronization sessions for all your users.



Sync Project Definition

SyncStudio Project Definition

A_TSTOP

Sync Direction: Bi-Directional **Conflict Resolution: Client Wins** **Filtered: No**

Column Name	Data Type	Primary Key
StopId	int	Yes
TS_GUID	uniqueidentifier	Yes
TypStreet	ntext (1073741823)	
HIN	ntext (1073741823)	
SuffixStreet	ntext (1073741823)	
CommitTime	ntext (1073741823)	
Pkgs	bigint	
MilesToStop	ntext (1073741823)	
StNumber	ntext (1073741823)	
ODO	bigint	
NameStreet	ntext (1073741823)	
PrefixStreet	ntext (1073741823)	
ETA	ntext (1073741823)	
StopCompleted	bit	

Current Page No.: 1 Total Page No.: 2 Zoom Factor: 100%

User List

SyncStudio User List

UserID	Device ID	API Version	Active	Last Sync
USER1	c1609990cad5c2e	1.30.0010	True	3/31/2014 3:27:00PM
USER2			True	
USER3			True	

Current Page No.: 1 Total Page No.: 1 Zoom Factor: 100%

Sync Log

SyncStudio Sync Log

Date: 03/31/2014
User: rjc

2:11:08PM Session: 194637e9396ef202fde264da6d2cbce537c9eaf

Table Name	Sync Direction	Inserts	Edits	Deletes
CUSTOMERS	DOWNLOAD	2,807	0	0
PRODUCTS	DOWNLOAD	2,275	0	0
SALES	DOWNLOAD	2,275	0	0

9:10:53AM Session: 25ac0fd9ecaf5a6a84e57263f979de4c5c456dc4

Table Name	Sync Direction	Inserts	Edits	Deletes
CUSTOMERS	DOWNLOAD	2,807	0	0
PRODUCTS	DOWNLOAD	2,275	0	0
SALES	DOWNLOAD	2,275	0	0

2:04:16PM Session: 28d15bebd625bc999e4fdf9dfb550b8b42fb0c06

Table Name	Sync Direction	Inserts	Edits	Deletes
CUSTOMERS	DOWNLOAD	2,807	0	0
PRODUCTS	DOWNLOAD	2,275	0	0
SALES	DOWNLOAD	2,275	0	0

9:29:53AM Session: 4086951d1a4e17f42f88896964a1086750e1baaf

Table Name	Sync Direction	Inserts	Edits	Deletes
CUSTOMERS	DOWNLOAD	2,807	0	0
PRODUCTS	DOWNLOAD	2,275	0	0
SALES	DOWNLOAD	2,275	0	0

Current Page No.: 1 Total Page No.: 3 Zoom Factor: 100%

Filtering Data

One of the most common requirements for database synchronization systems is to be able to filter the data rows that will be sent to the client device based on some type of criteria. For example, in a sales application a salesperson may only need to receive the customers located in some territory or area.

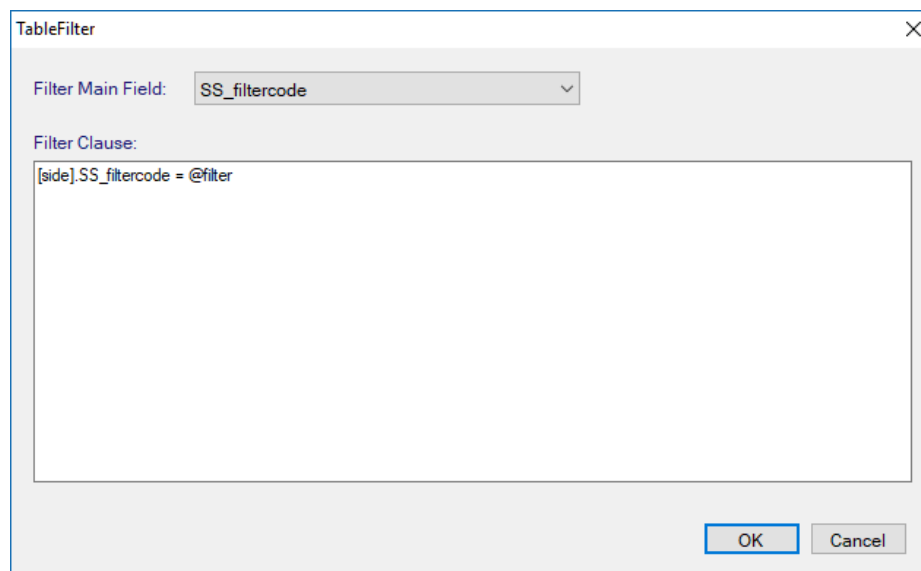
There are two ways to filter data in SyncStudio: **Simple Filtering** and **Advanced Filtering**.

Simple Filtering

Simple Filtering is useful when a row is intended to be given to one or more users, based on the user group. In this case, all you need to do is the following:

- 1) In the SyncStudio UI select the table, click the “Add/Edit Filter” button. A form will display with a pulldown control and an edit box. Open the pulldown and select any field from the table that you want to use to filter against.

Automatically upon selection a default WHERE clause will appear in the text box area. If you are ok with this standard filter condition just click “OK”.



The screenshot shows a dialog box titled "TableFilter". It has a "Filter Main Field:" label and a dropdown menu currently showing "SS_filtercode". Below that is a "Filter Clause:" label and a text area containing the clause "[side].SS_filtercode = @filter". At the bottom right of the dialog are "OK" and "Cancel" buttons.

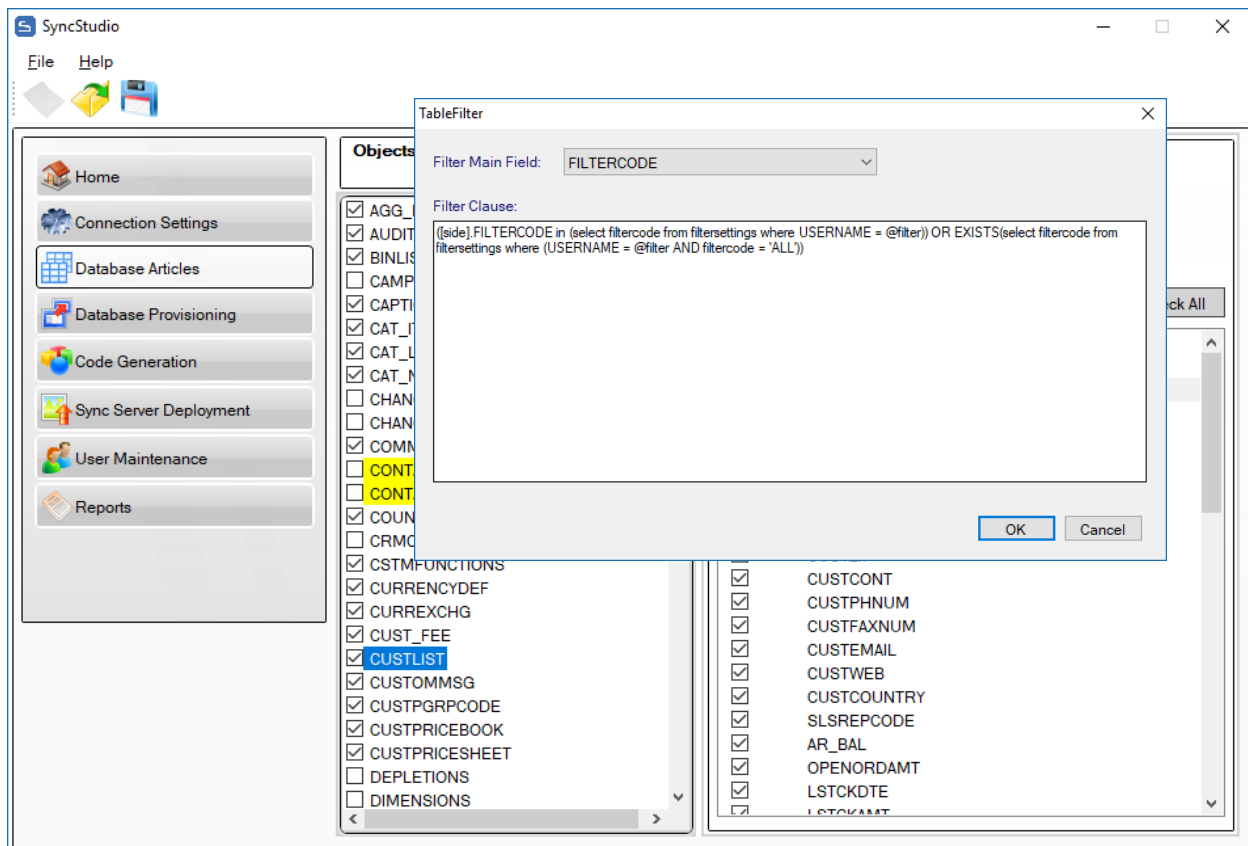
- 2) In order to put this new filter logic into effect during sync you will need to re-provision the database, re-generate the code and re-deploy the project to IIS.
- 3) Now when the device syncs it will pass a filter value to the server which is stored in the variable @Filter and passed used to filter against the selected field. Any rows that have a matching value in this field will be sent to the user.

Simple filtering can be very useful for things like subscription-based data synchronization, in which every group of user needs to get a completely different set of records based on a filter value (like group membership). It also can be used in scenarios where records can/should only be assigned to one user.

Advanced Filtering

However, if your requirement is for filtering to be done based on some more complicated set of criteria, such as a user being in some combination of region, territory, etc. then you should consider using Advanced Filtering instead, as described in the next section below.

An example is shown in the screenshot below. Here a table called CUSTLIST is being set-up for filtering.



Using Advanced Filtering means that you set up your own custom filtering criteria by editing in the text box the default WHERE clause.

`(([side].FILTERCODE in (select filtercode from filtersettings where USERNAME = @filter)) OR EXISTS(select filtercode from filtersettings where (USERNAME = @filter AND filtercode = 'ALL'))`

Where `[side].FILTERCODE` is selected field in your table in which you can store any arbitrary value, a territory or group, for example. Please note that fields in the table that you are synchronizing need to be prefixed with the `[side]` qualifier as shown above.

The sample filter WHERE clause above will filter based on the contents of the `FILTERCODE` field and the associations made in the `FILTERSETTINGS` table between the `USERID` and `FILTERCODE` fields.

For example, assume that the FILTERSETTINGS table has the following rows:

Row #1: USERGROUP=GROUP1, FILTERCODE=SALES
Row #2: USERGROUP=GROUP2, FILTERCODE=SALES
Row #3: USERGROUP=GROUP3, FILTERCODE=OPSUS
Row #4: USERGROUP=GROUP4, FILTERCODE=OPSEU
Row #5: USERGROUP=GROUP5, FILTERCODE=ALL

In this case the code snippet above will send any records with field FILTERCODE=SALES to USERGROUP1 and USERGROUP2, records with FILTERCODE=OPSUS will be sent to USERGROUP3, records with FILTERCODE=OPSEU will be sent to USERGROUP4 and finally USERGROUP5 is marked as "ALL" so it will get all the records.

The Standard SyncStudio Android Client

SyncStudio comes with two Standard/Sample Android Clients that can be used to synchronize the device with multiple SyncStudio Servers. One is created using a development tool called Basic4Android (B4A) and the other is created in straight Java via the Eclipse environment. Source code for both sample clients is included in your installation package.

Our sample clients provide a front end to the SyncStudio JAVA .JAR library that is the client side of our solution and the one that actually handles all interaction and synchronization with the server. You may use our sample client application as is, modify either to fit your needs or simply incorporate our .JAR into your Android applications.

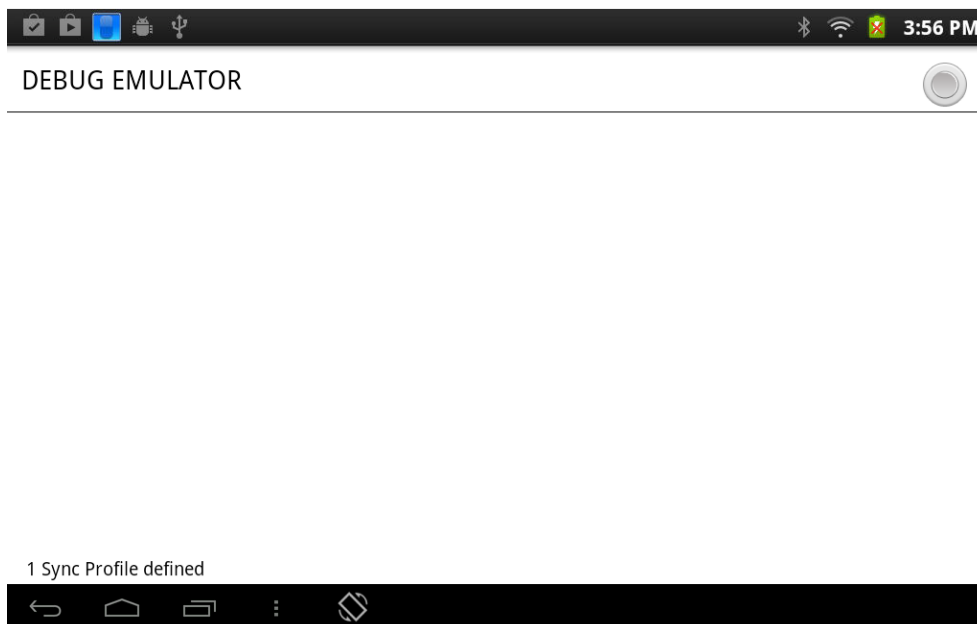
Please keep in mind when using our sample Clients that they cannot access private SQLite databases. In Android, a private database can only be accessed by the application that created it. In practical terms this means that if you decide to use our sample Android Client you will have to keep your SQLite database in a public folder (like on an SD card) where our client can access it.

If you would rather have a private database, then you must incorporate our .JAR into your application.

When you start the SyncStudio B4A sample Client you will see a screen like the following:



Click the Android Menu button and select the “Profiles” menu option. This will show a list of the available sync server profiles (which will be initially empty). The next figure shows a sample Profile List with a few profiles created:



If you click on any of the profiles you will see the details of that particular profile, as shown in the next figure:

Profile Name

SALES

Server Address (enter the IP address or the name)

192.168.1.115

Sync Project Name (no spaces allowed)

SYNCSTUDIO_SAMPLE

Server Port (leave blank for ports 80 or 443)

User ID

USER1

Save Profile	Delete Profile	Cancel Edit	Delete Local DB
--------------	----------------	-------------	-----------------

From the profile edit menu you can save any changes that you make to the profile, delete the profile and you also have the option of deleting the local copy of the server data.

To create a new profile, click on “Profiles” in the main menu, and then on “New Profile” in the profile list, fill-in the profile information and then click on the Android menu button and select “Save Profile”.

Profile Name

SALES

Server Address (enter the IP address or the name)

192.168.1.115

Sync Project Name (no spaces allowed)

SYNCSTUDIO_SAMPLE

Server Port (leave blank for ports 80 or 443)

User ID

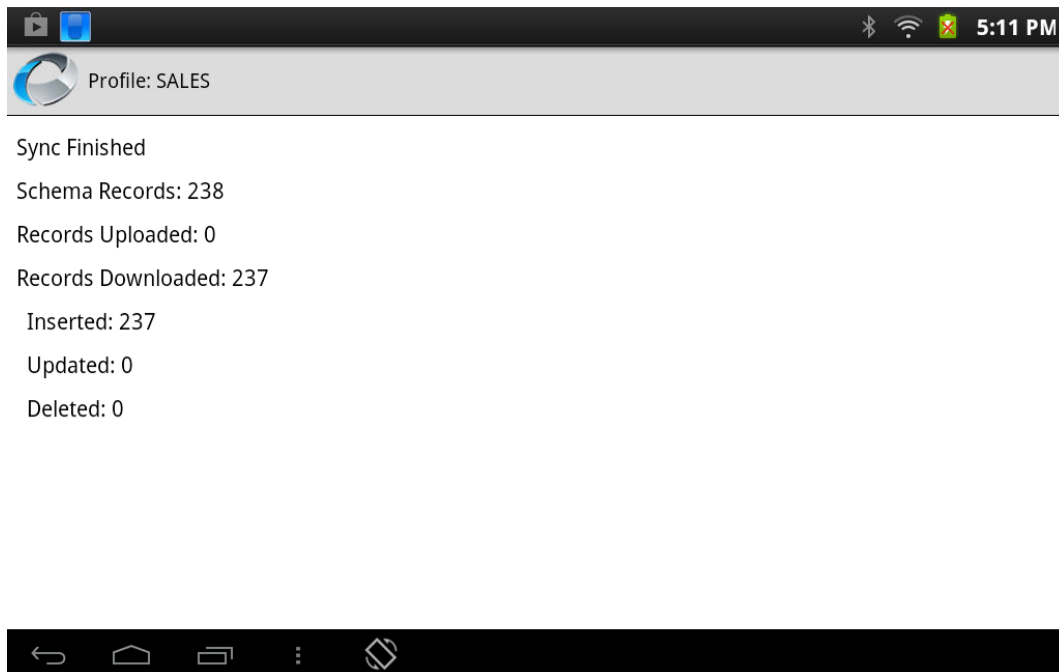
USER1

Password

....

Any time you make changes to the profile you need to click the Android Menu button to either save the changes (Save Profile) or discard them (Cancel Edit). From this menu, you can also delete the profile (Delete Profile) or delete the local copy of the data being synchronized.

Once you have at least one profile you can synchronize with the server. Please return to the main form and click the “Sync Now” button. When you do that, you will be asked to confirm the sync, and then you will see a screen like the following:



In the sample synchronization session above we can see that the synchronization app first detected that this was a new profile and performed a Schema Sync to download the database structures from the server, and then synchronized 237 records (that is all that was in the sample database).

Depending on the structure of your database (the number of tables and fields that you want to synchronize) it might take anywhere from a few seconds to several minutes to download the database structures from the server and create the corresponding SQLite data structures at the client. Please be patient!

For a new profile (and also whenever you delete the local database) the client will be forced to perform a complete download of all the records in the server (filtered if needed). For large databases, this might take some time. After the first sync, though, only new/changed/deleted records will be sent to the server, so a “normal” sync (which does not require a schema synchronization) should take just a few seconds.

The sync speed will depend on many factors, including the number of fields per table, the speed of the connection and the speed and load on your server, but it is usually in the thousands of records per minute.

Notes:

- 1) You need to have at least one profile to be able to synchronize. However, you can have as many profiles as you want. Please make sure that each profile targets a different database.
- 2) On the Profile screen please enter either the URL of your server or the IP address in the Server Address field provided. Then enter the name of the Synchronization project in the next field, labeled “Sync Project Name.” Do not use any spaces or special characters as

part of the project name, only a-z, A-Z, 0-9 and the Underscore (_) character are allowed.

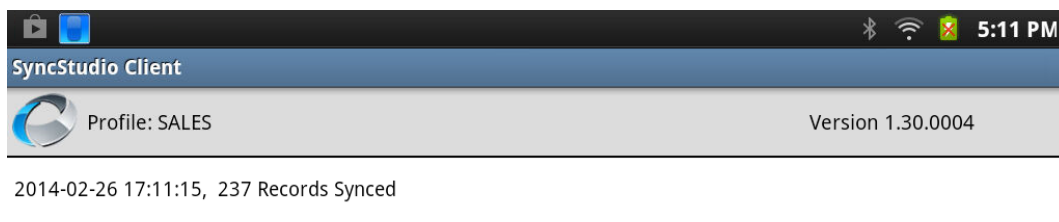
- 3) If you are using a port other than 80 or 443 (http/https) you can specify the Server Port in the field provided. If you are using http (Port 80) you should leave the port field blank, as the client will automatically default to Port 80. If you are using Port 443 (https) you can leave the port field blank also, and instead use the checkbox provided at the bottom of the profile screen. For all other ports, you should enter the custom port number in the space provided. Please remember to configure your server's firewall to let these ports through.
- 4) The Sync Server machine needs to be "visible" from the device. You can test easily this by simply entering the address of the server (followed by a forward slash and the name of your project) in a browser window; if the browser can "see" the server then the sync client should be able to access it as well. Depending on the details of your system you might have to either disable the Windows Firewall or configure it to let the device through.
- 5) The Delete Local database option applies to the database that contains a copy of the server data, not to the database that contains the synchronization profiles. When you delete the local database all the synchronization logs for that database are deleted as well (the reason is that the logs reside in the database that is being deleted). If you need to preserve the sync logs you should make a copy of the log table somewhere else in your device.
- 6) Please use some care with the delete option! If your user has created new entries that have not been sent to the server (i.e., are not synchronized) then a Delete Local DB will lose these entries permanently.
- 7) The user passwords for the Sync Server are stored in encrypted form inside the Profile database; the SyncStudio client does the encryption and decryption for you. If you need to manipulate these passwords outside of the SyncStudio Client you can "clone" the encryption code that comes with the Client source, or replace this with your own code.
- 8) If you run into synchronization trouble with a device, because of a corrupted database, for example, you can use the Delete Local DB option to force the SyncStudio client to re-create the database structures and download a complete copy of the server data. This should be your option of last resort, as you will lose any records that have not been synced back to the server, but sometimes it is the only way to clear a database corruption issue.
- 9) As explained elsewhere in this document, the USER GROUP field is used for filtering. The short version of filtering is that a user will get all the data records that match the contents of their USER GROUP field, plus all the records of tables that are not filtered. If you are using filtering, then your users will need to know their USER GROUP in order for them to get the correct records.

- 10) Do not use Auto-Increment Fields in your database! This might be the #1 issue that people have when they try to synchronize databases. An auto-Increment field is an Integer field that will basically add 1 to the field contents. When this is done at the server (under a lock) the database will take care of preventing two users from creating the same number. However, when it is done at the client (for a new record) the client-side database does not have any way of knowing what numbers have been used already. When two users try to create and then synchronize a new record with the same key you will have an error.

The Device Log

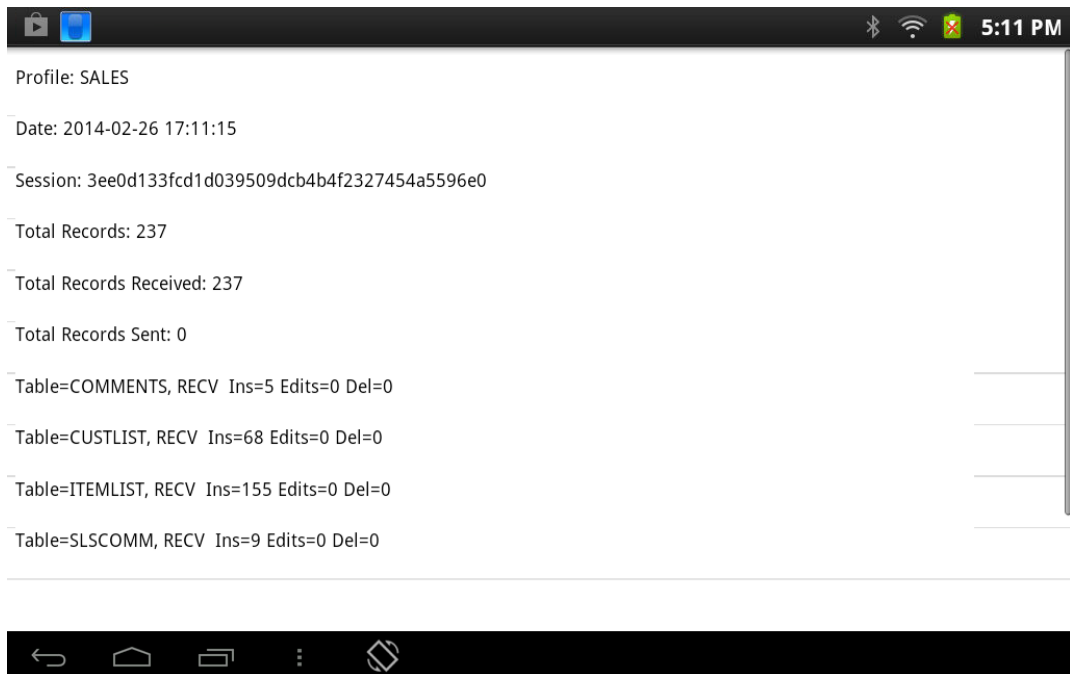
The SyncStudio Standard Android Client maintains a complete log of all the synchronization sessions. The synchronization log is kept as part of the database being synchronized (i.e., the log for a particular database is inside a table in the local database). Please note that this means that if you delete the local copy of the database you will also be deleting the synchronization log for that database.

If you click the Logs tab after selecting a profile you will see a list of all the synchronization logs collected by this device for that particular profile, as shown in the following figure:

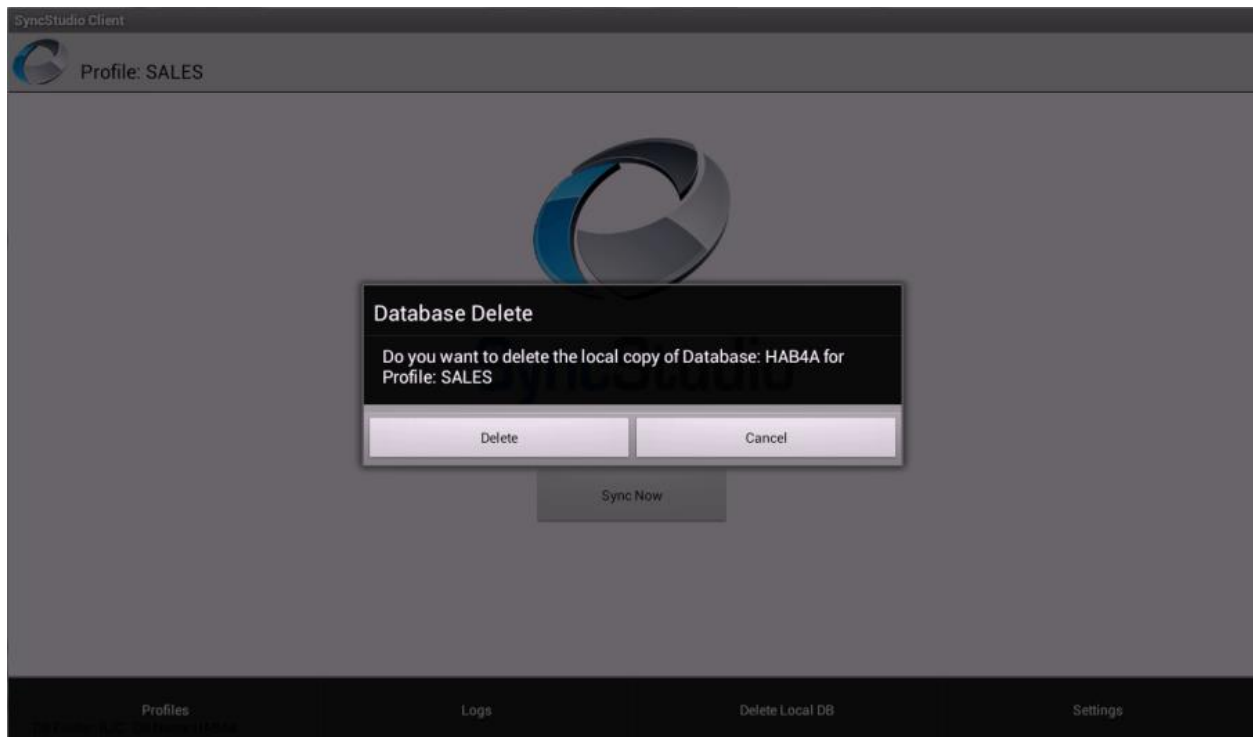


Clicking on any of the log entries will show the details for that synchronization session, as shown in the next figure.

The Session Id is a unique identifier and it corresponds to the Session Id that is kept at the server. If you have synchronization issues with some device, or if you want to know how many records were synchronized and in which tables you can compare this log against the one kept by the SyncStudio synchronization server to help diagnose issues.

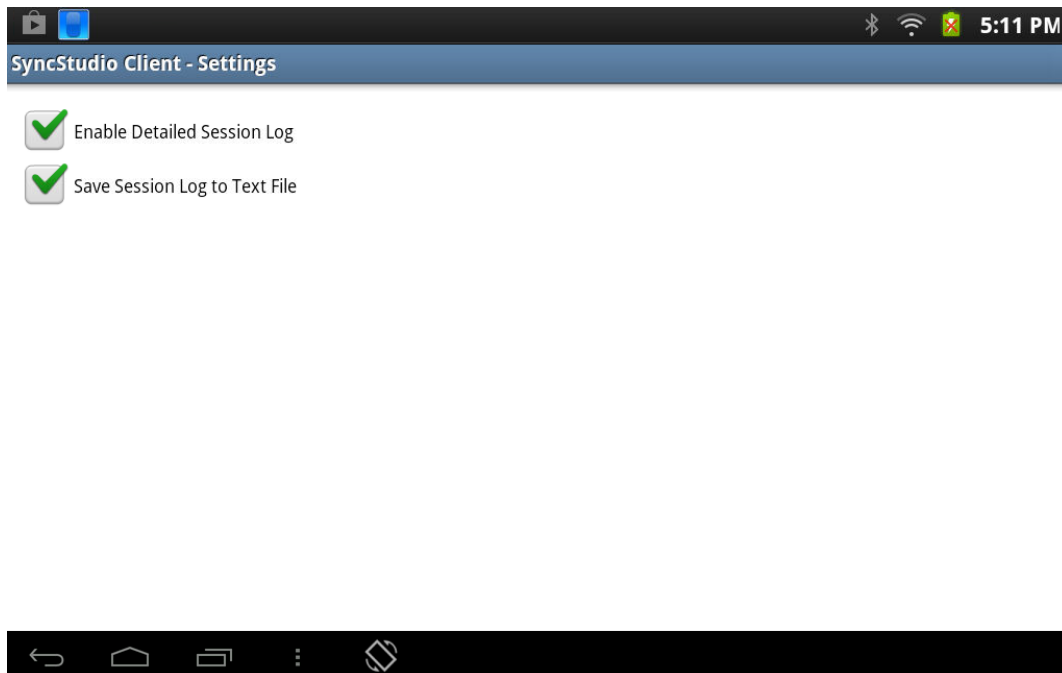


You can delete the local copy of the database by clicking on the “Delete Local DB” menu button. What this does is to erase the data that was downloaded from the server (not the profile itself).



The Settings option on the Main Menu allows you to enable or disable the detailed session log, and to save the detailed session log to a file. The detailed session log is meant to be used to assist a developer in diagnosing communication or synchronization issues; it is not useful for an end-use and it is not enabled by default.

The detailed session log is saved to a text file on the device in the same directory where the database being synchronized is located. If you are having difficulties with a particular device, you can ask your user to enable the detailed log and to check the “Save Session Log to Text File” options below. Then you can have them try a sync session and send/e-mail you the sync log text file, which will contain any errors that were found during synchronization.



Sample Code – SyncStudio Android Open Source synchronization apps

SyncStudio Sync Client (Basic4Android Project)

If you use the Basic4Android RAD Tool for your development you can open the source to our sample client application located in the following folder:

C:\Program Files (x86)\SyncStudio\DevSDK\Android\Basic4Android

This is the actually published version of our stand-alone sync client. Reviewing it should give you a good understanding of how to use the B4A version of our synchronization class library.

SyncStudio Sync Client (JAVA/Eclipse Project)

If you use Eclipse or other JAVA development environment for Android, you can open a sample client application located in the following folder:

C:\Program Files (x86)\SyncStudio\DevSDK\Android\Java

This is a simple straight forward example of a stand-alone sync application. This project has a very basic interface and is not intended to be a finished app you can give to a user. However, reviewing it should give you a good understanding of how to use the JAVA version of our synchronization class library.

Class Library API Reference – Basic4Android and Java

SyncStudio has an API in the form of two class libraries (.JAR). One .JAR works with the Basic4Android (B4A - <http://www.basic4ppc.com/>) RAD development environment and another .JAR is for standard Java (i.e., a native Java app created using Eclipse or similar development environment and running on an Android device). These Class Libraries are intended for developers that want to have complete control over the synchronization process, including the ability to provide their own user interface.

If you do not require a specific user interface, and your application database can be kept in a public directory (SD card for example) then you might consider using our stand-alone SyncStudio Sync Client to synchronize your data. This will free you from having to write code to interface to our class libraries.

If, however your app needs to have a private database then you need to use one of our class libraries to synchronize—the reason is that in Android private databases are not visible to other applications. This means that the standard SyncStudio Android client would not be able to “see” your private database or your app would not be able to see the public database created by our standard sync app.

We provide sample clients written in B4A and Java that you can use as a start to develop your own synchronization user interface (See above). The sample B4A application provided is actually a complete, generic synchronization client that can be used to maintain multiple synchronization profiles, synchronize with multiple servers, has full logging capabilities and maintains the profile information for multiple SyncStudio servers.

The sample JAVE client is much more rustic and simple and is intended only as an example.

The Basic4Android .JAR API

The following pages contain information and sample code for using the SyncStudio class library for Basic4Android. If you are using our class library for JAVA, please skip this section.

To use SyncStudio with your Basic4Android app you need to do the following:

- 1) First, copy the dbSyncStudioB4A.jar and dbSyncStudioB4A.xml files (located in the C:\Program Files (x86)\SyncStudio\DevSDK\Android\Basic4Android folder) to your additional libraries folder in B4A.
- 2) Add a reference to the SyncStudio Synchronization API Jar. In your project select the “Libs” tab; if you have copied the .jar and .xml files to the additional libraries directory you should see **dbSyncStudioB4A** as one of the additional libraries (note: you might need to refresh the list of additional libraries by right-clicking the libraries area and selecting “Refresh”, or by exiting the B4A development environment and re-starting it). Once you see the SyncStudio library in the list, check it so that it will be included in your B4A project.
- 3) Create a Synchronization Object in the Process Globals section of your Main activity (or any other activity of your choice). The Synchronization Object needs to be a **Process Global** object. For example:

```
Sub Process_Globals
    ... (other statements)
    'Declare the SyncStudio Synchronization Object:
    Dim SyncObj As dbSyncStudioClient
    ... (other statements)
End Sub
```

- 4) In the section of your code where you want to call the synchronization add a call like following example to initialize the Synchronization Object. Please note that you cannot use the synchronization object until it has been initialized:

```
Main.SyncObj.Initialize _  
    (PROFILE_NAME, _  
     SERVER_URL, _  
     USER_ID, _  
     PASSWORD, _  
     USER_GROUP, _  
     USE_SSL, _  
     DB_FOLDER, _  
     DB_NAME)
```

Where:

PROFILE_NAME	String that contains the name of the synchronization profile being used. This field is for your reference only and can be left blank.
SERVER_URL	This is the URL of the Synchronization server where you deployed your project
USER_ID	This is the ID of the user that is being Synchronized. Needs to be one of the User Id's that you have configured in your database.
PASSWORD	This is the password of the user that is being synchronized. Needs to be the same as the password in your database.
USER_GROUP	The group of the user being synchronized. This field is only needed if you are doing Filtering. Otherwise leave blank.
USE_SSL	Send "Y" to force the use of https or "N" if your server is not configured for SSL.
DB_FOLDER	Path (folder only) where the database resides Note: The folder name MUST end with "/"
DB_NAME	Name of the Database file (without the folder) including the extension (i.e, testdata.db).

- 5) To start the synchronization call:

```
SyncObj.startSync
```

Or if your object is declared in the Main Activity and you are calling it from some other activity:

```
Main.SyncObj.startSync
```

- 6) The SyncStudio Synchronization Object will raise events as it performs the synchronization. All the events have the same format, so you need only one event handler, which must have the signature in the example below:

```
Sub SyncStudio(eventName As String, param1 As String, _  
    param2 As String, param3 As String, param4 As String, _ param5 As  
    String, param6 As String, param7 As String)
```

Where:

param1	Number of Schema Records
param2	Number of Records Uploaded
param3	Number of Records Downloaded
param4	Downloaded Records Inserted
param5	Downloaded Records Updated
param6	Downloaded Records Deleted
param7	Blank or Error Code

Synchronization Example

The following code snippet shows how to call the synchronization object from a menu handler.

Please note that this code is assuming that somewhere in your app you have form controls for each of the parameters and that they contain data. Please refer to our sample B4A project for a more complete code example.

The first section of the code makes sure that the folder path is formatted correctly:

```
Sub mnuSync_Click
    'Makes Sure that we have the right format for the path (folder) and the db name:
    Dim Suffix As String
    Suffix = "/"
    Dim TMP_DB_FOLDER As String
    TMP_DB_FOLDER = Main.EditProfile_DB_FOLDER
    If TMP_DB_FOLDER.StartsWith (Suffix) = False Then
        TMP_DB_FOLDER = Suffix & TMP_DB_FOLDER
    End If
    If TMP_DB_FOLDER.SubString2(TMP_DB_FOLDER.Length-1,TMP_DB_FOLDER.Length) <> Suffix
Then
        TMP_DB_FOLDER = TMP_DB_FOLDER & Suffix
    End If
    Dim TMP_DB_NAME As String
    TMP_DB_NAME = Main.EditProfile_DB_NAME
    TMP_DB_NAME = TMP_DB_NAME.Replace(Suffix,"")
    Main.SyncObj.Initialize _
        (Main.EditProfile_PROFILE_NAME, _
        Main.EditProfile_SERVER_URL, _
        Main.EditProfile_USER_ID, _
        Main.EditProfile_PASSWORD.Trim, _
        Main.EditProfile_USER_GROUP, _
        Main.EditProfile_USE_SSL, _
        "N", _
        TMP_DB_FOLDER, _
        TMP_DB_NAME)
    SyncInProgress = True
    Main.SyncObj.startSync
End Sub
```

Handling Synchronization Events

To handle the events properly you need to look first at param7, which will contain either a blank or an error code. If param7 is blank then we simply have a regular synchronization status update telling you how many records have been synchronized so far. If param7 is not blank, then there is a synchronization error.

'Sync Event Handler

```
Sub dbsyncstudio(eventName As String, param1 As String, param2 As String, param3 As String,
param4 As String, param5 As String, param6 As String, param7 As String)
    If eventName.ToUpperCase = "SYNC FINISHED" Then
        SyncInProgress = False
    End If
    Label_SYNC_ACTIVITY.Text = eventName
    If param1 <> "" Then
        Label_SYNC_SCHEMA_RECS.Text = "Schema Records: " & param1
    End If
    If param2 <> "" Then
        Label_SYNC_UPLOAD_RECS.Text = "Records Uploaded: " & param2
    End If
    If param3 <> "" Then
        Label_SYNC_DOWNLOAD_RECS.Text = "Records Downloaded: " & param3
    End If
    If param4 <> "" Then
        Label_SYNC_DOWNLOAD_RECS_INSERTED.Text = " Inserted: " & param4
    End If
    If param5 <> "" Then
        Label_SYNC_DOWNLOAD_RECS_UPDATED.Text = " Updated: " & param5
    End If
    If param6 <> "" Then
        Label_SYNC_DOWNLOAD_RECS_DELETED.Text = " Deleted: " & param6
    End If
    If param7 <> "" Then
        MsgBox(param7, "Synchronization Failed")
        Log("Sync Error: " & param7)
        SyncInProgress = False
        Activity.Finish
    End If
End Sub
```

The Profile Database

The SyncStudio Sample Android Client keeps a separate database with the server profiles. A Server Profile includes all the information that is needed to contact a synchronization server, including the profile name, the URL of the server, the User Id and Password for that server, the User Group (for filtering), Y/N flag that indicates the use of SSL, plus the folder where the database resides and the name (including extension but no folder) of the database file. The following code is used to create the Profile Database:

'Create a new SyncStudio Profile Database

Sub CreateDb

Try

 SQLObj.Initialize(DbFolder, DbName, True)

 Dim fldMap As Map

 fldMap.Initialize

 fldMap.Put("PROFILE_ID", DBUtils.DB_INTEGER)

 fldMap.Put("PROFILE_NAME", DBUtils.DB_TEXT)

 fldMap.Put("SERVER_URL", DBUtils.DB_TEXT)

 fldMap.Put("USER_ID", DBUtils.DB_TEXT)

 fldMap.Put("PASSWORD", DBUtils.DB_TEXT)

 fldMap.Put("USER_GROUP", DBUtils.DB_TEXT)

 fldMap.Put("USE_SSL", DBUtils.DB_TEXT)

 fldMap.Put("DB_FOLDER", DBUtils.DB_TEXT)

 fldMap.Put("DB_NAME", DBUtils.DB_TEXT)

 DBUtils.CreateTable(SQLObj, "PROFILES", fldMap, "PROFILE_ID")

Return True

Catch

Return False

End Try

End Sub

Getting at the Database Location

In Android, we need to know where the database is located. This function checks the Internal Storage first. If the database is not located there it then checks for a writable SD card and if one is present, then searches the SD card. This function returns either the directory where the database is located or a blank string if no database is found.

```
'Returns the location (directory) of the database
'(SD Card or Internal Storage)
'Returns a blank string if the DB was not found.
Sub GetDBLocation(FileName As String) As String
    Dim TargetDir As String
    'Check to see if we have the file in the internal storage first:
    If File.Exists(File.DirInternal , FileName) = True Then
        'Yes, the DB is located in the internal storage
        Return File.DirInternal
    Else
        'No, see if we have a writable SD Card
        If File.ExternalWritable = True Then
            'Yes. See if the DB file is there:
            If File.Exists(File.DirDefaultExternal , FileName) = _
                True Then
                'Yes, the DB is in the SD Card
                'in the default directory
                'for the app
                ' <storage card>/Android/data/<package>/files/
                Return File.DirDefaultExternal
            Else
                'The DB is not there at all (or it has been moved)
                Return ""
            End If
        Else
            'No. This means we either do not
            'have a database (1st time app is loaded)
            'or that the DB is in the SD Card but
            'the SD Card is not accessible.
            Return ""
        End If
    End If
End Sub
```

The JAVA .JAR API

The following pages contain information and sample code for using the SyncStudio class library for JAVA. If you are using our class library for B4A please skip this section.

To use SyncStudio with your JAVA app you need to do the following:

- 1) First, if you want, copy the DbSyncStudioJavaLib.jar file (located in the C:\Program Files (x86)\SyncStudio\Android\Java\Library\) to your preferred location for third party .JAR files.

- 2) Add our .JAR to your project...

You can add our .JAR in eclipse by right clicking on the Project --> Build Path --> Configure Build Path. Under Libraries tab, click Add External JARs and go find our Jar in whatever path you stored it.

- 3) Add an import

```
import com.dbsyncstudio.client.SyncClient
```

- 4) Declare object variable inside the java client class

```
private SyncClient syncClient;
```

Please note that you can open our sample sync client project in Eclipse and study how we use the .JAR. When you do you will likely have to update the build paths for the various JARs so that they will match your system.

The important thing to keep in mind when using our .JAR is that when called it must be passed several parameters. Where the values for these come from are up to you but we recommend they not be hard coded in a production app. You can hard code for testing purposes but in a live app consider using the concept of a PROFILE. A PROFILE would be created in the app via a configuration screen and thereby you could enter values for these params and store them in a local database. We don't recommend storing the PROFILE data in the same DB that the app will create and sync via SyncStudio as if the DB is deleted then you also lose the profile settings. Later in this section is sample code for a PROFILE database.

ProfileName	String that contains the name of the synchronization profile being used. This field is for your reference only and can be left blank.
Server_URL	This is the URL of the Synchronization server where you deployed your project
User_Id	This is the ID of the user that is being Synchronized. Needs to be one of the User Id's that you have configured in your database.
Password	This is the password of the user that is being synchronized. Needs to be the same as the password in your database.
User_Group	The group of the user being synchronized. This field is only needed if you are doing Filtering. Otherwise leave blank.
Use_SSL	Send "Y" to force the use of https or "N" if your server is not configured for SSL.
"N"	This is default param that must always be sent.
Db_Folder	Path (folder only) where the database resides Note: The folder name MUST end with "/"
Db_Name	Name of the Database file (without the folder) including the extension (i.e, testdata.db).

Using the Sync Object

```
syncClient = new SyncClient();
syncClient.Initialize(ProfileName, Server_URL, User_Id, Password, User_Group, Use_SSL, "N",
Db_Folder, Db_Name);
syncClient.startSync();
```

Start Sync - Detailed Code Section

```
public void startProgress(View view) {
    // Disable the SYnc button
    if (haveProfileSelected == false) {
        Toast.makeText(DbSyncStudioJavaActivity.ctx, "No Profile Selected!",
Toast.LENGTH_LONG).show();
        return;
    }

    buttonStartSync.setEnabled(false);

    try {
        syncClient = new SyncClient();
        Log.d("", "Sync Client Started");
        syncTick = 0;

        syncStatusText.setText("Sync Started");
        syncSchemaEntries.setText("");
        syncUploadEntries.setText("");
        syncDownloadEntries.setText("");
        syncDownloadInserts.setText("");
        syncDownloadUpdates.setText("");
        syncDownloadDeletes.setText("");
        syncErrorFlag.setText("");
        syncCounter = "";

        String suffix = "/";
        // If the folder does not begin with / add the forward slash
        if (Db_Folder.startsWith(suffix, 0) == false) {
            Db_Folder = suffix + Db_Folder;
        }
        // If the folder does not end with / add the forward slash
        if (Db_Folder.endsWith(suffix) == false) {
            Db_Folder = Db_Folder + suffix;
        }

        String Server_URL = MakeURL(Server_Address, Server_Project, Server_Port,
Use_SSL);

        syncClient.Initialize(ProfileName, Server_URL, User_Id, Password, User_Group,
Use_SSL, "N", Db_Folder, Db_Name);
        syncClient.startSync();

    } catch (Exception e1) {
```

```

        buttonStartSync.setEnabled(true);
        syncStatusText.setText("Sync Failed - Cannot Initialize Sync");
        return;
    }

    // synchronization status monitor thread
    Runnable runnable = new Runnable() {
        @Override
        public void run() {
            try {
                exitSyncMonitor = false;
                syncTick = 0;
                while (exitSyncMonitor == false) {
                    try {
                        Thread.sleep(1000);
                    } catch (InterruptedException e) {
                    }
                    syncTick = syncTick + 1;
                    if (syncClient.syncCounter.contentEquals("") == false) {
                        if (syncClient.syncCounter.contentEquals(syncCounter) == false) {
                            syncTick = 0;
                        }
                    }
                    if (syncTick > maxSyncTicks) {
                        // Timeout
                        syncStatusText.setText("Sync Failed - Timeout");
                        buttonStartSync.setEnabled(true);
                        exitSyncMonitor = true;
                    } else {
                        // Get the stats
                        handler.post(new Runnable() {
                            @Override
                            public void run() {
                                syncStatusText.setText(syncClient.syncStatusMsg);

                                if (!syncClient.syncSchemaEntries.contentEquals("")) {
                                    syncSchemaEntries.setText("Schema Records: " +
syncClient.syncSchemaEntries);
                                }
                                if (!syncClient.syncUploadEntries.contentEquals("")) {
                                    syncUploadEntries.setText("Records Uploaded: " +
syncClient.syncUploadEntries);
                                }
                                if (!syncClient.syncDownloadEntries.contentEquals(""))
{
                                    syncDownloadEntries.setText("Records
Downloaded: " + syncClient.syncDownloadEntries);
                                }
                                if (!syncClient.syncDownloadInserts.contentEquals(""))
{
                                    syncDownloadInserts.setText("Records Inserted: "
+ syncClient.syncDownloadInserts);
                                }
                            }
                        });
                    }
                }
            }
        }
    };

```



```

        if
(!syncClient.syncDownloadUpdates.contentEquals("")) {
            syncDownloadUpdates.setText("Records Updated: "
+ syncClient.syncDownloadUpdates);
        }
        if (!syncClient.syncDownloadDeletes.contentEquals(""))
{
            syncDownloadDeletes.setText("Records Deleted: "
+ syncClient.syncDownloadDeletes);
        }

        syncErrorFlag.setText(syncClient.syncErrorFlag);

        if ((!syncClient.syncErrorFlag.contentEquals("")) ||
(syncClient.syncStatusMsg.contentEquals("Sync Finished")) )
        {
            exitSyncMonitor = true;
            buttonStartSync.setEnabled(true);
        }
    }
    });
}
}
buttonStartSync.setEnabled(true);
} catch (Exception e) {
    syncStatusText.setText("Sync Failed");
    exitSyncMonitor = true;
    buttonStartSync.setEnabled(true);
}
}
};
new Thread(runnable).start();
}

```

Creating Profile Database

```
public class DbSyncStudioOpenHelper extends SQLiteOpenHelper {
    private static final String DATABASE_NAME = "syncstudio.db";
    private static final int DATABASE_VERSION = 1;

    // Database creation sql statements
    protected static final String DATABASE_CREATE_PROFILES =
        "create table profiles " +
        "(_id integer primary key, " +
        "profile_name text not null, " +
        "server_address text not null, " +
        "server_project text not null, " +
        "server_port text not null, " +
        "user_id text not null, " +
        "password text not null, " +
        "user_group text not null, " +
        "use_ssl text not null, " +
        "is_selected_profile text not null, " +
        "db_folder text not null, " +
        "db_name text not null);";

    public DbSyncStudioOpenHelper(Context context) {
        super(context, DATABASE_NAME, null, DATABASE_VERSION);
    }

    // Method is called during creation of the database
    @Override
    public void onCreate(SQLiteDatabase database) {
        database.execSQL(DATABASE_CREATE_PROFILES);
        Toast.makeText(DbSyncStudioJavaActivity.ctx, "Profile Database Created",
            Toast.LENGTH_LONG).show();
    }

    // Method is called during an update of the database, e.g. if you increase
    // the database version
    @Override
    public void onUpgrade(SQLiteDatabase database, int oldVersion,
        int newVersion) {
        database.execSQL("DROP TABLE IF EXISTS profiles");
        onCreate(database);
    }
}
```